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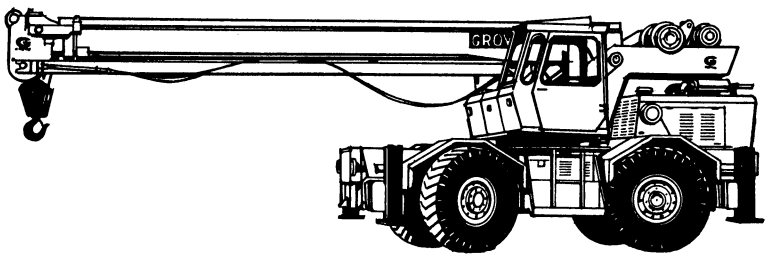
SERVICE MANUAL



MODELS RT59-59S & RT60-60S ROUGH TERRAIN CRANES

GROVE MANUFACTURING COMPANY
SHADY GROVE, PENNSYLVANIA 17256
A DIVISION OF WALTER KIDDE & COMPANY, INC.

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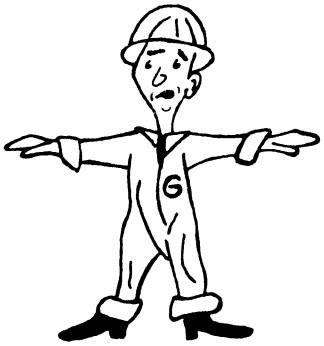

STOP !
READ THIS . . .

FOREWORD

The information contained in this manual provides service and maintenance guidance for the Grove RT59, 59S and RT60, 60S series hydraulic cranes. By following the recommended procedures as outlined, the machine will provide safe and trouble-free service.

Carefully read all sections of this manual. Keep in mind that safe and proper operation of your crane depends upon your knowledge of standard heavy equipment safety rules and good maintenance practices.

For detailed information on crane and carrier operation, refer to the applicable Operator's Handbook. Overhaul and repair of engines and major system components are to be accomplished by trained personnel operating in properly equipped shops; consequently such applicable information may be found in the appropriate manufacturer's manuals.

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SAFETY PRECAUTIONS

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GENERAL.

There are a number of basic safety rules that should be followed by the operator when handling heavy crane equipment. Safety is the prime responsibility of the operator. Any piece of heavy equipment is only as safe as the man operating the controls.

With this thought in mind, the following list of safety rules has been compiled to help the operator use his equipment in a safe and efficient manner – AT ALL TIMES – to promote the safety of himself and others.

REMEMBER, failure to follow just one safety rule can cause an accident, to men or machine.

With safety of the operator and proper use of the equipment being key points of interest, **WARNINGS, CAUTIONS,** and **NOTES** are strategically inserted throughout this manual, as necessary. They may be defined as follows:

WARNING

AN OPERATING PROCEDURE, PRACTICE, ETC., WHICH, IF NOT CORRECTLY FOLLOWED, COULD RESULT IN PERSONAL INJURY.

CAUTION

AN OPERATING PROCEDURE, PRACTICE, ETC., WHICH, IF NOT STRICTLY OBSERVED, COULD RESULT IN DAMAGE TO OR DESTRUCTION OF EQUIPMENT.

NOTE

AN OPERATING PROCEDURE, PRACTICE, ETC., WHICH IS IMPORTANT TO HIGHLIGHT.

Safety rules fall into the following general areas:

Equipment Servicing
Operation
Load Handling

EQUIPMENT SERVICING.

Maintain Proper Tire Inflation. Check daily and maintain proper pressure in tires on all wheels, particularly when working on rubber without outriggers or during extensive road travel.

Avoid Dirty or Greasy Machine. Keep turntable deck, foot and hand holds free from mud and grease.

Inspect all Cables and Clamps Daily. Replace damaged cables. Do not operate with partially broken, worn or frayed cables. Install new cables when old ones give any indication that they might fail.

Replace Guards. Always replace guards upon completion of lubrication or adjustment procedures. Remove and stow all tools before resuming operation.

Keep Machine in Proper Adjustment at All Times. Serious injury to ground personnel or damage to equipment could result if adjustments are neglected.

Stop Machine When Lubricating or Adjusting. It is imperative to stop all operations when cleaning, adjusting or lubricating the machine.

OPERATION.

WARNING

BEFORE STARTING CRANE ENGINE, ASSURE MAIN AND AUXILIARY TRANSMISSION SHIFTING LEVERS ARE IN NEUTRAL AND PARKING BRAKE IS ENGAGED.

BEFORE ENGAGING POWER TAKE-OFF FOR CRANE OPERATION, ASSURE SWING SET BRAKE IS FULLY ENGAGED.

Back Away from Dangerous Banks. Do not leave or operate the machine near a bank that is liable to collapse.

Never Swing Boom Over Persons on Ground.
Never Get On or Off A Machine in Motion.

Watch Clearances When Traveling. Avoid running into overhead or side obstructions. When moving in tight quarters, post a look-out to help guard against collisions.

Check Load Capacities of Bridges. Before traveling across bridges, check to assure they will support a load greater than the machine's weight.

Always Keep Boom at Least Six Feet Away from all Overhead Wires. If boom should contact overhead wires stay on the machine, until boom is freed or current is cut off. Keep ground personnel away from the machine. If you must leave the machine – JUMP – do not step off.

LOAD HANDLING.

CAUTION

OPERATE CRANE AT ALL TIMES WITH ENGINE AT SPECIFIED RPM. DO NOT ATTEMPT ANY CRANE FUNCTION WITH ENGINE AT IDLE SPEED.

Watch Load at all Times. Watch the load while it is moving. If you must look in another direction, stop operation immediately.

Use Adequate Parts of Line for Heavy Lifts. To obtain maximum lifting capacities, the hook block must be rigged with sufficient parts of line. (Check Capacity Load Chart.)

WARNING

WHEN OPERATING WITH MULTIPART REEVING, A MINIMUM OF 5 COILS SHOULD REMAIN ON HOIST DRUM.

Never Leave Machine with Load Suspended. Do not leave the machine with a raised load – if you must leave the machine – lower load to ground.

WARNING

KEEP EVERYONE AWAY AND FROM UNDER LOAD. ASSURE THAT ALL SLINGS, TIES AND HOOKS ARE PROPERLY PLACED AND SECURED BEFORE RAISING OR LOWERING LOADS. CHECK ALL SECONDARY ROPES.

Check Capacity Load Chart in Cab. Always refer to capacity load chart in cab before making any lifts. Adjust position of boom to radius recommended – then lift load.

CAUTION

USE OUTRIGGERS, WHENEVER POSSIBLE, WHEN LIFTING LOADS, EXTENDING, OR SWINGING BOOM.

OUTRIGGERS SHOULD BE FULLY EXTENDED AND DOWN BEFORE EXTENDING OR SWINGING BOOM.

Use Outriggers. Whenever possible, operate with outriggers fully extended and down. (Check Capacity Load Chart in Crane Control Cab.)

DO NOT RELY ENTIRELY ON MACHINE TIPPING STABILITY TO DETERMINE MAXIMUM LIFTING CAPACITY. DO NOT EXCEED CAPACITIES GIVEN IN CAPACITY LOAD CHART.

SECTION II
GENERAL DESCRIPTION
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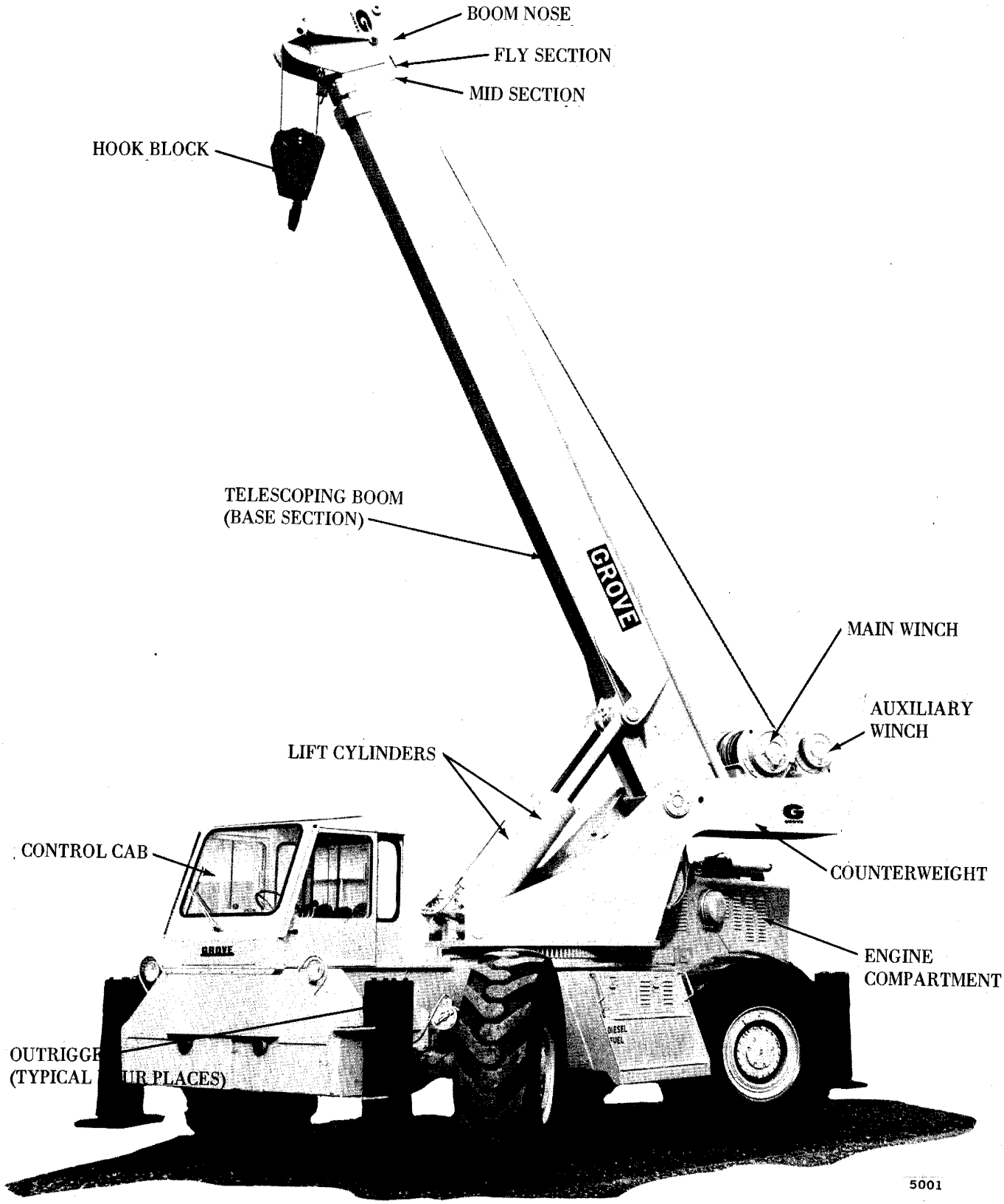


Figure 2-1. RT Hydraulic Crane-Typical (Models with Carrier Cab)

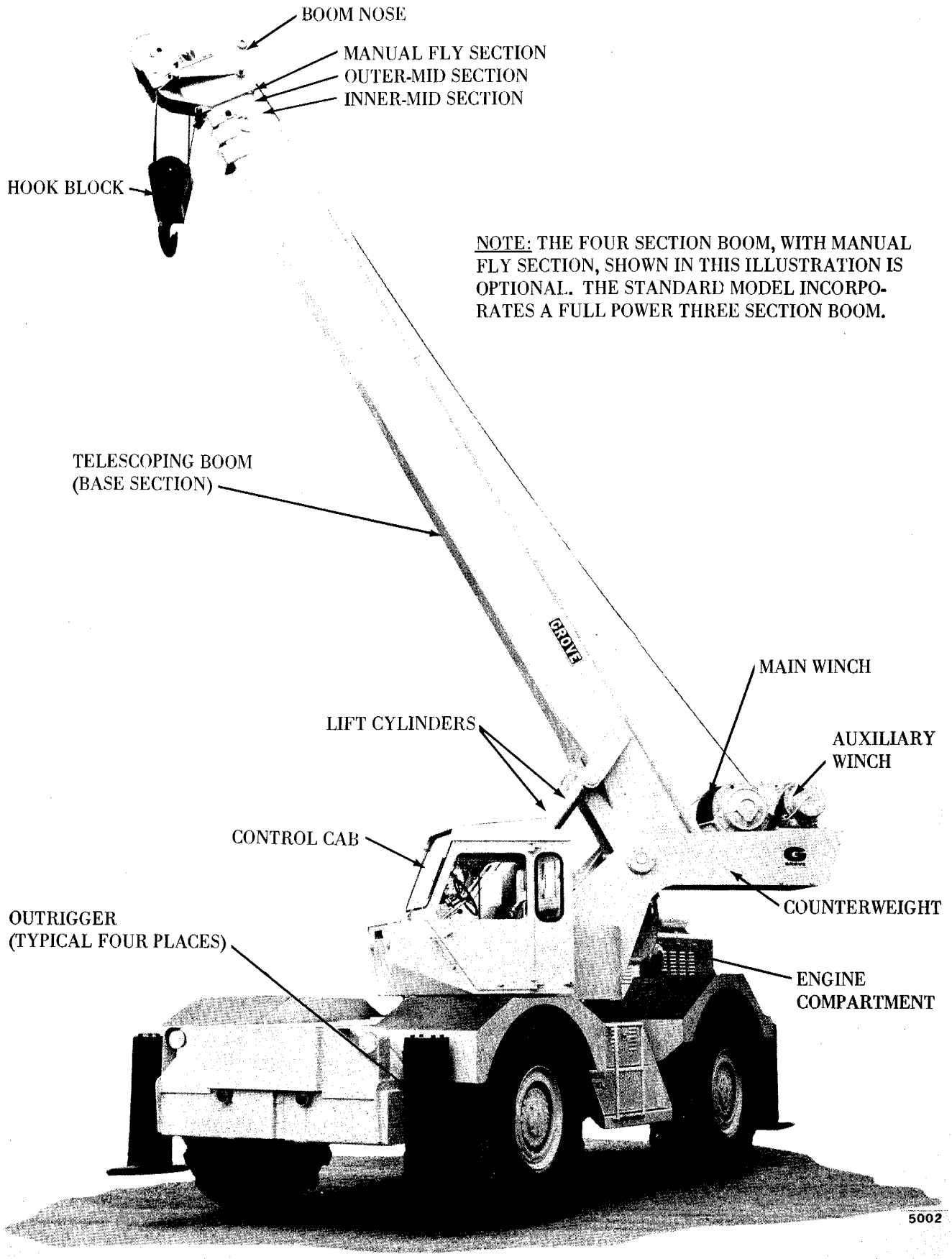
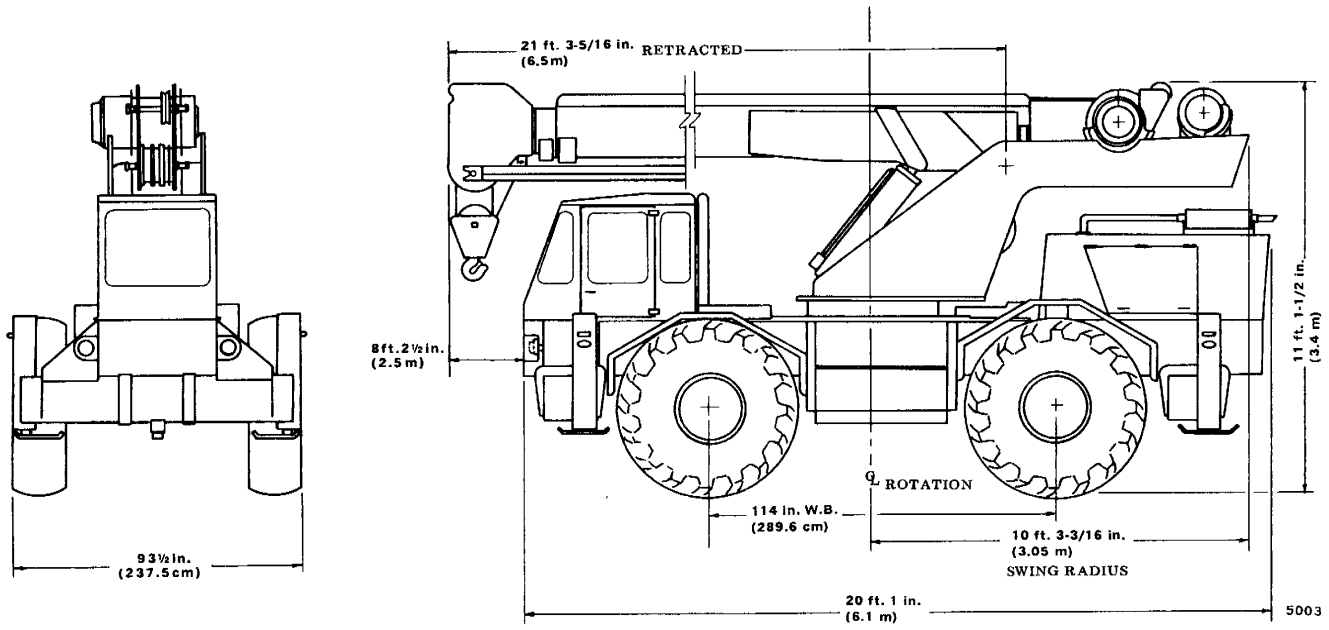
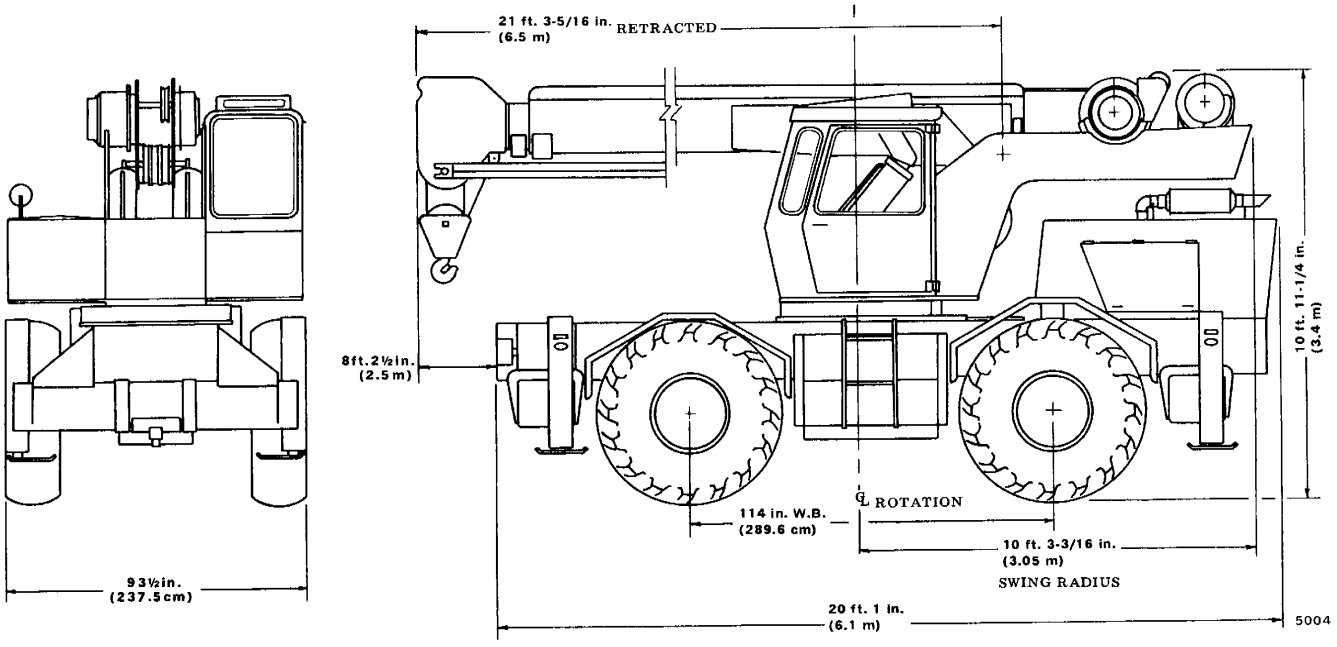


Figure 2-2. RT Hydraulic Crane-Typical (Models with Superstructure Cab.)



RT59/60 Models — Typical.



RT59S/60S Models — Typical.

Figure 2-3. Dimensions

GENERAL.

The rough terrain model hydraulic cranes discussed in this manual have maximum rated lifting capacities ranging from 30,000 to 36,000 pounds on fully extended outriggers. Maximum road speed is approximately 34 mph in high gear and a high degree of gradeability is provided in low gear and four wheel drive.

This model series utilizes the carrier engine to supply power for operation of the crane systems. On the RT59 and RT60 cranes, the operator's cab is located on the carrier while on the RT59S and RT60S cranes, the cab is located on, and swings with, the crane superstructure.

MAJOR CARRIER COMPONENTS.

The carrier power system consists of the engine, torque converter and transmission.

Engine. (See Figure 2-4.) A V-8 gasoline engine of 168 horsepower (@ 2800 rpm) is standard equipment on all models. Several optional diesel engines are available for installation at time of manufacture. Engine operation and maintenance procedures are provided in the separate manual provided with your Grove crane. Normal engine operation is at 2800 rpm during crane operations for optimum hydraulic system performance. From the engine, a torque converter supplies drive power to the carrier transmission and to the power take-off (PTO) gear. (Refer to Figure 2-4.)

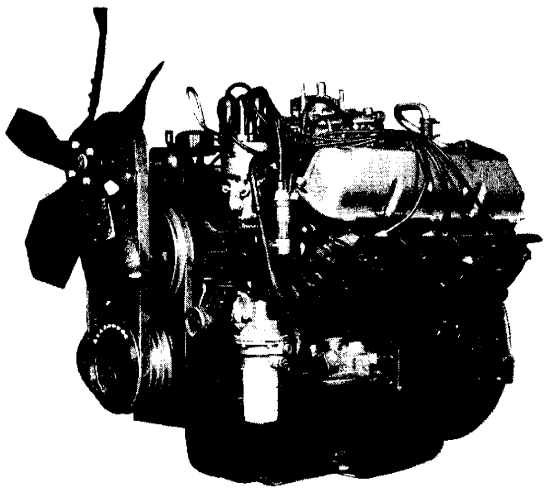


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Figure 2-4. Engine

Torque Converter. The torque converter operates directly off the engine flywheel and supplies drive power to the transmission. A gear on the pump section of the converter drives a power take-off gear which, in turn, drives the hydraulic pump providing oil flow to the hydraulic systems.

Transmission. An automatic, power shift, six-speed transmission is standard equipment on all RT models. The transmission distributes power to the front and rear axles. Four wheel drive is standard. (Refer to Figure 2-5.)

Power Take-Off (PTO). The power take-off gear drives a three-section pad mounted hydraulic pump for multiple crane functions, and a separate pump is driven to provide hydraulic power for carrier steering.

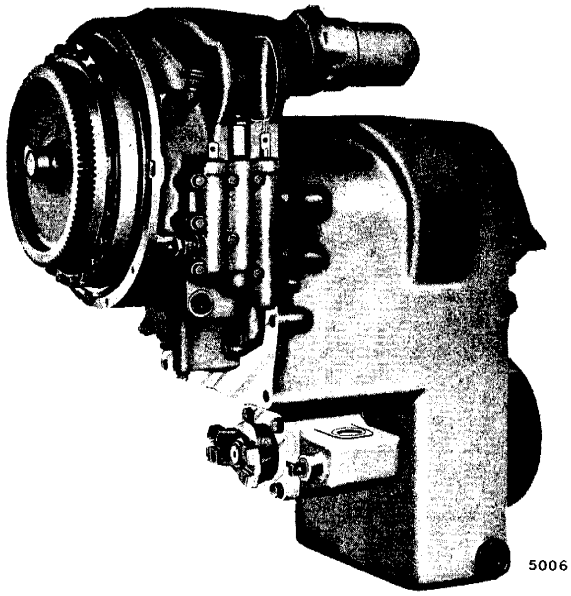

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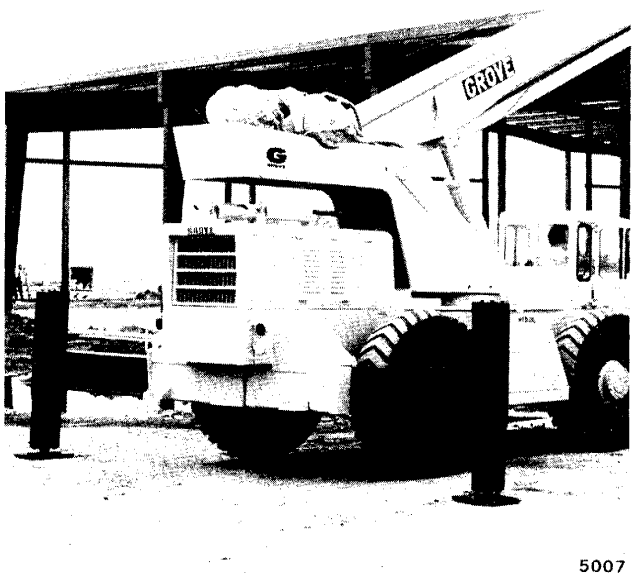
Figure 2-5. Transmission

Steering. Hydraulic power assisted steering is used on the front axle, controlled by a steering wheel. The rear axle uses a full hydraulic system with a tiller bar control lever. The hydraulic power is provided by a separate power take-off driven pump.

Outriggers. Independently controllable, hydraulic actuated, outriggers extend horizontally with vertical jacks to provide machine leveling and a stable crane platform. (Refer to Figure 2-6.) The telescoping beams are of double-box construction and are integral with the carrier main frame. The beams extend to approximately 16 feet and retract to approximately 8 feet. Separate and independent controls provide in, out, up and down movement of the jacks and a sequence control arrangement prevents accidental actuation. Integrated safety holding valves and manual locking pins are provided.



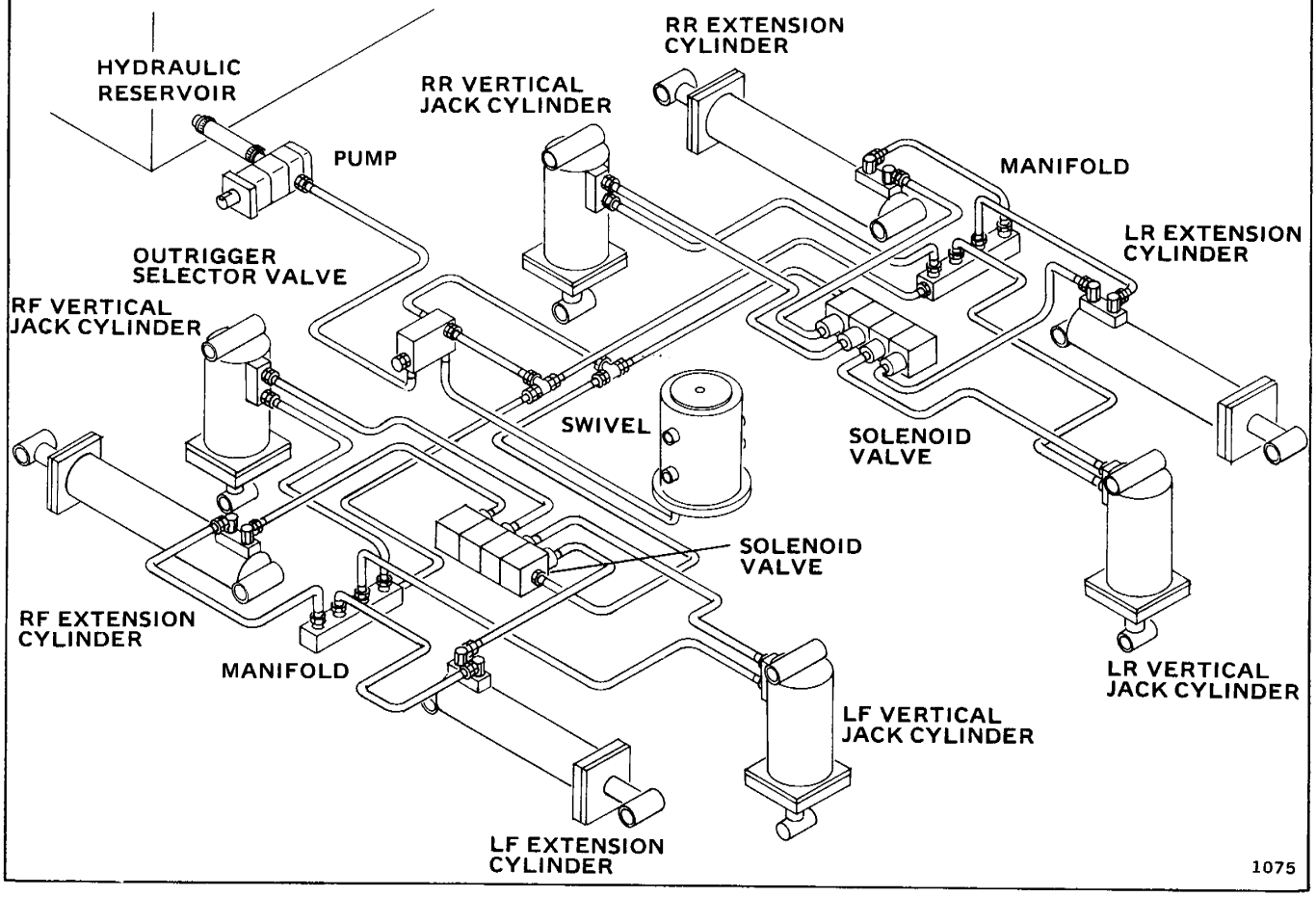


Figure 2-6. Outrigger System

Oscillation Lockout Stabilizers. Automatic hydraulic oscillation lockout stabilizers are mounted on each side of the frame, centered over the rear axle. The stabilizers operate automatically when the crane boom swings more than five degrees from the front center position.

Brakes. Hydraulic brakes, with air assist, are utilized on all four wheels.

MAJOR CRANE COMPONENTS.

Superstructure. The superstructure consists of the turntable assembly and swing mechanism, electro-hydraulic swivel, cab assembly (RT59S and RT60S models), boom assembly, hoist, counterweight, and all crane control components and hydraulic hosing.

Telescoping Boom. The standard three-section, full hydraulic power, telescoping booms extend from 21 to 51 feet on the RT59/RT59S models and 28 to 70 feet on the RT60/RT60S models. (See Figures 2-7 and 2-8.) Optional 24 to 78 foot, four-section booms are available, with two full power sections and a fly section power extended or retracted from a pinned position. The boom nose and hook block arrangement is shown in Figure 2-9.

Boom Elevation. Dual, double action hydraulic lift cylinders, with integral safety holding valves, raise and lower the boom from 0 to 75 degrees. (See Figure 2-10.)

Boom Swing. Continuous 360-degree rotation of the superstructure, mounted on a ball bearing swing circle assembly, is accomplished with a hydraulic motor and gearbox arrangement. (See Figure 2-11.) An automatic swing brake is incorporated as part of the swing system. Swing rate is approximately 3 rpm.

Hoist. The equal speed hoist is powered up and down by a hydraulic motor and planetary gearbox, which also contains an integral automatic brake. (See Figure 2-12.)

Hydraulic System. The hydraulic system is designed to provide adequate pressure and flow rate to permit simultaneous crane operations, including power steering and outrigger operation.

1. **Pump.** The hydraulic pump is a three-section gear type, driven directly from the torque converter power take-off (PTO), and produces a flow rate of up to 112 gallons per minute at pressure up to 2500 psi. (See Figure 2-13.) A manually operated pump disconnect is provided for extended over-the-road travel or cold weather starting.
2. **Swing Motor.** The hydraulic motor is a gear type and provides a low-speed high-torque output to the swing gearbox. (See Figure 2-14.)
3. **Gearbox.** Driven by the hydraulic swing motor, the gearbox is a planetary gear type and functions as a 22:1 speed reducer to rotate the boom. (See Figure 2-15.)
4. **Control Valves.** Hydraulic system control is provided by a set of four-way, dual-action control valves with integral load check, main, and circuit check relief valves. (See Figure 2-16.) Three separate banks of valves permit multiple control of crane functions. Main relief valves have maximum relief settings of 2250 psi.

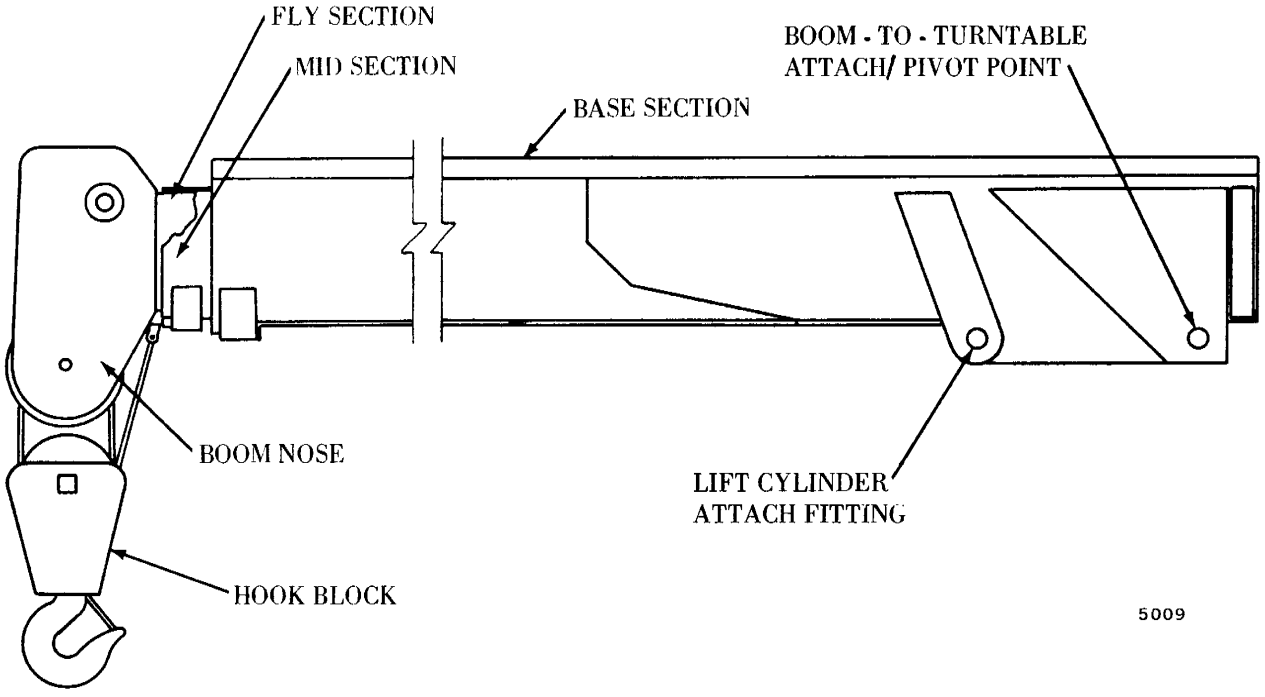


Figure 2-7. Telescoping Boom

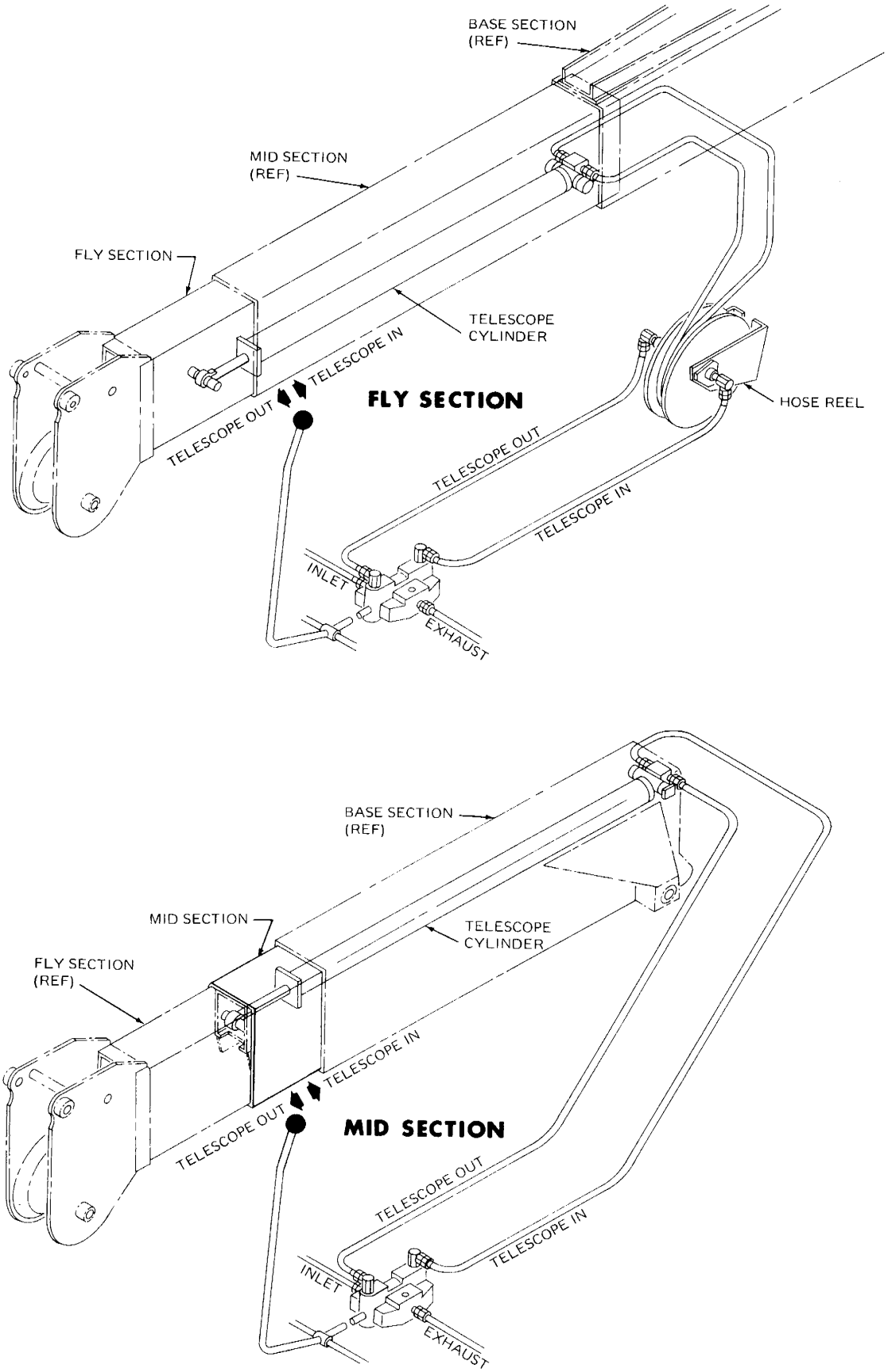


Figure 2-8. Telescope System

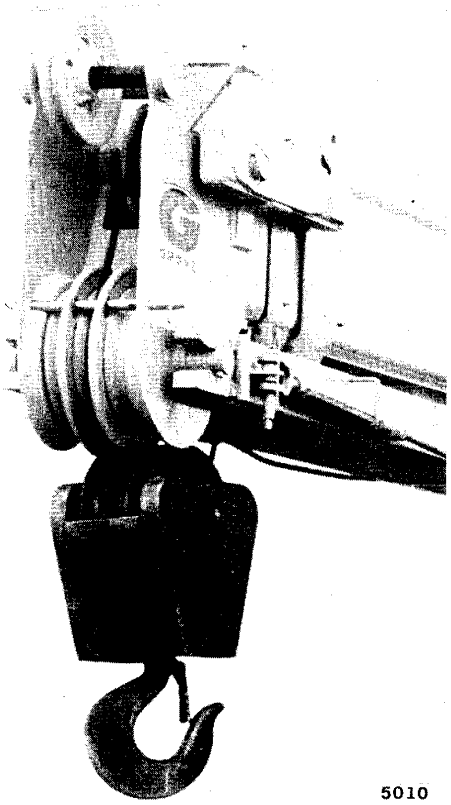


Figure 2-9. Boom Nose and Hook Block

PRINCIPLES OF HYDRAULIC SYSTEM OPERATION.

Hydraulic system operation is governed by two factors . . . volume and pressure. Volume is the quantity of hydraulic fluid which a pump forces through the system in a given time period at a predetermined rpm – for example: a three-section hydraulic pump rated at 112 gpm supplies a volume of 112 gallons of hydraulic fluid to the system per minute. System operation speed is directly proportional to pump volume (determined by gear size); the greater the volume, the faster the component (cylinder, motor, etc.) is filled with fluid, therefore the faster it functions. Primary system pressure is the measured amount of fluid force acting upon the components connected to the output side of the main circuit relief valve. Pressure is given in number of pounds per square inch (psi), e.g., the main supply pressure is 2250 psi.

Circuit relief valves are installed, as required, to provide protective measures by allowing pressures over and above the rated pressure capacities of components to be relieved.

Power for hydraulic pump operation is supplied indirectly by the carrier engine through the power take-off (PTO). It is essential that during crane functions the engine speed be kept at recommended operating rpm. It is both unsafe and impractical to attempt any crane function with the engine at idle rpm.

With the engine at near governed operating rpm, the hydraulic pump supplies fluid to the inlet ports of the various system control valves. As long as the operating controls remain in neutral, the hydraulic fluid flows through the control valves, manifold, filter, etc., and returns to the supply reservoir. Pressure in this non-functional condition is very slight since little or no resistance is encountered.

When the operator actuates a control lever, pressure in the applicable line of the selected system increases simultaneously, relative to resistance, resulting in functional performance of the selected system.

Hydraulic System Distribution.

RT59, 59S and RT60, 60S model cranes utilize a three-section hydraulic pump, with a flow rate totaling 112 gallons per minute, for crane operations. In addition, a separate pump, rated at 16 gpm, is utilized for front wheel steering hydraulic power. Hydraulic system power is distributed as follows:

Section 1 and Valve Bank – 46.0 gpm.
Distribution: (1) Hoist
(2) Auxiliary Hoist
Section 2 and Valve Bank – 39.5 gpm.
Distribution: (1) Lift Cylinders
(2) Rear Steer
(3) Telescope–Mid Section
Section 3 and Valve Bank – 26.5 gpm.
Distribution: (1) Swing
(2) Telescope–Fly Section
(3) Outriggers
Power Steering Pump – 16.0 gpm.
Distribution: Front Wheel Steering.

OPERATING CONTROLS AND INDICATORS.

Ignition Switch. An ignition/start switch is installed at the lower right of the engine control panel. Turning the key to the right completes the electrical ignition circuit and energizes the starter.

Choke. (Gasoline Engines.) A manual CHOKE is installed at the lower left on the engine control panel below the hourmeter. The choke is used during engine starting, as necessary, to restrict the air supply to the carburetor.

Foot Throttle. A foot throttle is installed on the far right side of the cab floor. The foot throttle is used during crane traveling operations.

Foot Brake. A foot brake is installed left of the foot throttle on the cab floor. Actuation of the foot brake activates the hydraulic power-assist brake system.

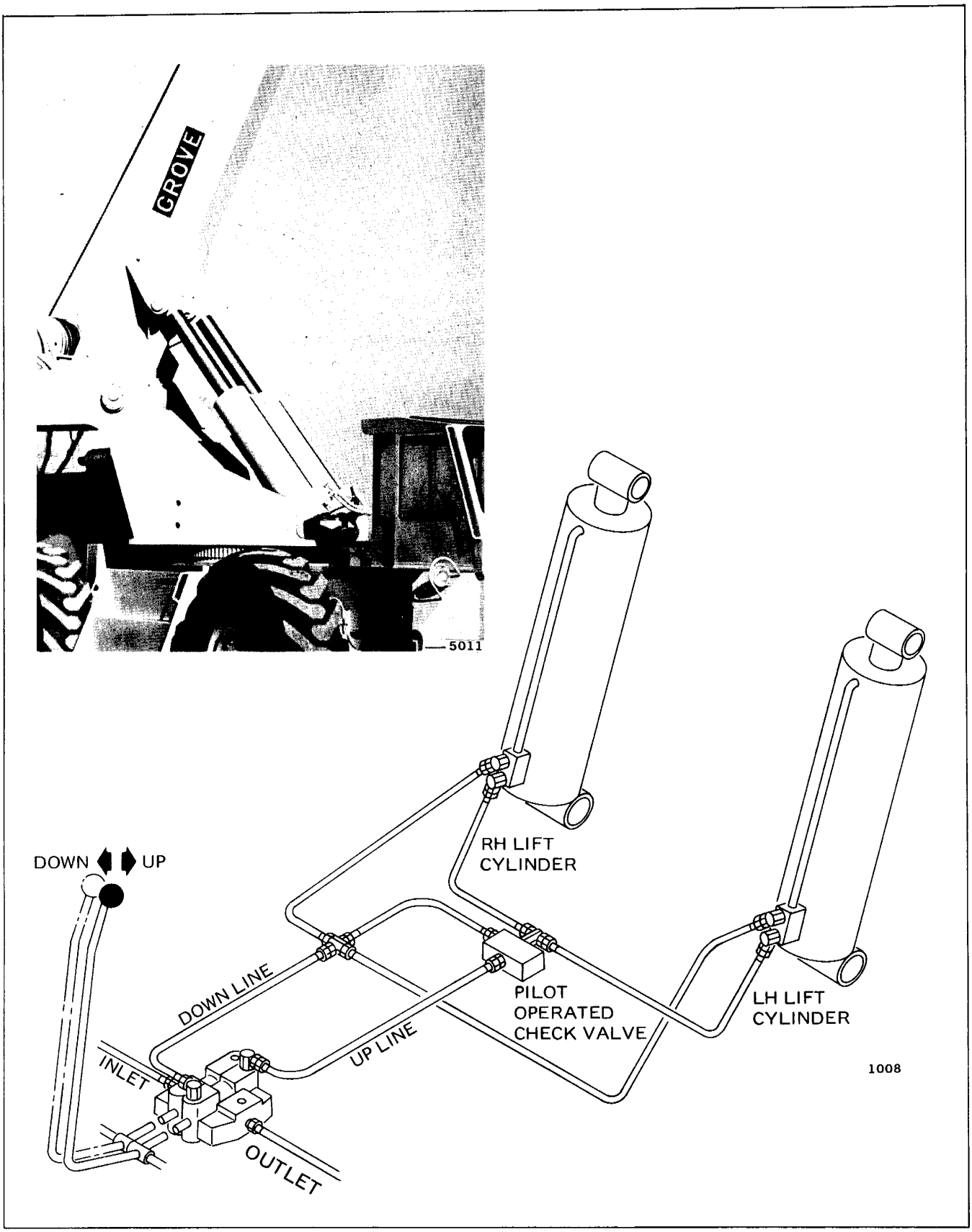


Figure 2-10. Boom Elevation System

Parking Brake. A lever type parking brake control is installed at the left side of the operator's seat. The brake will restrain the machine during static craning operations on level terrain and when the unit is parked or shut down.

Transmission Shift Lever. The transmission shift lever, installed at the right of the operator's seat, affords the operator a selection of eight forward and eight reverse speeds (RT59 and 60 models) or six forward and six reverse speeds (RT59S and 60S models) in crane traveling operations.

Rear Steer Tiller Bar Control. A rear steer tiller bar control is installed on the right side of the control panel at the near left. The tiller bar control permits independent rear wheel steering for greater machine maneuverability.

Two/Four Wheel Drive Selector. A lever-type, two/four wheel drive selector is installed to the left of the operator's seat. The selector, used in conjunction with the transfer case (if installed), affords the operator two- or four-wheel drive capabilities in high or low range operation.

Windshield Wiper Control. A push-pull windshield WIPER control is installed at the upper right on the engine control panel.

Head Light Switch. A head light control switch is installed at the upper left on the engine control panel above the hourmeter. When actuated, the head light and running light circuits are activated.

Turn Signal Control (Optional). A turn signal control unit is installed on the left side of the steering column. The unit provides the operator with directional signaling capabilities during crane traveling on public highways.

Horn Button. A horn button is installed on the right side plate of the engine control panel. When the button is depressed, the horn circuit is activated.

Swing House Safety Lock Control – (RT59S, 60S Models). The swing house safety lock control is installed on the side panel of the right console. The lever, when engaged, locks the superstructure to the carrier.

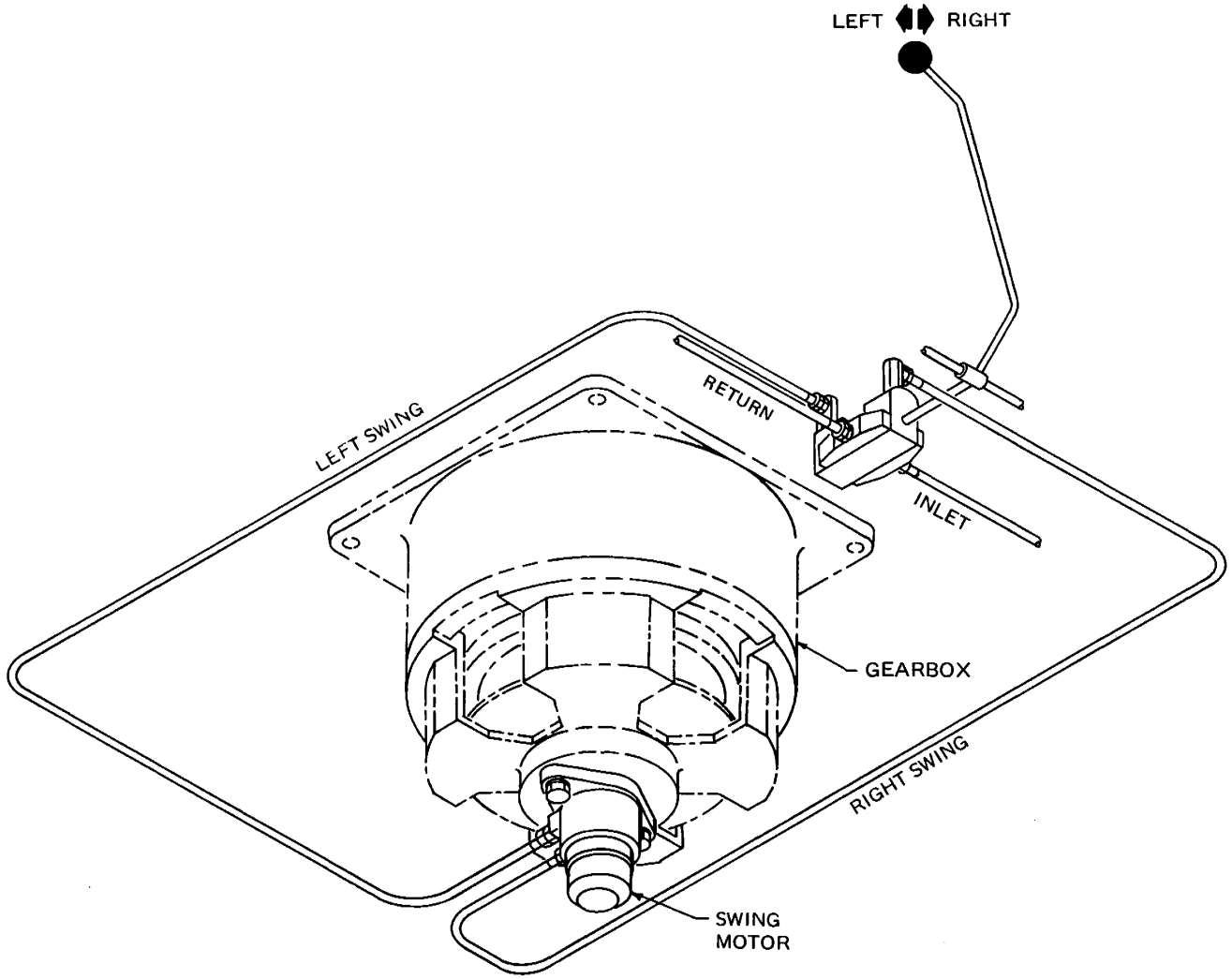


Figure 2-11. Boom Swing System

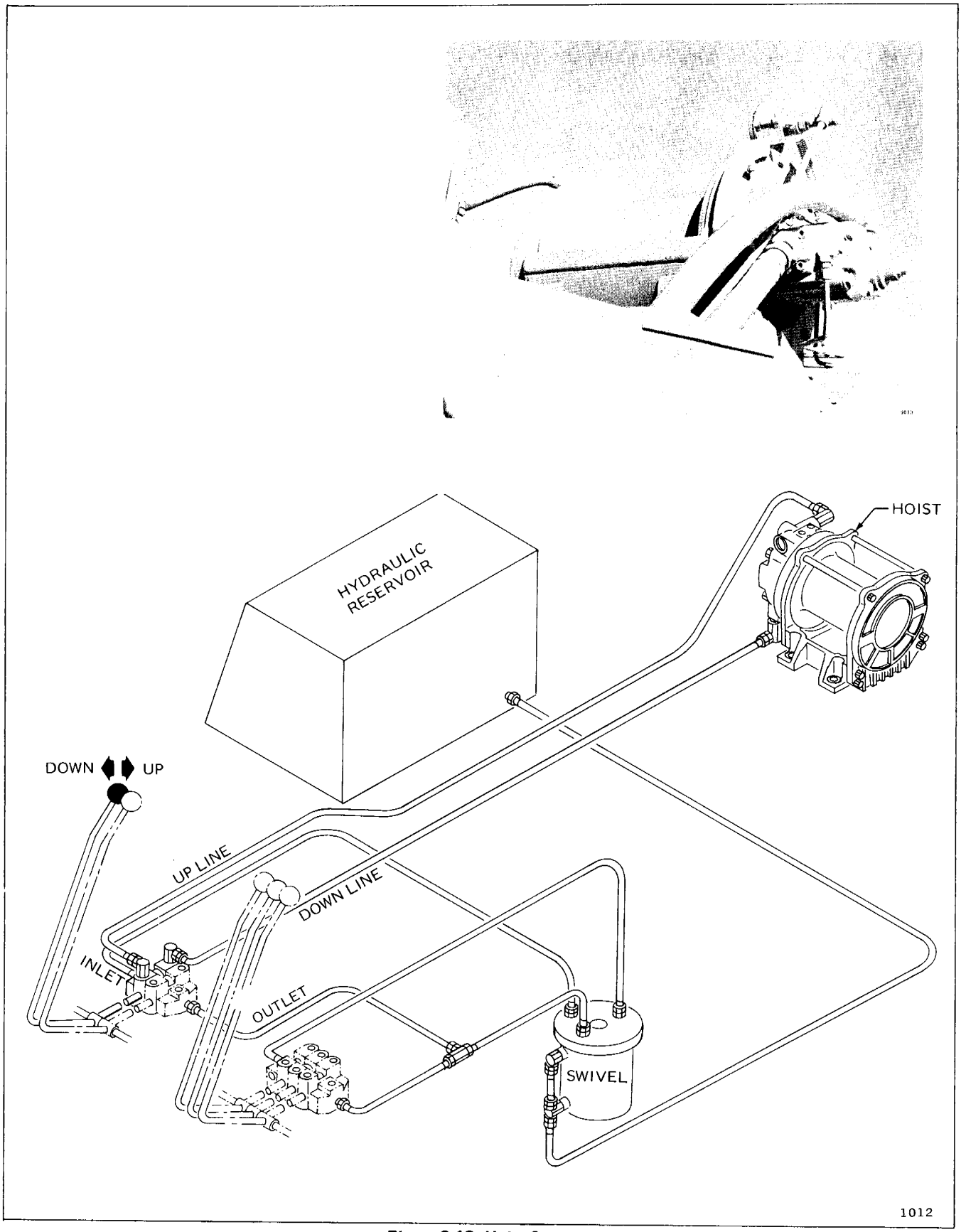


Figure 2-12. Hoist System

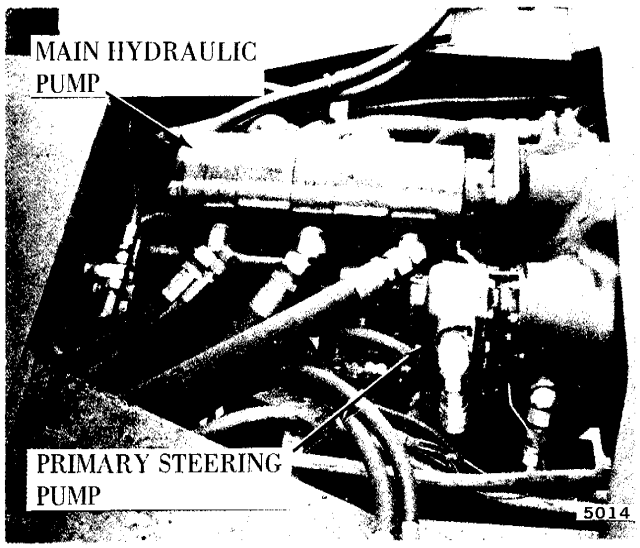


Figure 2-13. Hydraulic Pump and Steering Pump

TRAVELING INDICATORS. (Refer to Figure 2-18.)

Fuel Indicator. An electric fuel indicator is installed on the left instrument panel at the near right. The indicator presents engine fuel supply.

Engine Oil Pressure Indicator. An oil pressure indicator is installed on the right instrument panel, to the right of the ammeter. The indicator presents engine oil pressure.

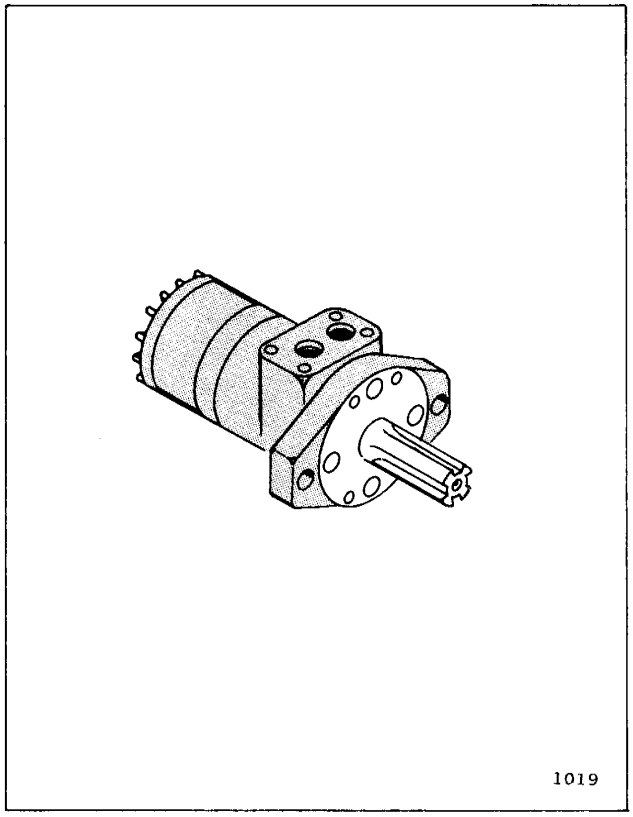


Figure 2-14. Swing Motor

Water Temperature Indicator. A standard water temperature indicator is installed on the far right of the right instrument panel. The indicator presents engine water temperature.

Ammeter. An ammeter is installed on the right instrument panel at the near left. The ammeter presents an indication of the battery's state of charge, i.e., charging, charged, or discharging.

Transmission Oil Temperature Indicator. An oil temperature indicator is installed on the left instrument panel, to the left of the fuel indicator. The indicator presents transmission oil temperature.

Clutch Oil Pressure Indicator. A clutch oil pressure indicator is installed on the left instrument panel at the far left. The indicator presents the clutch oil pressure.

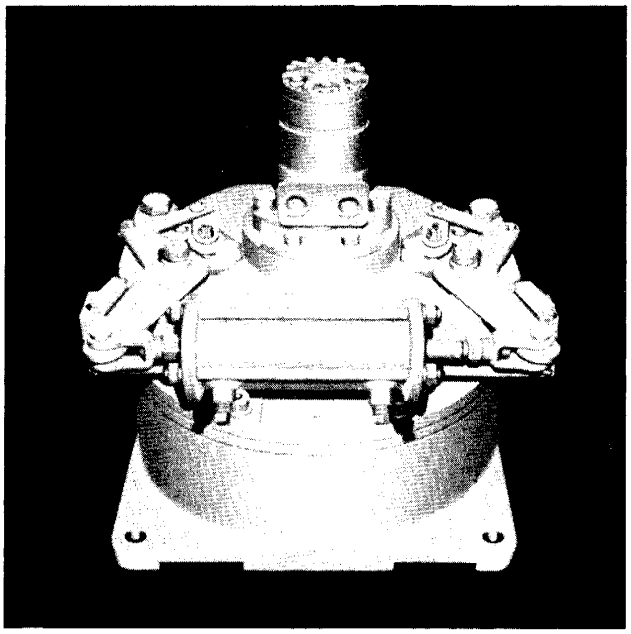


Figure 2-15. Swing Gearbox

Tachometer. A tachometer is installed in the center of the control panel between the two instrument panels. The tachometer presents the rpm at which the engine is operating.

Air Brake Pressure Indicator. A standard air pressure indicator is installed on the right console, forward of the transmission shifting lever. The indicator presents the air brake system's air pressure.

Air Pressure Warning Light. In conjunction with the air brake system's pressure indicator, a LOW AIR PRESSURE WARNING LIGHT is installed on the right console adjacent to the pressure indicator. The light illuminates when the system air pressure has depleted to an unsafe pressure for operation of the air brake system.

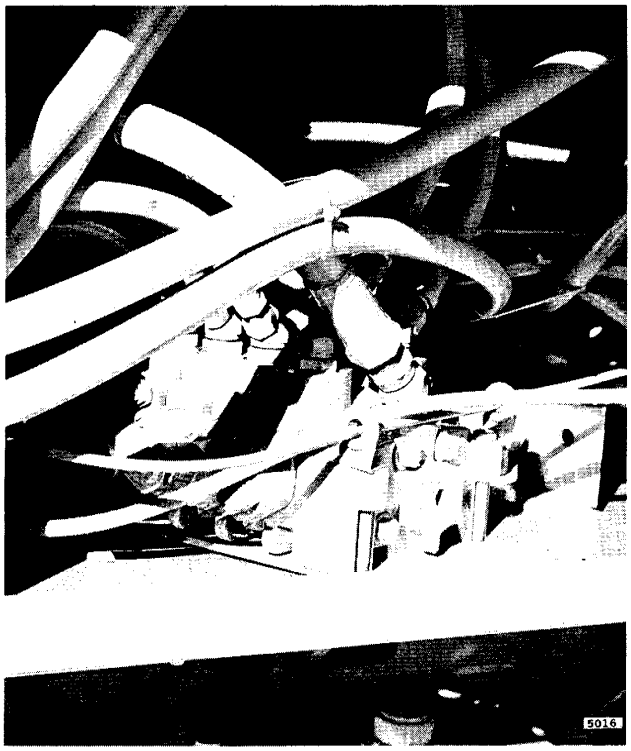


Figure 2-16. Control Valves

CRANE CONTROLS. (Refer to Figure 2-19.)

Hand Throttle. A lever-type hand throttle is installed on the operator's right console. The hand throttle is mechanically linked to the foot throttle and affords the operator a means of selecting and maintaining a constant operating rpm. The lever locks in the selected position during craning functions.

Foot Throttle. A conventional foot throttle is installed on the right side of the cab floor and is used for crane operation when it is not practical for the operator to utilize the hand throttle.

Boom Elevation Control. The BOOM elevation control lever is installed on the right side of the control console, right of the REAR STEERING control. Positioning of the BOOM control to UP or DOWN controls elevation of the boom from 0^{o} to 75^{o}.

Boom Swing Control. The boom SWING control lever is installed on the far left side of the control console. The lever, when positioned to LEFT or RIGHT, permits 360^{o} continuous rotation in the desired direction.

Boom Telescope Controls. The boom TELESCOPE control levers are installed on the left side of the control console, right of the boom SWING control lever. The levers, when positioned to IN or OUT, permit extension or retraction of the boom as desired.

Outrigger Activation Control. The OUTRIGGER activation control lever is installed on the left side of the control console at the near right. Activation of the lever, to the UP or DOWN position, diverts the oil from the valve bank to the outrigger control system.

Outrigger Operation Controls. The outrigger controls are installed on the right console, aft of the transmission shifting lever. Individual button-type switches control positioning of each outrigger as desired.

Hoist Cable Control. The hoist CABLE control lever is installed on the right side of the control console, left of the AUXILIARY CABLE control. Actuation of the CABLE control lever permits UP and DOWN (raising and lowering) of the hoist cable.

Auxiliary Hoist Cable Control. The auxiliary hoist AUXILIARY CABLE control lever is installed on the right side of the control console at the far right. Actuation of the AUXILIARY CABLE control lever permits UP and DOWN (raising and lowering) of the auxiliary hoist cable.

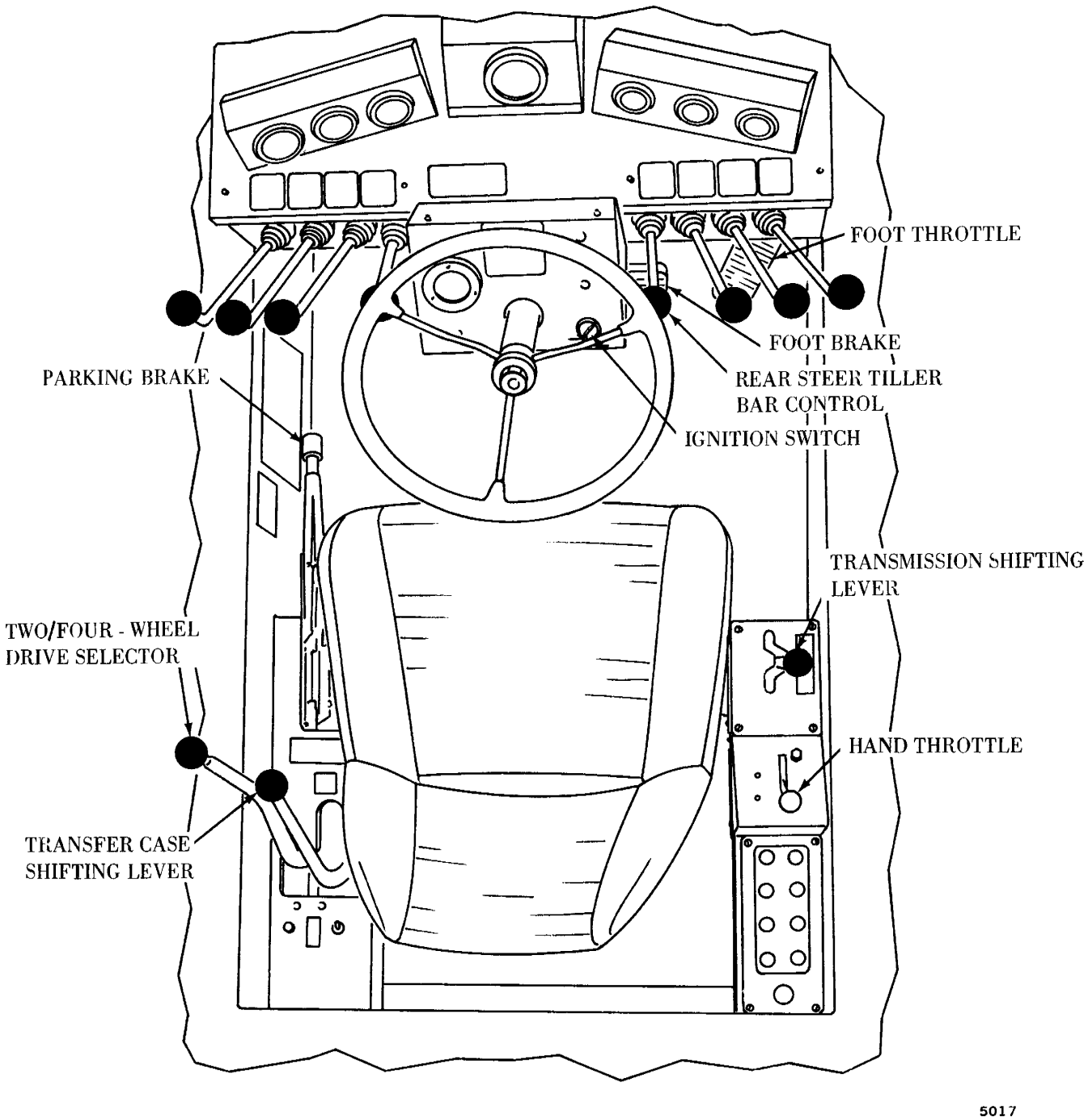
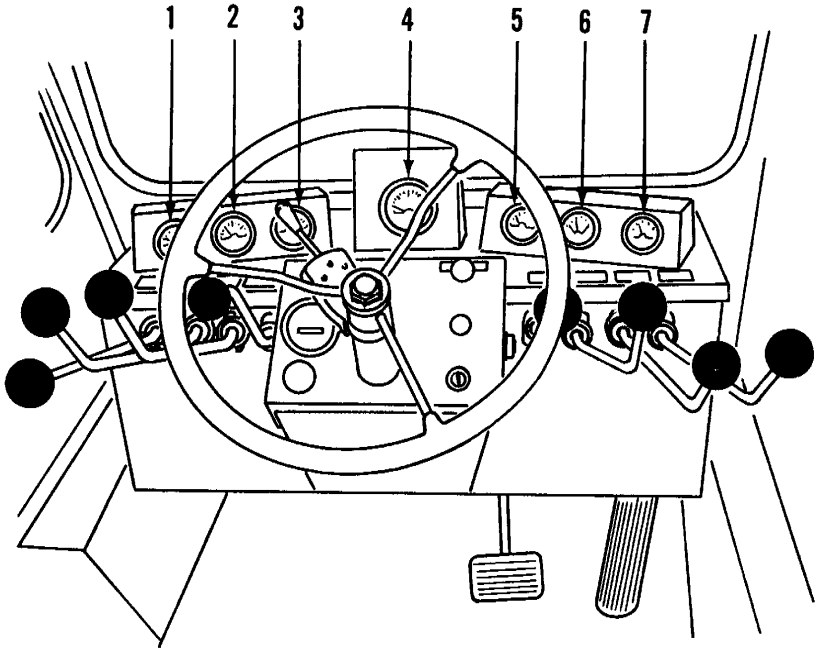


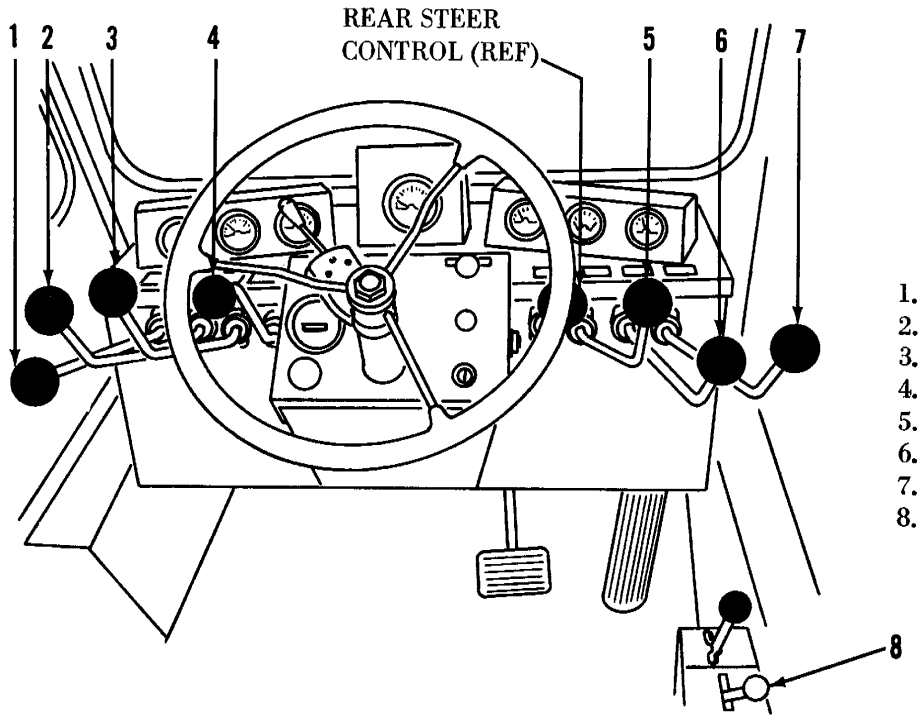
Figure 2-17. Traveling Controls



1. Clutch Oil Pressure Indicator
2. Transmission Oil Temperature Indicator
3. Fuel Indicator
4. Tachometer
5. Ammeter
6. Engine Oil Pressure Indicator
7. Water Temperature Indicator

5018

Figure 2-18. Indicators



1. Boom Swing Control
2. Boom Telescope Control - Fly
3. Boom Telescope Control - Mid
4. Outrigger Activation Control
5. Boom Elevation Control
6. Winch Cable Control
7. Auxiliary Winch Cable Control
8. Hand Throttle

5019

Figure 2-19. Crane Controls

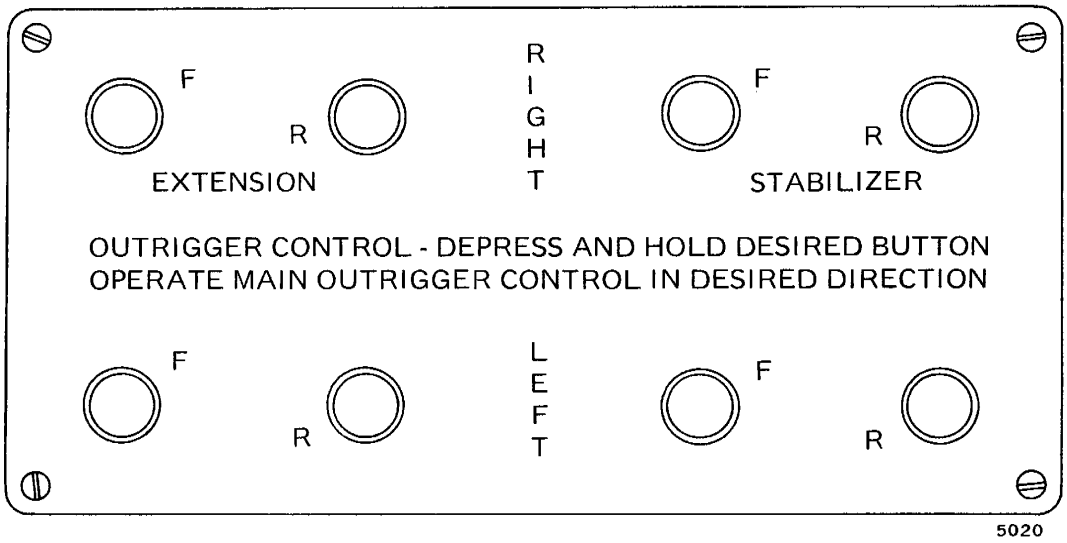


Figure 2-20. Outrigger Controls

SECTION III
HYDRAULIC SYSTEMS
TABLE OF CONTENTS

BASIC HYDRAULIC SYSTEM. (Refer to Figure 3-1.)

The heart of the crane hydraulic system is the engine-driven pump. The pump obtains hydraulic oil from the reservoir by means of a suction manifold and supplies sufficient pressure and volume to operate the crane systems. Directed by operator controlled valves to the boom swing motor, hoist motor, and outrigger systems, the oil is filtered and returned to the reservoir.

The greatest enemy of hydraulic systems is contamination, but even this can be controlled with reasonable efforts at good housekeeping. Contaminants can enter the system by addition of unfiltered hydraulic oils, allowing moisture to get into the system, replacement of components or lines that have not been stored properly, use of improper hydraulic oils, operating at excessively high temperatures or allowing pump cavitation by improper system warm-up, or with leaky suction lines.

Design and manufacturing tolerances of working parts in hydraulic systems are very close. Even small amounts of dirt or foreign material in a system can cause wear or damage to pumps and generally faulty operation. Every precaution must be taken to assure absolute cleanliness of the hydraulic oil. Filters provided in the return line should be checked and replaced at regular intervals.

Examination of the filters for metal particles is a must to detect potential component deterioration. Laboratory analysis of oil samples can be very helpful in not only detecting and identifying contaminants but also to determine oil condition which could dictate oil replacement. Cloudy oils indicate high moisture content that promotes organic growth and subsequent oxidation or corrosion. Immediate change and thorough flushing of the system must be accomplished when these conditions exist.

Never mix oils of different brands or types. Only good grades of mineral oils are recommended, with particular attention to viscosities suitable for existing ambient temperatures. Refer to hydraulic oil specification chart for oil selection.

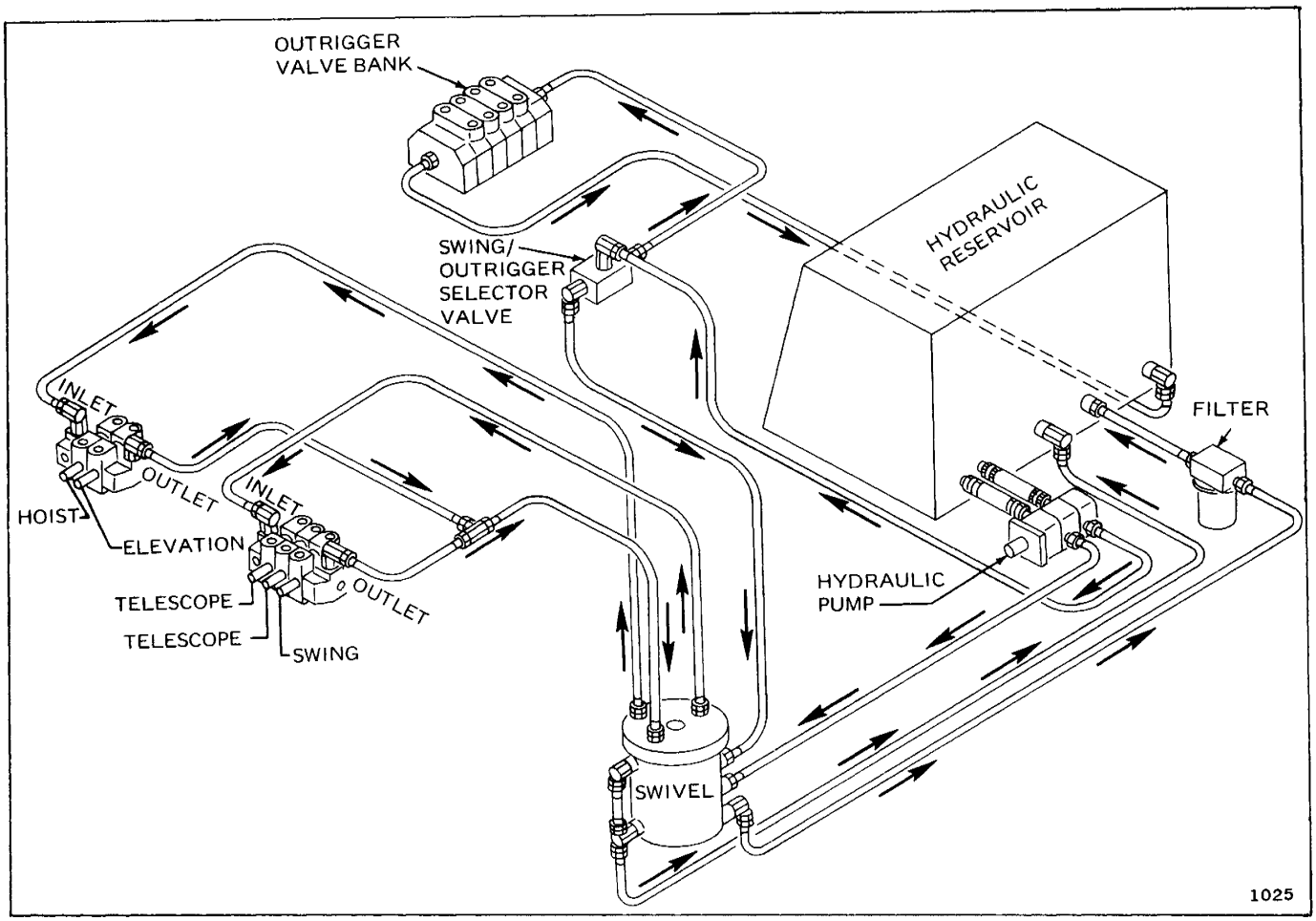


Figure 3-1. Basic Hydraulic System (Supply, Pressure and Return)

HYDRAULIC FLUID RECOMMENDATIONS.

Oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life. Oil must be selected with care and with the assistance of a reputable supplier.

Two important factors in selecting an oil are:

1. Antiwear Additives — The oil selected must contain the necessary additives to insure high antiwear characteristics and excellent chemical stability.
2. Viscosity — The oil selected must have proper viscosity to maintain a lubricating film at system operating temperature.

Suitable types of oil are:

1. Crankcase oil meeting MIL-L-2104C and latest applicable API service classifications is the key to proper selection of oils for mobile hydraulic systems.
2. Antiwear Type Hydraulic Oil — There is no common designation for oils of this type. However, they are produced by all major oil suppliers and provide the antiwear qualities of crankcase oils.

The following table summarizes oil types recommended for use in mobile hydraulic systems by viscosity. All must meet API service classifications.

RECOMMENDED OIL.

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE (MIN. TO MAX.)	SAE VISCOSITY DESIGNATION
0°F to 180°F (-18°C to 83°C)	10W
0°F to 210°F (-18°C to 99°C)	10W-30
50°F to 210°F (10°C to 99°C)	20-20W

Temperatures shown in the table are cold engine start minimums to maximum operating limits. Suitable start-up procedures must be followed to insure adequate lubrication during system warm-up.

OIL RECOMMENDATIONS FOR ARCTIC CONDITIONS.

Arctic conditions are considered those temperatures in the sub-zero range. These conditions represent a specialized field when extensive use is made of heating equipment before starting. Due to the variables involved in not only temperature but type of equipment available, the factory should be consulted for specific recommendations.

CAUTION

OPERATING TEMPERATURE MUST BE CLOSELY MONITORED WITH ALL THESE LIGHT WEIGHT OR DILUTED OILS AND NEVER BE ALLOWED TO EXCEED 130°F (54°C).

During cold start-up, high speed operation of system components must be avoided until the entire hydraulic system is warmed, to avoid pump cavitation and to provide adequate lubrication. Start-up of each operation after cold soak of more than a brief period must be considered in extremely cold conditions, e.g., when outriggers have been positioned and operations are performed for some time, the system and trapped oil will have quickly returned to ambient temperature.

DRAINING AND FLUSHING HYDRAULIC SYSTEMS.

NOTE

IT MAY BE NECESSARY TO ADD OIL DUE TO HYDRAULIC LINE OR COMPONENT LEAKAGE. HOWEVER, A COMPLETE DRAIN AND REFILL OF RESERVOIR SHOULD ONLY BE REQUIRED UPON COMPLETION OF ONE THOUSAND HOURS OF CRANE OPERATION, OR IF OIL BECOMES CLOUDY OR CONTAMINATED.

Whenever it becomes necessary to change hydraulic oil, it is important that whoever is charged with the task knows the reason for the change. Just draining the hydraulic reservoir is not enough, even if it is only for viscosity reasons. It must be remembered that oil trapped in the system, especially when hydraulic cylinders are involved, accounts for a large percentage of the total. If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained and flushed individually by removing lines and/or components that may have become contaminated.

Special cleaning oils containing compounds that remove gum and sludge, and also pick up loose rust, are available in a wide range of viscosities. These oils can be put to work while accomplishing a thorough cleaning. They are usually recommended for a period up to 50 hours operation before changing to regular oils. When the cleaner is in the system, check, change and/or clean filters and strainers frequently. When change is made to regular oil, flush all systems to prevent intermixing with cleaning oil.

IMPORTANT: WHEN HYDRAULIC OILS ARE CHANGED, IT WILL ALWAYS BE NECESSARY TO RECHECK RESERVOIR OIL LEVEL AFTER BRIEF OPERATION AND ADD OIL TO COMPENSATE FOR THAT WHICH WAS PUMPED INTO THE LINES AND COMPONENTS.

Drain and refill hydraulic system as follows:

1. Remove hydraulic reservoir drain plug. (Refer to Figure 3-2.) After oil stops flowing from drain port, allow an additional three minutes for side walls of tank to drain.

CAUTION

EXAMINE OIL FOR ANY EVIDENCE OF SYSTEM CONTAMINATION. DISCOVERY OF METAL PARTICLES REQUIRES THE REPLACEMENT OF THE DEFECTIVE COMPONENT AND A COMPLETE FLUSH AND REFILL OF THE HYDRAULIC SYSTEM. CLOUDY, MILKY OIL INDICATES WATER CONTAMINATION AND ALSO REQUIRES A SYSTEM FLUSH AND REFILL OF THE SYSTEM.

2. If system does not require flushing, reinstall drain plug and refill reservoir with clean hydraulic oil specified in Lubrication Chart, Section V of this manual.

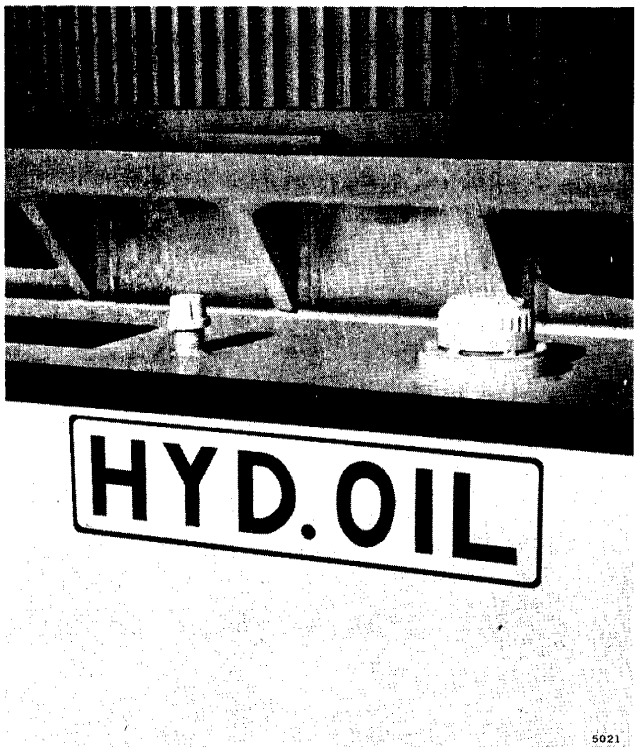


Figure 3-2. Hydraulic Reservoir Servicing Points

3. If system requires flushing, reinstall drain plug and fill hydraulic reservoir with a 50-50 mixture of diesel fuel and clean hydraulic oil.
4. Cycle all crane systems through all functions (including steering) several times. Return crane to stowed position.
5. Remove drain plug and drain flushing agent; reinstall drain plug and refill reservoir with clean hydraulic oil specified in Lubrication Chart, Section V of this manual.
6. Disconnect return line from each lift cylinder; raise boom to maximum elevation. (This will force flushing agent from cylinders.)
7. Reconnect cylinder return lines; lower boom to stowed position. Replenish reservoir oil level as necessary.
8. Disconnect return line from an outrigger extension cylinder; fully extend outrigger. (This will force flushing agent from cylinder.)
9. Reconnect outrigger return line; retract outrigger. Replenish reservoir oil level as necessary.
10. Repeat steps (8 and 9) for remaining outriggers.
11. Disconnect return line from outrigger jack cylinder; actuate outrigger to maximum down position. (This will force flushing agent from cylinder.)
12. Reconnect return line; raise outrigger to stowed position. Replenish reservoir oil level as necessary.
13. Repeat steps (11 and 12) for remaining outriggers.
14. Disconnect return line from mid-section telescope cylinder; fully extend mid-section. (This will force flushing agent from cylinder.)
15. Reconnect return line; retract mid-section. Replenish reservoir oil level as necessary.
16. Disconnect return line from fly section telescope cylinder; fully extend fly section. (This will force flushing agent from cylinder.)
17. Reconnect return line; retract fly section. Replenish reservoir oil level as necessary.
18. Disconnect return lines from front steer cylinders; position front wheels for maximum right or left turn. (This will force flushing agent from cylinders.)
19. Reconnect return lines; center front wheels. Replenish reservoir oil level as necessary.
20. Disconnect return lines from rear steer cylinders; position rear wheels for maximum right or left turn. (This will force flushing agent from cylinders.)
21. Reconnect return lines; center rear wheels. Replenish reservoir oil level as necessary.

HYDRAULIC SYSTEM FILTER. (Refer to Figure 3-3.)

The hydraulic system filter is installed in the reservoir return line. Replacement of the original filter element is recommended upon completion of 50 hours of system operation. Subsequent element replacement should be governed by the atmospheric conditions under which the machine is subjected to work in. In an average climate the

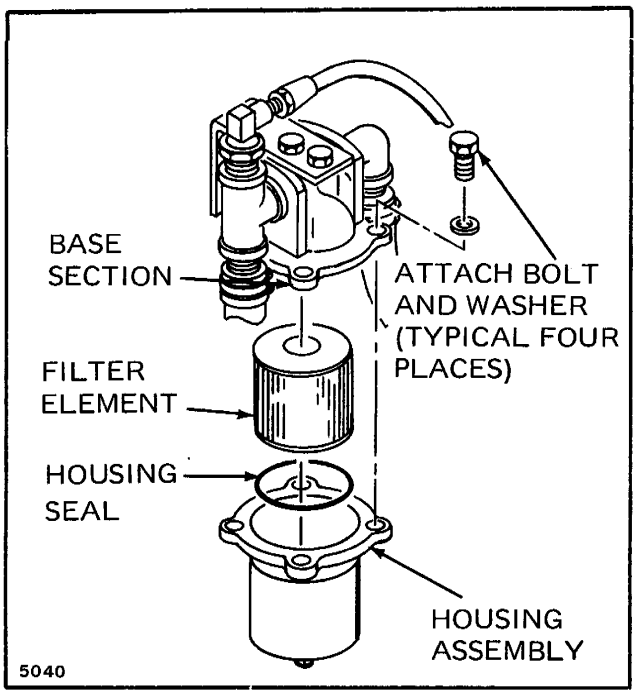


Figure 3-3. Replacing Hydraulic System Filter Element

element should be replaced after 200 hours of service. Should the machine be subjected to working in an unusually contaminated atmosphere, it is recommended that the element be replaced more often. Replace the filter element as follows:

1. Remove drain plug from bottom of filter; allow residue oil to drain and replace plug.
2. Remove four bolts and washers securing housing assembly to base section; remove housing.

CAUTION

WHEN REMOVING ELEMENT, CHECK FOR METAL PARTICLES. IF PARTICLES ARE FOUND, THIS IS AN INDICATION OF POSSIBLE COMPONENT FAILURE. DETERMINE/REPAIR MALFUNCTION AND DRAIN, FLUSH AND REFILL SYSTEM WITH CLEAN OIL BEFORE REPLACING FILTER ELEMENT.

IF NO EVIDENCE OF CONTAMINATION IS FOUND, BUT THE ELEMENT IS EXCESSIVELY DIRTY, DRAIN, FLUSH AND REFILL SYSTEM WITH CLEAN OIL BEFORE REPLACING ELEMENT.

3. Remove and discard housing seal and filter element.
4. Clean housing with soft-bristle brush and 50-50 mixture of clean hydraulic oil and kerosene.

CAUTION

ASSURE HOUSING SEAL IS PROPERLY POSITIONED IN HOUSING GROOVE.

5. Install new housing seal and filter element.
6. Position housing assembly on base section; secure with four bolts and washers.

HYDRAULIC PUMP. A single three-section hydraulic pump is powered by the engine and supplies the required gallons-per-minute output for crane operations.

The pump incorporates the following major components: shaft end cover, matched gears, bearings, and gear housing, bearing carrier, connecting shaft and port end cover. The number of gear housings and bearing carriers is dependent upon the number of pump sections incorporated in the pump assembly.

Operation. (Refer to Figure 3-4.) The hydraulic pump converts mechanical energy to fluid energy for operation of the various hydraulic circuits employed by the machine. With no resistance encountered by the pump (all controls in neutral), pump discharge registers minimum pressure. When a circuit is activated, whereby a resistance to flow is created, pressure increase occurs instantly. As the pressure exceeds resistance to flow, fluid energy is available to perform work.

Each pump section consists of two spur-type gears (driving gear A and driven gear B) which revolve inside a close fitting housing. As the gears are rotated (turning in opposite directions) oil is trapped between the gear teeth as the teeth move out of mesh. This volume of oil is then carried from the pump inlet around the periphery and exhausted

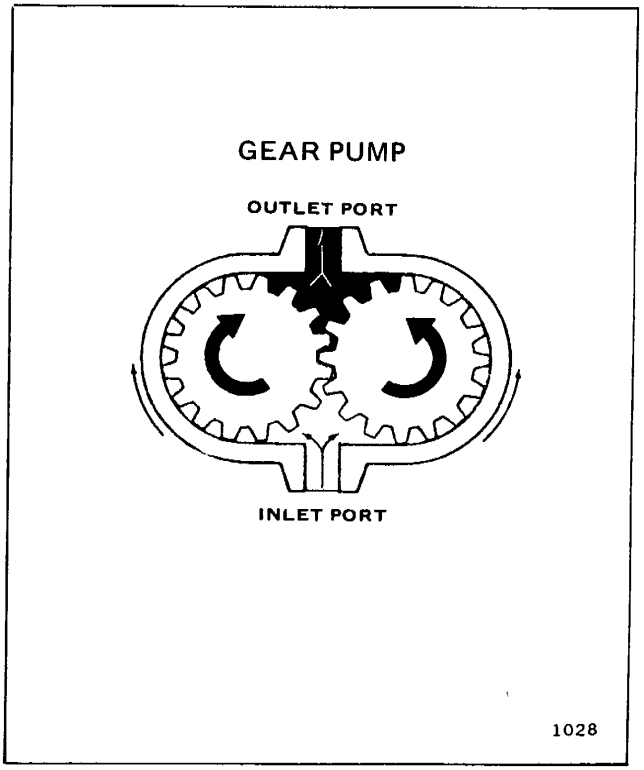


Figure 3-4. Pump Operation

Table 3-1. Hydraulic Pump Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Pump not delivering fluid.	Coupling or shaft sheared or disengaged.	Check that pump drive is properly engaged. If drive shaft or coupling is damaged or sheared, remove and repair or replace as necessary.
	Reservoir to pump supply line broken or restricted.	Clean, repair, or replace line as necessary.
	Air entering at suction manifold. Pump not priming.	Check all lines for security, manifold for cracks and proper attachment. Tighten, repair, or replace components as necessary.
	Internal contamination.	Repair or replace pump. Drain, flush, and refill system with recommended oil.
Excessive pressure build-up.	System relief valve set too high.	Use adequate pressure gage and adjust system relief valve, as necessary.
	Restricted pump-to-control valve supply line.	Clean, repair or replace line as necessary.
Pump noise. (Accompanied by oil foaming in reservoir.)	Air entering at suction manifold.	Check all lines for security, manifold for cracks and proper attachment. Tighten, repair or replace components as necessary. Assure that oil level in reservoir is adequate. (Fill to HIGH mark on dipstick.)

through the pump outlet as the teeth move into mesh. From the outlet, the oil is distributed to the respective circuit control valve and on to the components of that system, when the applicable control lever is actuated.

Pump delivery is measured in gallons-per-minute (gpm)/ liters-per-minute (lpm) at specified pump revolutions per minute. Pump delivery volume for any one size of gears can only be varied as the speed (rpm) of the pump is changed.

Inspection. Visually inspect pump for damage, corrosion, loose or missing parts, and evidence of leakage between gear housings and bearing carriers, and port end cover. Check that pump is properly mounted on pump drive and that all lines are attached securely.

Hydraulic Pump – Removal and Installation.

Removal. (Refer to Figure 3-5.)

1. Open engine cowling to gain access to pump.

NOTE

TO FACILITATE HYDRAULIC PUMP REMOVAL, THE SUCTION MANIFOLD MUST FIRST BE REMOVED.

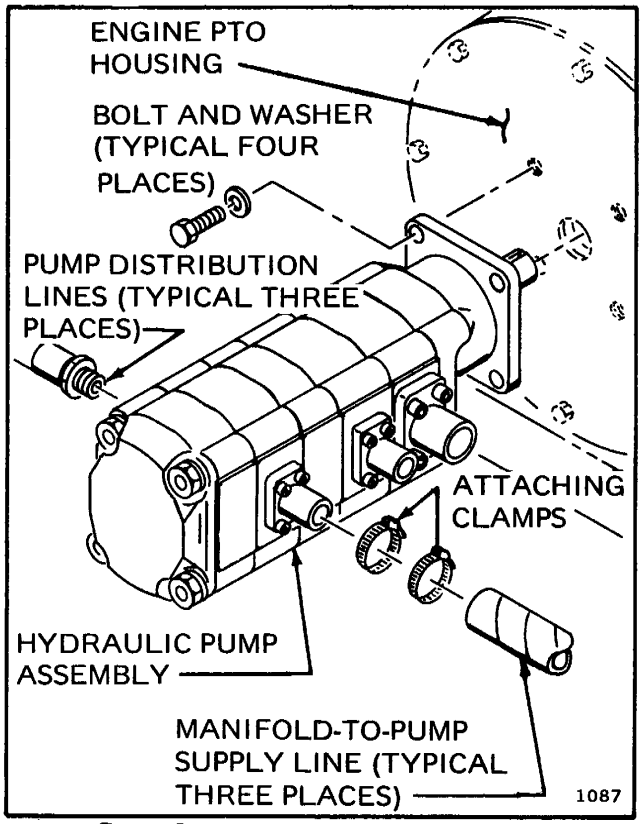


Figure 3-5. Removing and Installing Pump

2. Remove suction manifold:
   a. Close main hydraulic shutoff valve at manifold-to-reservoir attach point.
   b. Remove drain plug from manifold; drain residue oil, reinstall drain plug.
   c. Loosen clamps securing manifold-to-pump supply lines to pump port flanges.

NOTE

WHEN MANIFOLD IS REMOVED, MANIFOLD-TO-PUMP SUPPLY LINES WILL SLIDE FROM PUMP PORT FLANGES.

   d. Remove four bolts attaching manifold to shutoff valve face, remove manifold. Cap all lines and openings.

3. Tag or mark and disconnect pump distribution lines from pump; cap all lines and openings.

CAUTION

KEEP PUMP LEVEL WHEN DISENGAGING FROM PUMP DRIVE COUPLING TO AVOID DAMAGING SPLINE.

4. Remove bolts and washers securing pump to engine; remove pump.
5. Cover the pump mount opening to prevent dirt from entering unit.

THREE-SECTION HYDRAULIC PUMP – DISASSEMBLY. (Refer to Figure 3-6.)

Preliminary Disassembly.

CAUTION

DO NOT GRIP ON OR NEAR ANY MACHINED SURFACES DURING DISASSEMBLY OR REASSEMBLY.

1. Place pump in suitable vice with driveshaft down.

WARNING

BEARING PRELOAD MUST BE RELEASED PRIOR TO DISASSEMBLING PUMP.

2. Back off threaded retainer ring (1) a minimum of three full turns to release bearing preload.
3. Using prick punch, index mark all sections to assure proper alignment during reassembly.
4. Remove nuts (2) and washers (3) from studs (4) securing port end cover (5) to pump assembly.

CAUTION

IF END COVER WILL NOT LIFT OFF, PRY CAREFULLY TO AVOID DAMAGING MACHINED SURFACES.

5. Remove port end cover from pump assembly.

NOTE

THRUST PLATE (6), POCKET SEALS (7), AND ROLLER BEARINGS (8) WILL COME OFF WITH END COVER.

CAUTION

IF IT IS NECESSARY TO PRY ANY PARTS LOOSE, USE CARE SO AS NOT TO DAMAGE MACHINED SURFACES.

6. Separate driven gear (9), drive gear (10) and gear housing (11) from bearing carrier (12); keep gears together as they are a matched set.
7. Check drive and driven gears for serviceability. (Refer to Pump Component Inspection, following disassembly procedure.) Replace gear set if necessary.
8. Remove studs (4) from end cover (5).

CAUTION

PROTECT END OF SHAFT WHEN USING WRENCH.

9. Remove locknut (13) from connecting stud (14) on connecting shaft (15), using wrench to hold drive end of shaft.
10. Remove spacer (16) and connecting shaft (15).
11. Separate bearing carrier (12) from gear housing (17).

NOTE

THRUST PLATES (18 AND 22), POCKET SEALS (19 AND 23), ROLLER BEARINGS (20 AND 24), AND SHAFT BUSHINGS (21 AND 25) WILL COME OFF WITH BEARING CARRIER.

12. Separate driven gear (26), drive gear (27), and gear housing (17) from bearing carrier (28); keep gears together as they are a matched set.
13. Check drive and driven gears for serviceability. (Refer to Pump Component Inspection, following disassembly procedure.) Replace gear set if necessary.
14. Remove thrust plate (29), pocket seals (30), roller bearings (31) and shaft bushing (32).
15. Remove spacer (33) and connecting shaft (34).
16. Separate bearing carrier (28) from gear housing (35).

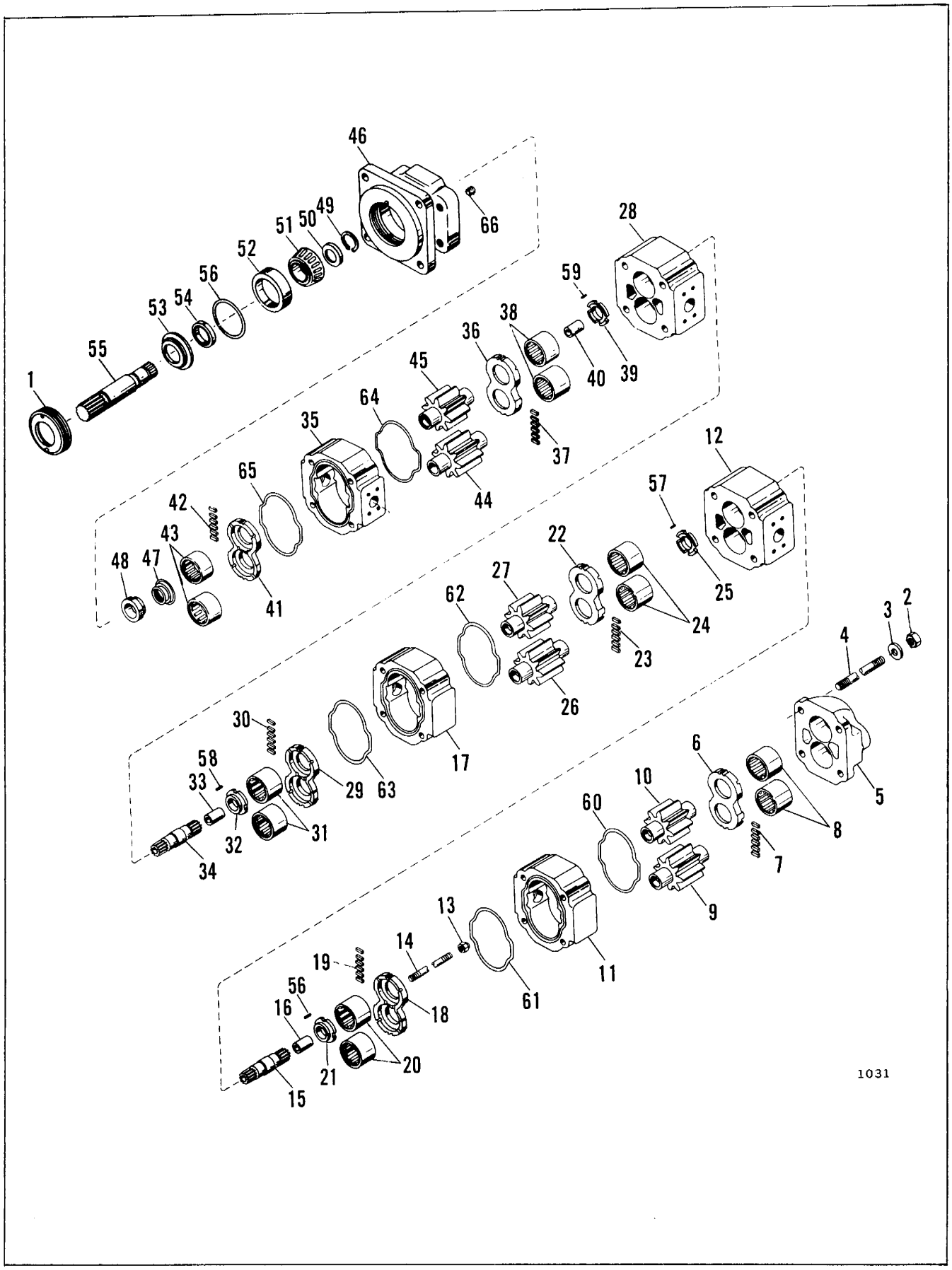


Figure 3-6. Hydraulic Pump Assembly

NOTE

THRUST PLATES (36 AND 41), POCKET SEALS (37 AND 42), ROLLER BEARINGS (38 AND 43), SHAFT BUSHING (39) AND SPACER (40) WILL COME OFF WITH BEARING CARRIER.

17. Remove driven gear (44), drive gear (45) and gear housing (35) from shaft end cover (46).

Shaft End Cover – Disassembly.

1. With drive end of shaft end cover facing up, remove retainer ring (1).
2. Pull assembled driveshaft from end cover (46).
3. Turn cover over with thrust plate (41) facing up; pry off thrust plate with knife blade or thin screwdriver. Remove and discard pocket seals.
4. Check roller bearings (43) for serviceability. (Refer to Pump Component Inspection, following disassembly procedure.) If bearings need replaced, remove with suitable bearing puller.
5. Remove conical spring (47) and shaft bushing (48).
6. Using snap ring pliers, remove snap ring (49) from gear end of driveshaft; remove spacer (50).
7. Using suitable press, remove tapered bearing (51), with cup (52) and seal retainer (53) with lip seal (54) from gear end of shaft (55).
8. Remove o-ring (56) from shaft bore; discard o-ring.
9. Remove lip seal (54) from seal retainer (53).

Port End Cover – Disassembly.

1. Pry off thrust plate (6) with knife blade or thin screwdriver; remove and discard pocket seals (7).
2. Check roller bearings (8) for serviceability. (Refer to Pump Component Inspection, following disassembly procedure.) If bearings need replaced, remove with suitable bearing puller.

Bearing Carrier – Disassembly.

1. Pry off thrust plates (18, 22, 29, and 36) with knife blade or thin screwdriver; remove and discard pocket seals (19, 23, 30, and 37).
2. Check roller bearings (20, 24, 31, and 38) for serviceability. (Refer to Pump Component Inspection, following disassembly procedure.) If bearings need replaced, remove with suitable bearing puller.
3. Remove shaft bushings (21, 25, 32, and 39).
4. Remove roll pins (56, 57, 58, and 59) if desired.

Housing Disassembly. Remove o-rings (60, 61, 62, 63, 64, and 65) from grooves in faces of housings (11, 17, and 35).

Pump Component Inspections. Inspect pump components in accordance with the following procedures.

Gear Housings.

Place straight edge across housing bore. If a .005 feeler gauge will slip between straight edge and housing, replace housing.

NOTE

WEAR IN EXCESS OF .005 INCH CUT-OUT REQUIRES REPLACEMENT OF HOUSING.

Drive and Driven Gears. Any wear on gear hubs detectable by touch, or exceeding .002 inch, requires replacement. Scoring, grooving, or burring of outside diameter of gear teeth, as well as nicking, grooving, or fretting of teeth surfaces would justify replacement.

NOTE

GEARS ARE A MATCHED SET, THEREFORE BOTH MUST BE REPLACED EVEN IF ONLY ONE WAS FOUND DAMAGED.

Driveshaft. Replace driveshaft if any wear is detectable visibly, or by touch, in seal areas or at drive coupling. A minimum of .002-inch wear is allowable. Wear or damage to splines justifies replacement. Wear in shaft seal areas indicates oil contamination.

Thrust Plates.

NOTE

THRUST PLATES SEAL THE GEAR SECTION AT SIDES OF GEARS. WEAR IN THIS AREA WILL ALLOW INTERNAL SLIPPAGE, RESULTING IN OIL BYPASSING WITHIN THE PUMP.

Maximum allowable wear is .002-inch. Replace thrust plates if they are scored, eroded, or pitted. Check center area of thrust plate where gears mesh. Erosion in this area indicates oil contamination. Pitting on plates indicates cavitation or oil aeration, whereas discoloration of plates would indicate overheating, probably as a result of insufficient oil.

Bearings.

CAUTION

IF GEARS ARE REPLACED, BEARINGS MUST ALSO BE REPLACED.

Bearings should fit into bore with a light press fit, however, a neat hand fit is allowable.

THREE-SECTION HYDRAULIC PUMP – ASSEMBLY. (Refer to Figure 3-6.)

Shaft End Cover – Reassembly.

1. Place shaft end cover (46), gear side up, in suitable vise.
2. Install conical spring (47) with smaller end of spring over pilot shoulder of shaft bushing (48,
3. Install roller bearings (43) in bores of end cover.

CAUTION

ASSURE THAT SPRING DOES NOT BECOME WEDGED BETWEEN BEARING AND BOTTOM OF BEARING COUNTERBORE.

4. Reposition end cover in vise, flange side up.
5. Reassemble driveshaft in accordance with the following procedures.
   a. Press lip seal (54) into recess of seal retainer (53), assuring that lip of seal is facing out.
   b. Press seal retainer subassembly onto driveshaft (55) with small diameter of seal retainer facing drive end of shaft.
   c. Place o-ring (56) in proper groove of seal retainer.
   d. Repack tapered roller bearing (51) with a good No. 2 consistency, lithium base, high temperature bearing grease; press bearing onto driveshaft, assuring that smaller diameter of bearing faces seal retainer.
   e. Place bearing cup (52) over bearing.
   f. Install spacer (50) over gear end of shaft; secure spacer on shaft with snap ring (49).
   g. Press seal retainer assembly, bearing, cup, and spacer tight against snap ring.
   h. Insert assembled shaft in shaft end cover.

CAUTION

DO NOT PRELOAD BEARING WHEN INSTALLING RETAINER RING.

6. Thread retainer ring (1) loosely into shaft end cover.
7. Reposition end cover assembly in vise, gear side up; check that plug (66) is installed in high pressure port.
8. Place small amount of heavy grease in the two middle slots in open face of thrust plate (41); insert two pocket seals (42).
9. Place thrust plate, with pocket seal slots toward face of end cover, over bearings (43); assure that pocket seals are still in place in center slots before tapping plate into position.

NOTE

LEAVE CLEARANCE OF APPROXIMATELY 1/32-INCH (.79MM) BETWEEN THRUST PLATE AND END COVER.

10. Insert remaining pocket seals (42) into each of four open slots in thrust plate (41); push each seal all the way into slot to assure that hidden end contacts roller bearing race.
11. Tap thrust plate assembly into position against face of shaft end cover.

12. Using razor blade or sharp knife, trim excess from exposed ends of pocket seals (square and flush with side of thrust plate).

Port End Cover — Reassembly.

1. Install roller bearings (8), if removed during disassembly, in bores of port end cover (5).
2. Place small amount of heavy grease in the two middle slots in open face of thrust plate (6); insert two pocket seals (7).
3. Place thrust plate, with pocket seal slots toward face of end cover, over bearings (8); assure that pocket seals are still in place in center slots before tapping plate into position.

NOTE

LEAVE CLEARANCE OF APPROXIMATELY 1/32-INCH (.79MM) BETWEEN THRUST PLATE AND END COVER.

4. Insert remaining pocket seals (7) into each of four open slots in thrust plate (6); push each seal all the way into slot to assure that hidden end contacts roller bearing race.
5. Tap thrust plate assembly into position against face of port end cover.
6. Using razor blade or sharp knife, trim excess from exposed ends of pocket seals (square and flush with sides of thrust plate).

Bearing Carrier — Reassembly.

1. Install roll pins (56, 57, 58, and 59) in holes in driveshaft bores.
2. Install shaft bushings (21, 25, 32, and 39) in shaft holes, assuring that flange side of each bushing is against bottom of bearing bore.

NOTE

FIT ONE SLOT OF BUSHING OVER ROLL PIN. DO ONE SIDE AT A TIME. THIS PREVENTS BUSHING FROM TURNING ON SHAFT.

3. Install roller bearings (20, 24, 31, and 38), if removed during disassembly.
4. Place small amount of heavy grease in the two middle slots in open face of thrust plates (18, 22, 29, and 36); insert two pocket seals (19, 23, 30, and 37) in each thrust plate.
5. Place thrust plate, with pocket seal slots toward face of bearing carrier (28), over bearings (31); assure that pocket seals are still in place in center slots before tapping plate into position.

NOTE

LEAVE CLEARANCE OF APPROXIMATELY 1/32-INCH (.79MM) BETWEEN THRUST PLATE AND BEARING CARRIER.

6. Insert remaining pocket seals (19, 23, 30, and 37) into each of four open slots in thrust plates (18, 22, 29, and 36); push each seal all the way into slot to assure that hidden end contacts roller bearing race.
7. Tap thrust plate assembly into position against face of bearing carrier.
8. Using razor blade or sharp knife, trim excess from exposed ends of pocket seals (square and flush with sides of thrust plate).

Final Reassembly.

1. Place shaft end cover assembly in suitable vise, gear side up.
2. Pour small amount of oil on face of thrust plates to provide lubrication in their respective bores; stone gear ends before installation to remove minute burrs.

NOTE

USE MEDIUM GRIT CARBORUNDUM STONE, OR EQUIVALENT, FOR DEBURRING.

3. Stone faces of gear housing (11 and 17 and 35) to remove any burrs that may have resulted from handling; blow with compressed air or carefully wipe clean.
4. Coat o-rings (60, 61, 62, 63, 64, and 65) with grease and install in grooves in face of housings (11, 17, and 35).

CAUTION

USE CARE SO AS NOT TO PINCH O-RINGS WHEN POSITIONING HOUSINGS.

5. Place gear housings over gears (45, 44, 27, and 26); tap into position using fiber mallet.

NOTE

POUR SMALL AMOUNT OF OIL OVER GEARS TO PROVIDE INITIAL LUBRICATION WHEN RETURNING PUMP TO SERVICE.

6. Install spacer (33) and connecting shaft (34) with spacer (40) into bore of drive gear (45).
7. Insert shaft connecting stud (14) through bore of connecting shaft; coat threads with sealant and thread stud into tapped hole in end of driveshaft.

CAUTION

ASSURE THAT SPACER (33) IS CORRECT LENGTH. USE SPACER 3/8-INCH (.95CM) SHORTER THAN GEAR LENGTH. EXAMPLE: IF TANDEM PUMP INCORPORATES 2-INCH (5.08CM) PUMP SECTION AND 1-1/4-INCH (3.16CM) PUMP SECTION, USE 1-5/8-INCH (4.13CM) SPACER BETWEEN DRIVESHAFT AND CONNECTING STUD, AND 7/8-INCH (2.22CM) SPACER UNDER LOCKNUT.

8. Place spacer (16) on connecting shaft (15) and over connecting stud (14) and start locknut (13); do not tighten locknut at this time.

CAUTION

USE CARE SO AS NOT TO SCORE SHAFT BUSHING IN SHAFT BORE WHEN INSTALLING BEARING CARRIER.

9. Install bearing carrier assembly (12) on gear housing (17).

CAUTION

USE CARE SO AS NOT TO PINCH O-RINGS (60, 61) WHEN POSITIONING HOUSINGS.

10. Using fiber mallet, tap bearing carrier (12) into place.
11. Install drive gear (10) over connecting stud, spacer, and locknut.
12. Install driven gear (9) into its respective bore in housing.
13. Using suitable wrench to hold drive end of shaft, torque locknut (13) to 19 pound feet.
14. Place gear housing (11) over gears; using fiber mallet, tap housing into place against bearing carrier. Pour small amount of oil over gears to provide lubrication when returning pump to service.

CAUTION

USE FIBER MALLET TO SEAT PORT END COVER ASSEMBLY AGAINST HOUSING, ASSURING THAT O-RING ON FACE OF HOUSING IS NOT PINCHED.

15. Install port end cover assembly (5) on gear housing.

NOTE

HUBS OF GEARS FIT INTO INSIDE DIAMETER OF ROLLER BEARINGS (8); THRUST PLATE (6) FITS INTO GEAR HOUSING.

16. Thread four studs (4) into shaft end cover, allowing enough thread showing above port end cover to permit installation of washers and nuts.
17. Install washers (3) and nuts (2); tighten finger tight.

CAUTION

PROTECT SHAFT END WHEN USING WRENCH.

18. Rotate shaft by hand or use suitable wrench. If shaft rotates easily, torque nuts to 200 pound feet.
19. Reposition pump assembly in vise, shaft end up.
20. Using pin-type wrench, tighten retainer ring (1).

NOTE

PROPER BEARING PRELOAD AND RUNNING CLEARANCE IS OBTAINED BY BACKING OFF RETAINER RING.

21. Adjust final running clearance in accordance with the following procedures.
    a. With retainer ring tight, scribe a line across face of ring and onto face shaft end cover flange.
    b. Back off retainer ring 1/2-inch (1.27cm) (measured from scribe line at outside diameter or edge of ring).

NOTE

THIS AMOUNT OF MOVEMENT OR BACKOFF WILL PROVIDE APPROXIMATELY .005-INCH CLEARANCE.

USE BLUNT TOOL TO FORCE METAL FROM OUTER EDGE OF RETAINER INTO SLOT IN INSIDE DIAMETER OF SHAFT END COVER PILOT.

Hydraulic Pump — Installation. (Refer to Figure 3-5.)

CAUTION

KEEP PUMP AS LEVEL AS POSSIBLE WHEN ENGAGING IN PUMP DRIVE TO AVOID DAMAGING SPLINE.

1. Engage pump spline in pump; secure with washers and bolts.
2. Connect suction manifold-to-pump supply hoses to pump.
3. Connect pump distribution hoses to pump, assuring that hoses are connected to correct port (as marked prior to pump removal).
4. Open main hydraulic shutoff valve.

NOTE

REPLENISH OIL IN RESERVOIR, IF NECESSARY.

Functional Check. Perform a functional check of the pump as follows:

CAUTION

TO AVOID POSSIBLE DAMAGE TO A NEW OR REBUILT PUMP, BACK OFF MAIN RELIEF VALVE ADJUSTING SCREW BEFORE OPERATING PUMP. AFTER PUMP HAS RUN IN FOR ABOUT FIVE MINUTES AT MINIMUM PRESSURE (ALL CONTROLS IN NEUTRAL), ADJUST RELIEF VALVE PRESSURE TO PROPER SETTING. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN ALMOST IMMEDIATE FAILURE OF PUMP, SHOULD RELIEF PRESSURE SETTING BE EXCESSIVE.

1. Start engine and allow for warm-up.
2. Shut down engine.
3. Engage pump drive.
4. Restart engine and adjust throttle to one-half governed rpm; allow engine to run with no load applied.
5. Using control lever, build up pressure intermittently for three (3) minutes.
6. Increase engine speed to recommended operating rpm and again build up pressure intermittently for three (3) minutes.
7. Reduce engine speed to idle rpm and allow to run for approximately five (5) minutes.
8. Shut down engine and check pump for leakage.
9. Check pump delivery in accordance with the following:
   a. Disconnect outlet (circuit supply) line from applicable pump section.
   b. Connect flow meter between pump outlet and circuit supply line. (Refer to Table 3-2, Pump Flow Chart, for applicable section delivery.)

NOTE

PUMP SECTIONS ARE NUMBERED FROM SHAFT END COVER TO PORT END COVER (AFT-FORWARD).

Table 3-2. Pump Flow

PUMP	SECTION	GPM*	LPM*
	1	45	
	2	32.5	
	3	26	98.4

*Engine @ 2400 rpm.

CONTROL VALVES. (Refer to Figures 3-7 and 3-8.)

The valve banks controlling crane functions are installed on the turntable assembly, behind the operator's cab. Access to the valve banks is gained through a door on the left side of the superstructure. Mechanical linkage extends from the base of the control lever, under the cab, to the respective valve installation.

Inspection. Inspect control valves for visible damage, binding spools, and evidence of leakage. If excessive internal leakage is suspected during operation with spool in center position, it is possible that the area between the spool and working section bore of the valve body is worn beyond serviceable limits. If this condition exists, the spool and body must be replaced as an assembly.

Main Relief Valve Checks.

The main relief valves, incorporated in the control valve assemblies, are pilot operated. The compression of the pilot spring within the relief valve body controls the relief opening the pilot poppet valve. When the pilot poppet valve opens, hydraulic oil enters under pressure and opens the large poppet in the valve, thereby protecting the system components from pressures over and above their design ratings.

Adjustment of main relief valves should be made only by qualified personnel using the proper equipment.

Valve Leakage Checks.

Severe external leaks show up through dripping oil — and if it leaks enough to drip, it is leaking badly enough to take the machine out of service for immediate repairs.

External leaks sometimes develop at fittings and seals. Spool seals are leak suspeptible since they are subject to wear. Seals may be damaged by temperatures that are too high, dirt, or paint accumulation on the spool. Damaged seals must be replaced.

Warped mounting surfaces can distort the assembly and cause leakage and extrusion. To check for valve distortion, loosen the mounting bolts slightly. If the leakage stops when the bolts have been backed off slightly, distortion was the problem. To correct this condition, shim the valve assembly level and retighten the mounting bolts.

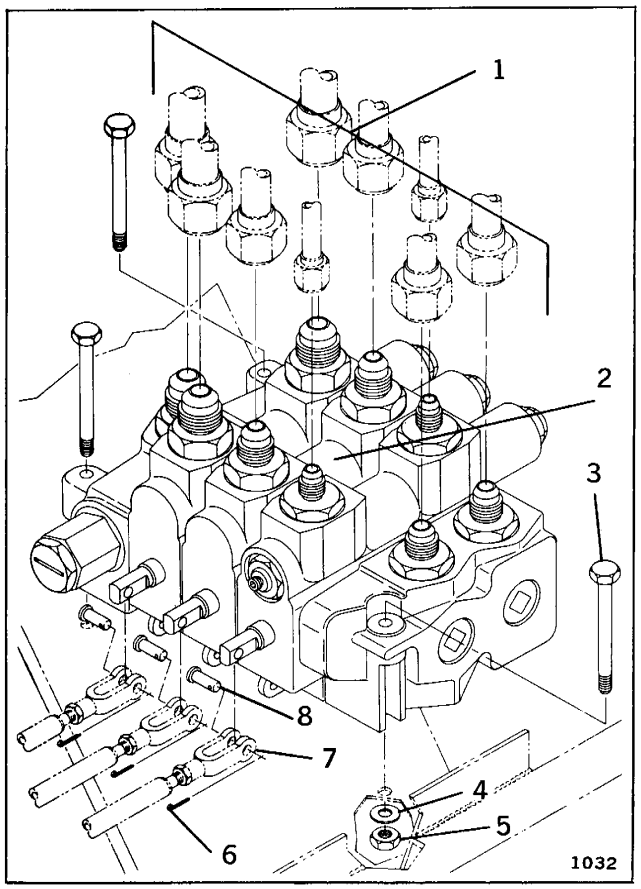


Figure 3-7. Control Valves Removal/Installation

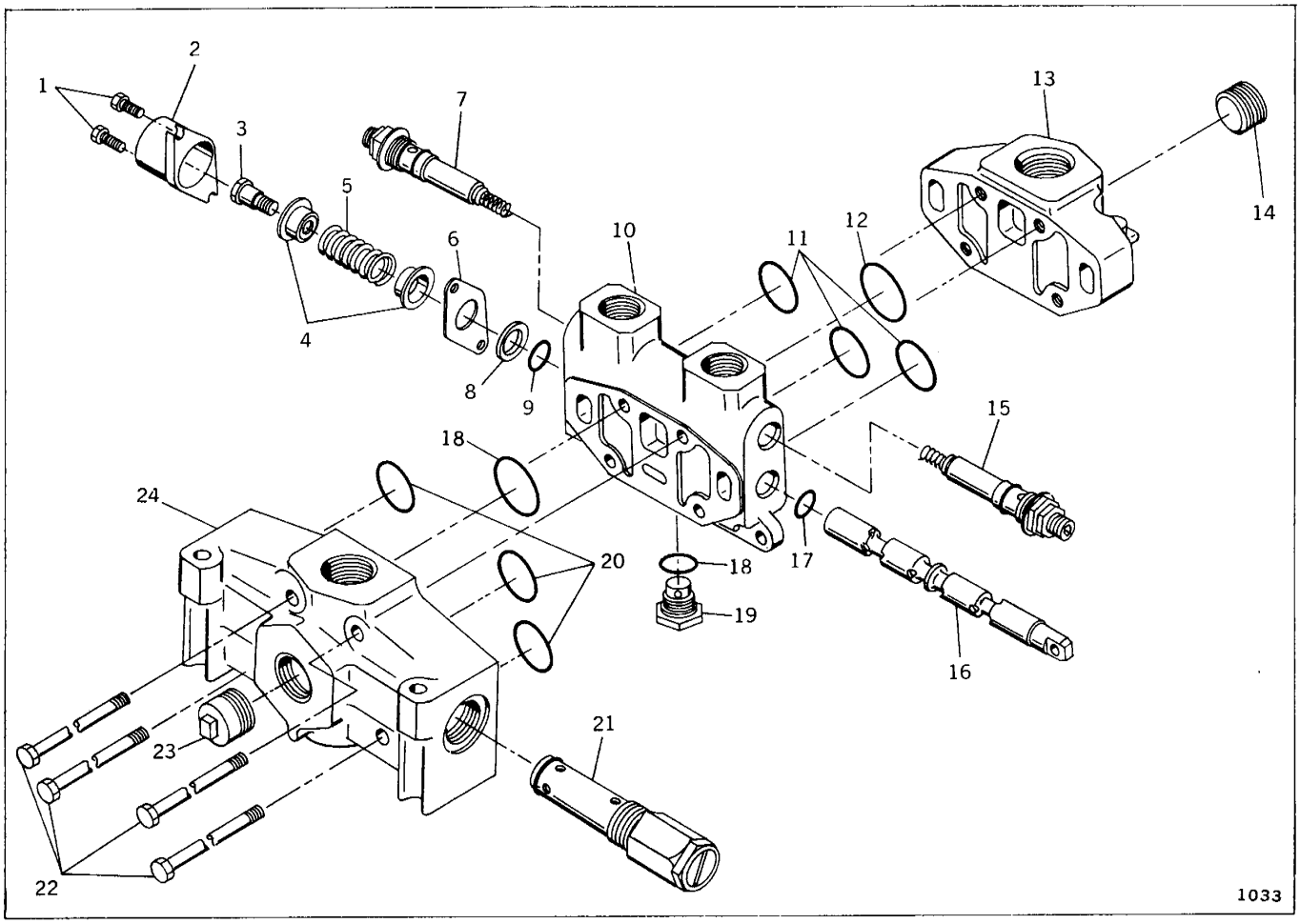


Figure 3-8. Control Valve Assembly

A component functioning at reduced efficiency may indicate the control valve for the component is leaking internally. Assuming preliminary check-out reveals adequate volume is being supplied to the affected valve bank, relief valves are properly adjusted and the component is not at fault, the next step would be to check the valve for scored or worn parts.

Scoring is a sign of the NUMBER ONE PROBLEM in hydraulics – CONTAMINATION: external contamination by dust, or internal contamination by debris from deteriorating components or oxidized oil. Scored or severely worn valve components must be replaced.

Also check the valve for rust. Rust or dirt collecting on the linkages can prevent free movement of the spool, and keep it out of true center position.

Excessive system pressure can create both internal and external leaks in valves that are otherwise sound. Therefore, it is extremely important that relief valves be adjusted only by qualified personnel using the proper equipment.

Causes of Sticking Valve Spools.

Some of the most common causes for stiff valve spool movement or jammed spool action are system overheating, excessive pressure, contaminated or deteriorated oil, or warped mountings. When deteriorated oil or contamination is the cause, flushing the system and replenishing with clean oil may solve the problem. If the spool bores are badly scored or galled, the valve must be removed for servicing. If the oil is scorched or deteriorated, similar treatment is required.

Warpage also occurs when mounting plates are not level, or become distorted from machine damage. As mentioned previously, the valve can be shimmed level.

Oil breakdown will occur if the oil becomes contaminated with air, water or dirt, or if the oil is exposed to excessively high temperatures or pressures. Even with normal usage, the additives that inhibit rust, oxidation, and foaming lose their effectiveness. Follow the recommended oil change intervals and procedures. They are intended to get the oil out of the system before it starts breaking down and before deterioration harms the system.

Table 3-3. Control Valve Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Sticking spool.	Excessively high oil temperature	Eliminate any restriction in pipe line or filtering system.
	Dirt in oil.	Change oil and flush system.
	Pipe fittings too tight.	Check torque. Retorque as necessary.
	Valve warped from mounting.	Loosen valve and check.
	Excessively high pressure in valve. (Relief valves not working properly.)	Check pressure at inlet and at working ports.
	Handle or linkage binding.	Free linkage.
	Spacer bent.	Replace valve.
	Return spring damaged.	Replace faulty parts.
	Spring or valve cap binding.	Loosen cap, recenter and retighten.
	Valve not thoroughly warmed up.	Allow time for system warm-up.
Leaking seals.	Paint on or under seal.	Remove and clean, as necessary.
	Excessive back pressure.	Open or enlarge line to reservoir.
	Dirt under seal.	Remove and clean, as necessary.
	Scored spool.	Replace valve.
	Loose seal plates.	Clean and tighten plates.
	Cut or scored seal.	Replace faulty parts.
Unable to move spool in or out.	Dirt in valve.	Clean and flush out valve assembly.
	Spool cap full of oil.	Replace seals.
	Bind in linkage.	Free linkage.
Load drops when spool moved from neutral.	Dirt in check valve.	Disassemble and clean check valve.
	Scored check valve poppet or seat.	Replace poppet or lap poppet to seat.
Poor hydraulic system performance or failure.	Damaged pump.	Check pressure or replace pump.
	Dirt in relief valve.	Disassemble and clean relief valve.
	Relief valve damaged.	Replace relief valve.
	Worn cylinder(s) or motor(s).	Repair or replace damaged components.
	Load too heavy.	Reduce load. (Refer to load chart for rated capacities.)
	Internal valve crack.	Replace valve.
	Spool not at full stroke.	Check movement and linkage.
	Oil low in reservoir.	Add oil. Fill to FULL mark on dipstick.
	System filter clogged.	Clean or replace filter element.
	Line restricted.	Check lines. Clean or repair as necessary.

Good oil is always a good investment. The money saved by switching from the recommended grade to a cheaper grade will probably be money spent repairing or replacing prematurely worn components, or cleaning sludge out of the system.

Control Valves – Removal. (Refer to Figure 3-7.)

NOTE

ACCESS TO VALVE ASSEMBLIES IS GAINED THROUGH DOOR BEHIND OPERATOR'S CAB.

1. Remove cotter pin (6) and clevis pin (8) attaching mechanical linkage (7) to control valve(s); reinsert hardware in linkage to prevent loss.
2. Tag and disconnect hydraulic lines from valve(s); cap all lines and openings.
3. Remove bolts (3), nuts (5), and washers (4) securing valve bank to mounting plate; remove valve bank.
4. Repeat steps (1) through (3) for each bank to be removed.

Control Valves – Disassembly – Typical. (Refer to Figure 3-8.)

CAUTION

USE CARE WHEN HANDLING VALVE HOUSING SO AS NOT TO DAMAGE FACES OR O-RING GROOVES.

1. Remove tie bolts (22), securing inlet (24) and outlet (13) sections to housing (10) assembly/assemblies.
2. Separate inlet, housing(s), and outlet assemblies.
3. Remove main relief valve assembly (21) from inlet section; remove and discard o-ring.
4. Remove o-rings (11, 12, 18, and 20) from face(s) of housing(s); discard o-rings.
5. Remove circuit or crossover relief valves (7 and 15) from housing, if applicable.
6. Remove load check valve (19) from bottom of housing.
7. Remove capscrews (1) securing cap over centering spring of spool assembly (16); remove spool assembly.
8. Remove ring seals (9 and 17) from housing; discard seals.
9. Remove remaining plugs (14 and 23) from unused ports.
10. If spool is to be disassembled, proceed as follows:
    a. Remove retaining plate (6) and back-up ring (8) from spool.
    b. Remove bolt (3) securing spring guides (4) and spring (5) to spool; remove spring and guides.

Control Valves – Reassembly – Typical. (Refer to Figure 3-8).

CAUTION

INSTALL NEW O-RINGS AND SEALS ON OR IN ALL COMPONENT PARTS.

1. If spool has been disassembled, reassemble as follows:
    a. Assemble spring guides (4 and 5); position assembly on end of spool (16); secure with bolt (3).
    b. Position retaining plate (6) and back-up ring (8) against spring assembly.
2. Install ring seals (9 and 17) in spool bore of housing (10).
3. Position spool assembly in housing; place cap (2) over centering spring and secure with capscrews (1).
4. Remove all burrs from face(s) of housing(s) and assure that all mating surfaces are clean.

NOTE

WHEN PLACING RING SEALS IN GROOVES ON HOUSING FACES, USE LIGHT COAT OF GREASE TO HOLD RINGS IN POSITION UNTIL SECTIONS ARE ASSEMBLED.

NOTE

A PINCHED RING WILL CAUSE LEAKAGE BETWEEN SECTIONS AND MAY CAUSE SPOOL TO BIND.

5. Remove circuit or crossover relief valves (7) and (15) from housing, if applicable.
6. Install o-rings (11, 12, 18, and 20) in grooves of inlet face.
7. Install load check valve (19) in housing base.
8. Stack number of housings required to form bank assembly.
9. Place outlet section on bank or housing assembly; tighten tie bolts (do not torque at this time).
10. Install main relief valve (21), if applicable, in inlet section.
11. Install circuit or crossover relief valves (7 and 15) in respective housing(s), if applicable.

CAUTION

ASSURE THAT ALL SECTIONS (INLET, HOUSING(S), AND OUTLET) ARE ALIGNED PRIOR TO APPLYING TORQUE.

12. Using suitable torque wrench, tighten tie bolts to a torque of 329 lb -in. (A-20 valve) or 400 lb.-in. (A-35 valve), as applicable.
13. Install plugs (14 and 23); tighten until bottomed.
14. Actuate spool(s) to assure free movement.

Control Valves — Installation — Typical. (Refer to Figure 3-7.)

1. Position valve bank on mounting plate; secure with bolts (3), washers (4), and nuts (5).
2. Connect hydraulic lines to valve(s), assuring that lines are connected as marked prior to removal.
3. Connect mechanical linkage (7) to valve bank; secure with clevis pin (8) and cotter pin (6).
4. Repeat steps (1) through (3) for each bank to be installed.

Functional Check. Perform a functional check of the applicable circuit(s) as follows.

1. With pump drive disengaged, start engine and check operation at high and low speed idle with no load applied.
2. Shut down engine.
3. Engage pump drive.
4. Restart engine and adjust speed to recommended operating rpm.
5. Operate control lever(s) for applicable circuit(s); check for smooth operation of cylinders of motors. Check all lines and valve assembly/assemblies for leakage.

MAIN RELIEF VALVES.

The main relief valves, incorporated in the control valve assemblies, are pilot operated. Turning the adjustment screw changes the compression of the pilot spring within the relief valve body, which in turn controls the relief opening of the pilot poppet valve. When the pilot poppet valve opens, hydraulic oil enters under pressure and opens the large poppet in the valve, thereby protecting the system components from pressures over and above their design ratings.

Main Relief Valve Adjustment.

CAUTION

ALL MAIN RELIEF VALVES HAVE BEEN PROPERLY ADJUSTED AT THE FACTORY. DO NOT ADJUST ANY RELIEF VALVE UNLESS A PRELIMINARY PRESSURE CHECK REVEALS THAT THE PRESSURE SETTING DOES NOT AGREE WITH THOSE LISTED IN THE ACCOMPANYING CHART.

ONLY QUALIFIED SERVICE PERSONNEL SHOULD ATTEMPT ADJUSTMENT OF THESE VALVES.

1. Perform the following preparation procedures before initiating actual adjustment.
   a. Check engine operation at high and low speed idle at no load; do not exceed 1200 rpm. Adjust idle speed as necessary.
   b. Activate hydraulic system and operate machine until hydraulic oil temperature reaches a minimum of 70°F (21.1°C).

CAUTION

WARM HYDRAULIC OIL BY NORMAL MACHINE OPERATION. DO NOT SUBJECT MACHINE TO UNDUE STRAIN FOR QUICKER RESULTS.

   c. Check control valve spools to assure that all spools have full travel (stroke) in either direction.

CAUTION

NEVER ACTUATE VALVE SPOOLS RAPIDLY. ALWAYS USE SLOW EVEN STROKES.

NOTE

AN ACCURATE PRESSURE GAGE CAPABLE OF READING 3000 PSI SHOULD BE USED FOR THIS CHECK.

2. Connect pressure gage to test port of pump section supplying circuit of valve being adjusted.
3. Remove adjustment screw cover nut (if installed) from relief valve and loosen locknut on applicable control valve.
4. Set hand throttle to maintain engine speed at approximately 1200 rpm with no load applied.
5. Apply a load to the cylinder(s), motor, etc., in the applicable circuit being checked, sufficient to activate main relief valve.
6. Move applicable control lever slowly to end of its travel, in the direction for which motion has been blocked. Note maximum reading on pressure gage. The gage will show a drop in pressure when the relief valve opens.

CAUTION

DO NOT HOLD PUMP ON RELIEF FOR MORE THAN ONE MINUTE AT A TIME. RELEASE CONTROL LEVER AFTER TAKING EACH READING AND WHILE MAKING NECESSARY ADJUSTMENTS.

7. If pressure of relief valve does not agree within (±) 150 psi of that listed in chart, reset relief valve by turning adjustment screw (in, to increase — out, to decrease) until proper setting is attained. (1/4 to 1/2 turn will change relief pressure 100-200 psi.)

CAUTION

DO NOT OVERTIGHTEN ADJUSTMENT SCREW, AS POSSIBLE DAMAGE TO THE PILOT SPRING MAY RESULT.

8. When proper pressure setting has been attained, tighten adjustment screw locknut and recheck pressure. It is possible that the setting may have been disturbed while tightening the locknut.

Table 3-4. Relief Valve Settings

CIRCUIT RELIEF VALVE SETTINGS (PSI)

MODEL	HOIST	LIFT	OUTRIGGERS	REAR STEER	FLY SECTION	MID SECTION	SWING	STEER PUMP	VALVE PORT
RT59	2250	500	2250*	2250*	2250*	2250*	1500	1500	Top
	2250	2250*	2000	2250*	2000	2000	1500	1500	Bottom
RT59S	2250	500	2250*	2250*	2250*	2250*	1500	1500	Top
	2250	2250*	2000	2250*	2000	2000	1500	1500	Bottom
RT60	2250	500	2250*	2250*	2250*	2250*	1500	1500	Top
	2250	2250*	2000	2250*	2000	2000	1500	1500	Bottom
RT60S	2250	500	2250*	2250*	2250*	2250*	1500	1500	Top
	2250	2250*	2000	2250*	2000	2000	1500	1500	Bottom

*Uses Main Relief Valve Pressure Setting (Plugged).

NOTE: OSCILLATION LOCKOUT OPERATES BY BACK PRESSURE OF HYDRAULIC SYSTEM

MAIN RELIEF VALVE SETTINGS

VALVE BANK SECTION	PSI SETTING
1	2250
2	2250
3	2250

Check Valves

Most control valve assemblies have an integral load-holding check valve. If this check valve is not holding properly, the load would drop before moving upward.

Check valves are designed to permit a flow of oil in one direction only. If a piece of dirt or rust has worked its way into the check valve, and lodges between the poppet and the seat, it would keep the valve open just enough to allow a return flow of oil.

The remedy is to clean the valve, but it is also a good idea to follow through by checking to make sure the hydraulic system filters are still serviceable.

SWING MOTOR. (Refer to Figure 3-9.)

To provide 360 degree boom swing operation, the superstructure of the crane is mounted on a large swing circle precision ball bearing assembly that is welded (or bolted) to the carrier platform. A swivel assembly mounted in the center of the turntable provides hydraulic and electric connections between the upper and lower machine sections, permitting full and continuous rotation by the swing motor.

The swing motor is a hydraulic gerotor type motor driving a reduction gearbox, which in turn is equipped with a drive pinion that engages the bull gear, integral with the swing bearing assembly.

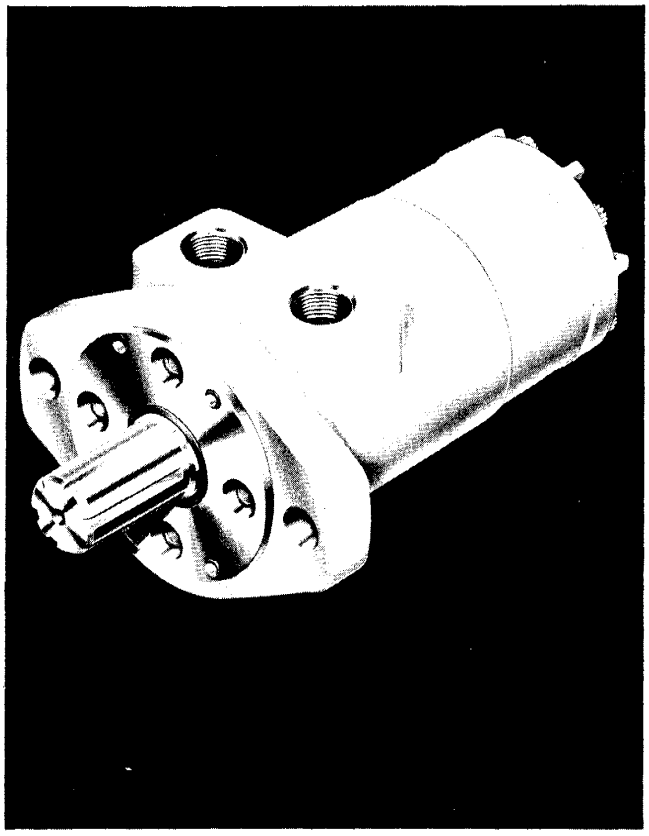


Figure 3-9. Swing Motor

Table 3-5. Swing Motor Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
No pressure.	Check pump drive for loose coupling.	Repair.
Fluctuating pressure.	Check fluid level.	Refill if needed.
	Check for broken lines.	Repair.
	Broken pump – worn pump.	Disassemble, inspect pump parts.
	Relief valve stuck.	Disassemble valve, clean, replace damaged parts.
Relief valve chatter.	Damaged valve.	Repair.
	Dirt between piston and seat in relief valve control head.	Disassemble, clean.
Noisy pump.	Restricted intake.	Clean intake strainer; check intake piping for obstruction.
	Cavitation at pump inlet.	Fluid viscosity too high, intake partially restricted.
	Pump picking up air a. around shaft or head packing;	Replace packing, grease pump fitting.
	b. at loose or broken intake pipe.	Repair or replace pipe.
	Worn pump.	Disassemble pump, inspect internal parts for wear.
	Excessive pressure.	Check relief valve setting for line restriction (clogged or undersize lines).
Slow operation of motor.	Worn pump.	Repair or replace pump.
	Worn motor.	Replace worn parts or motor.
	Extremely high fluid temperature causing pump and motor to slip (temperatures increase as pump and motor wear).	Increase reservoir size and use a high viscosity index oil such as 20W-40.
	Inadequate size oil lines.	Increase oil line size.
	Pump cavitation.	Increase oil line size to pump. In cold weather, use 5W-20 oil.
	Plugged filter.	Replace filter element or clean filter.
	Relief setting too low.	Set relief valve for proper psi.
Motor will not turn.	Shaft seized in housing due to excessive side load or misalignment. (Note: 500 lb. maximum radial loading on shaft.)	Replace housing assembly set if damaged.
	Large contaminating particles in fluid such as machining chips or sand. Very dirty fluid.	Flush new systems – use better filtration.
	Broken shaft from extreme side loads or misalignment.	Correct and replace.
Motor runs without turning shaft.	Broken shaft.	Replace shaft assembly. Check housing for wear and replace if necessary. Check for misalignment.

TROUBLE	PROBABLE CAUSE	REMEDY
Motor turns in wrong direction.	Hose connections wrong. Wrong timing.	Reverse connections. Retime.
Leak at shaft.	Worn or cut shaft seal.	Replace seal, polish shaft at seal area with a No. 600 wet or dry sanding cloth. Check for misalignment.
Leak between flange and housing.	Loose flange. Damaged seal between housing and flange. Leak in body plug seal.	Tighten. Replace seal. Check housing surface at seal for sharp nicks or deep scratches. Replace faulty o-ring.
Leak between housing and wear plates or between wear plates and gerotor.	End cap bolts loose. (Note: All motors are tested and rated at a maximum back pressure of 1000 psi.)	Tighten the 7 capscrews at gerotor end of motor. If the threads are accidentally stripped in the housing, the hole may be drilled and tapped deeper and the motor reassembled with longer bolts.
Leak between gerotor and end cap.	Dirt between surfaces. Scratches or nicks on surfaces.	Reassemble – clean and dry parts. Polish very carefully on a flat, hard surface. Use No. 600 or finer abrasive cloth and very little pressure – avoid rounding the edges.
Cracked front flange.	Use of installation bolts which are too long and bottom against housing.	Replace flange, and use proper size bolts.
Leak at oil ports.	Poor fittings. Damaged threads.	Replace fittings carefully. Replace housing or use nut such as "true seal".

Swing Motor – Removal. (Refer to Figure 3-10.)

1. Tag and disconnect hydraulic hoses from motor assembly. Cap all openings.

CAUTION

PULL STRAIGHT UP ON MOTOR ASSEMBLY TO AVOID DAMAGING SPLINED SHAFT.

2. Remove bolts and washers securing motor to swing box cover; lift swing motor free of swing box.

Swing Motor – Disassembly. (Refer to Figure 3-11.)

CAUTION

CLAMP ACROSS FRONT OF FLANGE. EXCESS PRESSURE ON HOUSING WILL CAUSE DISTORTION.

1. Place motor in suitable vise; clamp across front flange.

NOTE

WHEN CLAMPING MOTOR IN VISE, ALWAYS USE SOME PROTECTIVE MATERIAL SUCH AS SOFT JAW ADAPTERS, HARD RUBBER, OR HARD BOARD.

2. Remove capscrews (22) and sealwashers (21) securing end cap (20) to housing (14); slide end cap from housing, using care not to scratch mating surfaces.
3. Remove gerotor set (19) and spacer (16).
4. Remove splined drive (15), spacer plate (18), and thrust bearing (17).
5. Reverse motor in vise.

NOTE

SOME MODELS INCORPORATE A REMOVABLE SPACER TO SPACE THE DRIVE. BE SURE TO SECURE SPACER WHEN TURNING DRIVE.

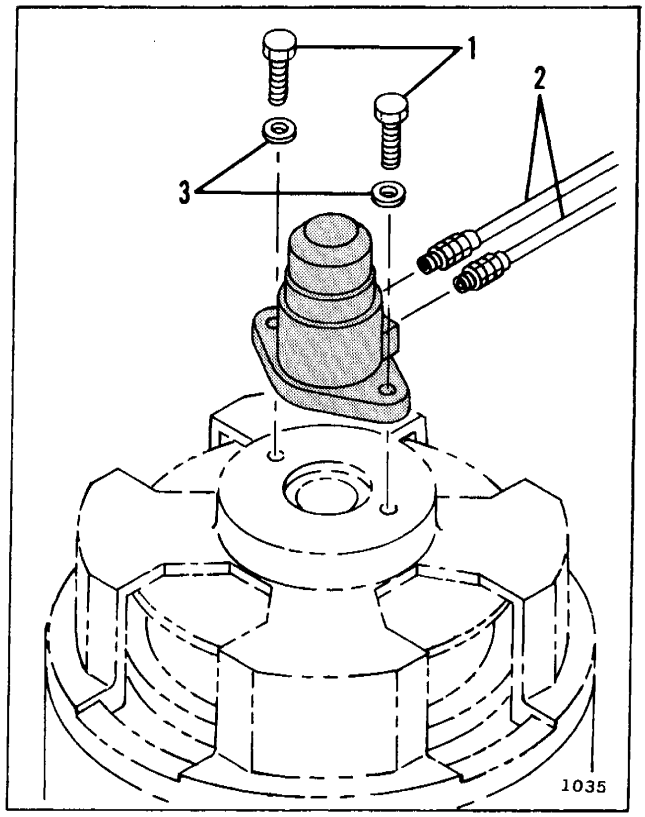


Figure 3-10. Swing Motor Removal/Installation

6. Remove capscrews (1) and lockwashers (2) securing mounting flange (5) to housing; tap flange lightly on underside with fiber mallet to remove.

NOTE

SEAL, WASHER, QUAD SEAL, AND O-RING WILL COME OFF WITH FLANGE.

7. Remove roll pins (4) from housing.
8. Remove bearing race (9) and thrust bearing (10).
9. Remove shaft from housing.
10. Remove washer (6), quad seal (7) and o-ring (8) from flange.
11. Using small screwdriver, remove seal (3) from outside face of mounting flange.
12. Remove housing plug (13) and o-ring (12) from housing. (Plug can be seen through right port opening.) Use an Allen wrench, or equivalent, to push plug through port for removal.

Inspection.

1. Clean all parts with solvent and dry with compressed air.
2. Check mating surfaces of all metal parts for nicks, burrs, scratches, etc. If any evidence of same is found, smooth the surfaces in accordance with the following procedure:
   a. Place a piece of No. 600 grit abrasive paper on a smooth surface. (If abrasive paper is new, remove sharp edges of grit by rubbing with a flat piece of scrap metal.)
   b. Place damaged part on grit paper and slide gently in figure eight motion several times.

NOTE

CHECK AROUND KEYWAY IN SHAFT FOR NICKS, BURRS, OR SHARP EDGES, AS THESE WILL DAMAGE SEAL DURING REASSEMBLY.

3. Clean with solvent and dry with compressed air, any parts that have been polished with abrasive paper.

CAUTION

DO NOT WIPE PARTS DRY, AS LINT FROM CLOTH DEPOSITED ON CRITICAL INTERNAL PARTS OF MOTOR CAN CAUSE LEAKAGE OR MALFUNCTION OF MOTOR.

Swing Motor – Reassembly. (Refer to Figure 3-11.)

1. Replace o-ring (12) on housing plug (13); reinstall plug in housing, being careful not to damage o-ring.

NOTE

LUBRICATE OUTPUT SHAFT PRIOR TO INSTALLATION.

2. Carefully place output shaft (11) in housing (14).

NOTE

MAKE A MARK (WITH GREASE PENCIL) IN LINE WITH A FORWARD VALVING SLOT TO FACILITATE TIMING.

3. Install thrust bearing (10) and race (9) on shaft. To assure that they are properly installed, pull shaft partially out of housing, install bearing and race and push all three parts simultaneously into housing.
4. Install new o-ring (8), washer (6), and quad seal (7). To provide adequate sealing, seals are slightly larger than their groove and must be compressed into groove with finger.
5. Install new seal (3) on outside face of mounting flange (5).
6. Install mounting flange. Lubricate shaft and seals when assembling. Be careful not to damage seals. Rotate flange slowly while pulling down on shaft.
7. Secure flange to housing with lockwashers (2) and capscrews (1); do not tighten capscrews at this time.

NOTE

IF NEW SCREWS ARE USED, ASSURE THAT THEY ARE OF CORRECT LENGTH. LONGER SCREWS WILL BOTTOM OUT AND WILL NOT PERMIT A PROPER SEAL BETWEEN FLANGE AND HOUSING.

8. Align roll pin holes in mounting flange and housing; torque capscrews to 250 lb. ins. Do not install roll pins at this time.
9. Turn motor around in vise and clamp across front flange.
10. Install spacer, if applicable.
11. Install thrust bearing (17) and spacer plate (18).

NOTE

THE RELATIONSHIP BETWEEN GEROTOR STAR, DRIVE, AND SPOOL DETERMINES TIMING OR ROTATION OF SHAFT. ASSURE THAT SHAFT AND HOUSING ARE ASSEMBLED IN RELATIONSHIP SHOWN IN FIGURE 3-12.)

12. Insert drive in housing. Note that centerline falls between teeth of spline.
13. Place gerotor star over drive splines with any one of star points 15 degrees to right of centerline. With this orientation, shaft will rotate in direction shown in figure 3-12, with ports pressurized as marked.
14. Install spacer (16) inside gerotor star.
15. Place end cap (20) in position on housing and realign attach screw holes, being careful not to disengage gerotor from drive splines.
16. Secure end cap in position with seal washers (21) and capscrews (22); tighten screws finger-tight only at this time.
17. Torque capscrews in three phases, in accordance with the following procedure, with reference to the illustrated sequence (figure 3-12).
    a. Torque all capscrews to 50 pound-inches.
    b. Torque all capscrews to 125 pound-inches.
    c. Torque all capscrews to 175 pound-inches.
18. Install roll pins (4) in mounting flange.

Swing Motor — Installation. (Refer to Figure 3-10.)

CAUTION

USE CARE WHEN ENGAGING SWING MOTOR DRIVE GEAR WITH SUN GEAR; DO NOT FORCE SHAFT TO ENGAGE.

1. Position swing motor on swing box cover, engaging shaft with sun gear.
2. Secure motor to swing box cover with washers and bolts.
3. Connect hydraulic lines to swing motor.

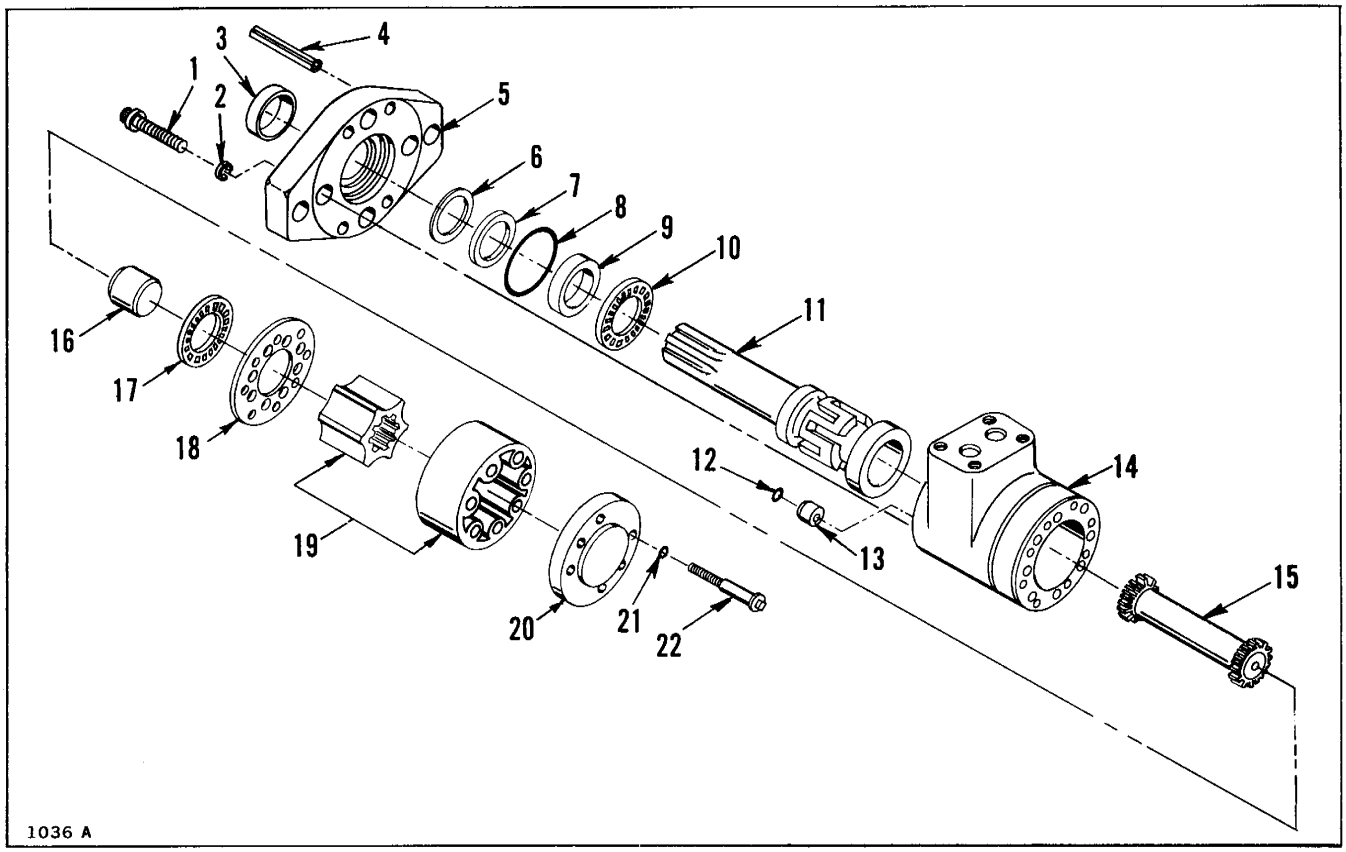


Figure 3-11. Swing Motor Assembly

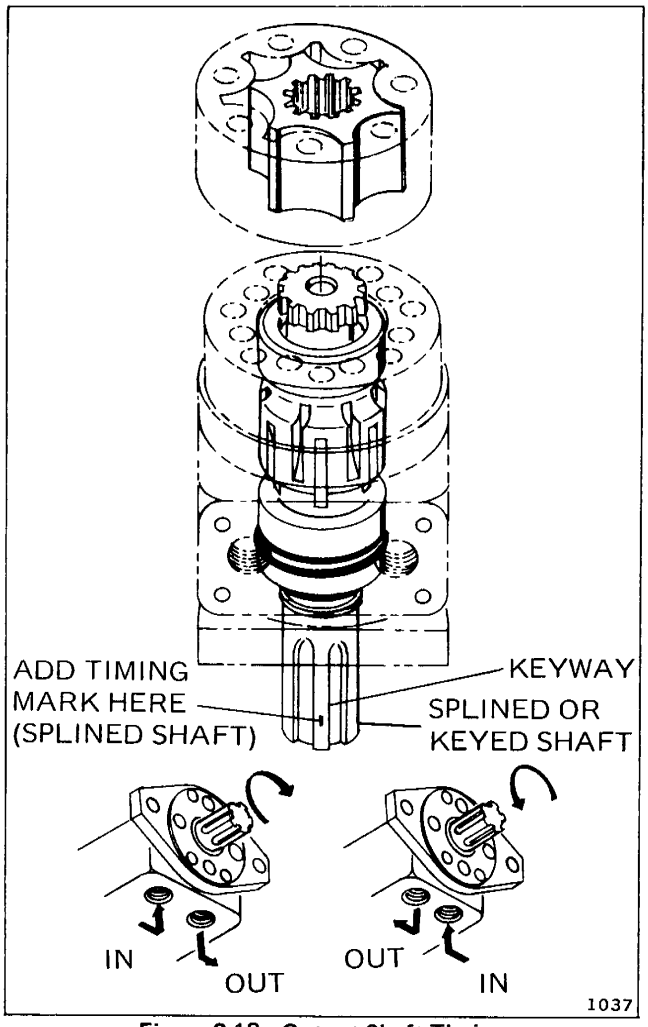


Figure 3-12. Output Shaft Timing

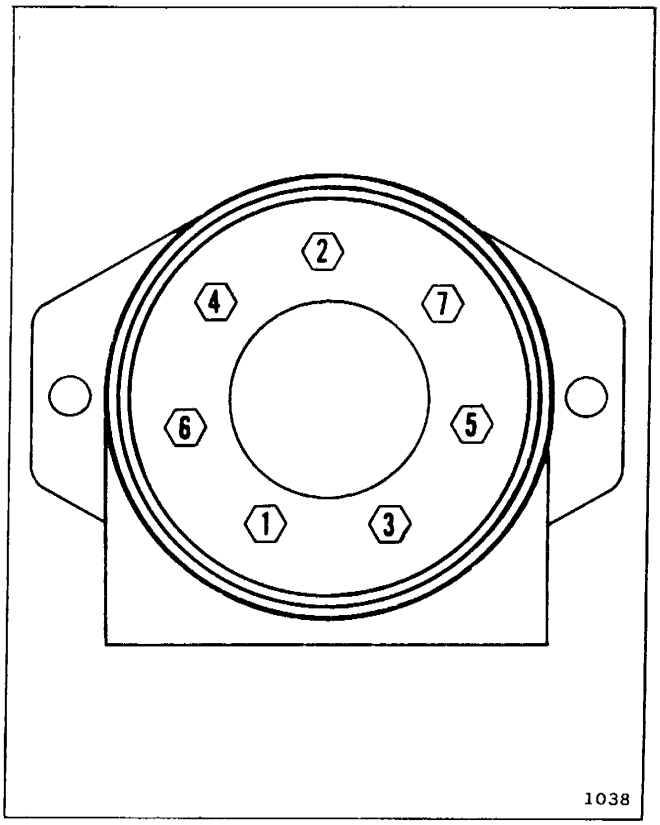


Figure 3-13. Capscrew Tightening Sequence

SWING GEARBOX.

Grove swing gearbox design, utilizing double reduction planetary gearing, results in a compact circular unit of high strength and efficiency. The round gearcase with horizontal rotating gears insures lubricant circulation, eliminating stagnant oil areas common to square or rectangular units. Low operating temperatures result from elimination of the high friction worm gear drives usually used in gear reduction designs.

Two hydraulic caliper type brakes, mounted in the upper housing, engage the floating brake disc on the primary driveshaft. These swing brakes are operated by a foot pedal actuated master cylinder. A third caliper brake, serving as a swing lock, is mechanically operated and actuated by an over-center type locking lever.

Servicing. (See Figure 3-14.)

As with all highly stressed mechanisms, reasonable operating procedures are always required. Normal maintenance should only consist of proper lubrication and a periodic check of mounting bolt torque values.

Lubrication consists of lubrication of upper and lower shaft bearings, and maintenance of the gearbox oil level. Oil in a new gearbox should be drained and flushed out after approximately 300 hours of operation, and replaced with premium quality SAE90 gear oil. Lubricant capacity is 5½ quarts. Subsequent oil changes should be scheduled after approximately 2500 hours of operation or each year, whichever occurs first. Operation in high humidity or polluted air areas will require more frequent changes to minimize moisture or contaminate accumulation. Change oil as follows:

1. Remove drain plug; allow approximately three minutes for sidewalls to drain, after oil stops flowing from drain port.
2. Flush case with light flushing oil.

Cleaning of the gearbox with a solvent is recommended to prevent an accumulation of grit and grime. Avoid steam cleaning where moisture and dirt might be driven into the vent or swing bearing.

3. Install drain plug and refill case with oil specified in lubrication chart, Section V.

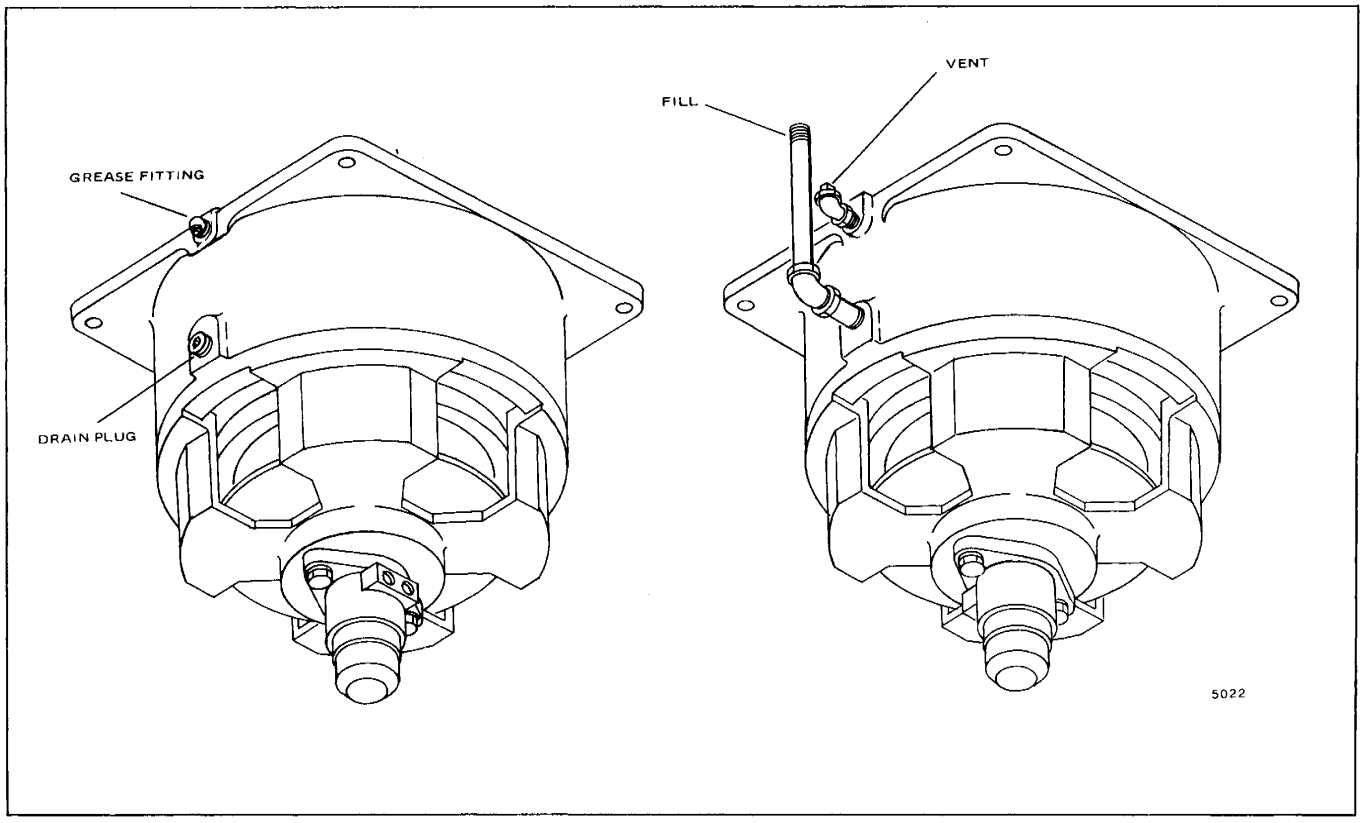


Figure 3-14. Swing Gearbox Servicing

A torque check of mounting bolts and the swing bearing bolt should be made. Torque values for these bolts should be maintained at 150 pound-feet. Lockwire should always be installed through the bolts in the direction that resists loosening.

SWING GEARBOX REMOVAL/INSTALLATION.

Swing Gearbox Removal – RT59/60.

1. Fully extend, set, and lock outriggers.

WARNING

ASSURE SUPERSTRUCTURE IS SECURED TO AVOID POSSIBLE SWINGING.

2. With boom fully retracted, elevate to maximum elevation.
3. Remove cover and disconnect hydraulic lines, brake linkage, and brackets from swing gearbox and swing motor.
4. Remove mechanical and hydraulic brake assemblies. (Refer to Swing and Set Brake Assemblies – Removal.)
5. Remove lockwire, bolts and washers securing swing gearbox to mounting plate; attach suitable sling to lifting eyes on cover.
6. Attach adequate lifting device to sling; remove swing gearbox.

Swing Gearbox Removal – RT59S/RT60S.

(Refer to Figure 3-15.)

Non-swing cab Rough Terrain model cranes have the swing gearbox mounted beneath the carrier swing bearing support plate. In this position, the hydraulic motor drive and swing brake installation is mounted below the gearbox.

To avoid damage to these components and to facilitate access, it is advisable to remove or disconnect the motor, swing brake, and associated plumbing prior to proceeding with gearbox removal.

NOTE

TO PROVIDE WORKING SPACE FOR LOWERING AND REMOVING THE GEARBOX, THE CRANE CARRIER DRIVE SHAFT MUST BE REMOVED.

To support the gearbox, during attachment bolt removal and to lower the unit, a chain hoist should be attached to the boom. Installation of an eye bolt in lieu of the pinion gear retainer stud will provide a hoist attachment point.

Adequate clearance provisions must be made to remove the gearbox from beneath the crane after being lowered from the installed position.

REMOVAL PROCEDURE. (Refer to Figure 3-15.)

1. Disconnect hydraulic lines from hydraulic motor and swing brake. Cap lines and fittings. Tag for proper replacement.
2. Remove motor and brake assembly.
3. Drain gearbox oil and remove filler pipe.
4. Remove drive gear pinion stud and replace with eye bolt. Attach hoist line to eye bolt and snug up sufficiently to support weight of assembly.
5. Loosen and remove gearbox mounting bolts, and lockwashers avoiding unsymmetrical loading of lugs.
6. Lower and remove gearbox.

Gearbox Disassembly. (Refer to Figure 3-16.)

NOTE

FOR EASE OF ALIGNMENT DURING REASSEMBLY, SCRIBE OR PENCIL MARK A LINE THROUGH HOUSING COVER AND BASE.

1. Remove vent (1) and drain plug (2). Place gearbox on side and drain.
2. Position gearbox on clean work surface, with swing motor up, and remove bolts and washers securing motor to gear housing cover. Remove motor. (Refer to Figure 3-10.)
3. Remove bolts (3), washers (4) and lifting eyes (5) securing gear housing cover (6) to gearbox housing (7). Remove cover.
4. Pull brake disc (8), coupling (9) and coupling support bearing (10) assembly from gear housing.
5. Using bearing puller or small pry bar, remove upper support bearing (10) from coupling (9).
6. Remove bolts (11) and washers (12) securing bearing spacer (13), seals (14), shim stock (15) and o-ring (16) to gear housing cover (17). Remove spacer, o-ring and shim stock.
7. Using fiber mallet, tap spacer seal (14) from spacer (13).
8. Partially install lifting eyes in gear housing; using pry bar, remove gear housing (7), o-ring (18) and seal (19).
9. Using brass rod and mallet, remove inner race of planet shaft bearing (20), seal retainer (21) and seals (22) with o-rings (23).
10. Lift sun gear pinion and shaft (24), seals (25), and support bearing (26) from planet cage assembly (27).
11. Using bearing puller and small pry bar, remove pinion and sun gear support bearing (28).
12. Align planet gears (29) with cutouts in housing lip and lift planet cage assembly out of housing.
13. Using bearing puller or fiber mallet, remove lower shaft bearing (26) and seal retainer (25) from planet shaft.

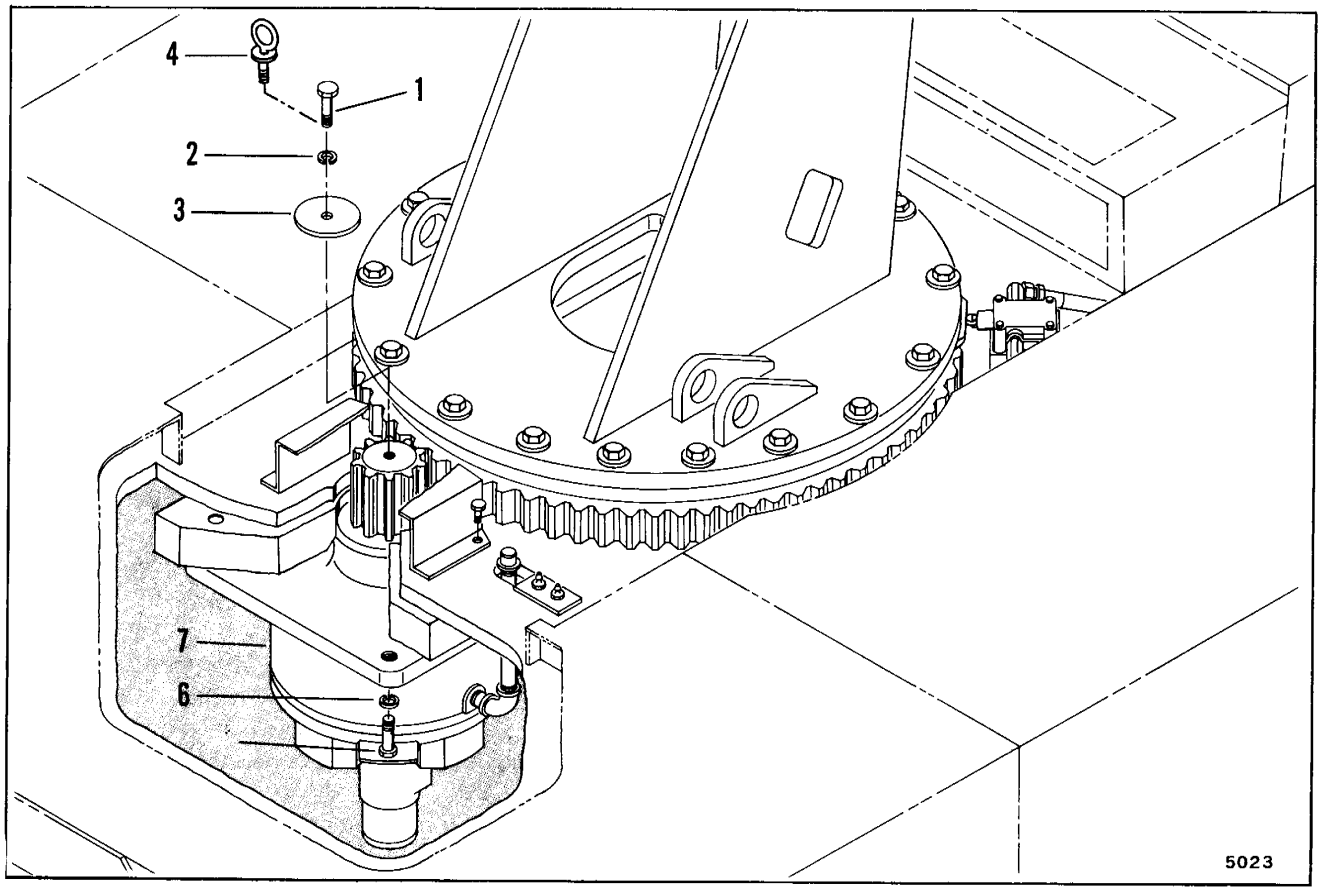


Figure 3-15. Swing Gearbox Removal/Installation

14. Remove roll pin (30) from planet cages and planet gear shafts (31).

NOTE

IF ROLL PINS ARE LONG AND EXTEND THROUGH PLANET GEAR SHAFT, TURN A SHEET METAL SCREW INTO ROLL PIN AND REMOVE PIN WITH TWO SMALL PRY BARS.

IF ROLL PIN DOES NOT EXTEND THROUGH PLANET GEAR SHAFT, DRIVE PIN INTO GEAR SHAFT (ASSURE THAT PIN DOES NOT ENGAGE LIP OF SHAFT ON INSIDE). THE ROLL PIN IS SHORTER THAN THE DIAMETER OF THE GEAR SHAFT, ALLOWING SHAFT TO BE REMOVED.

15. After roll pins have been removed, tap gear shaft from planet gears and planet cage assembly; remove gears (29), spacers (32) and bearings (33).

NOTE

AFTER PLANET GEAR SHAFTS HAVE BEEN REMOVED, THE ROLL PINS CAN BE TAPPED OUT AND REUSED IF THEY ARE SERVICEABLE.

16. Remove bolts (34) and nuts (35) securing internal ring gear (36) in housing; remove gear.
17. Turn housing and, using brass rod and mallet, remove lower shaft bearing outer race (20).
18. If desired, disassemble brake disc and coupling by removing nuts (37), washers (38), and bolts (39). Using snap ring pliers, remove retaining ring (40) from coupling.

SWING GEARBOX ASSEMBLY. (Refer to Figure 3-16.)

NOTE

PRIOR TO REASSEMBLY, CLEAN ALL COMPONENTS WITH SOLVENT.

1. Coat lower shaft bearing outer race (20) with Lock-Tite, or equivalent, and install in housing (7).
2. Position internal ring gear (36) in housing and secure with eight bolts (34) and nuts (35). Torque bolts to 150 pound-feet (dry).
3. Install shaft seals (22) and seal retainer (21), assuring that seal lips face in same direction, away from planet seal. Lubricate seal and retainer with oil to aid installation.
4. Install two new o-rings (23) on shaft seal retainer.
5. Press bottom shaft bearing inner race (20) on planet cage and shaft assembly.
6. Turn planet cage and shaft assembly over and place spacer (13) and upper shaft bearing (28) on shaft. Press spacer and bearing into position.
7. Install inner bearing (33), spacer (32), and outer bearing (33) into each planet gear using a press or fiber mallet.
8. Place planet gears on work surface with small diameter gears up. Locate timing notch (approximately 1/8-inch from OD of large diameter gear, centered on one of the gear teeth). With light colored grease pencil, mark timing notch, gear tooth, and other gear face (at least half-way from OD to ID).
9. Position planet gears in planet cage assembly and install gear shafts (31).

NOTE

DURING SHAFT INSTALLATION, ALIGN SHAFT ROLL PIN HOLE WITH HOUSING.

10. Install roll pins (30) in planet gear shafts, approximately half-way.
11. Position planet cage assembly in housing assembly (7) and align timing marks. Timing marks should be on the inside and aligned horizontally across the housing assembly.
12. Seat planet cage assembly in housing.

NOTE

TIMING MAY BE RECHECKED BY MEASURING DISTANCE FROM PLANET SHAFT TO HOUSING LIP AT SEVERAL OPPOSING POINTS AROUND ASSEMBLY.

13. Using fiber mallet, tap pinion and shaft support bearing (26) on sun gear and pinion shaft (24).

NOTE

LOOKING INTO SUN GEAR SECTION OF PLANET CAGE, CHECK ALIGNMENT OF PLANETARY GEAR TIMING MARKS.

14. Install sun gear and pinion assembly in planet cage assembly.

NOTE

IF SUN GEAR AND PLANETARY GEARS ARE PROPERLY ALIGNED, EIGHT TEETH ON SUN GEAR WILL BE ON EACH SIDE OF TIMING MARKS.

15. Tap roll pins completely into planet gear shafts.
16. Using fiber mallet, tap inner race of planet cage and shaft assembly bearing (20) into gear housing cover (17).

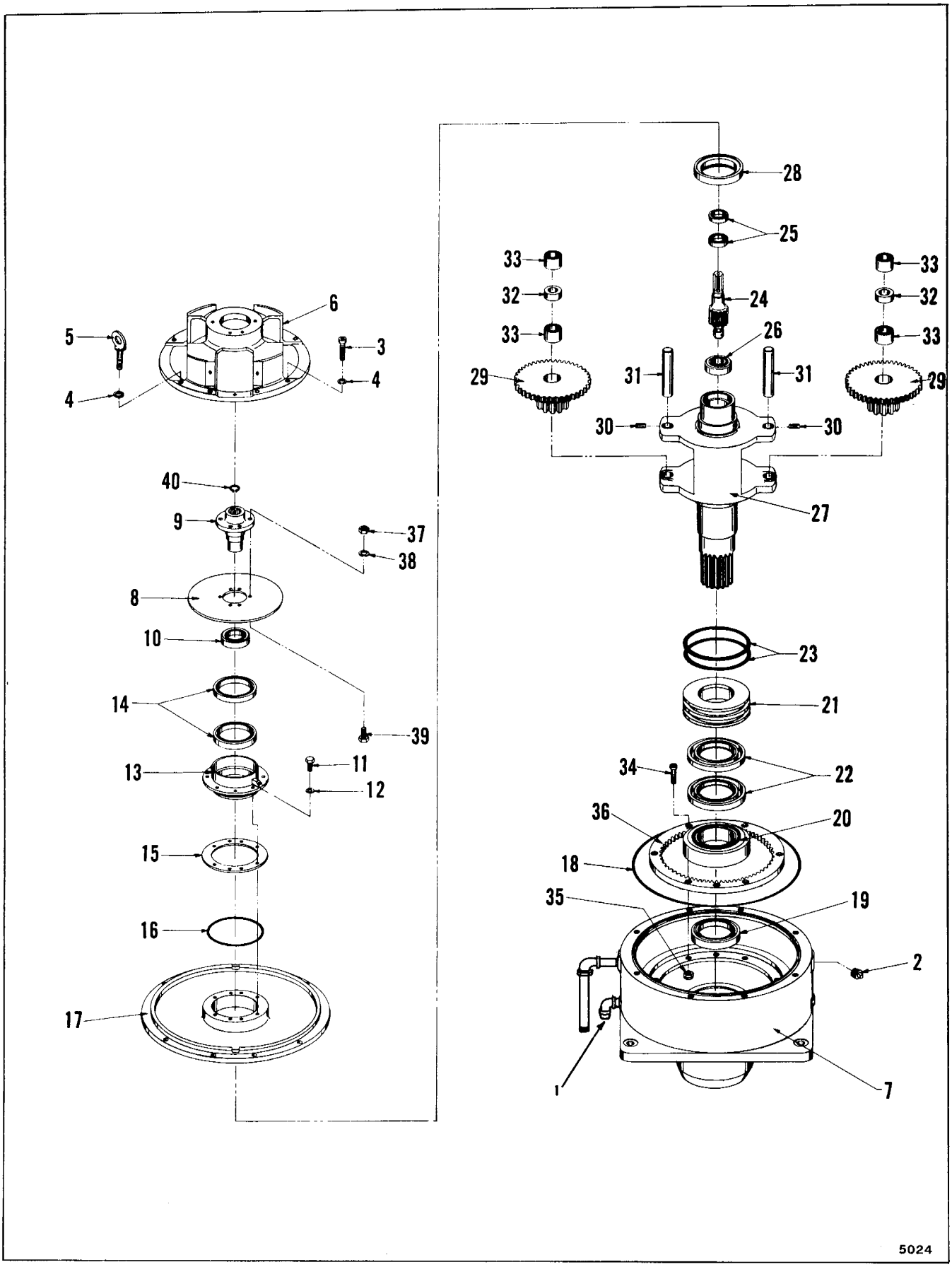


Figure 3-16. Swing Gearbox Assembly

17. Install seals (22) and retainer (21) in gear housing, assuring that lip of seal is facing race previously installed.
18. Coat seal groove of planet cage housing (7) with light grease (to hold o-ring in place during installation); install o-ring (18) and seal (19). Trim excess material from seal for proper fit.
19. Position gear housing on planet cage housing; align scribe mark and install four opposing bolts at this time.
20. Position bearing spacer (13) on gear housing; install four opposing bolts at this time. Bolts should be equally snugged down, not tight.
21. With feeler gauge, check clearance between bearing spacer and gear housing. Clearance should be no greater than .005 ft.(±).
22. Peel laminated shim stock (15) to required thickness; remove four bolts and install shim stock under bearing spacer.
23. Secure bearing spacer with eight washers (12) and eight bolts (11). Torque bolts to 29 pound-feet (dry).
24. Lubricate and install top bearing seal (14), using fiber mallet, assuring that lip of seal is facing planet cage assembly.
25. Press support coupling support bearing (10) onto brake disc coupling (9); install assembly on brake disc (8) with bolts (39), washers (38), and bolts (39).
26. Install brake disc assembly onto sun gear and pinion shaft; tap in place with fiber mallet.
27. Install gear housing cover (6) and secure with washers (4), bolts (3), and two lifting eyes (5) 180° apart. Torque bolts to 70 pound-feet.
28. Install drain plug (2) and vent (1).

CAUTION

USE CARE SO AS NOT TO OVER LUBRICATE UPPER BEARING, AS GREASE WILL GET ONTO BRAKE DISC.

29. Using hand gun or pressure lubricating equipment, lubricate upper and lower carrier bearings.

GEARBOX INSTALLATION (RT59-RT60).

1. Assure outriggers are fully extended, set, and locked; elevate boom to maximum elevation.
2. Attach suitable sling to lifting eye on gearbox cover.
3. Using adequate lifting device, lift and position gearbox in place on mounting plate.

NOTE

IF A NEW GEARBOX IS BEING INSTALLED, THE KEY STOCK WELDED TO THE DECK MAY NOT ALIGN WITH GROOVES IN GEARBOX HOUSING, THEREFORE, SOME FILING MAY BE REQUIRED.

4. Secure gearbox to mounting plate with washers and bolts (34). Install lockwire.
5. Install mechanical and hydraulic brake assemblies. (Refer to Swing and Set Brake Assemblies – Installation.)
6. Connect hydraulic lines, brake brackets, and linkage to gearbox.
7. Install swing motor on gearbox; secure with two washers and bolts.
8. Connect hydraulic lines to swing motor.

GEARBOX INSTALLATION (RT59S-RT60S).

1. Hoist gearbox into position with eye bolt.
2. Install four mounting bolts and lockwashers securing gearbox to mounting plate.

NOTE

MOUNTING BOLTS MUST BE TORQUED IN ACCORDANCE WITH TORQUE CHART.

3. Remove eye bolt and install drive gear pinion stud.
4. Install filler pipe and fill gearbox with oil.
5. Install motor and brake assembly.
6. Connect hydraulic lines to motor and swing brake.

SWING AND SET BRAKES. (Refer to Figure 3-17.)

No mechanical adjustment is provided on the hydraulic swing brakes. Replacement of brake pucks are required when brake piston travel becomes excessive. A check of hydraulic brake fluid level in the master unit should be made at each crane lubrication schedule. Bleed vents are provided in the top brake assembly casting.

NOTE

IF WORK ON BRAKES OR GEARBOX REQUIRES LOOSENING OF HYDRAULIC LINES OR FITTINGS, AVOID SPILLAGE OF HYDRAULIC OIL ON BRAKE PUCKS OR BRAKE DISC – OIL-SOAKED BRAKE PUCKS MUST ALWAYS BE REPLACED BEFORE RETURNING THE UNIT TO SERVICE.

Swing Brake Assembly – Removal. (Refer to Figure 3-17.)

1. Disconnect hydraulic lines from assembly; cap lines and plug ports.
2. Remove cotter keys (1) and pins (2) securing actuator arms (3) to actuator cylinder (4).
3. Remove bolts (5) securing actuator arms to gearbox housing.
4. Remove cotter keys (6), nuts (7) securing actuator arms and springs (8) to brake puck assemblies (9).

5. Remove nuts (10), washers (11), washers (12) and bolts (13) securing brake puck assemblies to support weldment plates.
6. Remove bolts (14) securing support weldment plates (15) to gearbox housing.
7. Remove the two bolts (16) and washers (17) securing stop assembly bracket (18) to gearbox housing.
8. Remove bottom plate adjustment screws (19) with nuts (20) and remove bottom plates.

Swing Brake Assembly — Installation. (Refer to Figure 3-17.)

1. Install bottom plate adjustment screws (19) with nuts (20) on bottom support weldment plates and into nuts welded to the gearbox housing.
2. Install stop assembly bracket (18) to gearbox housing with washers (17) and bolts (16).
3. Install upper support weldment plates (15) and secure with bolts (14).
4. Secure brake puck assemblies (9) to support weldment plates with bolts (13), washers (12), washers (11) and nuts (10).
5. Install actuator arm springs (8) on brake puck assembly studs and secure actuator arms to units with nuts (7) and cotter keys (6).
6. Attach brake actuator arms (3) to gearbox housing with bolts (5).
7. Attach actuator cylinder (4) to arms (3) with pins (2) and secure with cotter keys (1).
8. Reconnect hydraulic lines.

SWING BEARING

The swing bearing is basically a large ball bearing assembly on which the rotating superstructure is mounted to the carrier, permitting full rotation, and is therefore an area of high stress concentration. Proper care of the bearing and periodic maintenance of the turntable-to-bearing attach bolts IS A MUST, to insure safe and efficient operation. The bearing inner race is welded or bolted to the superstructure base plate and the outer race is bolted to the carrier mounting plate.

Maintenance requirements are periodic lubrication and routine checking of torque of the attachment bolts. Replacement or disassembly of the swing bearing assembly is a critical, precision procedure and must not be attempted without factory supervision or advice.

Lubrication. Refer to Section V, this manual, for lubrication instructions and recommendations.

IMPORTANT: IF A PARTICULAR OPERATION REQUIRES A CONSTANT REPETITION OF SWINGS THROUGH A SMALL ARC, FULL 360° SWINGS IN BOTH DIRECTIONS SHOULD OCCASIONALLY BE MADE TO MAKE CERTAIN LUBRICANT HAS NOT BEEN FORCED FROM HIGH BEARING LOAD AREAS AND TO INSURE EVEN BALL AND SPACER DISTRIBUTION IN THE BEARING RACE.

Maintenance. Mounting bolts must be tightened and maintained at the recommended torque as listed in the Turntable Bolt Maintenance section in the Appendix of this manual.

WARNING

FAILURE TO MAINTAIN PROPER TIGHTNESS OF TURNTABLE ATTACH BOLTS COULD RESULT IN DAMAGE TO MACHINE AND INJURY TO PERSONNEL.

CAUTION

REPEATED RETORQUING MAY CAUSE BOLTS TO STRETCH. IF BOLTS KEEP WORKING LOOSE, THEY SHOULD BE REPLACED WITH NEW BOLTS OF THE APPLICABLE GRADE AND SIZE.

It is recommended that the attach bolts be inspected and retorqued, as required, after the first 50 hours of machine operation. The bolts may loosen in service due to vibration, shock-loads, and temperature changes, therefore, periodic inspection should be accomplished every 500 hours thereafter, assuring that the bolts are secure.

HYDRAULIC SWIVEL COUPLING.

NOTE

REFER TO SECTION IV FOR DISCUSSION AND PROCEDURES APPLICABLE TO THE ELECTRICAL SWIVEL COUPLING.

Removal of the electric swivel section will always be necessary before the hydraulic section can be removed as the electric wires run down through the center of the assembly.

The hydraulic coupling, installed on the turntable (center of rotation) serves as a means of hydraulic power transfer between the superstructure and carrier. The swivel incorporates a spool, spool housing, pivot shaft, base assembly, cover plate, cover spacer, and rings and seals, as required.

On units where multiple hydraulic lines are attached to the hydraulic section of the swivel, it is usually more

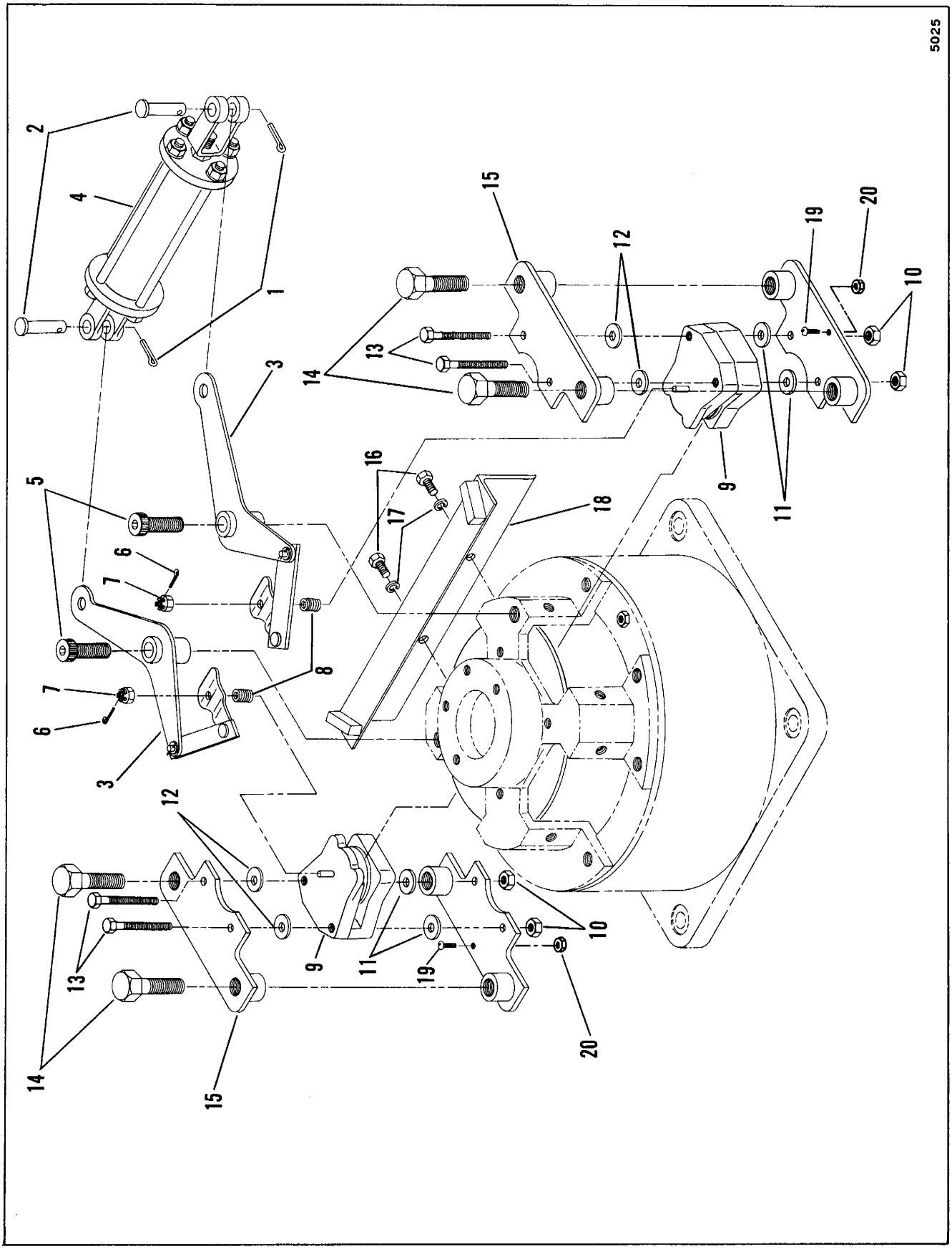


Figure 3-17. Swing Brake Assembly

convenient to disconnect the lines at applicable components or couplings, thus removing the lines with the swivel. Each installation should be studied before attempting removal.

In all cases, hydraulic lines and openings should be capped and plugged to prevent entrance of contaminants into the unit and lines.

Hydraulic Swivel Coupling – Removal.

1. Elevate boom sufficiently to gain access to hydraulic swivel coupling; block boom in position.
2. Remove electrical swivel coupling in accordance with Electrical Swivel Coupling – Removal, Section IV.
3. Tag and disconnect hydraulic lines at top of swivel (4); cap lines and openings.
4. Remove bolts (5) and washers (6) securing top plate (2) to turntable.
5. Withdraw swivel coupling sufficiently to remove hydraulic lines (8) to swivel coupling barrel; remove lines; cap lines and openings.
6. Withdraw swivel coupling from machine. Mark swivel and mounting plate to assure the same positioning when reassembling.

Hydraulic Swivel Coupling – Disassembly. (Refer to Figure 3-18.)

NOTE

ANY MAINTENANCE REQUIRING DISASSEMBLY OF THE HYDRAULIC SWIVEL COUPLING SHOULD INCLUDE REPLACEMENT OF ALL SEALS AND RINGS.

1. Remove top plate (2) from barrel.
2. Place coupling on a clean work surface in a dust-free area; block coupling to prevent movement during disassembly.

NOTE

DURING ROUTINE MAINTENANCE IT IS NOT NECESSARY TO REMOVE MOUNTING PLATE.

3. Remove capscrews (14) securing spool (12) to barrel (13); remove spool.

CAUTION

WHEN REMOVING SEALS AND RINGS, AVOID SCRATCHING GROOVED AND GLAND SURFACES.

4. Remove seals and rings from spool.

NOTE

ALIGNING DISCARDED SEALS AND RINGS IN ORDER OF DISASSEMBLY WILL FACILITATE INSTALLATION OF NEW SEALS AND RINGS.

Inspection.

1. Clean spool and housing with suitable solvent and dry with compressed air.
2. Check spool and inside of barrel for scratches, grooves, scoring, etc. If any grooves have developed with a depth exceeding .005 inch (.13 mm), the unit should be replaced.

Hydraulic Swivel Coupling – Reassembly. (Refer to Figure 3-18.)

1. Lubricate spool (12), o-rings, and seals with lubricating oil prior to assembly.

CAUTION

WHEN INSTALLING NEW SEALS AND RINGS, AVOID STRETCHING SEALS OR SCRATCHING GROOVED AND GLAND SURFACES.

2. Install new seals and rings on spool. (Refer to Arrangement of Discarded Seals and Rings, Figure 3-18.)

CAUTION

DO NOT FORCE SPOOL INTO BARREL.

3. Insert spool into barrel (13); secure with attaching capscrews (14).

NOTE

IF ADAPTER PLATE WAS REMOVED DURING OVERHAUL, REINSTALL AT THIS TIME, MAKING CERTAIN TO REPOSITION THE UNIT AS REMOVED. TORQUE BOLTS TO 57 POUND-FEET.

Hydraulic Swivel Coupling – Installation. (Refer to Figure 3-18.)

1. Connect hydraulic lines (8) to barrel.
2. Secure top plate (2) to turntable with attaching bolts (5) and washers (6).
3. Connect hydraulic lines (4) to top of swivel coupling.
4. Install electrical swivel coupling in accordance with Electrical Swivel Coupling – Installation, Section IV.
5. Secure swivel coupling to stop plate (10) with attaching bolts (12) and washers (11).

Functional Check.

Activate hydraulic system; rotate superstructure and cycle outriggers. Observe outriggers for proper operation. Check hydraulic swivel and connections for security and evidence of leaks.

BOOM ASSEMBLY.

Three section rectangular box type booms, with the two outer sections individually hydraulically extended and retracted, are normally considered the basic boom. The optional four section boom also uses two hydraulic extension cylinders with the fourth section being actuated by manually relocating the third section cylinder end pin to the extra boom section. (Reference Operator's Handbook.)

Four section full hydraulic extension booms have three extension cylinders, two of which move out with sections requiring two double hose reels.

Low friction replaceable load carrying graphite impregnated Nylatron slide blocks are provided on each section of all booms, with mild steel slide blocks provided for side loading.

The importance of proper boom maintenance cannot be overemphasized, as a boom malfunction will most likely result in crane down time. Proper lubrication and telescope cylinder maintenance are the key items governing boom performance. Adjustment of the wear pads affects boom alignment. Refer to procedure in Boom Alignment and Servicing.

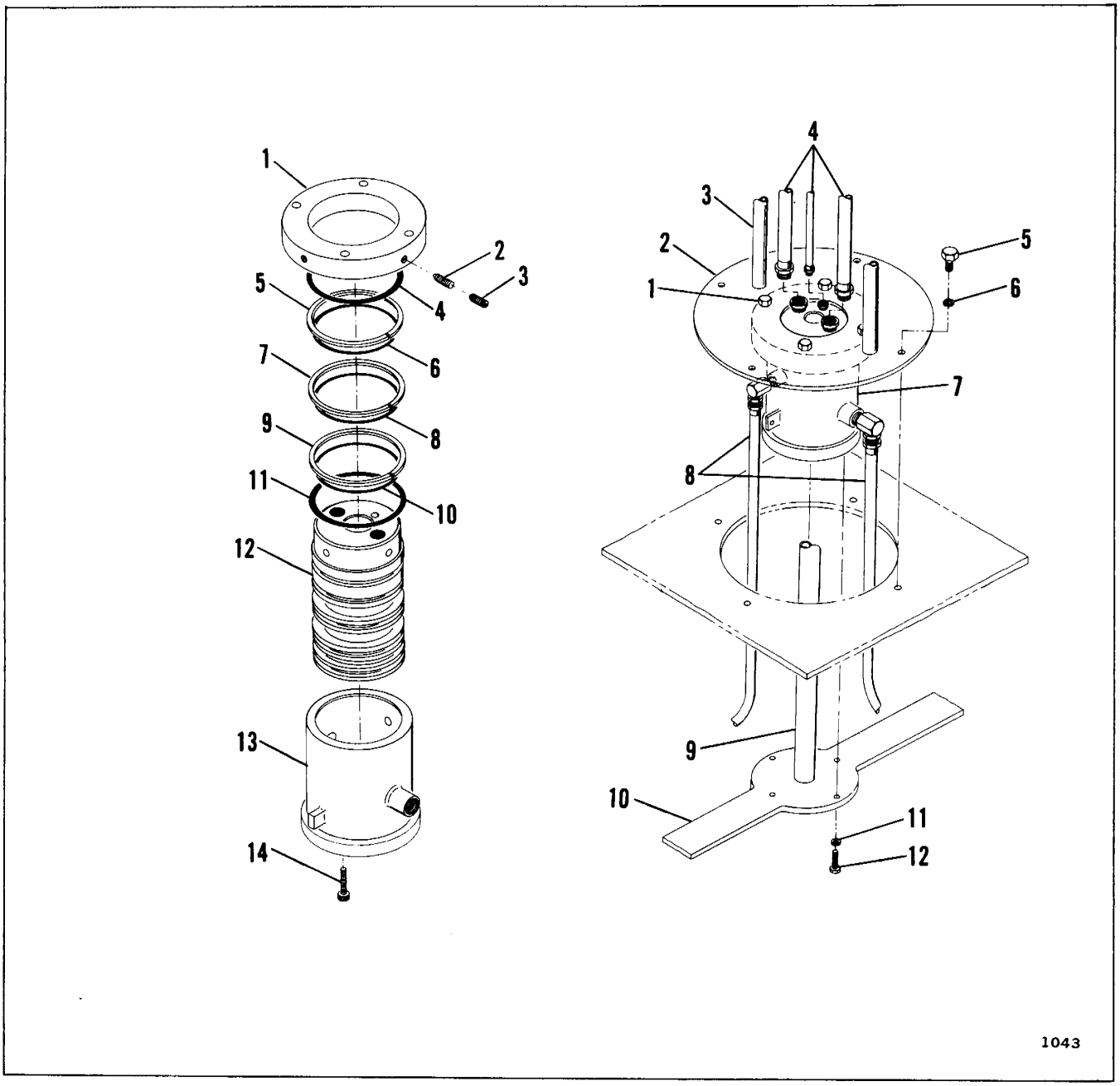


Figure 3-18. Hydraulic Swivel Coupling Assembly

Inspection.

Visually inspect telescoping sections for adequate lubrication of bottom plates. Observe extended sections for evidence of cracks, warping, or other damage. Periodically check security of boom wear pads. Check boom nose sheaves for security and freedom of movement.

NOTE

REFER TO LUBRICATION CHART, SECTION V, FOR BOOM LUBRICATION REQUIREMENTS.

Boom Assembly — Removal. (Refer to Figure 3-19.)

The entire boom assembly can be removed as a unit if desired. It will be necessary to remove the hoist to provide access for removal of the hydraulic hose fittings and to prevent damage to the hoist itself.

1. Tag (identify) and disconnect hydraulic lines from hoist; cap all lines and plug ports.

NOTE

IF IT IS NECESSARY TO REMOVE THE HOIST FROM THE BOOM, REFER TO HOIST REMOVAL PROCEDURES.

WARNING

BEFORE ATTEMPTING ANY BOOM REMOVAL OPERATIONS, THE BOOM ASSEMBLY MUST BE SUPPORTED BY ADEQUATE LIFTING EQUIPMENT. ATTACH LIFTING DEVICE TO CLOSEST PROXIMITY OF CG (CENTER-OF-GRAVITY) POINT.

2. Rotate extension cylinder hose reel sufficiently to furnish enough slack to disconnect hose from boom extension cylinders.

CAUTION

LOCK HOSE REEL TO PREVENT ROTATION AND TO MAINTAIN ORIGINAL HOSE TENSION DURING REASSEMBLY.

3. Disconnect and cap extension cylinder hose and cylinder fittings.
4. Activate hydraulic system and elevate boom, exposing approximately eight inches of lift cylinder rod; take up slack in lifting device to retain boom at this elevation and to remove load from cylinder rod end shafts.
5. Loosen locknuts and back off set screws securing lift cylinder rod end anchor shaft to boom trunnion blocks.

CAUTION

REMOVE GREASE FITTING FROM ENDS OF SHAFT BEFORE REMOVING SHAFT.

6. Carefully tap shaft cylinder rod ends. (A, Figure 3-19.)

7. Activate elevation system and retract cylinder rod ends; lower and block cylinders.

WARNING

ASSURE ALL HYDRAULIC POWER IS REMOVED FROM CRANE BEFORE CONTINUING REMOVAL OPERATIONS.

NOTE

BEFORE ATTEMPTING TO REMOVE BOOM PIVOT/ANCHOR SHAFT, THE BOOM SHOULD BE RESTRAINED IN A LEVEL AND PARALLEL ATTITUDE WITH THE CARRIER DECK. (THIS WILL LESSEN SHIFTING AND BINDING WHILE THE SHAFT IS BEING REMOVED.)

8. Loosen locknuts and back off set screws securing boom pivot/anchor shaft to boom trunnion blocks.

WARNING

TAKE UP ANY SLACK IN LIFTING DEVICE AND ATTACH RESTRAINT TO AFT END OF BOOM.

CAUTION

REMOVE GREASE FITTING FROM ENDS OF SHAFT BEFORE REMOVING SHAFT.

9. Carefully tap shaft from turntable weldment housing and boom. (B, Figure 3-19.)
   Raise boom clear of turntable weldment and machine; lower to ground level.

Boom Installation. (Refer to Figure 3-19.)

1. Attach adequate lifting device to boom in closest proximity of boom center of gravity point.
2. Raise boom and position in turntable weldment, aligning pivot/anchor shaft hole with shaft housings in turntable weldment.

CAUTION

BEFORE INSTALLING SHAFT, ASSURE BOOM ASSEMBLY IS LEVEL, PARALLEL WITH CARRIER DECK AND HOLES ARE ALIGNED.

3. Carefully tap in shaft. (C, Figure 3-19.)
4. Secure shaft to boom trunnion blocks by tightening set screws and locknuts; install grease fitting in each end of shaft.
5. Attach lifting device to lift cylinders; raise cylinders and slowly lower boom, aligning cylinder rod ends with boom attach fittings.

6. Activate elevation system and extend cylinder rod ends until alignment with boom attach fittings is attained.

CAUTION

BEFORE INSTALLING LIFT CYLINDER ROD END ANCHOR SHAFT, ASSURE SHAFT HOUSINGS ARE ALIGNED WITH BOOM ATTACH FITTINGS.

7. Carefully tap shaft in place. (C, Figure 3-19.)
8. Secure shaft to boom trunnion blocks by tightening set screws and locknuts; install grease fitting in each end of shaft.
9. Activate hydraulic system and lower boom to horizontal position.
10. Remove all lifting and restraining devices.
11. Connect hydraulic hose to boom extension cylinders. Release hose reel lock.

NOTE

IF HOIST WAS REMOVED, REFER TO HOIST INSTALLATION.

12. Connect hydraulic lines to hoist, assuring proper line is connected to correct port.

Boom Wear Pad Adjustment.

Mechanical adjustment is provided for the telescoping boom sections wear pad clearance to compensate for normal wear of the nylatron pad material and to maintain boom alignment. (Refer to Figure 3-20.) The adjustment is accomplished by capscrews and jam nuts. (Refer to Figure 3-21.) Adjust as follows:

1. Retract boom sections.
2. While observing boom sections at the wear pad areas, extend boom and chalk mark the high points of the sections.
3. Extend or retract each boom section until its highest point is adjacent to its wear pad.
4. Loosen jam nuts (1) from capscrews (2) positioning wear pads (3). Tighten capscrews until nylatron pads touch boom section, then back off one-eighth turn to obtain approximately 1/32 inch clearance. (Refer to Figure 3-22.) Tighten jam nuts.
5. Extend and retract boom several times to make certain boom sections move freely without binding.

BOOM WEAR PAD REPLACEMENT.

Boom sections slide on graphite impregnated Nylatron wear pads that reduce friction and lubrication requirements. The upper and lower pads are not adjustable and must be replaced if worn or are damaged to the extent that metal to metal contact becomes imminent or boom section droop is apparent.

Top base end and side wear pads seldom wear sufficiently to require replacement. However, inasmuch as a particular sliding boom section must be removed for replacement of any pad, all new pads should be installed at one time.

Boom section removal procedure will vary depending on which section pads are to be replaced.

FLY SECTION PADS – INSTALLATION.

1. Provide adequate lifting and handling equipment for boom section removal.

Table 3-6. Telescoping Boom Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Boom will not extend or boom will not retract.	Hydraulic oil level low.	Replenish system.
	Clogged, broken, or loose hydraulic lines or fittings.	Clean, tighten, or replace lines or fittings.
	Damaged control valve.	Repair or replace valve.
	Telescope cylinder(s) locked.	Repair or replace cylinder(s).
	Damaged telescope cylinder(s).	Repair or replace cylinder(s).
Boom extends and/or retracts erratically.	Hydraulic oil level low.	Replenish system.
	Clogged, broken, or loose hydraulic lines or fittings.	Clean, tighten, or replace lines or fittings.
	Damaged relief valve.	Repair or replace valve.
	Damaged control valve.	Repair or replace valve.
	Insufficient lubricant on lift cylinders and/or shafts.	Lubricate component. (Refer to Lubrication Chart, Section V.)
	Damaged telescope cylinder(s).	Repair or replace cylinder(s).

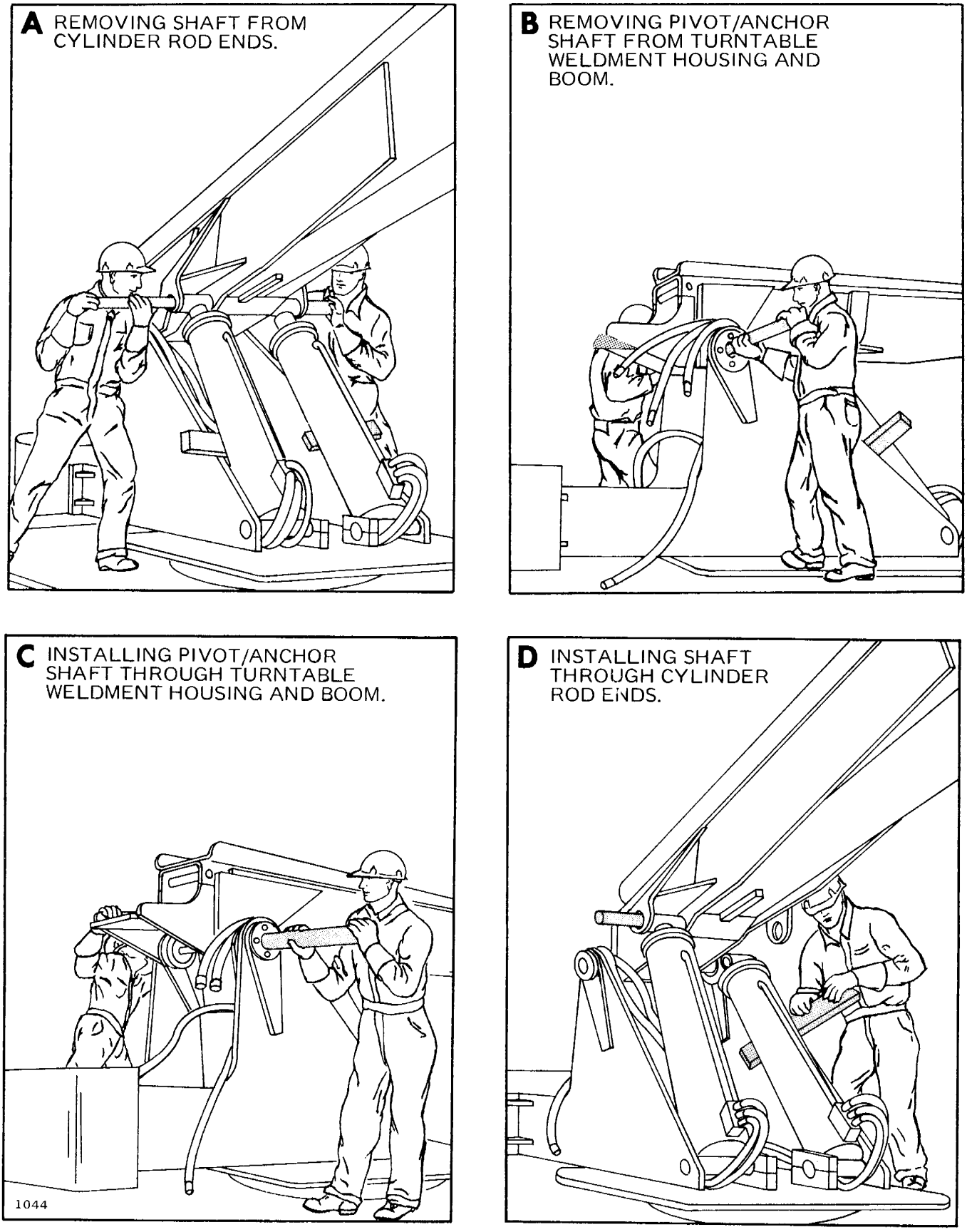


Figure 3-19. Boom Removal/Installation

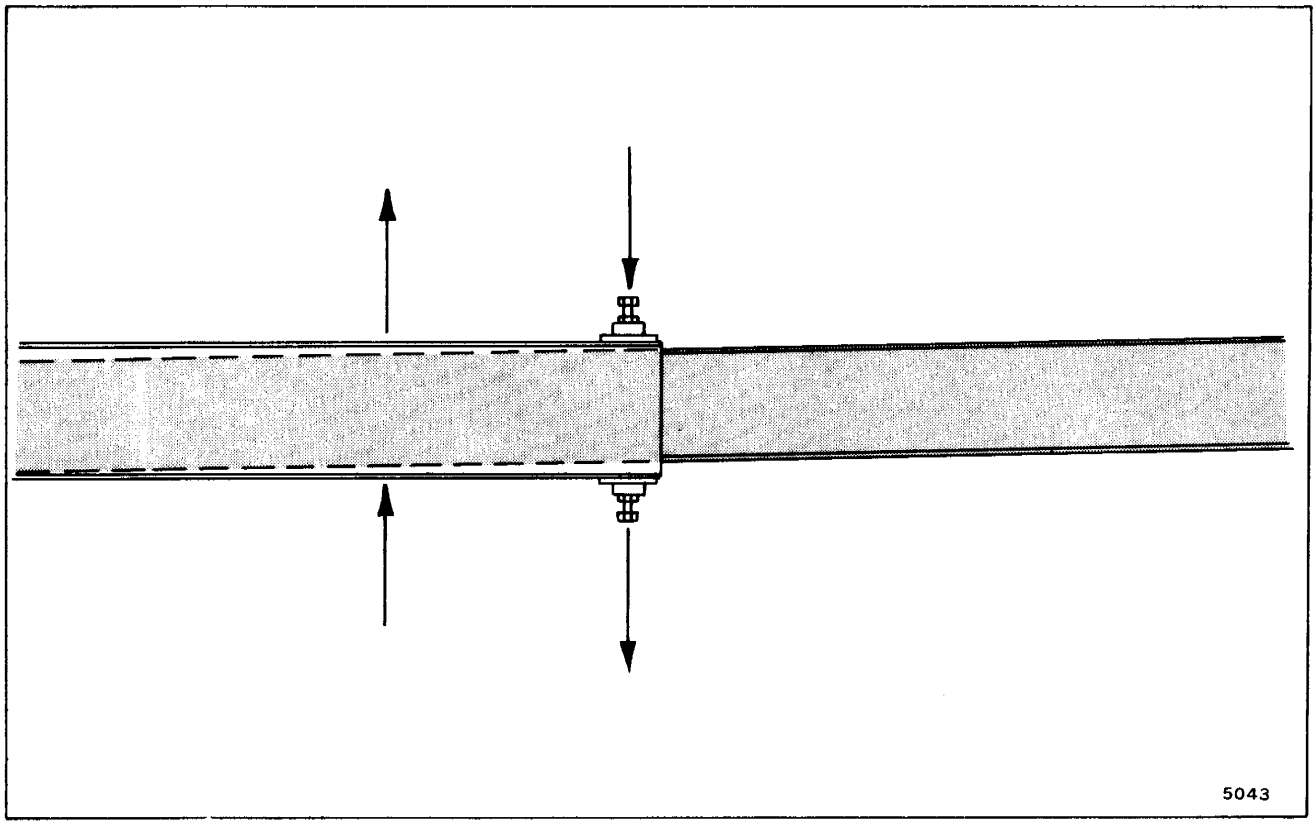


Figure 3-20. Boom Section Alignment

2. Extend fly section until extension cylinder cross shaft is exposed sufficiently for removal.
3. Loosen jam nuts on side wear pad capscrews on mid-section. Adjust capscrews outward sufficiently to avoid binding during fly section removal.
4. Use a length of wood, inserted through the boom nose, to support the hydraulic cylinder rod end to avoid dropping it and remove cross shaft.
5. Using support equipment, slide fly section from mid-section.
6. Remove all pads and replace with new pads.
7. Reinstall fly section using reverse procedure of above, using care to avoid chipping of Nylatron pads.
8. Align boom section in accordance with alignment procedure, Boom Wear Pad Adjustment.

MID-SECTION PADS – INSTALLATION.

Mid and fly sections may be removed as a unit for mid-section pad replacement.

1. Provide adequate lifting and handling equipment for boom removal.
2. Rotate hose reel sufficiently to provide slack for hose disconnection at extension cylinders. Lock hose reel to prevent rotation and to maintain original hose tension during reassembly.
3. Disconnect and cap hose and fittings at base of extension cylinders.
4. Loosen jam nuts on side wear pad capscrews on base section. Adjust capscrews outward sufficiently to avoid binding during mid-section removal.
5. Remove hydraulic cylinder cross shaft at end of base section.
6. Slide mid and fly sections from base section as a unit.
7. Replace wear pads and reinstall unit in reverse order of above procedure.
8. Align all sections in accordance with alignment procedure, Boom Wear Pad Adjustment.

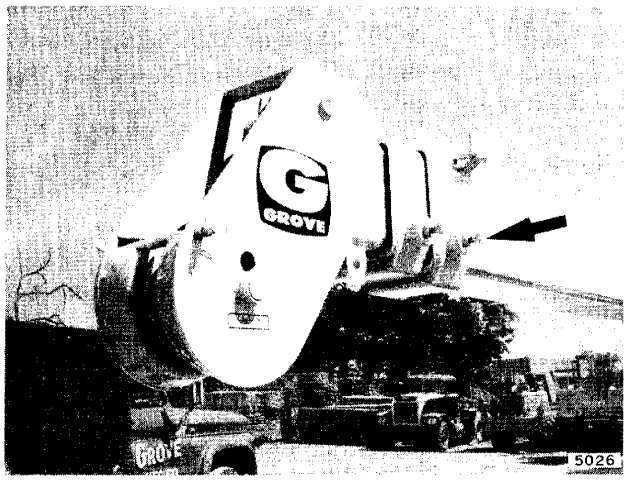


Figure 3-21. Wear Pads

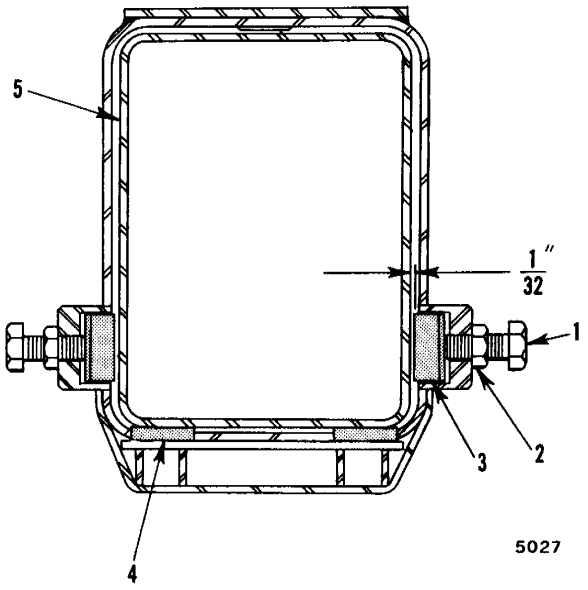


Figure 3-22. Wear Pad Adjustment

LIFT CYLINDERS. (Refer to Figure 3-23)

Two hydraulic cylinders are used to raise and lower the boom and are controlled by a single lever by the operator. The cylinders are pivot mounted on the turntable and attach to the boom at the lift cylinder attach fittings.

The boom lift cylinders are matched in stroke and end stop positions in order that boom sections will not be twisted when cylinders reach full extension or retraction. Either or both cylinders may be removed as required for repair or replacement. If both cylinders are to be repaired simultaneously, they should be marked when removed to assure replacement in the same position.

Models differ in design of booms, location, and installation of the upper cylinder cross shaft. In some cases it will be necessary to remove the superstructure cab window to facilitate shaft removal. However, in general, removal and installation procedures are similar. Service and maintenance procedures are common to all cylinders.

Inspection.

Visually inspect hydraulic connections and hoses for security. Check lift cylinders for leaks indicating worn or damaged seals. Check lift cylinder safety valves for security.

NOTE

A SMALL AMOUNT OF WEEPING FROM THE SAFETY VALVES IS NORMAL.

Troubleshooting.

Lift Cylinder Drift Checks. If the boom has a tendency to drift down when elevated, the following procedure should be followed to locate the malfunction.

1. To check for holding valve leakage, complete the following:
   a. Elevate boom approximately eight inches from horizontal.
   b. Disconnect hydraulic line from inlet side of elevation control valve. If valve leaks, reconnect hydraulic line, lower boom and shut down operation.
   c. Remove valve, inspect for scoring, wear and evidence of foreign material. Clean and repair or replace as necessary.
2. If boom drifts down consistently only at one specific elevation, this indicates that a short scored area exists in one of the cylinders. Proceed as follows:
   a. Elevate boom approximately eight inches from horizontal.
   b. Inspect both cylinders for evidence of scoring or any other defect which could cause the drift problem.
   c. Determine which cylinder is damaged and repair or replace as necessary.
3. If boom drifts down at all angles, proceed as follows:
   a. Elevate boom approximately eight inches from horizontal.
   b. Shut down all operation and disconnect the top interconnecting line from each lift cylinder.

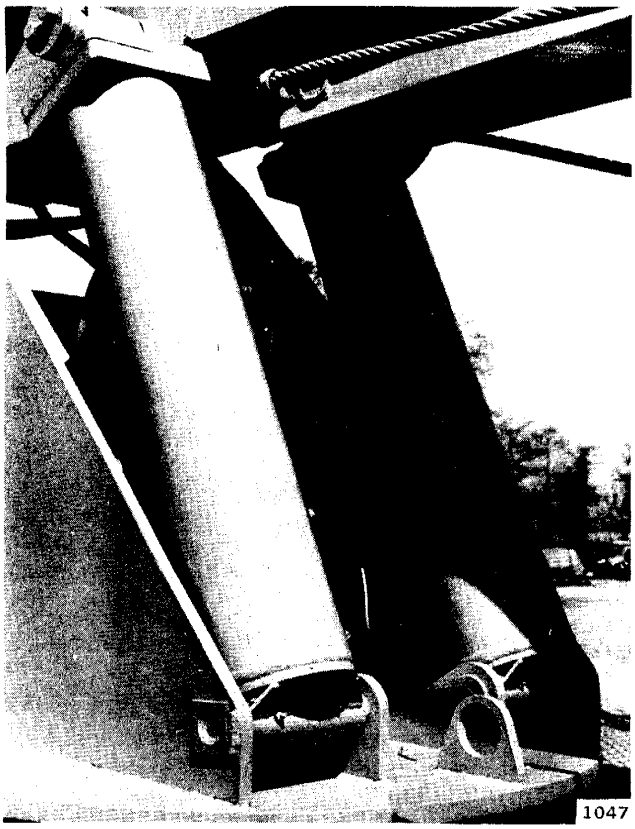


Figure 3-23. Lift Cylinders

c. Allow excess oil to drain from fittings. If oil continues to drain from a cylinder port, the cylinder is damaged. Repair or replace cylinder as necessary.

Lift Cylinder Removal.

1. Elevate boom so that boom rest pin is out of the collar sufficiently to insert at least an 8" wooden block. Lower boom sufficiently to take boom weight from cylinder cross shaft(s).
2. Disconnect hydraulic hoses from the base end of cylinder(s) and drain oil. Plug and cap applicable hose and fittings.
3. Block lift cylinders in place at the base.
4. Remove bolts and securing washers from rod end of cylinder cross shaft.
5. Loosen set screws at back and front of top cylinder shaft end.
6. Tap cross shaft out as required for either or both cylinder removal.
7. Remove retainer bolts from base end cross shaft end plate(s).
8. Remove cross shaft(s) trunnion cap bolts and caps.
9. Tap out cross shaft(s) and lift cylinder(s) from trunnion.

Table 3-7. Elevation System Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Boom raises erratically.	Low hydraulic oil level.	Replenish hydraulic oil to proper level.
	Low engine rpm.	Increase engine rpm to recommended setting.
	Main relief valve defective.	Replace relief valve.
	Air in cylinder rods.	Bleed cylinder rods.
	Bent cross shaft.	Replace cross shaft.
Boom lowers erratically.	Low hydraulic oil level.	Replenish hydraulic oil to proper oil level.
	Low engine rpm.	Increase engine rpm to recommended setting.
	Circuit and/or relief valve inoperative.	Repair or replace relief valve.
	Air in hydraulic cylinder.	Bleed air from cylinder.
	Control valve linkage out of adjustment.	Adjust linkage to obtain full spool travel.
	Air in cavity of safety valve.	Bleed port blocks.
	Air in remote holding valve.	Bleed remote holding valve.
	Remote holding valve damaged.	Repair or replace valve.
	Improperly adjusted remote holding valve.	Adjust remote holding valve.
	Damaged hydraulic pump section.	Repair or replace pump section.
Boom raises slowly.	Low hydraulic oil level.	Replenish hydraulic oil to proper level.
	Low engine rpm.	Increase and maintain engine rpm.
	Damaged relief valve.	Repair or replace relief valve.
	Extremely cold hydraulic oil.	Operate unit to bring oil to operating temperature.
	Improper hose or fittings installed.	Replace hose or fittings.
	Color flow valve improperly adjusted on units so equipped.	Readjust color flow valve.
	Control valve linkage out of adjustment.	Adjust linkage to obtain full spool travel.
	Operating two functions within the same control valve bank assembly.	Feather controls to obtain desired speed of both functions.
	Restriction in return hose.	Replace return hose.
	Cylinder piston seals leaking.	Replace all cylinder seals.
	Scored cylinder barrel.	Hone or replace barrel.
	Worn hydraulic pump section.	Repair or replace pump section.

TROUBLE	PROBABLE CAUSE	REMEDY
Boom lowers slowly.	Low hydraulic oil level.	Replenish hydraulic oil to proper level.
	Low engine rpm.	Increase rpm to recommended level.
	Damaged relief valve.	Repair or replace relief valve.
	Operating two functions within the same control valve bank assembly.	Feather controls to obtain desired speed of both functions.
	Extremely cold hydraulic oil.	Operate unit to bring oil to operating temperature.
	Improper hose or fittings installed.	Replace hose or fittings.
	Color flow valve improperly adjusted on units so equipped.	Adjust color flow valve.
	Control valve linkage out of adjustment.	Adjust linkage to obtain full spool travel.
	Restriction in return hose.	Replace return hose.
	Improper adjustment of remote holding valve.	Adjust remote holding valve.
	Cylinder piston seals worn.	Replace all cylinder seals.
	Scored cylinder barrel.	Hone or replace barrel.
	Worn hydraulic pump section.	Repair or replace pump section.
	Piston rod broken (loose from piston).	Replace piston rod and all cylinder seals.
Boom will not raise.	Low hydraulic oil.	Replenish hydraulic oil to proper level.
	Main relief valve or circuit relief valve damaged.	Repair or replace relief valve.
	Excessive load.	Reduce load as required.
	Improperly adjusted control valve linkage.	Adjust linkage to obtain full travel.
	Worn or damaged hydraulic pump section.	Repair or replace pump section.
	Broken pump shaft.	Replace pump shaft and seals.
	Broken pump drive coupling.	Replace drive coupling.
	Broken control valve spool.	Replace control valve.
Boom will not lower.	Low hydraulic oil.	Replenish hydraulic oil to proper level.
	Main relief valve or circuit relief valve damaged.	Repair or replace relief valve.
	Improperly adjusted control valve linkage.	Adjust linkage to obtain full spool travel.
	Worn or damaged hydraulic pump section.	Repair or replace pump section.
	Broken pump shaft.	Replace pump shaft and seals.
	Broken pump drive coupling.	Replace drive coupling.
	Broken control valve spool.	Replace control valve.

Lift Cylinder – Disassembly. (Refer to Figure 3-26.)

CAUTION

WHEN USING HOIST EQUIPMENT TO LIFT HYDRAULIC CYLINDERS, NEVER USE CHAINS ALLOWING METAL TO METAL CONTACT WITH CYLINDER SHAFT. IF CYLINDER IS TO BE STORED OR SHIPPED, SHAFT MUST BE FULLY RETRACTED TO PREVENT POSSIBILITY OF DAMAGE OR RUSTING OF THE POLISHED SURFACE.

NOTE

ANY MAINTENANCE REQUIRING DISASSEMBLY OF CYLINDERS SHOULD INCLUDE REPLACEMENT OF ALL CYLINDER SEALS. A SEAL KIT WILL SUPPLY THE REQUIRED ITEMS.

1. Remove bleeder screw and stat-o-seal (25 and 26) from lift cylinder shaft. Discard stat-o-seal.

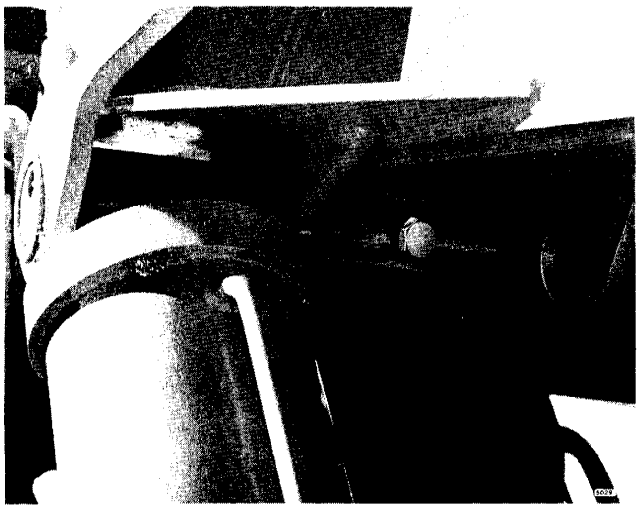


Figure 3-24. Top of Lift Cylinders

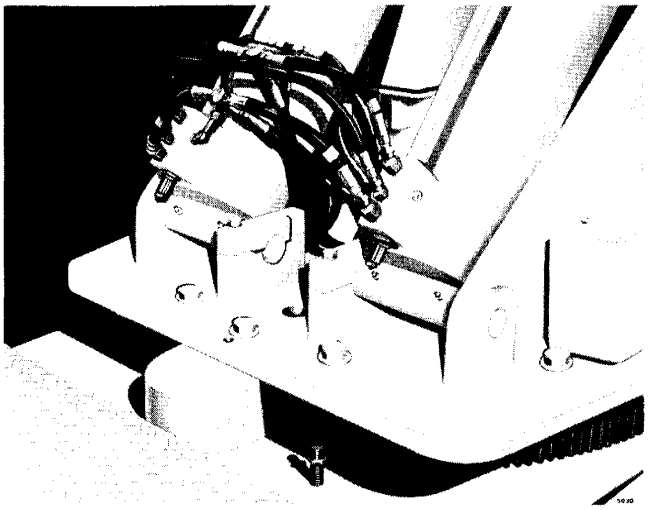


Figure 3-25. Base of Lift Cylinders

2. Drain hydraulic oil from lift cylinder assembly.
3. Remove socket head lock screw (21) and head gland retaining screw (22 and 23) from draw ring (20).
4. Remove (unscrew) draw ring.

CAUTION

EXERCISE EXTREME CARE WHEN HANDLING OR SETTING DOWN CYLINDER ROD. DAMAGE TO ROD SURFACE MAY CAUSE UNNECESSARY MAINTENANCE AND EXPENSE.

5. Withdraw cylinder rod assembly from cylinder barrel.

NOTE

IT IS ADVISABLE TO COVER CYLINDER BARREL OPENING TO PRECLUDE CONTAMINATION FROM DUST AND DIRT.

6. Secure cylinder rod (24) from moving; remove set screws (4 and 5) in piston locknut (3); remove locknut from rod (24).
7. Remove piston (10), spacer (14), and cylinder head (17) from cylinder rod.

CAUTION

WHEN REMOVING SEALS AND RINGS, AVOID SCRATCHING GROOVED AND GLAND SURFACES. SCRATCHES CAUSE WEAR RESULTING IN LEAKAGE.

8. Remove back-up rings (11 and 13) and o-rings (12) from groove on piston end of rod.
9. Remove all seals and rings from cylinder piston and head.

NOTE

ALIGNING DISCARDED SEALS AND RINGS IN ORDER OF DISASSEMBLY WILL FACILITATE INSTALLATION OF NEW SEALS AND RINGS.

Inspection.

1. Clean all parts with solvent and dry with compressed air. Inspect all parts for serviceability.

CAUTION

BEFORE INSTALLING NEW SEALS AND RINGS, CLEAN ALL SURFACES AND REMOVE BURRS AND NICKS. PARTS DISPLAYING EXCESSIVE WEAR OR DAMAGE SHOULD BE REPLACED.

2. Stone out minor blemishes and polish with fine crocus cloth.
3. Clean with solvent and dry with compressed air, any parts that have been stoned and polished.

Lift Cylinder – Reassembly. (Refer to Figure 3-26.)

CAUTION

WHEN INSTALLING NEW SEALS AND RINGS, AVOID STRETCHING SEALS OR SCRATCHING GROOVED AND GLAND SURFACES.

1. Install new seals and rings on cylinder piston (10) and head (17). (Refer to Arrangement of Discarded Seals and Rings and Figure 3-26.)
2. Lubricate cylinder rod (24).

3. Slide cylinder head onto rod.
4. Install back-up rings (11 and 13) and o-ring (12) into groove on piston end of rod.
5. Install spacer (14) and piston on cylinder rod.
6. Fasten locknut (3) onto cylinder rod and secure with set screws (4 and 5).
7. Lubricate cylinder piston and head.
8. Remove cylinder barrel cover; install rod assembly into cylinder barrel with a twisting motion; slide piston assembly about half-way into cylinder barrel.
9. Slide head down cylinder rod into cylinder barrel.

CAUTION

TAP CYLINDER BARREL WITH A SMALL HAMMER TO FACILITATE SEATING OF DRAW RING.

10. Install draw ring (20); screw down flush with top of lift cylinder barrel (±1/16-inch).
11. Install head gland retaining screws (22 and 23); do not tighten.
12. Install socket head lock screw (21) into draw ring.

CAUTION

TAP CYLINDER BARREL WITH A SMALL HAMMER TO FACILITATE SEATING OF DRAW RING.

13. Tighten head gland retaining screws.
14. Install new stat-o-seal (26) on bleeder screw (25), and screw into tapped hole in cylinder rod.

Lift Cylinder Installation.

1. Lubricate headed cross shaft and insert partially through the cylinder base end fitting.
2. Place cylinder in position with cross shaft resting on the trunnion block. Tap cross shaft into position and install trunnion cap, bolts and end plate retainer bolts.
3. Connect hydraulic hose and extend cylinder shaft so that the upper cross shaft can be installed.
4. Lubricate and tap in cross shaft. Install retainer caps, bolts and/or screws.
5. Tighten all bolts and insert lubrication fittings that have been removed.

BOOM TELESCOPE CYLINDERS.

Two hydraulic cylinders are utilized to extend the movable sections of the three-section boom. It is not necessary to remove or disassemble the complete boom assembly in order to remove or install either or both extension cylinders. It will be necessary to either remove the hoist or pivot it downward so the upper cylinder box assembly and/or fly extension cylinder assembly can be removed back through the base end of the boom.

1. Remove telescope cylinders. (Refer to Figure 3-27.)
   a. Place boom in stowed position with boom rest pin in boom rest collar.
   b. Extend fly section until rod end fly cylinder shaft is exposed. (See 11, 12, and 13, Figure 3-27.)
   c. Extend mid section until base end fly cylinder shaft is aligned with access holes. (See 5, 6, 7, and 8 of Figure 3-27.)
2. Remove desired cylinder in accordance with the following applicable instructions:

Fly Section Cylinder Removal.

1. Extend fly section until fly cylinder rod end cross shaft assembly is exposed (11 and 13, Figure 3-27.)
2. Remove access hole covers (8) from boom base section.
3. Extend mid section until base end of fly cylinder cross shaft is aligned with access holes (5 and 6, Figure 3-27.)

IMPORTANT: MAKE CERTAIN THAT THE HYDRAULIC HOSE REEL IS PINNED TO PREVENT ROTATION WHEN THE FLY SECTION IS RETRACTED FOR CYLINDER REMOVAL.

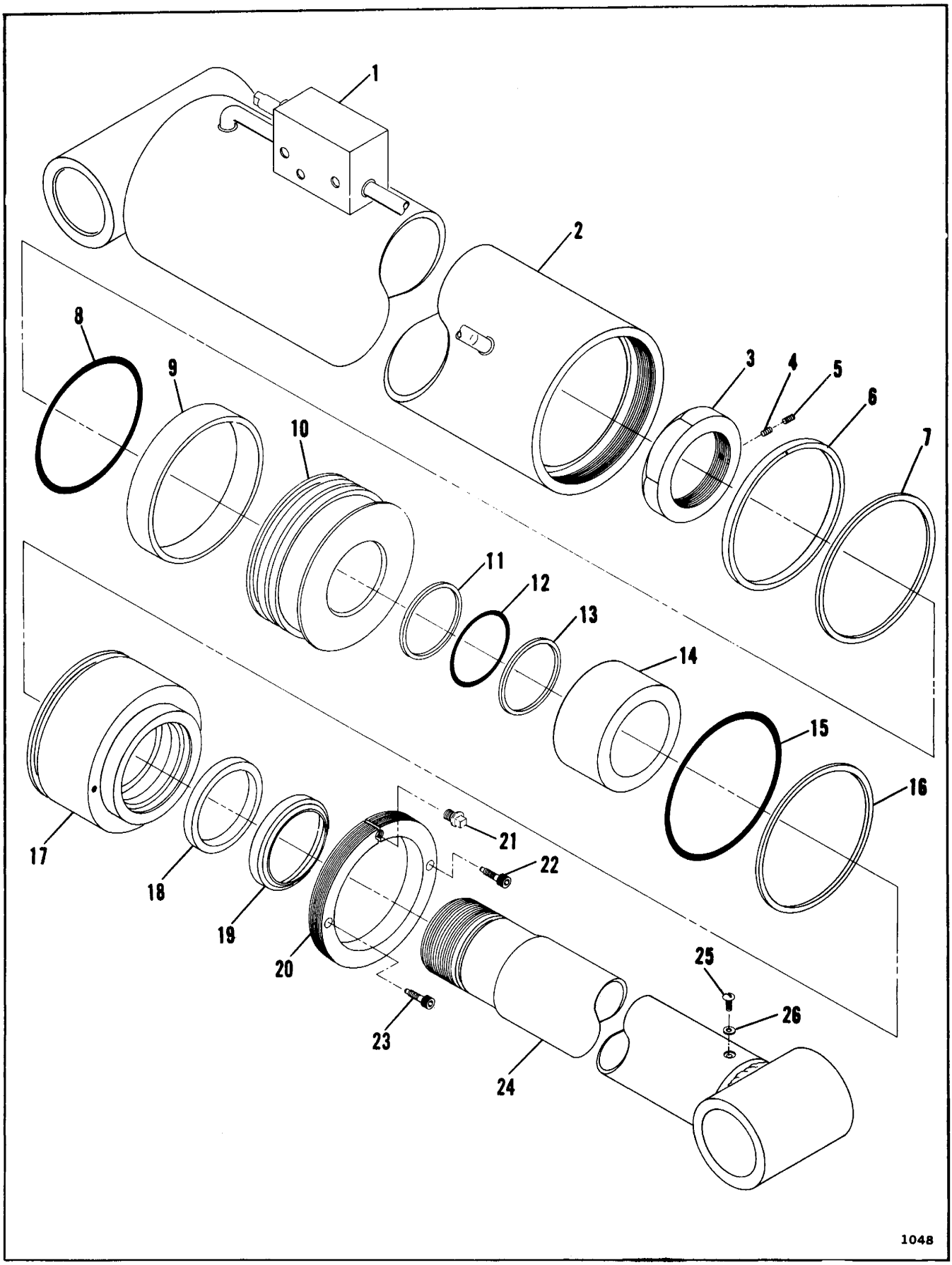


Figure 3-26. Lift Cylinder Assembly

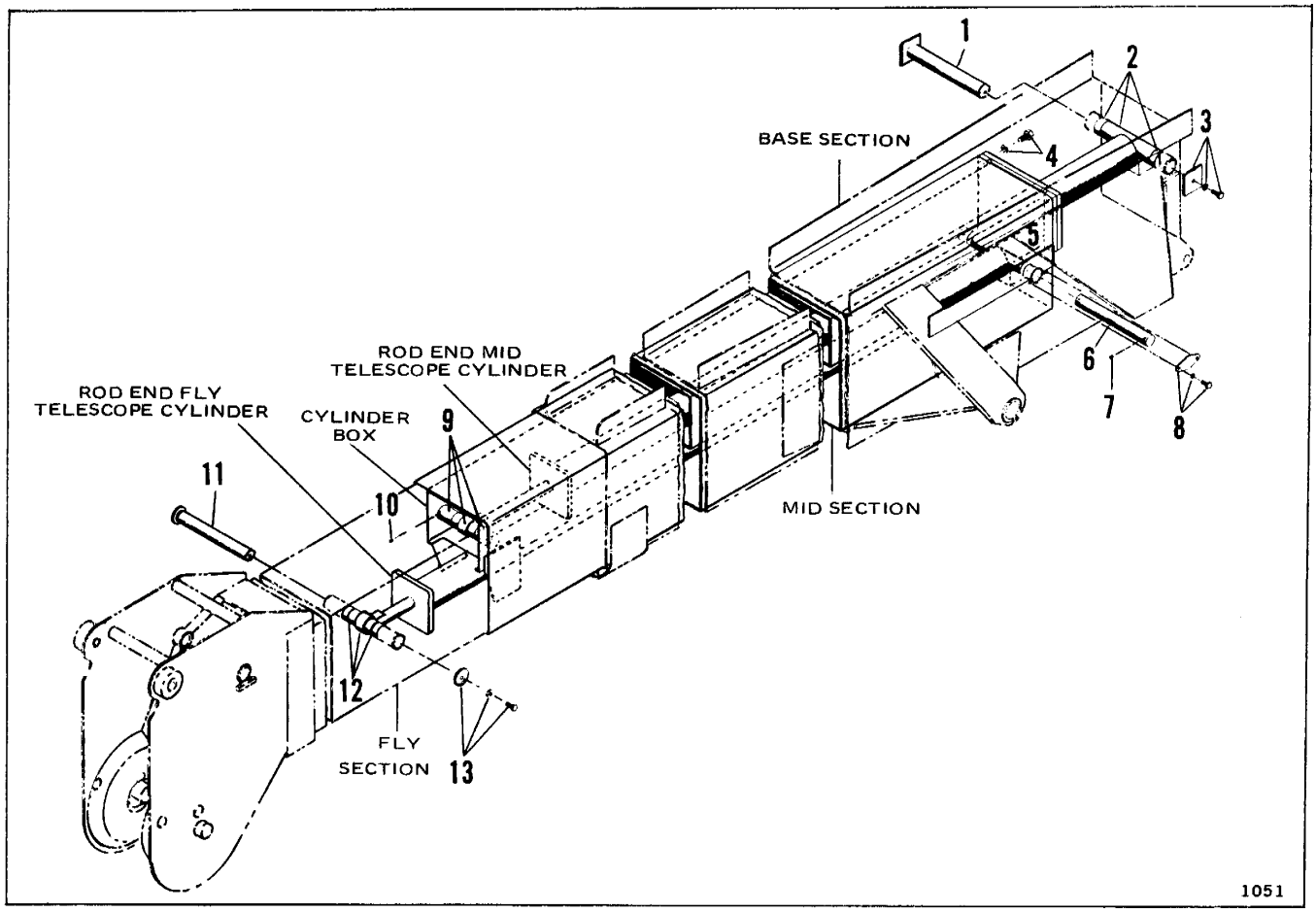


Figure 3-27. Telescoping Cylinder Installations

4. Remove shaft retainer, cap washer and bolt (13) from shaft (11).
5. Tap out shaft (11) being careful not to damage threads.
6. Remove set screws (7), from fly cylinder cross shaft bushing spacer.
7. Tap out cross shaft.
8. Slide cylinder back, remove hydraulic hose and cap fittings, and remove cylinder from boom.

Replace shafts that indicate visible wear, scoring, or deformation. If any hairline scratches or scores appear suspect, magnaflux or dye penetrant check for cracks.

Fly Section Cylinder Installation.

1. Slide cylinder into base end of boom.
2. Tap cross shafts (6 and 11, Figure 3-27) into bushings.

NOTE

LUBRICATE SHAFTS PRIOR TO ASSEMBLY.

3. Install set screws (7) into cylinder cross shaft bushing spacer.
4. Replace shaft retainer, cap washer and bolt (13), on shaft (11).
5. Connect hydraulic hoses.
6. Install access hole covers on boom base section.

Mid Section Cylinder Removal.

1. With boom stowed in horizontal position, remove hoist and cable.
2. Remove hydraulic hose from mid section cylinder. Cap lines and fittings.
3. Remove cap, bolt and washer (3) and tap out shaft (1).
4. Remove four bolts (4) that attach cylinder box to boom mid section base.
5. Slide cylinder and box from boom as a unit.
6. Remove set screws (10) from bushings and tap out cross shaft.
7. Slide mid telescope cylinder from box.

Replace shafts that indicate visible wear, scoring, or deformation. If any hairline scratches or scores appear suspect, magnaflux or dye penetrant check for cracks.

Mid Section Cylinder Installation.

1. Slide mid telescope cylinder into box.
2. Tap cross shaft into bushings and install set screws (10).

NOTE

LUBRICATE SHAFTS PRIOR TO ASSEMBLY.

3. Slide cylinder and box into boom and install the four attaching washers and bolts.
4. Tap cross shaft (1) into the boom base and install the cap, bolt and washer (3).
5. Install hydraulic hose lines.

HOSE REEL. (Refer to Figure 3-28.)

The hose reel provides automatic rewinding of the boom telescope cylinder hydraulic hoses during retracting operations. The main components of the hose reel assembly are as follows: base assembly, hose guard, reel assembly, spring, and spring cover.

Servicing. Avoid rust and corrosion of the spring in hydraulic hose reels.

Grove recommends that after every 50 operating hours, the hydraulic hose reels be lubricated in the following manner: With boom fully retracted, spray motor oil — under pressure — into the hose reel spring housing. The spring should be saturated liberally with oil. If air pressure lubricating equipment is not available — use pump oil can, making sure that spring is completely lubricated.

Access hole located on left side of hose reel, above hose reel pivot shaft. Spring can be seen through access hole.

Hose Reel Removal.

1. Tag and disconnect hydraulic hoses from hose reel; cap hoses and openings.
2. Tag and disconnect hydraulic hoses from telescope cylinders; cap hoses and openings.

NOTE

WHEN DISCONNECTING TELESCOPE CYLINDER LINES, SPRING TENSION OF HOSE REEL MAY TEND TO REWIND HOSES IF THEY ARE NOT HELD.

3. Remove bolts (15, Figure 3-28) and washers (16) securing hose reel to turntable; remove hose reel.

Hose Reel Disassembly.

1. Disconnect hoses from reel as follows:
   a. Clamp hose reel assembly to suitable work surface.
   b. Pull hoses to full length and pin reel (1) to prevent rotation.
   c. Disconnect hydraulic hoses from reel.

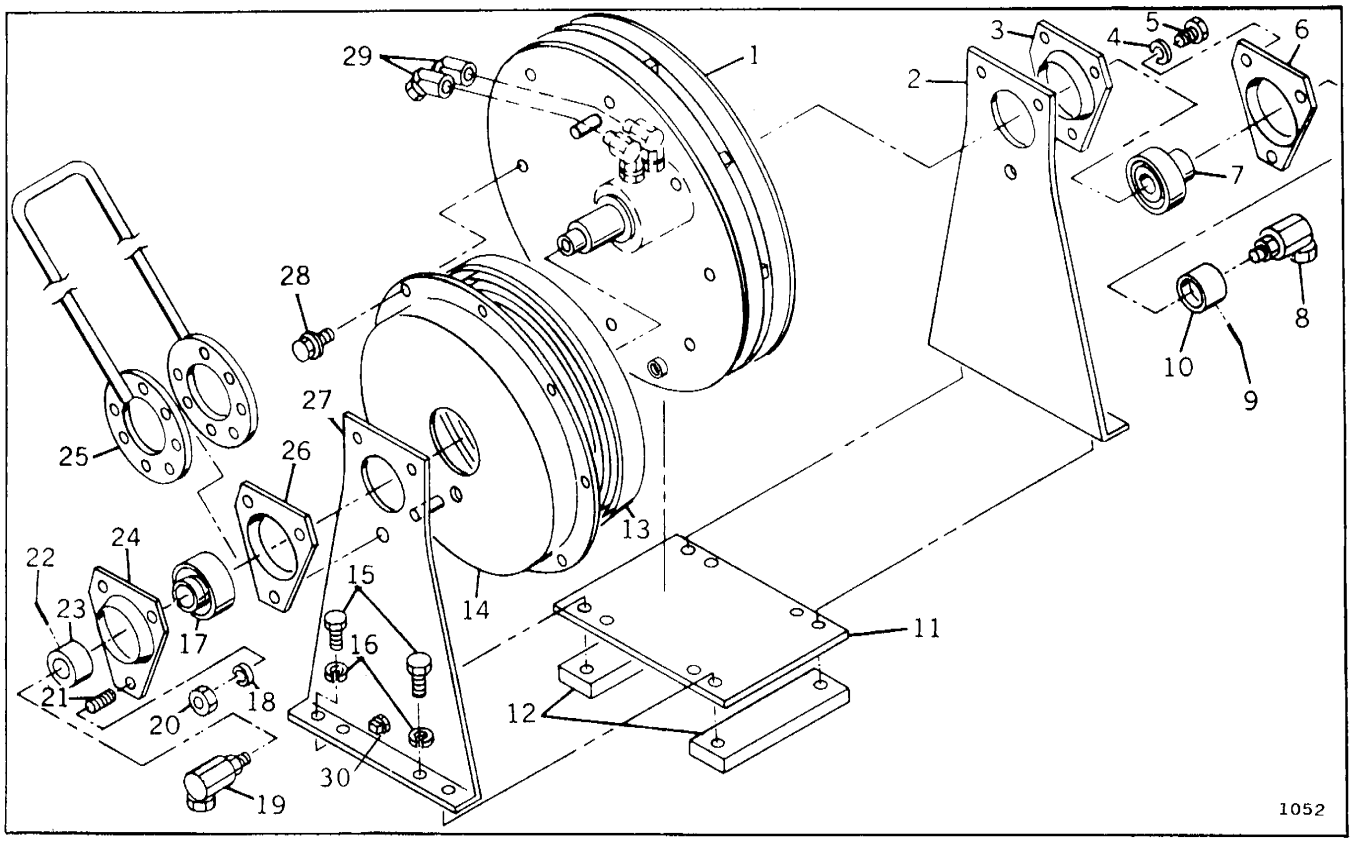


Figure 3-28. Hose Reel Assembly

NOTE

USE LOCKING PIN STUD TO RESTRICT REEL FROM RAPIDLY REWINDING.

2. Remove 90° supply line fittings (8 and 19).
3. Loosen set screws (9 and 22) securing covers (10 and 23) on bearings (7 and 17).
4. Remove nuts (20), washers (4 and 18), and bolts (5) securing hose guard (25) to base side plates; remove guard and covers.

CAUTION

USE CARE WHEN REMOVING BEARING TO AVOID DAMAGING INNER RACE.

5. Using pry bars, remove bearing retainers (6 and 24), bearing covers (10 and 23), bearings (7 and 17), and bearing retainers (3 and 26).
6. Remove spring and reel assembly from base assembly.
7. Remove spring cover attach screws (28).
8. Keep reel against spring and cover and lay assembly on cover face.

WARNING

USE EXTREME CAUTION WHEN LIFTING REEL FROM SPRING COVER. IF RETAINING BAND IS BROKEN AND SPRING HAS EXPANDED, MAKE NO ATTEMPT TO REMOVE SPRING FROM COVER BY HAND.

9. Carefully lift reel from spring and cover assembly.
10. If spring retaining band is not broken, proceed with step (12); if band is broken, remove expanded spring in accordance with one of the methods prescribed in step (11).
11. Remove spring (13) from cover (14) by one of the following methods:
    a. Remove cover and spring assembly to open area cleared of all personnel; carefully toss assembly into open area, allowing spring to dislodge from cover and expand completely.
    b. Drop cover and spring assembly into 55 gallon drum, thereby dislodging spring from cover and allowing complete expansion.

WARNING

FAILURE TO SAFETY SPRING TO RETAINING BAND MAY RESULT IN INADVERTENT UNWINDING AND RELEASE FROM COVER.

12. Using lockwire, or equivalent, safety spring to retainer at three equal-distant points around the circumference.

Hose Reel Reassembly.

1. Remove lockwire securing spring (13) to spring retaining band. Lubricate spring with Molybdenum Disulfide (Dow-Corning) assembly lubricant, or equivalent.
2. Position spring and cover on reel assembly (1); secure with screws (28).
3. Position reel assembly in base assembly; install bearing retainers (3 and 26), bearings (7 and 17), and bearing covers (10 and 23); secure covers with set screws (9 and 22).
4. Install bearing retainers (6 and 24) and hose guard (25); secure with bolts (5), washers (4 and 18), and nuts (20).
5. Install 90° supply line fittings (8 and 19).
6. Facing spring cover, wind spring by turning reel assembly 12 revolutions counterclockwise; clamp reel.
7. Connect hydraulic hoses to reel.
8. Release clamp and allow hoses to wind on reel.

Hose Reel Installation.

1. Position hose reel assembly on turntable; secure with washers (16) and bolts (15).
2. Connect hydraulic supply hoses to reel.
3. Connect hydraulic hoses to telescope cylinders.

OUTRIGGER SYSTEMS.

RT series cranes are equipped with hydraulic actuated double box type extendible outriggers, box enclosed vertical hydraulic jacks with integral holding valves and manual pin type locks. (See Figure 3-29.)

Outrigger positions are selected by individual electrical switches on the upper control panel, energizing solenoid operated hydraulic valves. Hydraulic power output is controlled by a foot pedal in the operator's cab.

Servicing.

Routine lubrication of the pivot points on the hydraulic cylinders and the outrigger pivot arms is normally all that is required over long periods of usage. In the event that hydraulic cylinder damage or seal leakage occurs, it will be necessary to remove the cylinder(s) for repair.

Removal — Outriggers.

Extension/retraction cylinders can be removed without removing the entire outrigger. Vertical jack cylinders can be removed individually if it is possible to locate the jack over a pit or by digging a hole sufficiently deep to allow the box to be lowered out. Otherwise, the outrigger will have to be removed as a unit before disassembly.

1. Extend outrigger (1) sufficiently to allow jack box end of extension cylinder (2) cross shaft (3) to be exposed for removal.
2. Remove bolt (4), washer (5) and cap (6) and tap out rod end shaft (3).

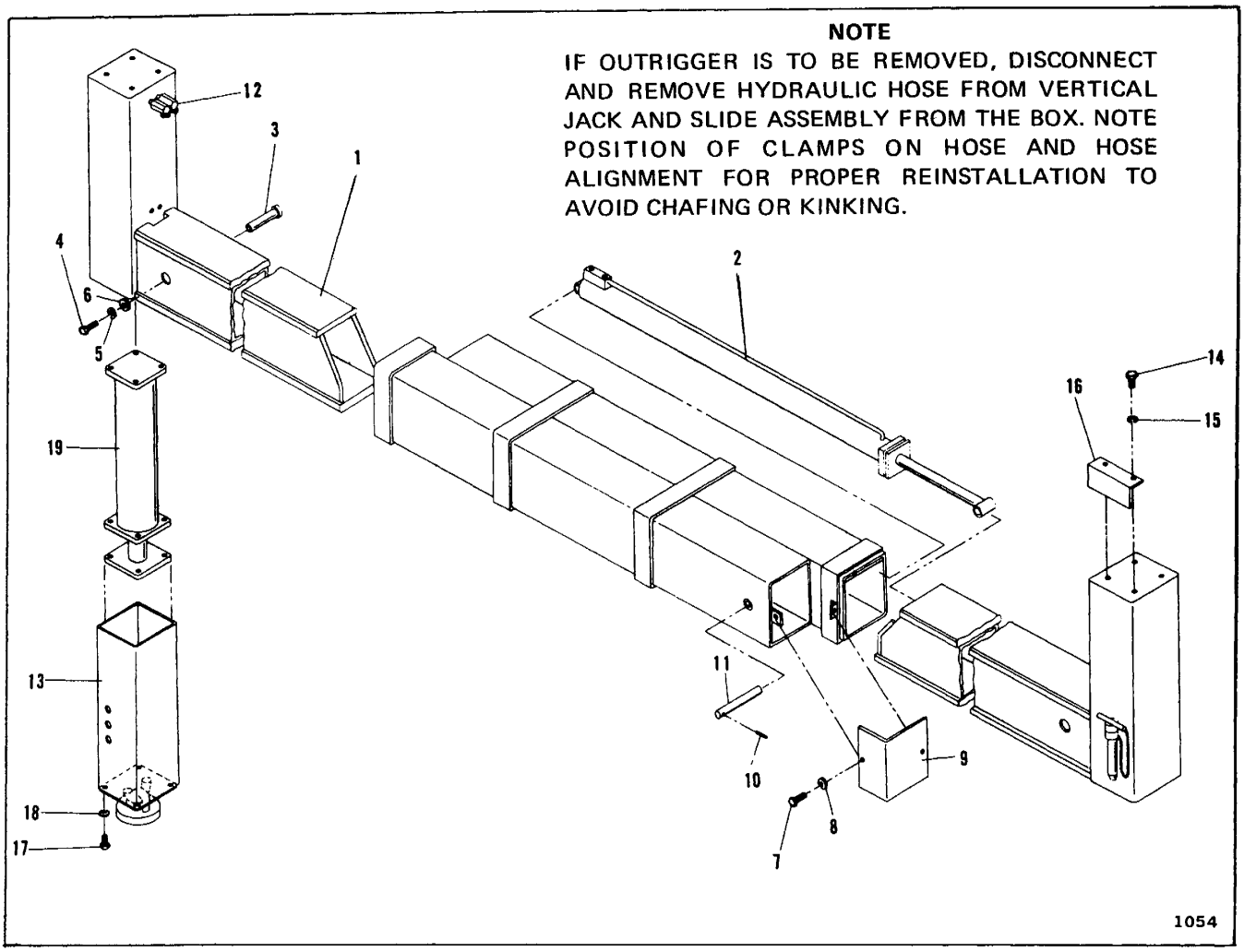


Figure 3-29. Outrigger Assembly

3. Remove bolts (7) and washers (8) securing cover plate (9) from outrigger box.
4. Disconnect and remove hoses and cap all fittings.
5. Remove roll pin (10) from shaft (11).

NOTE

IF OUTRIGGER IS TO BE REMOVED, DISCONNECT AND REMOVE HYDRAULIC HOSE FROM VERTICAL JACK AND SLIDE ASSEMBLY FROM THE BOX. NOTE POSITION OF CLAMPS ON HOSE AND HOSE ALIGNMENT FOR PROPER REINSTALLATION TO AVOID CHAFING OR KINKING.

VERTICAL JACK REMOVAL. (Refer to Figure 3-29.)

Place jack box over pit so that cylinder can be lowered out with box.

1. Disconnect hydraulic hose and cap fittings.
2. Remove elbow fittings (12) at top of cylinder housing and insert plugs for contamination prevention.
3. Support cylinder box (13) at jack pad and remove the four bolts (14), four washers (15) and plate (16) at top of jack housing. Lower box and cylinder from housing.
4. Remove bolts (17) and washers (18) securing cylinder (19) to box and remove.

VERTICAL JACK INSTALLATION. (Refer to Figure 3-29.)

1. Install hydraulic cylinder (19) into jack box and secure with bolts (17) and washers (18).
2. Raise jack box and cylinder into outrigger vertical housing.
3. Support cylinder box (13) at jack pad and install the four bolts (14), four washers (15) and plate (16) at the top of housing.
4. Install elbow fittings at top of cylinder and connect hydraulic hose.

Installation - Outriggers.

1. Extend cylinder to approximate length of distance between cross shaft holes.

2. Slide cylinder into outrigger box and install base end cross shaft (11) making certain roll pin hole is lined up. Install new roll pin (10). (Shaft should be well lubricated prior to installation.)
3. Lubricate rod end cross shaft (3) and install bolt. A length of wood used as a lever will be of help in hole alignment.
4. Attach hydraulic hoses using caution in proper alignment to avoid chafing or kinking.
5. Replace end plate (9) with bolts (7) and washers (8).

OSCILLATION LOCKOUT CYLINDER. (Refer to Figure 3-30.) Automatic hydraulic oscillation lockout cylinders mounted on the rear axle prevent crane oscillation, except when the boom is positioned over the front of the unit.

OSCILLATION LOCKOUT CYLINDER – REMOVAL. (Refer to Figure 3-30.)

1. Remove cover bolts and remove cover (A).
2. Disconnect hydraulic hoses and plug all openings.
3. Remove nut (B) and tap out bolt (C) with washer from rod end of cylinder shaft.
4. Remove cylinder shaft.
5. Remove bolt (D), washer and lockwasher from base end of cylinder shaft.
6. Remove cylinder shaft.
7. Lift lockout cylinder from housing and place in clean working area for overhaul.

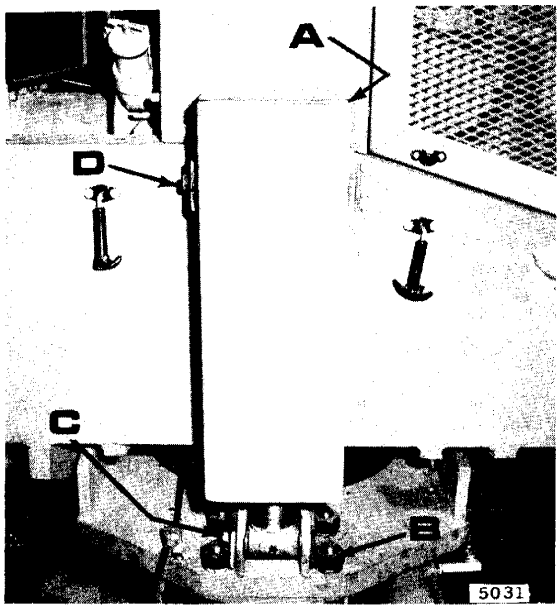


Figure 3-30. Oscillation Lockout Cylinder Attach Points

OSCILLATION LOCKOUT CYLINDER–INSTALLATION. (Refer to Figure 3-30.)

1. Place cylinder into housing with rod end down.
2. Align cylinder base end bushing with attachment holes and install shaft with lockwasher, washer and bolt (D).
3. Align rod end of cylinder shaft and install bolt (C), washers and nut (B).

Table 3-8. Oscillation Lockout Cylinder Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Rear axle lockout cylinders inoperative for oscillation.	Improper valve to turntable cam alignment.	Realign to obtain proper plunger engagement.
	Clogged or restricted hose or fitting.	Clean or replace hose or fitting.
	Boom more than 5^{o} - 7^{o} off center line of machine.	Center boom with machine.
	Broken plunger roller.	Replace roller.
Rear axle lockout cylinders will not lock up.	Stuck lockout valve plunger.	Remove and clean.
	Boom within 5^{o} - 7^{o} of being centered.	Rotate turntable to disengage lockout plunger.
	Leaking cylinder seals.	Replace seals.
	Improperly adjusted (aligned).	Readjust (realign).
	Air trapped in cylinders.	Bleed by cycling oscillation.
	Broken plunger spring in lockout valve.	Replace spring.
	Scored piston and/or barrel.	Replace piston and/or barrel.
	**Stuck valve plunger on override valve.	Remove and clean valve.
	**Broken plunger spring on override valve.	Replace spring.
	**Damaged solenoid valve and/or electrical switch.	Repair or replace valve on switch.

**If Applicable.

4. Connect hydraulic hoses.
5. Lubricate rod end of cylinder shaft.
6. Install cover (A) with bolts.

POWER STEERING CONTROL (ORBITROL). (Refer to Figure 3-31.) Hydraulic fluid is directed to the front axle steering cylinders by a control column mounted control valve unit (Orbitrol). The unit is lubricated by the working fluid used to power the steering system.

SERVICING.

A normal periodic functional check of the entire vehicle power steering system will generally be adequate to insure satisfactory service. The oil level of the reservoir that supplies the system is MOST IMPORTANT. If the oil level drops appreciably over short periods of use, it will be wise to search for a leak in the system.

An accumulation of dirt at a fitting can indicate a leakage point. If the fitting is to be taken apart to correct leakage, first clean the area completely with a solvent-wetted cloth, steam clean, or otherwise clean off any debris from the immediate area and any dirt accumulation above the area, so that contamination will not enter the system while the connection is open. Be extremely careful to apply sealing compound sparingly to the male fitting only. Do not let any compound enter an area in which it may be washed into the oil stream.

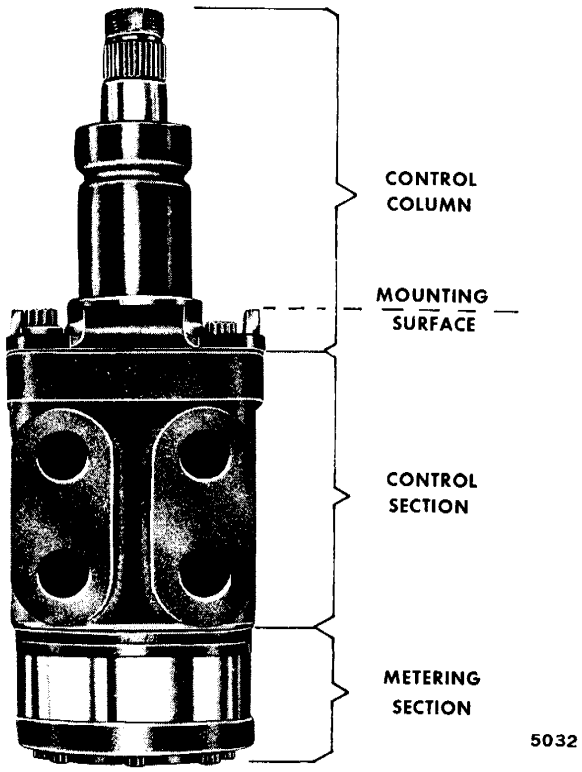


Figure 3-31. Orbitrol Steering Unit

WARNING

NEVER USE FLUID SYSTEM "STOP LEAK" ADDITIVES TO ATTEMPT TO SEAL FLUID LEAKAGE. STEERING SYSTEMS HAVE BEEN RUINED BY SUCH ATTEMPTS.

To continue the functional check of the system, turn the steering wheel through its full travel. Do this at engine idle and full throttle, with the machine standing still and the steered wheels on dry concrete, and with the machine rolling slowly. Note any speed irregularities or hesitating sensation which may indicate dirt in the fluid. If under any of these conditions the steering wheel continues to rotate when started and released, a condition known as MOTORING exists. This may also indicate contaminated (dirty) fluid in the system.

If contaminated oil is present, clean or replace the filter element. (Refer to Figure 3-3.) There is no filter in the Orbitrol unit.

Drain and replace as much of the oil as possible; crank the pump over by hand to exhaust oil from it and swing the cylinder through a full travel, but do not forcibly rotate the Orbitrol steering wheel if a dirty fluid is suspected. Refill the system with clean oil, run the system briefly, and recheck and refill as necessary to obtain proper fluid level. Operate the system for a short time to determine whether a correction has resulted. It is less costly to rinse and clean the system twice than to completely tear down and reassemble a unit.

TROUBLESHOOTING.

In the functional check, also determine that the actuating cylinder achieves full travel without hesitation. If the cylinder seems to pause in its travel, this may indicate that it contains trapped air. In filling and refilling a system, it is sometimes necessary to lift the vehicle weight off the steered axle, or to remove the cylinder and hold it in a position with the ports uppermost so that air will be bled back to the system reservoir and effectively exhaused from the system at the reservoir vent. During this inspection, determine that the mechanical or other limit stops at the axle are functioning properly. Proper wheel alignment is every bit as important on power-steered vehicles as on any other, to insure satisfactory tire life and geometrically true steering.

Inspect to insure that the system has adequate power. An indication of hard-steering can indicate either a reduced oil flow to the control or reduced system relief pressure. Adequate oil flow under all conditions can best be checked by timing the full travel of the cylinder with the steered axle unloaded and loaded. A great difference at low engine and slight difference at high engine speed may indicate a

damaged pump drive. Adequate oil pressure can only be determined by connecting a pressure gage (2000 psi full scale recommended) at the pump outlet port or at the IN port of the Orbitrol. With the engine running at a medium speed, turn the steering wheel to one end of the travel and hold the cylinder at the travel limit briefly – just long enough to read the pressure gage. Never hold a system at relief pressure for more than a few seconds at a time. Longer operation at relief pressure can overheat most systems quite rapidly. The pressure relief valve is a protection for all of the various parts of the steering system. There is no pressure relief in the Orbitrol.

If the system is reported to operate extremely hot, connect a pressure gage as above and operate the engine at near full throttle. Rotate the steering wheel slowly in each direction and bring the wheel to the position that shows the lowest pressure reading. This places the control section of the unit in neutral.

Turn the steering wheel to a limit stop and hold it there for one to two seconds. Release the steering wheel gently and watch the gage. If the pressure does not drop to very nearly the same neutral pressure as measured when placing the control in neutral deliberately, a binding control shaft or dirt between the spool and sleeve of the control valve can be the cause of difficulty.

If the recentering characteristic is erratic and if the control feels slightly sticky through most of the travel, apply the pressure gage in the OUT line of the Orbitrol. This return line pressure should be below 30 psi during all periods of normal operation. Check this downstream line to insure that no fittings are obstructed. If the system uses a return line filter, as in many common power steering pump-tank units, a higher return line pressure may indicate that the filter needs cleaning.

ORBITROL STEERING CONTROL – REMOVAL.

Before removing the Orbitrol unit from the vehicle, clean all accumulated dirt from the unit, connecting lines, and surrounding area to prevent contamination.

NOTE

IF IT IS NECESSARY TO REMOVE THE STEERING WHEEL, USE A WHEEL PULLER. DO NOT HAMMER THE END OF THE SHAFT OR THE STEERING WHEEL NUT, AS DAMAGE TO THE UPPER SHAFT BEARING WILL RESULT.

1. If entire unit is to be removed from crane, remove steering wheel, using care to not damage the upper shaft bearing.
2. Remove mounting screws and lower unit from assembly. If it is **not** necessary to remove entire unit (with column) from crane, drop unit only far enough to gain access to the two screws (1), which attach column (2) to the lower unit (3) and separate the two components.
3. Observe the shaft area of the lower unit immediately upon separation from the column assembly. An oil-wetted appearance indicates that the shaft seal may have been leaking.

NOTE

IF THERE IS A FUNCTIONAL PROBLEM OR LEAKAGE AT THE CONTROL END OF THE UNIT ONLY, THE DISASSEMBLY OF THE CONTROL END OF THE UNIT ONLY WILL BE REQUIRED AND IT IS GENERALLY ADVISABLE TO LEAVE THE BOLTED END ASSEMBLED.

DISASSEMBLY – ORBITAL STEERING CONTROL (Refer to Figure 3-32.)

1. If a complete tear down and reassembly of the unit is planned, clean all paint and surface contamination from the unit at points of separation. This is extremely important at the meter end of the unit, so that no paint flakes or particles will enter these closely fitted parts as they are being reassembled. To clean the unit adequately, plug all four ports, wire brush around the meter area, and rinse and blow away all surface contamination before any disassembly is begun.

NOTE

FOR ANY DISASSEMBLY, AN EXTREMELY CLEAN BENCH AREA IS NECESSARY. DO **NOT** USE SHOP CLOTHS OR COTTON WASTE TO WIPE OR CLEAN THE PARTS. THE LINT DEPOSITED BY THESE CAN DISRUPT FUNCTION OR CAUSE LEAKS. THE CLEAN INSIDE SURFACE OF A CORRUGATED CONTAINER IS FREQUENTLY A VERY ADEQUATE ASSEMBLY SURFACE. ASSEMBLY IS GENERALLY EASIER AND MORE SATISFACTORY WITH CLEAN, DRY PARTS. AFTER PARTS ARE RINSED CLEAN IN SOLVENT THEY MAY BE BLOWN DRY WITH AN AIR HOSE OR PLACED ON CLEAN PAPER TOWELS TO DRAIN AND AIR DRY.

2. Place the assembly in a vise, control end up. Clamp lightly across port surface and opposite side of housing.
3. Remove the two cap screws (1) that fasten column (2) to control unit (3). Remove column and set aside. Mark the two cap screw hole locations so that the ports will be in the proper location when reassembled.
4. Rotate position of unit in vise 180° and clamp in place across mounting plate edges with meter end up. Remove the seven cap screws (4).

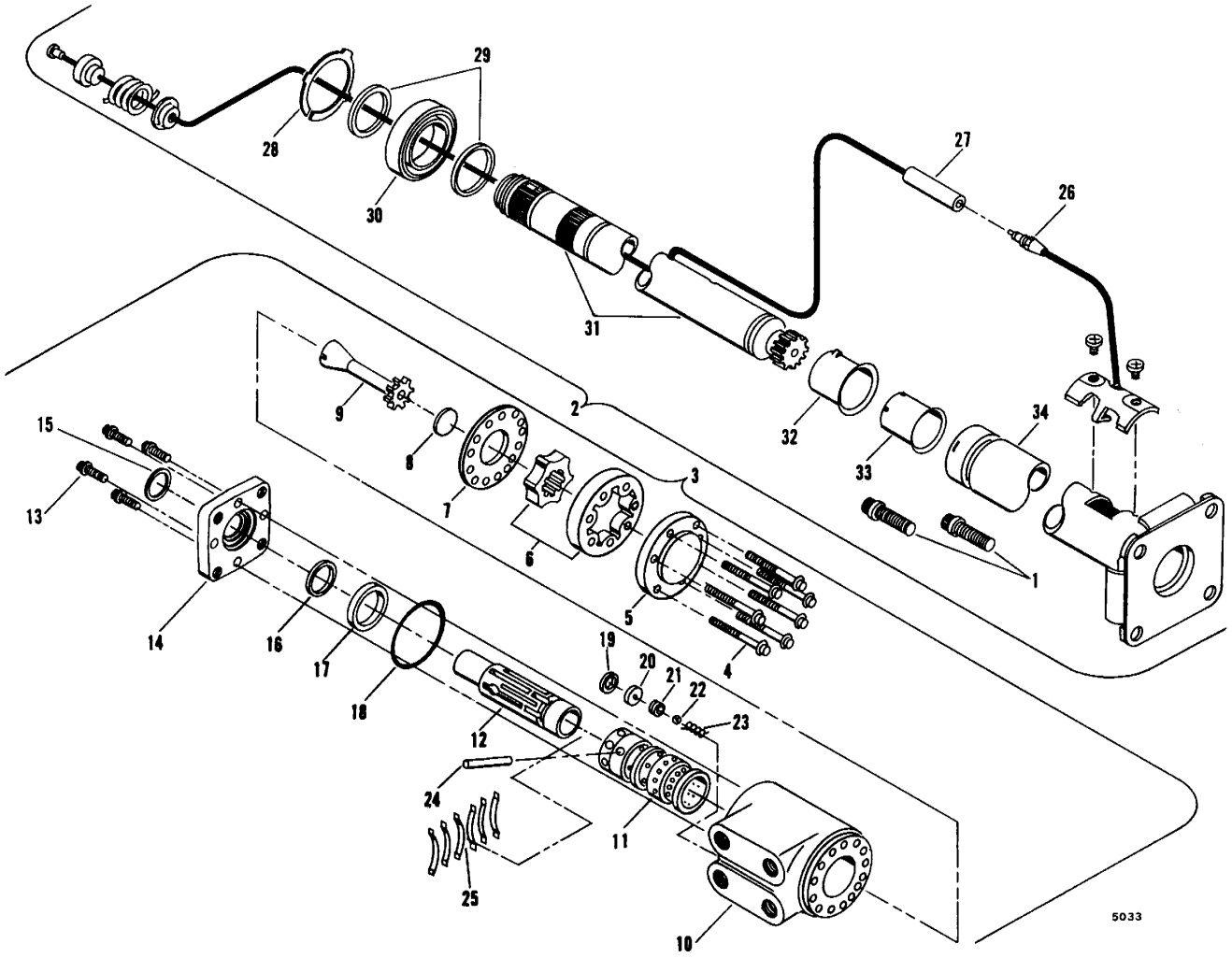


Figure 3-32. Steering Control Assembly

5. Remove end cap (5), gerotor set (6), plate (7), spacer (8), and drive shaft (9) from housing (10).
6. Remove control assembly from vise and check for free rotation of the control spool (11) and sleeve (12).
7. Place clean wooden block beneath vise jaws to support spool and clamp housing across port face with the control end up.
8. Remove four cap screws (13). Hold spool assembly down against wooden block in vise and lift off end cap plate (14) with seals (15) and (16).
9. Inspect mating surfaces of end plate and housing for obvious leakage path, wear, and seal condition.
10. Remove cap locator bushing (17) and o-ring seal (18).
11. Place housing on solid surface with port face down, so that it can be held securely, and remove spool-sleeve assembly from end of housing with fourteen cap screw holes.

NOTE

ROTATE SPOOL-SLEEVE ASSEMBLY DURING REMOVAL TO PREVENT BINDING.

12. Remove o-ring seal (19) and seal plug (20). Place housing in vise, control end up, and unscrew check valve seat (21) with a 3/16 inch hex wrench.
13. Up end the housing and tap slightly with butt of hand. Remove check valve ball (22) and spring (23).
14. Using drift pin, push out cross pin (24) from spool-sleeve assembly. Push inside lower edge of spool so that it moves toward splined end and remove carefully from sleeve.
15. Push centering spring set (25) out of spring slot in spool.

Inspection.

1. Clean all parts by rinsing in clean solvent, including capscrews and all seals which appear reusable. (If possible, replace all seals with new upon reassembly.) Dry parts on clean paper towels.
2. Inspect all moving surfaces to insure that they have not been scored or abraded by dirt particles or otherwise disrupted. Smooth burnished surfaces are normal in

many areas. Slightly scored parts can be cleaned with 600 grit abrasive paper by hand rubbing only.

3. To prepare all surfaces of the meter section for reassembly and insure that all edges of the parts are burr free, place a piece of 600 grit abrasive paper face up on an extremely flat, clean, hard surface. The surface to be used for this purpose should be as flat as plate glass or better. If the 600 grit paper is new, it should first be rubbed down with a scrap steel part to remove sharp grit, which would produce scratches. The ends of the star gear can be used for this purpose if necessary. Both sides of the ring gear, both sides of the plate, the 14-hole end of the housing and the flat side of the end cap should be cleaned lightly.

   Stroke each surface across the abrasive several times and observe the part. Any small bright area near an edge indicates a burr which must be removed. Hold the part so that contact with the abrasive is as flat as possible. (Do not push one edge down hard or the flatness will become rounded.) Check each part after six to ten strokes across the abrasive. After polishing each part, rinse clean in solvent and blow dry. Keep these parts absolutely clean until they are assembled.

REASSEMBLY – ORBITROL STEERING CONTROL.
(Refer to Figure 3-32.)

1. Place housing (10) in vise with control end up. Protect 14-hole end, and clamp lightly across port surface.
2. Drop check valve spring (23) into valve hole with large end down. Drop the check ball (22) in valve hole and insure that it rests on the small end of the spring within the hole.
3. Place the check valve seat (21) on hex wrench and screw into threads of check valve hole with machined counterbore of seat toward the ball. Tighten valve seat to 150 pound-inches torque. Test ball action by pushing ball (with small clean pin) against spring. Ball need **not** be snug against seat for proper function. Install seal plug (20) and o-ring seal (19).
4. Install spool (11) within sleeve (12) carefully so that spring slots of both parts will be at same end. Rotate parts while sliding together to assist assembly. Spool and sleeve should rotate freely with no binding.
5. Align spring slots of spool and sleeve and stand upright on end of workbench. Insert spring installation tool through spring slots of both parts. Position the sets of centering springs (25) on workbench so that the extended edge is down and arched center section is together. In this position, enter one end of entire spring set into spring installation tool. Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time.
6. Center spring set so that they push down evenly and flush with the upper surface of the spool and sleeve. Install cross pin (24) through spool assembly until flush or slightly below the sleeve diameter at both ends.
7. Position the housing on a solid surface with the port face down. Start the spool assembly so that the splined end of the spool enters the 14-hole end of the housing first. Rotate assembly while inserting in place and maintain proper alignment to prevent binding.

   Insert spool assembly into housing until flush with the meter end (14-hole end) of the housing (but not beyond this point, to prevent the cross pin from dropping into the housing). Check for free rotation.

   Hold spool assembly and housing in flush position and rest the 14-hole end of the assembly on the protective wooden block on the vise and clamp lightly across the port face.
8. Position seal (18) and the cap locator bushing (17) (with large O.D. chamfer up) partly into end of housing, insuring that it seats flat against spool assembly. Check by rotating with finger tips.
9. Check the mounting plate (14) and shaft seal (16) carefully to insure that they are clean and in good condition. Insure that the mounting plate seal grooves are clean and smooth. (Each of these seals is slightly larger than its seal groove so that they will be adequately retained in service.) Push each gently into place and smooth down into seal groove with finger tip.
10. Thin oil seal (15) at exterior of mounting plate is a dirt exclusion seal and does not usually need replacement. If this is replaced it should be pressed into counterbore so that the lip is directed away from the unit.
11. Place the mounting plate sub-assembly over spool shaft and slide down into place over cap locator bushing smoothly, so that seals will not be disrupted in assembly. Align bolt holes with tapped holes. Be certain that the mounting plate rests fairly flush against end of housing assembly, so that the cap locator bushing is not cocked, and install four mounting plate cap screws (13). Tighten evenly and gradually to a torque setting of 250 pound-inches.
12. Reposition housing assembly in vise (14-hole end up) and clamp across the edges of the mounting plate. Insure that the spool and sleeve are flush or slightly below the surface of the housing.
13. Place the plate (7) on the housing and align the plate bolt holes with the tapped holes in the housing.
14. Place the meter gear ring portion of the gerotor set (6) on the assembly and align the bolt holes.
15. Insert the splined end of drive shaft (9) into the meter gear star portion of the gerotor set (6) so that the slot at the control end of the drive is in alignment with the

valleys between the meter gear teeth (see figure 3-33).

16. Push the splined end of the drive through the gear so that the spline extends about one-half its length beyond the meter gear star and hold it in this position while installing into the unit. Note the position or direction of the cross pin within the unit. Enter the meter gear star into the meter gear ring and wiggle the parts slowly in position so that the drive does not become disengaged from the meter gear star. Hold the plate and meter gear ring in position on the assembly while the star is being installed. Rotate the meter gear star slightly to bring the cross slot of the drive into engagement with the cross pin and the splined end of the drive will drop down against the plate.

WARNING

ALIGNMENT OF THE CROSS SLOT IN THE DRIVE WITH VALLEYS BETWEEN THE TEETH OF THE METER GEAR STAR DETERMINES PROPER VALVE TIMING OF THE UNIT. THERE ARE 12 TEETH ON THE SPLINE AND 6 PUMP TEETH ON THE STAR. ALIGNMENT IS EXACTLY RIGHT IN 6 POSITIONS AND EXACTLY WRONG IN 6 POSITIONS. IF THE PARTS SLIP OUT OF POSITION DURING THIS PART OF THE ASSEMBLY, REPEAT UNTIL YOU ARE CERTAIN THAT CORRECT ALIGNMENT IS OBTAINED.

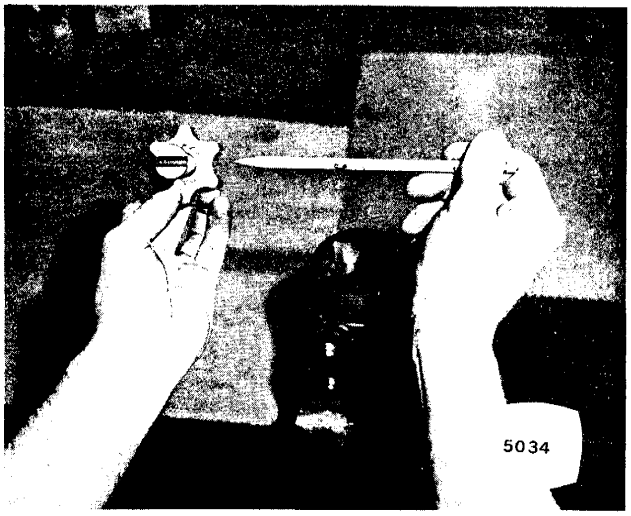


Figure 3-33. Gerotor Alignment

17. Place the spacer (8) in position within the end of the meter gear star. If the spacer does not drop flush with the gear surface, the drive has not properly engaged the cross pin – RECHECK.
18. Place the meter end cap (5) over the assembly and install two cap screws (4), finger tight, to maintain alignment of the parts. Install remaining seven cap screws and bring them gradually and evenly to 150 pound-inches torque.

Clean and check condition of the column assembly (2). If disassembly is required, proceed as follows:

1. Disconnect horn wire terminal (26) from connector (27).
2. Remove retaining ring (28) securing bearing snap rings (29) and bearing assembly (30), steering shaft assembly (31), contact ring (32) and contact ring insulator (33) from tube and flange assembly (34).
3. Inspect and replace components as required.
4. Reassemble column components and reconnect horn wire.

ORBITROL STEERING CONTROL – INSTALLATION.

1. Mate the steering column assembly (2) with the control unit housing (3). Rotate the steering column shaft (31), while bringing the surfaces into contact, to allow splines to engage. Secure assemblies together with two cap screws (1) and torque to 280 pound-inches.
2. Lift unit into place on the crane and attach with mounting screws. Install steering wheel.

POWER STEERING CYLINDERS.

Two hydraulic cylinders are utilized on the front axle to provide power assisted steering wheel control. The rear axle uses a full hydraulic system with two cylinders and a tiller bar control lever. The hydraulic power is provided by a separate power-takeoff driven pump.

Steer Cylinder – Removal. (Refer to Figure 3-34.)

1. Remove bolt, lockwasher, and washer from rod end of steer cylinder (A) and tap out rod end pivot shaft.
2. Disconnect hydraulic lines and cap all openings.
3. Remove bolt, lockwasher, and washer from base end of cylinder (B) and tap out base end anchor shaft.
4. Place cylinder in clean working area for overhaul.

Steer Cylinder – Installation. (Refer to Figure 3-34.)

1. Position steer cylinder, aligning base end bushing (at point B) and tap in pivot shaft.
2. Install washer, lockwasher, and bolt.
3. Align rod end bushing (at point A) and tap in anchor shaft.
4. Connect hydraulic lines.
5. Lubricate rod end of cylinder shaft.

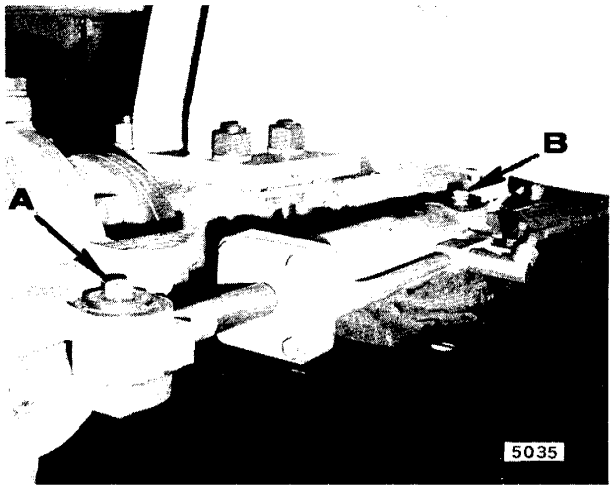


Figure 3-34. Steer Cylinder Attach Points

Table 3-9. Steering Cylinder Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Primary (front) steering inoperative.	Inoperative steering bypass (relief) valve.	Repair or replace valve.
	Loose or broken hydraulic pump suction hose or fittings.	Replace hose or fittings.
	Leaking steer cylinder seals.	Replace seals.
	Scored cylinder barrel.	Hone or replace barrel.
	Broken or scored piston.	Replace piston.
	Inoperative steering orbitrol.	Repair or replace orbitrol.
	Worn or inoperative steering pump.	Repair or replace pump.
	Broken pump shaft.	Repair or replace shaft.
	Leaking seals in hydraulic turntable swivel.	Replace seals.
	Damaged hydraulic swivel spool or housing.	Replace damaged components.
	Hydraulic oil level low.	Replenish system.
Secondary (rear) steering inoperative.	Dirty or inoperative relief valve.	Clean or replace valve.
	Loose or broken hydraulic pump suction hose or fittings.	Retorque or replace hose or fittings.
	Low hydraulic oil level.	Replenish to proper level.
	Leaking steer cylinder seals.	Replace seals.
	Broken or scored piston.	Replace piston.
	Scored cylinder barrel.	Hone or replace barrel.
	Leaking seals in hydraulic swivel.	Replace seals.
	Damaged hydraulic swivel spool or housing	Replace damaged components.
	Worn or inoperative main hydraulic pump section.	Repair or replace pump.

HOIST.

The hoist has three basic component parts: base and side frames; hydraulic motor and brake valve; and cable drum assembly. In turn, the cable drum assembly is made up of four basic assemblies: cable drum; brake assembly; primary planetary reducer; and final planetary reducer.

The hydraulic motor is bolted directly to the brake assembly housing. This housing is bolted and doweled to the side frame. The ring gear of both planetary reducers is splined to the brake housing. The cable drum is supported by this brake housing through a large bushing. A quad ring in the bushing prevents oil leakage.

The cable drum is supported on the other end by the final planet carrier to which it is splined. The carrier is supported by an anti-friction roller bearing on a ground and polished shaft projecting from the end frame.

The hydraulic motor drives the sun gear of the primary planetary reducer. The output is transmitted, by the planet carrier, to the sun gear of the final planetary reducer.

This output is transmitted directly to the cable drum by a splined fitting between the planet carrier and the drum.

The automatic braking system has four operating component parts: brake valve attached to hydraulic motor; spring loaded friction brake; an overriding cam clutch; and a hydraulic piston and cylinder.

The brake valve is basically a counterbalance valve. It contains a check valve to allow free flow of oil to the motor in a hoisting direction of rotation, and a pilot operated check valve that prevents flow of oil out of the motor when the operating valve is placed in the reverse or lowering position until sufficient pressure is present for the pilot piston to open the check valve. It also contains a small pressure relief valve set to prevent excessive shocks on the motor when a lowering operation is stopped.

The friction brake is a load holding brake only and has nothing to do with dynamic braking or stopping the descent of a load.

The overriding clutch is splined to the driveshaft between the motor and primary sun gear. It will allow this driveshaft to turn freely in a rotation to raise a load and force the brake discs to turn with the shaft in rotation to lower a load.

The hydraulic cylinder when pressurized will release the spring pressure on the brake discs. This is a double-acting cylinder and is balanced to back pressure when the hoist is not being operated.

When the hoist is powered in a hoisting direction, the drive from the motor to the primary sun gear runs free. The overriding clutch between the driveshaft and the brake discs allows complete freedom of rotation in this direction. The brake remains fully engaged as the brake release piston is balanced to any amount of back pressure that may exist.

When the lifting operation is stopped, the brake being fully engaged, prevents the load from lowering.

When the hoist is powered to reverse, the motor cannot rotate until sufficient pressure is present to open the brake valve. The friction brake within the hoist will completely release at a pressure lower than that required to open the brake valve. The extent to which this valve will open will determine the amount of oil that can flow through it and the speed at which the load will be lowered. Increasing the flow of oil to the hoist motor will cause the pressure to rise and the opening in the brake valve to enlarge speeding up the descent of the load. Decreasing this flow causes the pressure to lower, the opening in the brake valve to decrease, slowing down the descent of the load.

When the operating valve is shifted to neutral the pressure will drop, the brake valve will close, stopping the load. The friction brake will engage after the valve has closed and hold the load.

When lowering a load very slowly for precise positioning, no oil flow actually occurs through the hoist motor. The pressure will build up to a point where the brake will release sufficiently to allow the load to rotate the motor through its own leakage. This feature results in a very slow speed and extremely accurate positioning.

The hoist in raising a load is not affected by any braking action. When lowering a load the brake valve has complete control of the speed at which it is lowered. When the hoist is stopped by returning the control lever to neutral – the brake valve stops the load and the friction brake engages to hold the load.

Thus, the brake receives very little wear in lowering operations. All of the heat generated by the lowering and stopping of a load is absorbed by the hydraulic oil where it can be readily dissipated. The only heat absorbed by the hoist in either hoisting or lowering is to the efficiency losses within the hoist itself.

Servicing. (Refer to Figure 3-35.)

Checking Oil Level.

1. Remove rope from hoist.
2. There are two pipe plug holes in the drum of the hoist. Turn the hoist drum until one plug is at the highest point on the drum. Oil should be level with the lowest plug. Add 90 weight worm gear oil through top plug, if necessary.
3. Reinstall pipe plugs and cable.

For proper lubricant, refer to the Lubrication Chart, Section V, of this manual.

Oil Change.

1. Oil should be changed after first two months of operating time.
2. Drain and fill with clean kerosene and run for 15 minutes in each direction. Drain thoroughly and refill with approved 90 weight worm gear oil. Oil should then be changed every six months. Oil capacity is four pints.

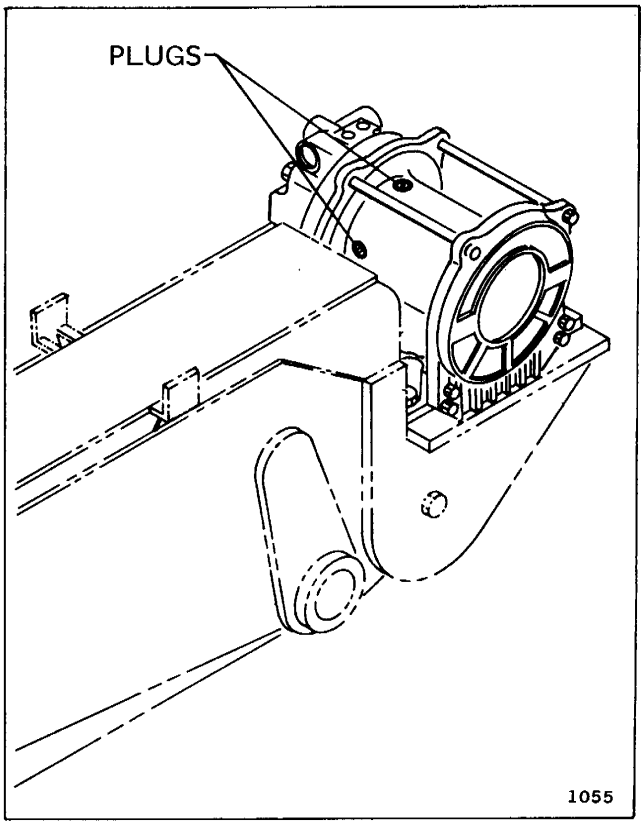


Figure 3-35. Hoist Servicing Points

Table 3-10. Hoist Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Hoist will not let out rope.	Broken lines or fittings.	Replace lines or fittings.
	Damaged relief valve.	Repair or replace valve.
	Damaged control valve.	Repair or replace valve.
	Damaged primary drive assembly.	Repair or replace primary drive assembly.
Hoist will not take in rope.	Load capacity exceeded.	Reduce load. (Refer to applicable Load Chart.)
	Hydraulic oil low.	Replenish system.
	Broken hydraulic lines or fittings.	Replace lines or fittings.
	Damaged relief valve.	Repair or replace valve.
	Damaged control valve.	Repair or replace valve.
	Damaged primary drive assembly.	Repair or replace primary drive assembly.
Rope movement erratic (hoist operation ok).	Rope binding or not properly positioned on sheave.	Properly align or position rope.
	Rope broken or bird caged.	Replace rope.
	Insufficient lubricant on sheaves or idler wheels.	Lubricate component. (Refer to Lubrication Chart, Section VI.)

Troubleshooting.

A. Hoist Will Not Lower Load.
This is an indication that either the orifice plug in the brake valve is clogged or the brake is not being released. To check orifice plug, remove tube (17) and elbow (29).

Remove the plug, using a screwdriver with an 1/8-inch wide blade. Check the hole in the plug with a wire of less than .020 inch in diameter. If the hole is open, the fault is probably not in the brake valve. Since the hoist brake is not being released, the brake cylinder should then be removed and disassembled to determine the cause.

B. Hoist Leaks a Large Volume of Oil Through the Vent Plug. This is caused by the hydraulic oil leaking into the hoist through the hydraulic motor seal or a damaged o-ring in the hoist brake.
1. In order to determine the cause of the leak, remove the tubing from the motor manifold to the hoist brake.
2. Attach a hydraulic jack to the brake connection and apply 500 psi to the brake. The brake should be able to hold this pressure for ten minutes. Be certain that all connections are tight and that oil does not leak back into the jack.
3. If the brake holds the pressure, then the motor seal is leaking and should be replaced.
4. If the hydraulic seal must be replaced, it is necessary to remove the drain line check valve from the brake valve. Be certain that the check valve is clean and that it does not leak. Replace, if necessary.
5. If the brake will not hold pressure, the hoist should be returned to the factory for repair.

C. Hoist Will Not Lift Rated Load.
1. Be certain that the hoist has not been mounted on an uneven surface. If necessary, shim shock should be used.
2. Be certain to check for proper hydraulic pressure to the hoist brake valve. Check the pressure at the hoist for accurate readings.
3. Be certain that the hydraulic system which operates the hoist is not running more than 180°F.
4. Remember that the hoist ratings are established on the first layer of rope.
5. Be certain that the cable sheaves, used with the hoist, are operating efficiently.

D. Hoist Runs Hot (over 200°F) or Makes Excessive Noise.
1. Be certain that the hoist has not been mounted on an uneven surface.
2. Be certain that the hydraulic system which operates the hoist is not running more than 180°F.

E. Hoist Chatters While Raising Rated Capacity Load.
1. This is probably caused by the relief valve in the hydraulic system trying to by-pass.

Inspection.

Visually inspect hydraulic lines and connections for evidence of leaks, indicating parts that may be loose or damaged. Check general condition of hoist assembly and security of hoist mounting bolts.

HOIST MOUNTING ALIGNMENT.

Hoist mounting alignment with the boom is important to maintain level rope wrap, optimum rope life, and avoidance of unsymmetrical loading on the hoist bearings and gear case. Line-up is a relatively simple procedure requiring a minimum of equipment. If misalignment exceeds 1/2 degree, proper adjustment should be made immediately. This can only be accomplished with the rope removed from the drum.

Procedure.

1. Lower boom to level position.
2. Find a line on top of hoist drum which is parallel to the drum axis as follows:
   a. Use a Miracle Point Gage and find a zero degree dial point next to each flange on top of the drum.

NOTE

IF THIS SPECIAL EQUIPMENT IS NOT AVAILABLE, SUFFICIENT ACCURACY IN LOCATING A CENTERLINE MAY BE OBTAINED BY USING A STEEL SQUARE AGAINST THE MACHINED INNER SURFACES OF BOTH FLANGES. IT IS ADVISABLE TO AVOID USING ANY CAST SURFACE IN THIS PROCEDURE UNLESS A CHECK FROM BOTH FLANGES INDICATES THAT THE RESULTANT LINE IS STRAIGHT. (FIGURE 3-36.)

   b. Draw a line between the hoist drum flanges, passing through both points as located above and determine midpoint.
3. Find the midpoint of lines drawn across top of base boom section, perpendicular to its length, at both ends of the boom section. (See Figure 3-36, points A and B.)
4. Check as follows to see if hoist is aligned perpendicularly to boom. (See Figure 3-36.)
   a. String a chalk line from point A, (outer boom centerline) across base section centerline and hoist drum midpoint.
   b. Pull line taut, aligning it directly over top of point B.

c. With a protractor, measure angle between chalk line and cross line drawn on hoist. If measurement of angle exceeds tolerance of 90 degrees (± 1/2 degree), realignment will be necessary.

5. If realignment is necessary, remove hoist mounting bolts and shift hoist as necessary to achieve minimum angular tolerance. Trial and error location may be necessary for proper line-up of bolt holes and stop blocks. If all bolts cannot be inserted or stop blocks interfere with line-up, slight elongation of hoist bolt holes and/or grinding of the mounting lugs might be necessary.

CAUTION

DO NOT ALTER HOLES OR STOP BLOCKS ON THE CRANE MOUNTING PLATE, AS VERY SMALL ADJUSTMENTS RESULT IN LARGE ANGULAR CHANGES. EXTREME CARE SHOULD BE TAKEN TO AVOID OVER-CORRECTION.

IMPORTANT: WHEN PROPER POSITIONING OF HOIST IS COMPLETED, CHECK HOIST MOUNTING LUGS FOR LEVELNESS WITH THE MOUNTING PLATE. IF ONE MOUNTING LUG IS HIGH, IT WILL BE NECESSARY TO USE SHIM STOCK TO AVOID DISTORTION OF THE HOIST ASSEMBLY WHEN ALL BOLTS ARE TORQUED DOWN. PROCEDURE TO FOLLOW IS TO INSTALL AND SNUG DOWN THREE BOLTS (ON TWO LOW AND ONE HIGH LUG) AND DETERMINE SHIM THICKNESS REQUIREMENTS UNDER FOURTH LUG WITH A FEELER GAUGE. LOOSEN BOLTS, INSTALL SHIM STOCK AND THE FOURTH BOLT. RECHECK TO MAKE CERTAIN ALIGNMENT HAS NOT BEEN DISTURBED AND TORQUE ALL BOLTS.

NOTE

IF IT APPEARS THAT EXCESSIVE THICKNESS OF SHIM IS REQUIRED, SPLIT THE SHIM STOCK AND PLACE UNDER THE TWO HIGH LUGS.

Hoist Removal.

1. Prior to initiating hoist removal, let out all cable and disconnect from hoist drum.
2. Attach suitable lifting sling to hoist.
3. Tag and disconnect hydraulic lines from hoist ports; cap all lines and openings.
4. Remove nuts, washers, and bolts (and shims, if installed) securing hoist to mounting pad; lift hoist free of pad and remove.

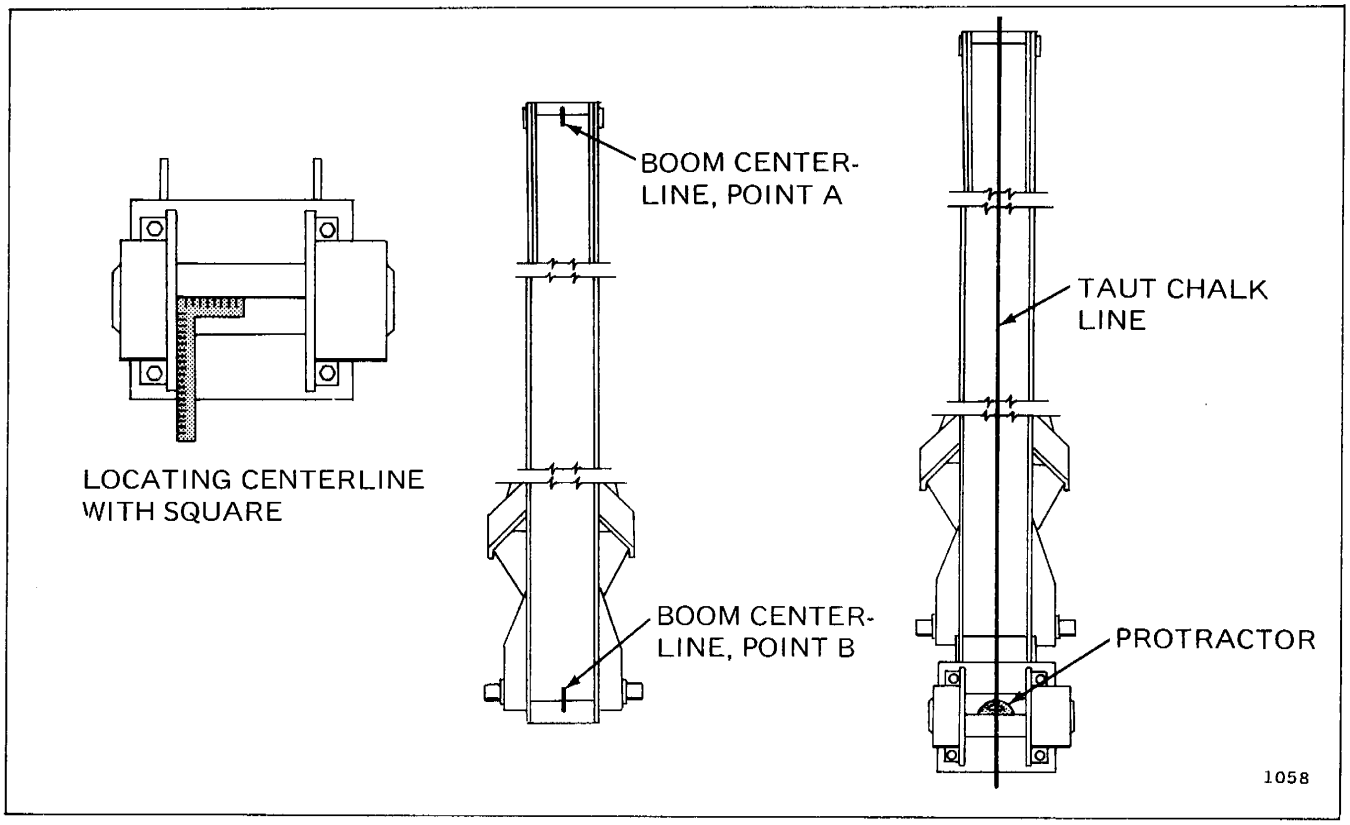


Figure 3-36. Hoist Mounting Alignment

Disassembly — Model 15 Hoist.

Brake Unit — Removal. (Refer to Figure 3-37.)

1. Disconnect hydraulic lines to brake housing (1); cap lines and openings.
2. Remove bolts (2) and washers (3) securing brake assembly to right end cover (4).
3. Using fiber mallet, tap assembly until loose and remove from hoist.

Brake Unit — Disassembly.

1. Remove o-ring (5) from groove in housing.
2. Place brake assembly in suitable press; using sleeve larger than overrunning clutch, compress springs.

NOTE

TWO LARGE C-CLAMPS CAN BE USED TO COMPRESS SPRINGS FOR REMOVAL OF SNAP RING.

3. Remove snap ring (6); relieve pressure from springs and remove assembly from press.
4. Remove pressure plate (7), brake discs (8), brake plates (9) and backing plate (10) from housing.
5. Remove cap screws (11) securing brake piston to housing.
6. Lift housing free of cylinder and piston assembly.
7. Remove springs (12) from cast sprocket of cylinder.
8. Using fiber mallet, remove brake piston (13) from cylinder (14).
9. Remove o-ring (15) from cylinder.
10. Remove o-rings (16, 17, and 18) from sides and face of piston.

Hydraulic Motor — Removal.

1. Drain oil from drum (19) by removing plugs (20 and 21).
2. Tag and disconnect hydraulic lines from motor (22) and valve (23); cap lines and openings.
3. Remove hex head bolts (24) and washers (25) securing motor to left end housing (26); remove motor and valve; discard motor gasket (27).

Hoist — Disassembly.

1. Remove bolts (28) and washers (29) securing left side end housing (26) to center housing (30); remove end housing.
2. Remove bolts (31) and washers (32) securing left drum end (33) to drum (19); remove left drum end.
3. Remove bearing (34) with seal (34A) from left drum end.
4. Remove o-ring (35) from left drum end.
5. Remove shaft (36) (with coupling 36A and o-ring 36B).
6. Remove overrunning clutch (37), key (38) and snap ring (39) from main shaft.
7. Remove spacer (40) from main shaft (right side).
8. Remove cap screws (41) securing hub (42) to right end housing (4).
9. Remove bolts (43) and washers (44) securing right end housing to center housing (30); remove right end housing.
10. Remove o-ring (45) from right end housing.
11. Remove cap screws (46) securing gear reduction unit (47), drum end (48), o-ring (49), and spacer (50) to drum; remove assembly from drum.
12. Remove drum from center housing.

Gear Reduction Unit — Disassembly.

1. Remove cap screws (51) securing cover plate and thrust washer (52) to unit end cover (53); remove cover plate.
2. Remove bolts (54) and washers (55) securing unit end cover to ring gear (56); remove cover.
3. Remove spacer (57).
4. Remove sun gear (58).
5. Remove primary carrier assembly (59).
6. Remove ring gear (56).
7. Expand snap ring (60) from groove in hub (42) inside of secondary carrier.
8. Remove secondary carrier assembly (61).
9. Press hub from right drum end bearing (62).
10. Remove seal (63) from bearing retainer (64).
11. Remove cap screws (65) securing bearing retainer (64); remove bearing retainer and gasket (66).
12. Remove bearing (62), if required.

NOTE

BEARING (62) SHOULD NOT BE REMOVED FROM RIGHT DRUM END UNLESS REPLACEMENT IS REQUIRED.

13. Remove snap ring (67) securing bearing (68) to hub; remove bearing and main shaft (69).
14. Remove shaft seals (70 and 71).

Inspection.

1. Clean all parts with suitable solvent and dry with compressed air.

CAUTION

DO NOT ALLOW COMPRESSED AIR TO SPIN BEARINGS.

2. Check all parts for cracks, nicks or other damage.
3. Examine bearings for smoothness and freedom of movement.

Gear Reduction Unit — Reassembly.

1. Press bearing (62), if bearing was removed during disassembly, into right drum end.
2. Install gasket (66) and bearing retainer (64); secure with cap screws (65).
3. Install seal (63) in bearing retainer.
4. Install hub (42) through seal and bearing in right drum end.
5. Install seals (71 and 70) in hub.
6. Install shaft (69) and bearing (68) into hub; secure with snap ring (67).
7. Invert hub and drum end and press spacer (50) into position on hub.
8. Position hub retainer ring (60) in place in secondary carrier (61).
9. Assemble secondary carrier over hub splines, expand the retainer ring and seat retainer ring in hub groove after carrier is in position on hub splines.
10. Position ring gear (56) over secondary carrier and against drum end face.
11. Position primary carrier (59) into ring gear and secondary carrier.
12. Position sun gear (58) into primary carrier gears engaging main shaft splines.
13. Position spacer (57) in place over sun gear.
14. Secure unit end cover (53) with washers (55) and cap screws (54) to ring gear and right drum end (48).

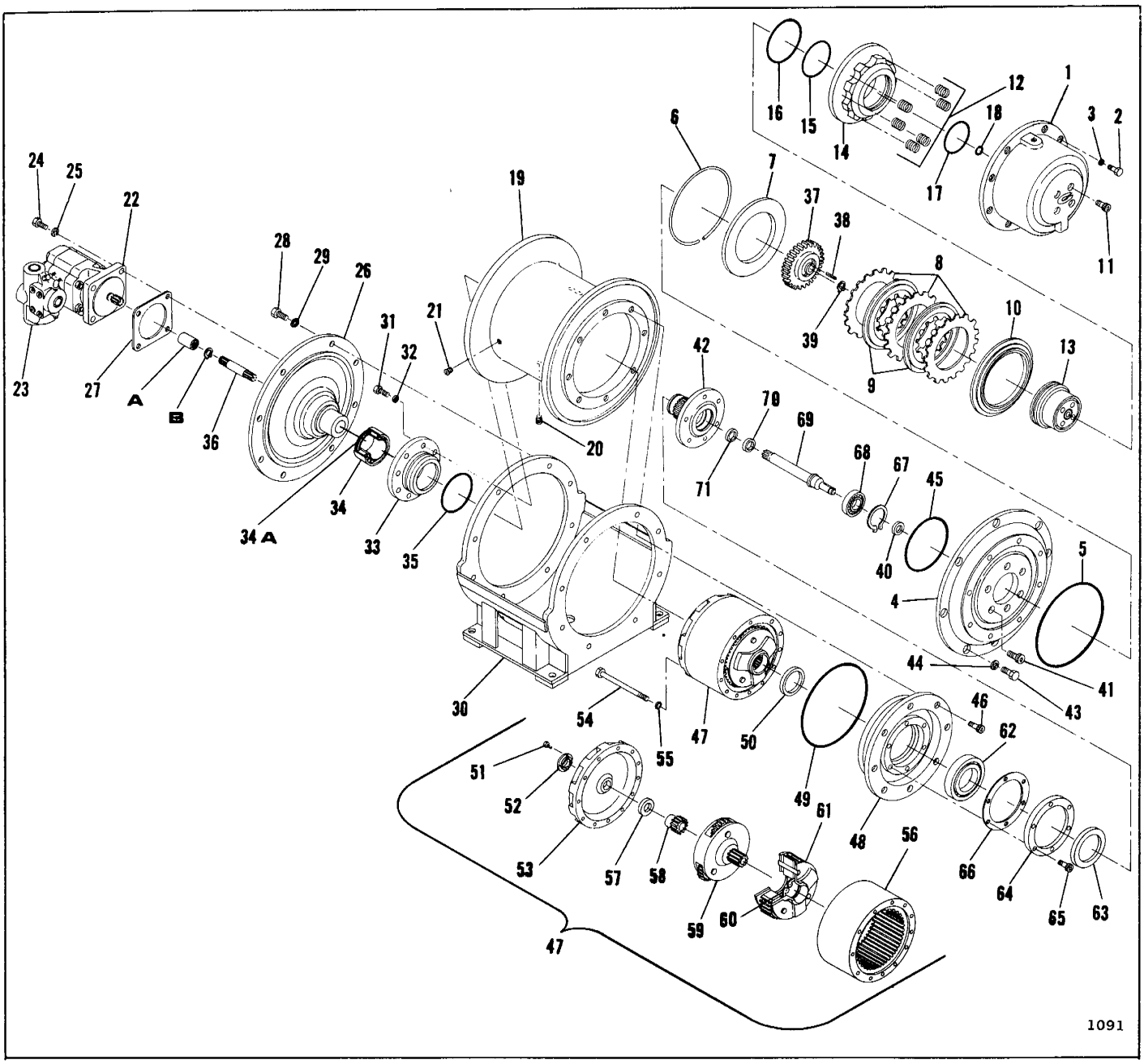


Figure 3-37. Model 15 Hoist Assembly

Torque cap screws with dry threads to 40-45 pound-feet or with lubricated threads to 20-25 pound-feet.

15. Install cover plate (52); secure with cap screws (51). Torque cap screws with dry threads to 20-25 pound-feet.
16. Turn main shaft by hand to check for free rotation with no tendency to lock-up or bind.

CAUTION

UPON REASSEMBLY, REPLACE ALL O-RINGS WITH LIKE SERVICEABLE ITEMS.

Hoist — Reassembly. (Refer to Figure 3-37.)

1. Set drum (19) into position in center housing (30).
2. Position gear reduction unit (47) into center housing; secure with drum end (48), o-ring (49), and cap screws (46).
3. Lubricate and install new o-ring (45) in right end housing.
4. Position right end housing in place on center housing; secure with attaching washers (44) and bolts (43).
5. Apply thread sealer to cap screws (41); install cap screws securing hub to right end housing.
6. Place key (38) and overrunning clutch (37) in position on main shaft.
7. Install shaft (36), o-ring (36B) and coupling (36A).

CAUTION

SHOULD BEARING REPLACEMENT BE REQUIRED, SEALS MAY BE INSTALLED ON BOTH ENDS OF NEW BEARING. REMOVE SEAL ON DRUM SIDE OF BEARING.

8. Install bearing (34) into left drum end assuring seal (34A) is properly positioned.
9. Lubricate and install o-ring (35) on left drum end (33).
10. Position left drum end in place on drum; secure with attaching washers (32) and bolts (31).
11. Install bolts (28) and washers (29) securing left side end housing (26) to center housing.

Brake Unit — Inspection.

1. Clean all parts with suitable solvent and dry with compressed air.
2. Inspect brake cylinder and piston for evidence of cracks, nicks, or other damage.
3. Polish out any minor blemishes on piston and cylinder mating surfaces with a fine crocus cloth.
4. Check compression springs for proper 2-1/2 inch free length.

CAUTION

IF ANY ONE SPRING IS DAMAGED, ALL SPRINGS SHOULD BE REPLACED AS A COMPLETE SET.

Brake Unit — Reassembly.

1. Install o-rings (16, 17, and 18) on sides and face of piston (13).
2. Install o-ring (15) in cylinder (14).
3. Lubricate piston and cylinder mating surfaces with a light coating of oil.
4. Using fiber mallet, start piston into cylinder, complete installation using suitable press.
5. Set springs (12) into position on cast sprocket of cylinder.
6. Position cylinder and piston assembly on spacer (of approximate height difference between assembly and brake and clutch housing).
7. Position brake housing (1) over assembly, aligning vent hole with top of brake housing.
8. Start cap screws (11) into piston; draw screws into piston alternately until piston face is snug against brake housing.
9. Tighten cap screws in the following sequence: upper left; lower right; lower left; upper right.
10. With opening of housing up, center overrunning clutch, using spacer under clutch to raise clutch flush with housing.

NOTE

SPACER IS USED FOR ALIGNMENT ONLY AND WILL BE REMOVED PRIOR TO FINAL ASSEMBLY.

11. Install back plate (10).
12. Install brake disc (8) followed by brake plate (9), alternating until all disc and plates are installed.
13. Install pressure plate (7).
14. Place assembly in suitable press; using sleeve larger than overrunning clutch, compress disc support springs.
15. Install snap ring (6); remove unit from press.
16. Remove overrunning clutch and spacer from assembly.
17. Using grease as temporary adhesive, lubricate o-ring groove in housing; install o-ring (5).

Brake Unit — Installation.

1. Position brake unit in place on right end cover (4); secure with attaching bolts (2) and washers (3).
2. Connect hydraulic lines to brake housing as marked prior to removal.

Hydraulic Motor — Installation.

1. Apply thread sealer to bolts (24). Position motor (22) and valve (23) and new gasket (27) in place in left end housing (26); secure with washers (25) and bolts (24).
2. Connect hydraulic lines to motor and valve as tagged prior to removal.

HYDRAULIC BRAKE SYSTEM.

Master Cylinder. Service of the master cylinder consists of keeping the reservoir filled to within ¼" of the top. Fill with approved heavy duty hydraulic brake fluid only. Refer to the manufacturer's service manual for repair and adjustment procedures.

Bleeding Hydraulic Brake System. Whenever any part of the brake system has been disconnected, it is necessary to bleed the system in order to expel all air. Fill the master cylinder reservoir with heavy duty hydraulic brake fluid before starting this operation and keep the reservoir at least half full of fluid. Bleed the brake system as follows:

NOTE

IF THE MASTER CYLINDER IS DRAINED DURING THE BLEEDING OPERATION, AIR WILL ENTER THE SYSTEM AND REBLEEDING WILL BE NECESSARY.

START BLEEDING OPERATION AT THE BRAKE CYLINDER WITH THE LONGEST CONNECTING LINE.

1. Remove capscrew from end of brake cylinder, bleed valve and insert bleed drain fitting.
2. Place bleed hose in a suitable, clean container.
3. Loosen drain valve three-fourths of a turn and depress foot pedal slowly. This forces fluid through the brake lines and out the brake cylinders, carrying with it any air that may have been trapped in the line.

NOTE

APPROXIMATELY TEN COMPLETE CYCLES OF THE BRAKE PEDAL WILL BE NECESSARY TO BLEED EACH WHEEL CYLINDER.

THE BLEED DRAIN VALVE MUST BE CLOSED BEFORE RELEASING THE BRAKE PEDAL.

4. Observe the flow of fluid from the bleed drain (end of hose should be kept below surface of fluid level in container).
5. Close bleed valve when bubbles no longer appear in fluid or when a solid flow begins.
6. Open bleed valve and allow a slight amount of fluid to drain, then tighten bleed valve securely.
7. Remove bleed drain fitting and reinstall capscrew.

NOTE

FLUID DRAINED DURING THIS OPERATION SHOULD NOT BE REUSED AND THE FLUID LEVEL IN THE MASTER CYLINDER SHOULD BE REPLENISHED FOLLOWING EACH BLEEDING SEQUENCE.

8. Repeat steps (1) thru (7) for each brake cylinder, starting with the cylinder having the shortest line.

Brake Pedal Adjustment. To insure full return of the master cylinder piston to its top position, thus preventing brake drag, a certain amount of play is required in the push rod. This provides a clearance at the seating point in the master cylinder. Adjust the push rod length to obtain ½ inch free play at the brake pedal before the initiation of the pressure stroke. Perform the push rod adjustment as follows:

1. Remove cotter pin and clevis pin securing brake arm to push rod fork fitting.
2. Lift fork fitting and back off lock nut.
3. Rotate fork fitting counterclockwise if rod is to be lengthened; clockwise if rod is to be shortened.
4. After proper rod length has been attained, tighten lock nut against fork fitting.
5. Position brake pedal arm in fork fitting and secure with clevis pin and cotter pin.

Brake Shoe Adjustment. Brake adjustments can be divided into two classes; a minor adjustment which compensates for brake lining wear and which also restores the brake pedal reserve, providing the brake system is in good condition, and a major adjustment which is necessary after relining the brake shoes when the brake shoe anchors have been refaced or when a minor adjustment fails to give satisfactory results.

Brakes need adjusting if brake pedal travels to within 2 inches of cab front wall panel and brakes are not fully applied.

Before making a major adjustment, check the linings for wear and loose rivets; correct as necessary. Also inspect for foreign particles imbedded in the lining surface; remove any, if found. Check the condition of the brake drums.

Shoes having lining soaked with lubricant or hydraulic brake fluid should be relined. Brake fluid leaks at the brake cylinders should be corrected by replacing or reconditioning the cylinders.

When servicing linings, and after reassembly of the brake, hub and drum, insure proper wheel bearing adjustment. Approximately 30 pounds of preload is required, which is obtained by applying 400 foot-pound torque on the spindle jam nut of the front drive-steer axle; 300 foot-pound torque on the rear drive-steer axle jam nut. This is to be accompanied by sufficient rapping of the hub with a non-metallic hammer to be sure the bearings are fully seated, since the nut torque alone may not seat the bearings. Measure the preload with a scale on one of the wheel lug studs. The measurement must not include any oil seal drag and there should be no brake shoe drag. The measurement must be made before the wheel hub planetary sun gear is installed.

Removal of the planetary sun gear located in the wheel hub may be necessary for wheel and drum rotation while adjusting the drive-steer axle front if equipped with a No-Spin differential unit. Removal of the planetary sun gear prior to adjusting the brakes is also recommended for the rear drive-steer axle although it is not an absolute necessity. Refer to manufacturer's Axle and Wheel Maintenance Manual for gear removal.

On brake assemblies improved by the addition of slots, insert feeler gauges between the lining and drum to assure that the proper clearances are established.

NOTE

WHENEVER THE WHEELS HAVE BEEN REMOVED, THE ¾-INCH SPHERICAL WHEEL NUT SHOULD BE TIGHTENED BY APPLYING 450 FOOT-POUNDS TORQUE AFTER MOUNTING THE WHEELS ON THE WHEEL LUG STUDS. THE FRICTION IN THE SPHERICAL SEAT, WHEN TIGHTENING THE NUT, ABSORBS APPROXIMATELY 50% OF THE TORQUE VALUE.

Minor Brake Shoe Adjustment. This adjustment changes the toe adjustment only. The anchor adjustments are not moved. Adjustment is made at the outside of the brake backing plate on the inner side of the wheel. Perform adjustment as follows:

1. Raise the wheels off the ground and check wheel rotation. If the wheels cannot be rotated by hand, remove the planetary sun gear from the wheel hub for repairs. Refer to manufacturer's Axle and Wheel Maintenance Manual for gear and wheel removal and repair.
2. Rotate the brake shoe cam outward in the direction of the arrow (left cam counterclockwise, right cam clockwise) until the brake lining drags on the drum.
3. Back off the brake shoe cam just enough to relieve the drag (lining to drum clearance as indicated by a feeler gauge should be .010 - .014 at toe of shoe and .004 - .008 at heel).
4. Repeat steps (1) thru (3) for remaining brake shoes.

Major Brake Shoe Adjustment. This adjustment changes the toe and heel adjustment of the brake shoes. Adjustment is made at the outside of the brake backing plate on the inner side of the wheel.

1. Raise the wheels off the ground and check wheel rotation. If the wheels cannot be rotated by hand, remove the planetary sun gear from the wheel hub for repairs. Refer to manufacturer's Axle and Wheel Maintenance Manual for gear and wheel removal and repair.
2. Loosen the anchor pin lock nut just sufficient to permit the eccentric anchor pin to be rotated with a wrench.
3. Rotate the brake shoe cam outward in the direction of the arrow (left cam counterclockwise, right cam clockwise) until the brake lining drags on the drum.
4. Rotate the eccentric anchor pin inward in the direction of the arrow (left anchor pin clockwise, right anchor pin counterclockwise) until drag is relieved.
5. Repeat steps (3) and (4) until drag cannot be relieved.
6. Back off the brake shoe cam and then the eccentric anchor pin just enough to relieve the drag (lining to drum clearance as indicated by a feeler gauge should be .010 - .014 at toe of shoe and .004 - .008 at heel).
7. Repeat steps (1) thru (7) for remaining brake shoes.
8. Torque anchor pin lock nuts to 150 pound-feet assuring no pin rotation occurs during tightening.
9. Check the operation of wheels and brakes to assure brake will set and that there is no bind or drag when brakes are released.

Parking Brake Adjustment (Mechanical). Adjustment of the parking brake is accomplished by turning the top portion of the parking brake control lever while the brake is released. To assure that the brake has sufficient holding power, start the engine, engage the transmission, and attempt to move the crane with the brake engaged.

CAUTION

DO NOT OVER ADJUST THE CABLE AS THIS WILL IMPAIR PROPER OPERATION OF THE CRANE AND DAMAGE THE PARKING BRAKE ASSEMBLY.

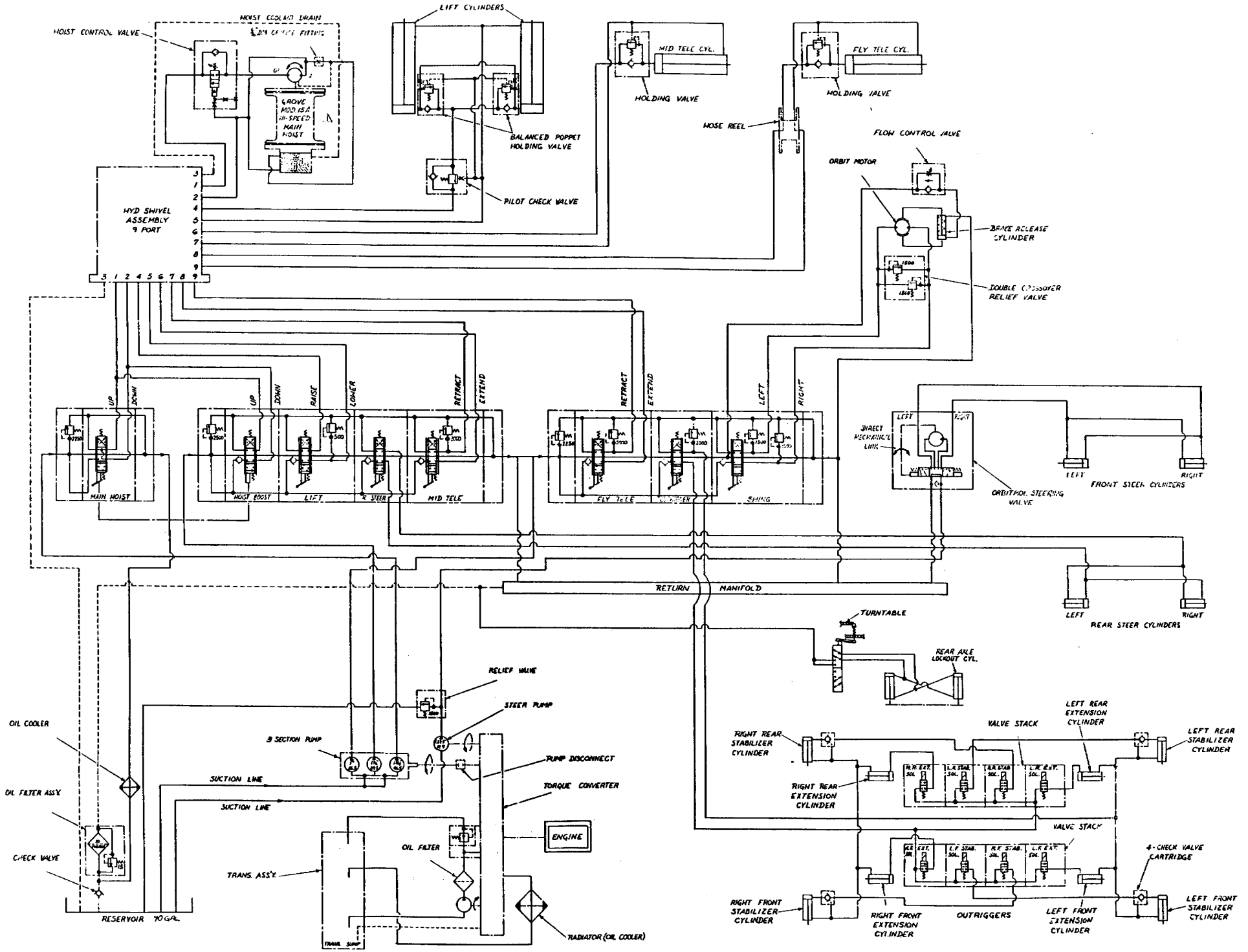


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Figure 3-38. Hydraulic System Schematic, RT59-RT60

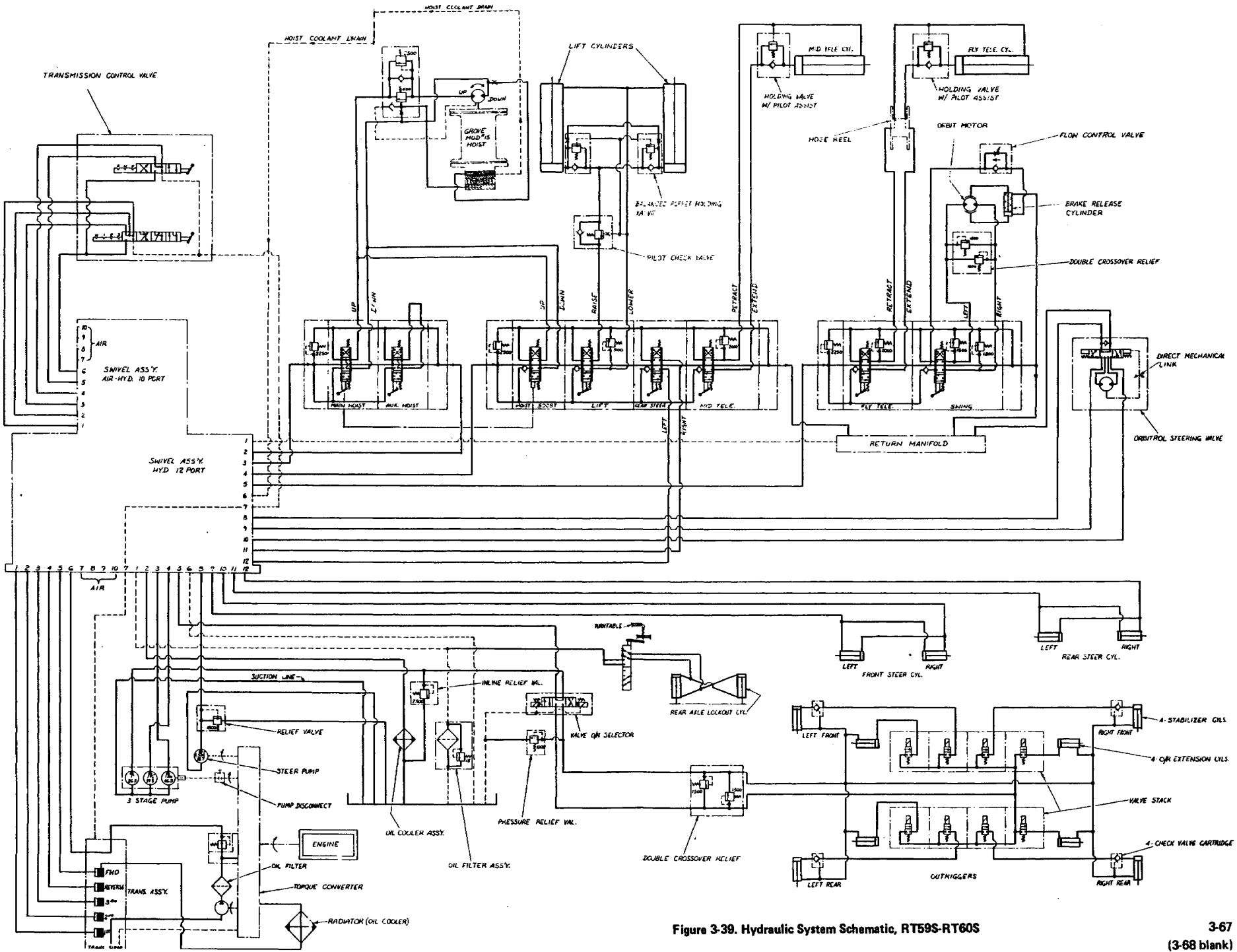

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Figure 3-39. Hydraulic System Schematic, RT59S-RT60S

SECTION IV
ELECTRICAL SYSTEMS
TABLE OF CONTENTS

ELECTRICAL SWIVEL COUPLING.

DESCRIPTION. (Refer to Figure 4-1.)
The electrical swivel coupling, spring-mounted above the hydraulic swivel coupling, serves as a means of electrical power transfer between the carrier and superstructure. The coupling consists of required sets of brushes and brush holder assemblies, an adapter bracket, and cover assembly. For higher capacity and a more positive contact, each circuit incorporates two brushes, leads and clips which are attached to brush holder assemblies. The brush holder assemblies are installed 180° apart, allowing each set of brushes to contact and rotate around one of the conductors on the stationary collector ring. Electrical leads from the collector ring extend down through the hollow mounting shaft of the coupling, from which point they are routed to the various electrical components in their respective system.

ELECTRICAL SWIVEL COUPLING – REMOVAL.

1. Disconnect batteries.
2. Remove bolts and washers securing cover over swivel coupling. Remove coupling cover.
3. Tag and disconnect all upper electrical leads so they can be reinstalled properly. (All leads on the swivel are normally number marked on metal tabs.)
4. Loosen setscrews securing coupling turntable bracket to shaft.
5. Tape cable ends routed up through the center of the swivel into a smooth roll and lift off swivel being careful not to entangle wires.
6. Remove washers and springs from drive plate pins.
7. If the hydraulic swivel is to be removed, pull the electric cable down through the assembly.

Inspection and Repair.

Brushes. Check brushes for proper contact with collector ring conductors. If brush sets are oil soaked or worn to one-half of original length, they should be replaced. Spring tension should be uniform on all brushes.

Collector Rings. Inspect collector rings for evidence of arcing, pitting, and corrosion. If any deterioration is evident, remove brush sets and clean conductors with .0000 non-metallic abrasive paper and carefully wipe clean.

NOTE
REINSTALL BRUSHES IN SAME POSITION AS WHERE REMOVED.

Check continuity between electrical leads through collector ring assembly.

Electrical System.

1. **Battery and Cables.** Inspect the battery for cracks, corrosion and other visible damage. Check the electrolyte level and specific gravity. Check the battery box, cables and terminal connections for tightness and damage. Tighten and repair or replace as necessary.
2. **Switches.** Check operation of all electrical switches. Tighten switch, attaching hardware and electrical connections as necessary. Replace damaged switches.
2. **Indicating Instruments and Lights.** Check all indicating instruments and lights for proper operation, loose electrical connections and secure mounting. Tighten connections and replace damaged instrument and lights.

Electrical Swivel Coupling – Installation.

WARNING
MAKE CERTAIN THAT BATTERIES ARE DISCONNECTED.

1. Install springs and washers on drive plate pins.
2. Install swivel coupling on drive plate pins; secure to shaft with setscrews.
3. Reconnect all electrical leads as marked prior to removal. Check all leads to make certain that no possibility of shorting exists when coupling cover is installed.
4. Install cover over coupling, securing with bolts and washers.

BATTERY.

Specific Gravity Test. Specific gravity testing of the battery electrolyte determines the state of charge of each battery cell. Perform a specific gravity check of the battery electrolyte as follows:

1. Remove all vent caps from battery.
2. Using a hydrometer, check the specific gravity reading of each battery cell.

NOTE
A SPECIFIC GRAVITY READING, IN ANY ONE CELL, OF 1.250 OR LESS, INDICATES THAT THE BATTERY REQUIRES CHARGING OR REPLACEMENT.

3. Reinstall battery vent caps.

Adding Water to Battery. The water in the battery electrolyte solution evaporates at high temperatures or with excessive charging rates, therefore it may sometimes be necessary to add water to the battery. Add only clean, distilled water, as necessary, to bring the electrolyte level to ¾ inch above the plate separators — avoid over filling the battery.

Battery Cleaning. The top of the battery, as well as the battery terminals and cable connectors, must be kept clean at all times. Clean the battery as follows:

WARNING

COVER ALL METAL AREAS OF CLEANING BRUSH WITH INSULATING TAPE PRIOR TO USE.

1. Tighten all vent caps and clean top of battery and terminals with a soft-bristle brush dipped in an alkaline solution (ammonia) or a solution of bicarbonate of soda and water.
2. After foaming action of cleaning solvent stops, flush top of battery with clean water.
3. Coat terminals and cable connectors with a light coat of petroleum jelly, or equivalent.

Battery Ground Check. A check of the battery ground connection can be made to assure the negative battery cable has a "solid" ground connection to the unit frame. Perform the check as follows:

1. Check that the negative battery cable is securely attached to the negative (–) battery terminal and the unit frame.
2. Connect the positive load of a dc voltmeter to the unit frame close to the negative battery cable attach point.

NOTE

A DC VOLTMETER WITH A 15 VOLT SCALE (MINIMUM) SHOULD BE USED FOR THIS CHECK.

3. Connect the negative lead of the voltmeter to the negative (–) terminal on the battery.
4. Motor the engine with the starter. The voltmeter should indicate "zero".
5. If a voltage reading is indicated on the voltmeter, clean and tighten the unit ground connection.
6. Disconnect voltmeter leads from battery and unit frame.

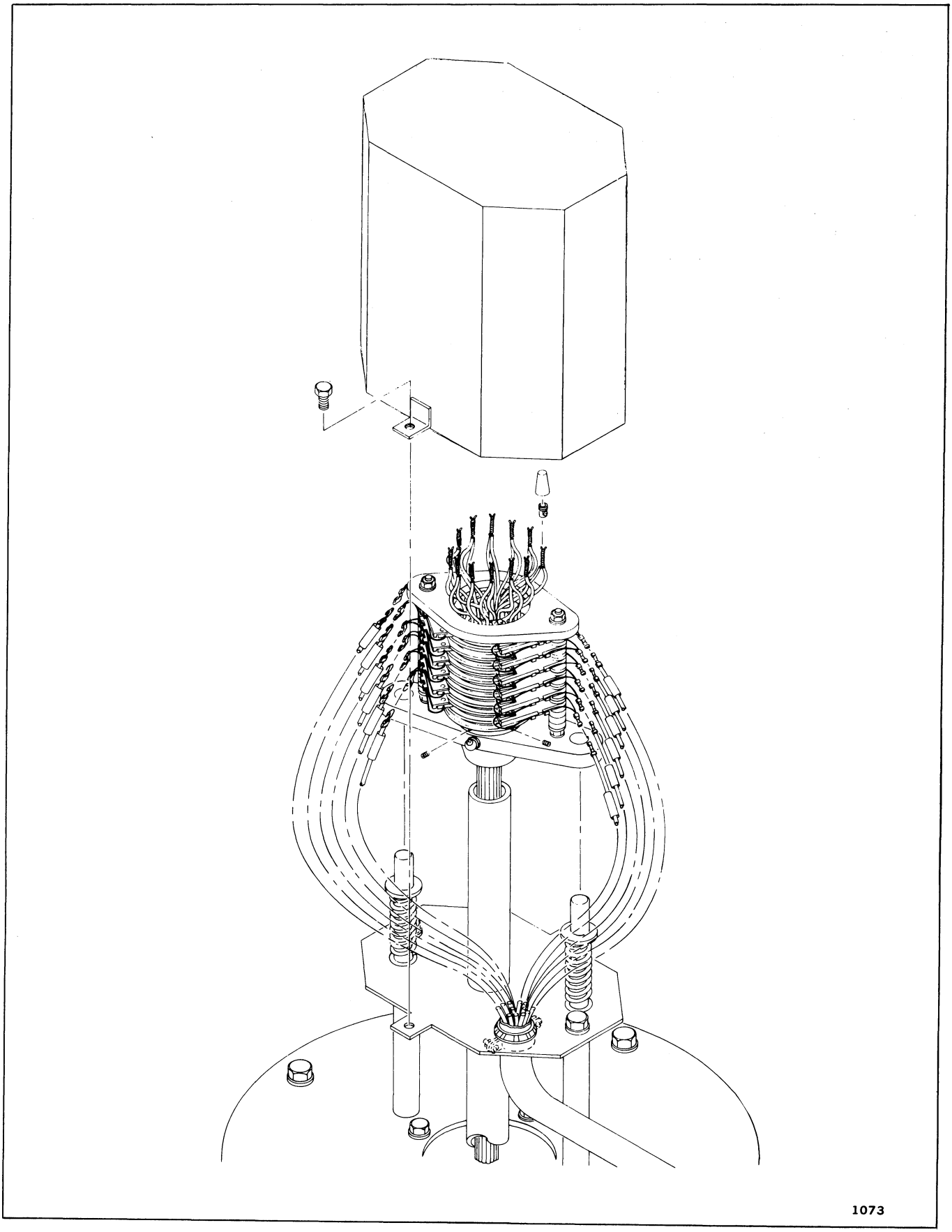

Figure 4-1. Electrical Swivel

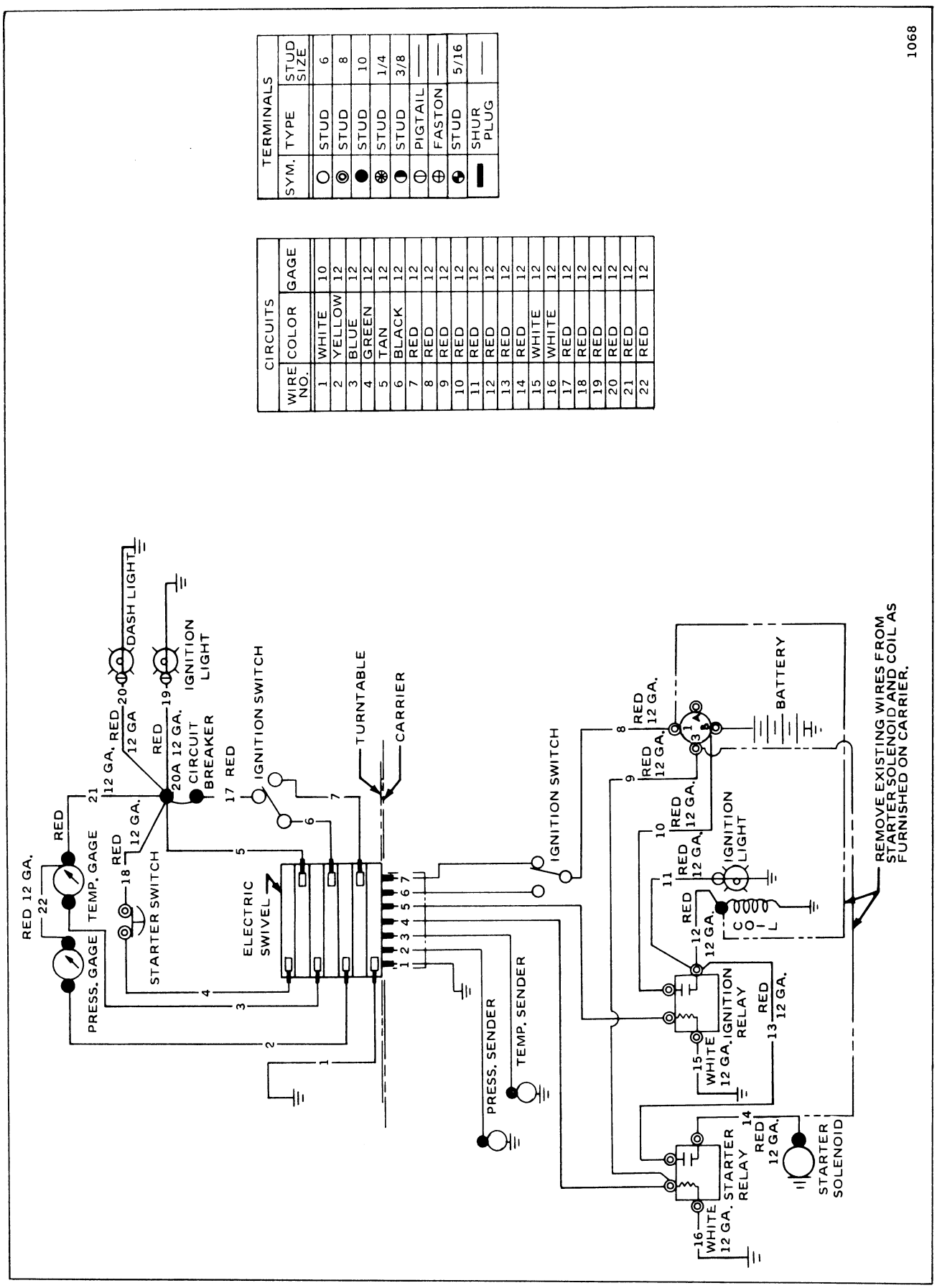

Figure 4-2. Wiring Diagram – Typical

SECTION V
PNEUMATIC SYSTEM
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AIR BRAKE SYSTEM.

Air power assist hydraulic brakes are installed on all four wheels. Air pressure is supplied by an engine mounted compressor. Normal operating air pressure is between 95 and 125 psi and can be monitored by the AIR PRESSURE gage on the console. If the reservoir tank pressure is below 75 psi, the low pressure warning light will illuminate, indicating an unsafe braking condition. The brakes are actuated by a treadle type foot pedal, located to the left of the foot throttle pedal on the cab floor. Actuation of the treadle controls movement of the air inlet and exhaust valves (integral of the brake valve assembly), which in turn control the pressure being supplied to, or released from, the brake actuators on the machine. The braking force of the system corresponds to the amount of pressure (depression) applied to the foot treadle. Thus, the further the treadle is depressed, the greater the pressure applied to the brake actuators. The brake system automatically locks any time system air pressure drops below 60 psi.

SERVICING.

Check air reservoir for moisture condensate. Moisture can be drained by building up air pressure and opening drain cock. Close drain when all visible moisture has been expelled.

After each 50 hours of operation, apply grease at brake pedal fitting. Refer to Lubrication Chart, Section VI of this manual. After every 200 operating hours, lubricate air brake control valve treadle roller, hinge pin, and linkage. Lift boot away from mounting plate, lubricate area between mounting plate and plunger with four or five drops of SAE20 engine oil. Lower boot in position over plate.

INSPECTION.

Brake Treadle. Check treadle for security and proper operation relative to pressure applied. Adjust as necessary.

Pneumatic Lines, Tank and Compressor. Check lines, tank, and compressor for visible damage and leaks. Tighten fittings and connections as necessary.

Leakage Check. Check for evidence of brake control valve leakage as follows:

1. Depress treadle fully.
2. Coat exhaust port with soap suds; leakage creating a one-inch soap bubble in one second justifies removal of the control valve for repair or replacement.

Pressure Check. Check delivery pressure of brake control valve, using an accurate air pressure test gage as follows:

NOTE

AN AIR PRESSURE GAGE WITH A 75 PSI SCALE SHOULD BE USED FOR THIS CHECK.

WARNING

EXERCISE CAUTION WHEN DISCONNECTING SUPPLY LINE, AS PRESSURE MAY BE PRESENT.

1. Disconnect supply line (downstream of valve) at most convenient location.
2. Connect air pressure test gage.
3. Depress treadle fully; control valve should deliver full reservoir pressure. The reading should correspond with air pressure indicator in the control cab.
4. Depress treadle to several positions between fully released and fully applied; check to assure that the pressure registered by the test gage varies in relation to the treadle position.

WARNING

ASSURE TREADLE IS FULLY RELEASED BEFORE DISCONNECTING PRESSURE TEST GAGE.

5. Disconnect air pressure test gage.
6. Reconnect system supply line.

Control Valve – Removal. Should it become necessary to remove the control valve, proceed as follows:

1. Relieve all pressure from air brake system.
2. Disconnect air lines from control valve; cap all openings.
3. Remove bolts, washers, and nuts securing control valve to control cab floor; remove valve.

Control Valve – Installation.

1. Place control valve in position and secure to control cab floor with bolts, washers, and nuts.
2. Connect air lines to control valve.
3. Replenish air supply to system and check valve for proper operation.

NOTE

REFER TO VALVE MANUFACTURER'S OPERATION AND MAINTENANCE MANUAL FOR DETAILED SERVICING, MAINTENANCE AND OVERHAUL INSTRUCTIONS.

PARKING BRAKE.

MECHANICAL PARKING BRAKE. (RT59 and 60 Models.) A parking brake control lever is located on the left side of the operator's seat. (See Figure 5-1.) The brake is actuated when the lever is pushed down to the horizontal position and released when the lever is pulled up to the vertical position. (Brake adjustment is accomplished by rotating the control lever knob clockwise.)

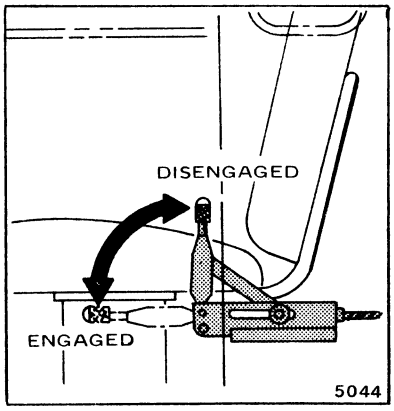


Figure 5-1. Mechanical Parking Brake Operation

AIR-OPERATED PARKING BRAKE. (RT59S/60S.) The PARKING BRAKE control is located on the control panel (or console). (See Figure 5-2.) PULL TO PARK for actuation of the air-operated parking brake; PUSH TO RELEASE for deactivation of the brake.

CAUTION

DO NOT ATTEMPT TO MOVE MACHINE UNLESS AIR PRESSURE INDICATOR REFLECTS A MINIMUM OF 75 PSI (95-125 NORMAL), AS AUTOMATIC SPRING BRAKE WILL NOT BE FULLY RELEASED UNTIL AIR PRESSURE REACHES 71 PSI.

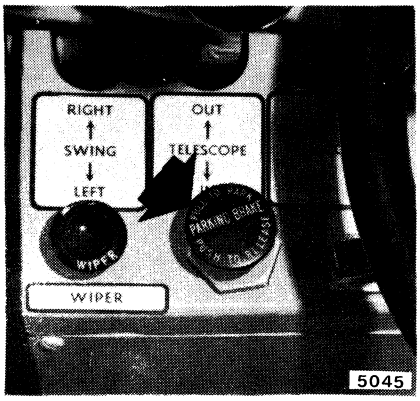


Figure 5-2. Air-Operated Parking Brake

SECTION VI
LUBRICATION
TABLE OF CONTENTS

GENERAL.

The procedures and lubrication charts in this section include information on type of lubricants used, lubricating time intervals and location of lubricating points. The service intervals specified are for normal operation where moderate temperature, humidity, and atmospheric conditions prevail. In areas of extreme heat and humidity, or extreme cold temperature, the service periods and lubrication specifications should be altered to meet existing conditions.

WARNING

PROPER LUBRICATION IS A SAFETY FACTOR IN ANY HEAVY EQUIPMENT OPERATION .

NOTE

THE IMPORTANCE OF PROPER LUBRICATION, AT SPECIFIED TIME INTERVALS, CANNOT BE OVERESTIMATED. EFFICIENT CRANE OPERATION DEPENDS GREATLY UPON HOW WELL LUBRICATION RECOMMENDATIONS OF THE MANUFACTURER ARE FOLLOWED.

PIVOT AND ANCHOR SHAFTS – BOOM AND LIFT CYLINDERS. (Refer to Figures 6-1 and 6-2.)

Lubrication requirements of the pivot and anchor shafts should be based upon crane usage. It is recommended that they be lubricated every ten hours of crane operation. Refer to the lubrication chart for detailed information.

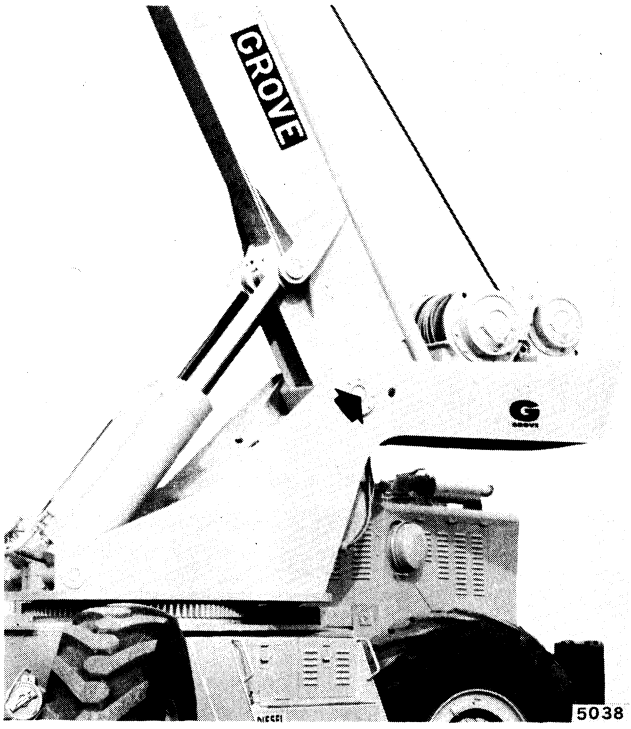


Figure 6-1. Boom Pivot Shaft Lubrication Fitting

NOTE

POSITION BOOM ON BOOM REST FOR PIVOT SHAFT LUBRICATION.

BOOM SECTIONS.

Some booms incorporate SAE standard grease fittings for lubrication of the individual sections; however, to assure that all sections are thoroughly lubricated, the boom should be fully extended (in the horizontal attitude) and brushed (sides and bottom) with open gear (OG) lubricant.

HYDRAULIC HOSE REEL.

The hydraulic hose reel spring should be lubricated after every 50 hours of crane operation. Lubricate spring as follows:

1. Assure boom is in fully retracted position.

NOTE

LUBRICATING ACCESS HOLE IS LOCATED ON LEFT SIDE OF HOSE REEL ABOVE PIVOT SHAFT.

2. Using pressure lubricating equipment, if available, lubricate hose reel spring housing with SAE 20 engine oil, or equivalent, until spring is thoroughly saturated.

NOTE

LARGER SIZE HOSE REELS INCORPORATE TWO SPRINGS REQUIRING LUBRICATION.

SWING BEARING LUBRICATION.

Each bearing is equipped with one or two grease fittings. Required lubrication varies with application and amount of usage. Intermittent rotation work will require lubrication about every 100 hours but almost continuous rotation work will require lubrication as frequently as 10 or 20 hours.

It is necessary to distribute the grease around the race by injecting grease through the fittings as the machine is rotated at least two revolutions. When complete rotation is impractical on the job, swing the upper as far as possible and as soon as practical thereafter, complete the rotation while lubricating. Lubricate sufficiently to flush out contaminated grease which should be wiped off to prevent accumulation of grime and dirt.

Lubrication of the drive gear is best accomplished by brush application on the entire circumference of both the bearing bull gear and the gearbox drive pinion.

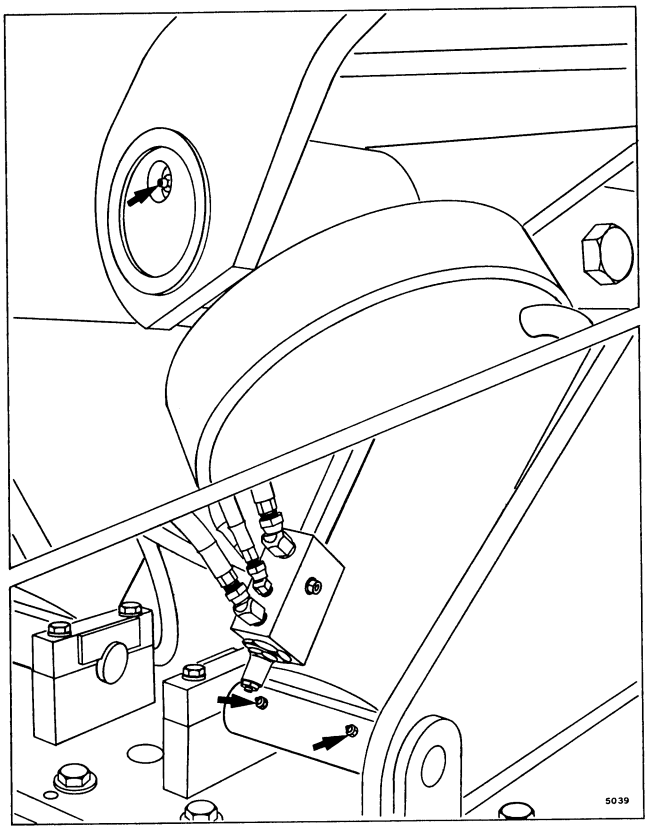


Figure 6-2. Lift Cylinder Lubrication Fittings

CONTROL VALVE-AIR BRAKE SYSTEM.

Minor Servicing. The air brake control valve servicing should be accomplished after every 200 operating hours or every 5000 miles.

Treadle roller, hinge pin, and linkage – lift boot away from mounting plate; lubricate area between mounting plate and plunger with 4 to 5 drops of SAE 20 engine oil; lower boot in position over plate.

NOTE

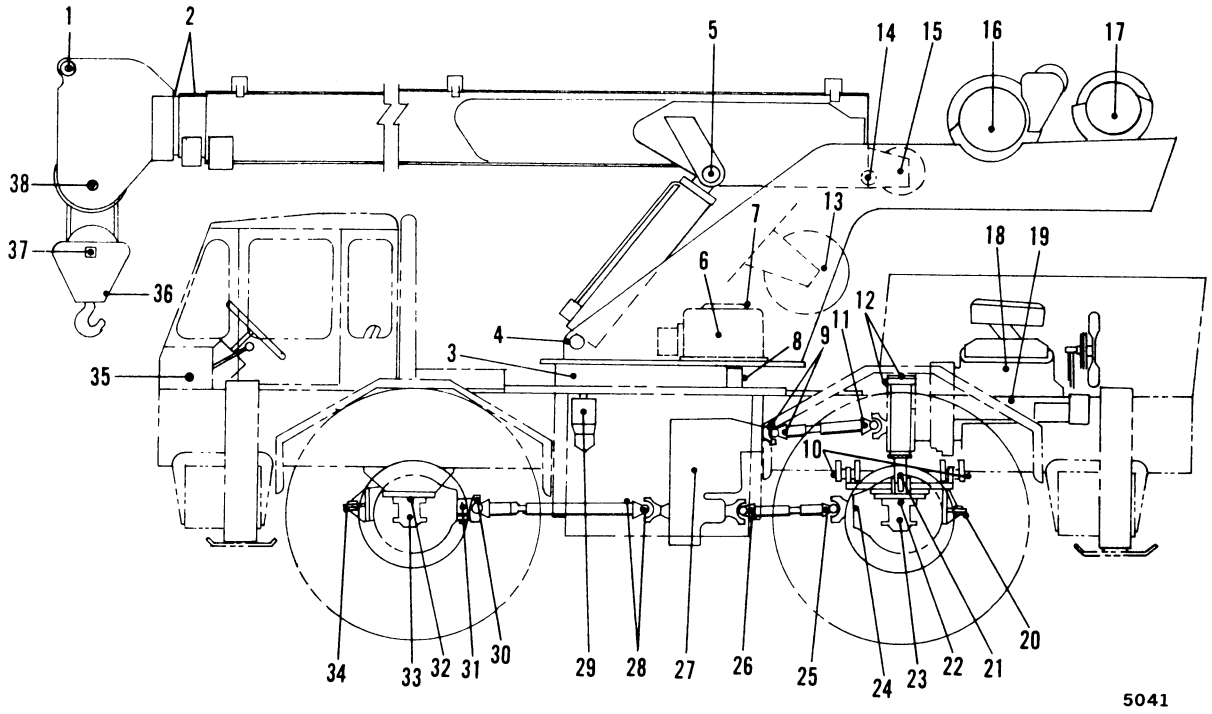
IF EQUIPMENT HAS BEEN STORED OR INACTIVE FOR SUCH LENGTH OF TIME THAT THE LUBRICANT APPEARS TO HAVE DRIED, LUBRICATE THOROUGHLY BEFORE PUTTING THE MACHINE TO WORK.

ALL EQUIPMENT SHOULD BE GREASED AT LEAST TWICE YEARLY, REGARDLESS OF AMOUNT OF USAGE.

Some recommended lubricants are shown below.

Table 6-1. Swing Bearing Lubricants

	MOBIL	TEXACO	SUNOCO	PURE	SOHIO
RACE	Mobilplex EP No. 2	Multifak EP No. 2	Prestige 742EP	Poco Ht EP No. 2	Sohitran EP No. 1
GEAR	Mobilcote–S	Crater Compound	407 Compound B	Poco Gearshield	Sohitac No. 1



LUBE SYMBOL KEY

EO - Engine oil
EP - Heavy duty Extreme Pressure Mill Type
HO - Hydraulic oil — SAE 10W — (MIL-L-2104C)
EPGL - Extreme Pressure Gear Lube SAE90
ATF - Automatic Transmission Fluid, Type "A"
N/A - Not Applicable

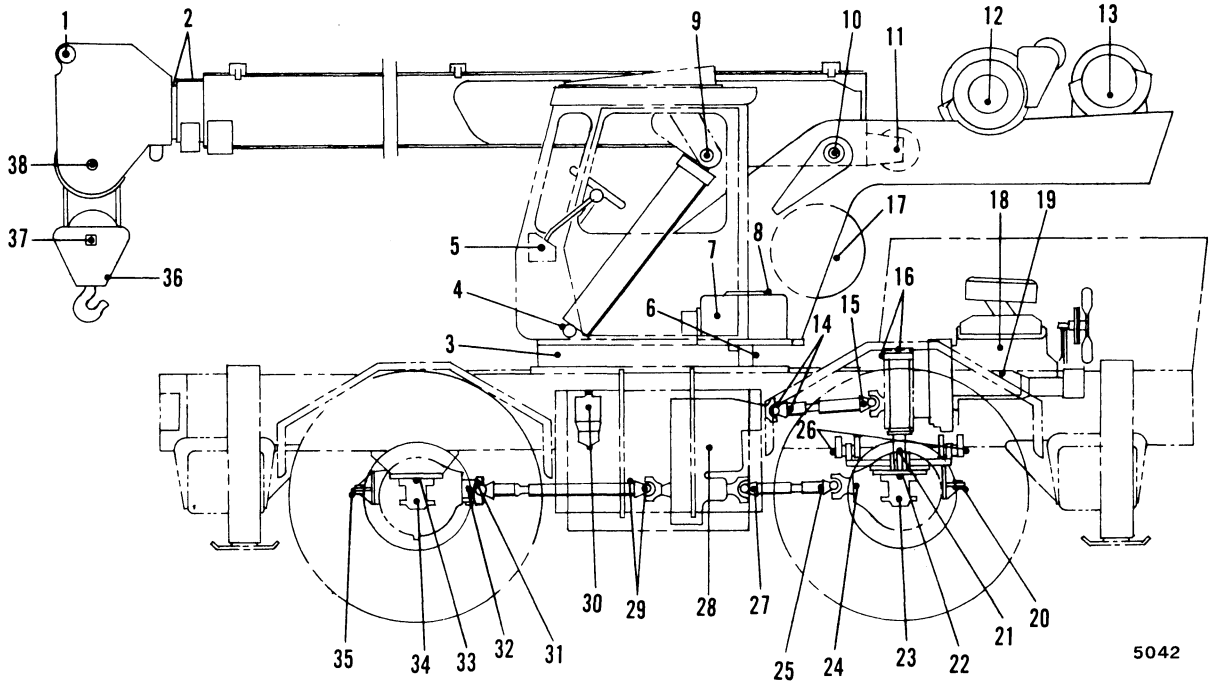
RESERVOIR CAPACITY
90 U.S. Gal. (340.7 liters)

Figure 6-3. RT59-RT60 Lubrication

INDEX NO.	ITEM	TYPE OF LUBE OR FILL POINTS	LUBE SYMBOL	FREQUENCY OF LUBRICATION (HOURS)	CAPACITIES AND INSTRUCTIONS
1	Boom Nose Idler Sheave	SAE Std. Grease Fitting	EP	50	
2	Boom Sections	None	EP	25	Brush sides & bottom
3	Ring Gear	SAE Std. Grease Fitting	EP	100	
4	Lift Cylinder (base shaft)	SAE Std. Grease Fitting	EP	10	
5	Lift Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	10	
6	Speed Reducer Gear Case	Fill Plug	EPGL	**1000**	5½ U.S. Qts. (5.2 liters)
7	Speed Reducer Bearing	SAE Std. Grease Fitting	EP	100	
8	Pinion Gear	SAE Std. Grease Fitting	EP	100	
9	Drive Shaft Universal (trans.)	SAE Std. Grease Fitting	EP	50	
10	Oscillation Lockout Cradle	SAE Std. Grease Fitting	EP	50	
11	Drive Shaft Universal (trans.)	SAE Std. Grease Fitting	EP	50	
12	Oscillation Cradle Cylinder (base)	SAE Std. Grease Fitting	EP	50	
13	Hose Reel	SAE Std. Grease Fitting	EP	50	
14	Boom Pivot/Anchor Shaft	SAE Std. Grease Fitting	EP	10	
15	Hose Guide Sheave	SAE Std. Grease Fitting	EP	50	
16	Main Hoist Final Drive	Fill Plug	EPGL	500	Fill to Fill Plug opening (4) (6)
17	Auxiliary Hoist Final Drive	Fill Plug	EPGL	500	Fill to Fill Plug opening (4) (6)
18	Engine Crankcase	Fill Cap	EO	100	9 U.S. Qts. (8.5 liters) dry (5)
19	Engine Oil Filter	Replaceable Cartridge	N/A	100	Replace with oil change
20	Rear Steer Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	50	
21	Oscillation Lockout Cradle	SAE Std. Grease Fitting	EP	25	
22	Trunnion Bearing (rear axle)	SAE Std. Grease Fitting	EP	50	
23	Planetary Hub (rear)	Fill Plug	EPGL	100	Fill to OIL LEVEL plug opening
24	Tie Rod (rear)	SAE Std. Grease Fitting	EP	50	
25	Drive Shaft Universal (rear dr.)	SAE Std. Grease Fitting	EP	50	
26	Drive Shaft Universal (rear dr.)	SAE Std. Grease Fitting	EP	50	
27	Transmission Gear Case	Fill Pipe	ATF	1000	Fill to FULL mark on dipstick (7)
28	Drive Shaft Universal (front dr.)	SAE Std. Grease Fitting	EP	50	
29	Hydraulic Oil Filter	Replaceable Cartridge	N/A	200	
30	Drive Shaft Universal (front dr.)	SAE Std. Grease Fitting	EP	50	
31	Tie Rod (front)	SAE Std. Grease Fitting	EP	50	
32	Trunnion Bearing (front axle)	SAE Std. Grease Fitting	EP	50	
33	Planetary Hub (front)	Fill Plug	EPGL	100	Fill to OIL LEVEL plug opening
34	Front Steer Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	50	
35	Control Lever Attach Shaft	SAE Std. Grease Fitting	EP	50	
36	Hook Block Swivel Bearing	SAE Std. Grease Fitting	EP	10	
37	Hook Block Sheaves	SAE Std. Grease Fitting	EP	50	
38	Boom Nose Sheaves	SAE Std. Grease Fitting	EP	50	

NOTES:

1. Be sure to lubricate like items on both sides of machine.
2. For detailed information regarding lubricants, refer to Lubrication and Fuel Recommendations, this Section.
3. Frequency of lubrication is recommended by the Manufacturer under normal machine applications. Where severe operating conditions exist, the user must adjust the lubricating schedule accordingly.
4. Change lubricant in hoist after first 250 hours.
5. Engine crankcase requires one (1) additional U.S. quart (.946 liters) with oil filter change. (Capacity given is for engine supplied with standard machine.)
6. Fill plug located on drum barrel of Grove Model 15 hoist.
7. Check with engine running.



LUBE SYMBOL KEY

EO - Engine Oil
EP - Heavy duty Extreme Pressure Mill Type
HO - Hydraulic Oil — SAE 10W — (MIL-L-2104C)
EPGL - Extreme Pressure Gear Lube SAE90
ATF - Automatic Transmission Fluid, Type "A"
N/A - Not Applicable

RESERVOIR CAPACITY

90 U.S. Gal. (340.7 liters)

Figure 6-4. RT59S-RT60S Lubrication

INDEX NO.	ITEM	TYPE OF LUBE OR FILL POINTS	LUBE SYMBOL	FREQUENCY OF LUBRICATION (HOURS)	CAPACITIES AND INSTRUCTIONS
1	Boom Nose Idler Sheave	SAE Std. Grease Fitting	EP	50	
2	Boom Sections	None	EP	25	Brush sides & bottom
3	Ring Gear	SAE Std. Grease Fitting	EP	100	
4	Lift Cylinder (base shaft)	SAE Std. Grease Fitting	EP	10	
5	Control Lever Attach Shaft	SAE Std. Grease Fitting	EP	50	
6	Pinion Gear	SAE Std. Grease Fitting	EP	100	
7	Speed Reducer Gear Case	Fill Plug	EPGL	1000	5½ U.S. Qts. (5.2 liters)
8	Speed Reducer Bearing	SAE Std. Grease Fitting	EP	100	
9	Lift Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	10	
10	Boom Pivot/Anchor Shaft	SAE Std. Grease Fitting	EP	10	
11	Hose Guide Sheave	SAE Std. Grease Fitting	EP	50	
12	Main Hoist Final Drive	Fill Plug	EPGL	500	Fill to Fill Plug opening (4)
13	Auxiliary Hoist Final Drive	Fill Plug	EPGL	500	Fill to Fill Plug opening (4)
14	Drive Shaft Universal (trans.)	SAE Std. Grease Fitting	EP	50	
15	Drive Shaft Universal (trans.)	SAE Std. Grease Fitting	EP	50	
16	Oscillation Lockout Cylinder (base)	SAE Std. Grease Fitting	EP	25	
17	Hose Reel	SAE Std. Grease Fitting	EP	50	
18	Engine Crankcase	Fill Cap	EO	100	9 U.S. Qts. (8.5 liters) dry (5)
19	Engine Oil Filter	Replaceable Cartridge	N/A	100	Replace with oil change
20	Rear Steer Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	50	
21	Oscillation Lockout Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	25	
22	Trunnion Bearing (rear axle)	SAE Std. Grease Fitting	EP	50	
23	Planetary Hub (rear)	Fill Plug	EPGL	100	Fill to OIL LEVEL plug opening
24	Tie Rod (rear)	SAE Std. Grease Fitting	EP	50	
25	Drive Shaft Universal (rear dr.)	SAE Std. Grease Fitting	EP	50	
26	Oscillation Lockout Cradle	SAE Std. Grease Fitting	EP	25	
27	Drive Shaft Universal (rear dr.)	SAE Std. Grease Fitting	EP	50	
28	Transmission Gear Case	Fill Pipe	ATF	1000	Fill to FULL mark on dipstick(6)
29	Drive Shaft Universal (front dr.)	SAE Std. Grease Fitting	EP	50	
30	Hydraulic Oil Filter	Replaceable Cartridge	N/A	200	
31	Drive Shaft Universal (front dr.)	SAE Std. Grease Fitting	EP	50	
32	Tie Rod (front)	SAE Std. Grease Fitting	EP	50	
33	Trunnion Bearing (front axle)	SAE Std. Grease Fitting	EP	50	
34	Planetary Hub (front)	Fill Plug	EPGL	100	Fill to OIL LEVEL plug opening
35	Front Steer Cylinder (rod shaft)	SAE Std. Grease Fitting	EP	50	
36	Hook Block Swivel Bearing	SAE Std. Grease Fitting	EP	10	
37	Hook Block Sheaves	SAE Std. Grease Fitting	EP	50	
38	Boom Nose Sheaves	SAE Std. Grease Fitting	EP	50	

NOTES:

1. Be sure to lubricate like items on both sides of machine.
2. For detailed information regarding lubricants, refer to Lubrication and Fuel Recommendations, this Section.
3. Frequency of lubrication is recommended by the Manufacturer under normal machine applications. Where severe operating conditions exist, the user must adjust the lubricating schedule accordingly.
4. Change lubricant in hoist after first 250 hours.
5. Engine crankcase requires one (1) additional U.S. quart (.946 liters) with oil filter change. (Capacity given is for engine supplied with standard machine.)
6. Check with engine running.

KEY	SPECIFICATION
EP (LSB)	A multi-purpose type grease, having a minimum dripping point of 350°F (176.6°C) excellent water resistance, and of an extreme pressure type (minimum Timken OK load 40 pounds.) For normal ambient temperatures – NLGI No. 1 or No. 2 grade. For above 100°F (37.8°C) temperatures – NLGI No. 2 or No. 3 grade. For sub-zero °F (–17.8°C) temperatures – NLGI No. 0 grade.
GL	A straight mineral gear oil of good quality; minimum viscosity Index 85, and meeting viscosity requirements of the SAE grade used.
EPGL	A multi-purpose extreme pressure gear oil designed to meet the requirements of military specification MIL-L-2105C (also recommended by major commercial vehicle manufacturers).
EPGL (SCL)	An extreme pressure gear oil compound with Sulphur-Chlorine- Lead additives.
WGL	Quality oil designed for lubrication of worm gears under the ambient temperatures indicated below.
CG	Chassis Lubricant – a suitable grease for general chassis lubrication, having good water resistance and adhesiveness qualities, minimum oil viscosity 300 SSU @ 100°F (37.8°C). For summer use NLGI No. 2 or No. 3 grade; winter use NLGI No. 1 grade. Higher quality multi-purpose automotive greases may also be used.
EP	Heavy duty extreme pressure grease – a grease for heavier service meeting the following requirements: Dropping point – minimum 180°F (82.2°C) NLGI grade – as local temperature requirements indicate. Extreme pressure – TIMKEN OK 40 pounds minimum. Oil viscosity – minimum 75 SSU @ 210°F (98.8°C). Must have good water resistance. NOTE: SAME AS U. S. STEEL NO. 350 EP ROLLING MILL GREASE.)
HO	Hydraulic oil – use Severe Duty Type Engine Oils meeting API service. MS – or – anti-wear type hydraulic oils. Moderate Hydraulic Service. Use qualified Type A Suffix A Automatic Transmission Fluid or General Motors approved Dexron Automatic Transmission Fluid.
OG	A viscous lubricant designed for lubrication of open gears and having good water resistance and adhesiveness. Viscosity to be appropriate to operating temperature and to assure remaining on gear teeth.
ATF	Automatic Transmission Fluid.

Typical Inspections

Gravity ° API	29.2
Flash Point	405°F (201.6°C)
Pour Point	–40°F (–40°C)
Viscosity, SSU @ 100°F (37.8°C)	207
Viscosity, SSU @ 210°F (98.8°C)	50.9
Viscosity Index (ASTM D567)	134
Viscosity Index (ASTM D2270)	145
Color	Red
Qualification No.	AQ-ATF-2924A

Table 6-2. Suggested Lubricant Standards

Ambient Temperature Range	Maximum Temperature	Specification
-30°F (-34.4°C) to +15°F (-9.5°C)	150°F (66°C)	Maximum pour point – 30°F (-34.4°C) Minimum viscosity 200 SSU @ 100°F (37.8°C)
+16°F (-8.9°C) to 50°F (10°C)	185°F (85°C)	Maximum pour point 10°F (-12.2°C) Minimum viscosity 1350 SSU @ 100°F (37.8°C) Must be extreme pressure type (minimum TIMKEN OK 40 pounds) – or – compounded 3%-10% acidless tallow oil. Minimum viscosity Index 80.
51°F (10.6°C) to 110°F (43°C)	225°F (107.2°C)	Should be AGMA No. 8 comp. or AGMA No. 8 EP type lubricant.
111°F (43.9°C) to 165°F (73.9°C)	225°F (107.2°C)	Should be AGMA No. 8a Comp. type lubricant.

Operating Temperature Range	SAE	ASTM Viscosity
0°F (-17.8°C) to 180°F (82.2°C)	10W	150
15°F (-9.5°C) to 210°F (98.8°C)	20-20W	315
0°F (17.8°C) to 210°F (98.8°C)	10W/30 10W/40	
-10°F (23.3°C) to 180°F (82.2°C)	5W/20 5W/30	
Severe Hydraulic Service 0°F (-17.8°C) to 180°F (82.2°C)	5W/20	Must be API service MS & DM and meet ASTM G-IV Car Maker's Engine Tests
0°F (-17.8°C) to 35°F (1.7°C)		75% above oil. 25% No. 1 or No. 2 Fuel Oil of good quality.

APPENDIX

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STANDARD BOLT TORQUE VALUES

Following are torque value charts as approved by Grove Manufacturing Company and used in production on original equipment installation. These charts include the following:

1. Nut and bolt combinations (not lubricated).
2. Nut and bolt combinations (lubricated and with washers).
3. Hydraulic cylinder head bolts.
4. Boom and lift cylinder shafts (set screws and jam nuts).

GENERAL.

Proper torque values of bolts used in assembly of modern equipment is not only extremely important for structural strength but it can seriously affect performance and reliability when variation in torque might cause distortion, binding or fatigue failure.

Identification of bolt grade is always necessary. When marked as a high strength bolt (grade 3, 5, etc.), the mechanic must be aware that he is working with a highly stressed component and the fastener should be torqued accordingly.

NOTE

SOME SPECIAL APPLICATIONS REQUIRE VARIATION FROM STANDARD TORQUE VALUES. REFERENCE SHOULD ALWAYS BE MADE TO COMPONENT OVERHAUL PROCEDURES FOR RECOMMENDATIONS.

When a bolt must be replaced and a similar grade is not available, always use a higher grade. However, it should be torqued to match the original grade. As soon as available the correct grade bolt should be installed to avoid a future state of confusion by the improper installation.

Special attention should be given to the existence of lubricant, plating, or other factors that might dictate variation from standard torque values.

When maximum recommended torque values have been exceeded, the fastener should be replaced.

IMPORTANT: TEMPERATURE VARIATION, VIBRATION AND ELASTICITY OF METAL, USUALLY RESULTS IN INITIAL GRADUAL REDUCTION OF BOLT TORQUE. TURNTABLE, SWING GEARBOX AND HOIST MOUNTING BOLTS SHOULD BE REQUIRED AFTER THE FIRST 300 HOURS OF OPERATION AND EVERY 500 HOURS THEREAFTER.

When using the applicable torque charts, values as close as possible to the mid-range are recommended to allow for wrench calibration tolerance. Erratic or a jerking motion of wrenches can easily result in excessive torque values. ALWAYS use a slow even wrench movement and STOP when the pre-determined value has been reached.

Torque wrenches are precision instruments and are to be handled with care to insure calibrated accuracy. Calibration checks should be made on a scheduled basis. Whenever the wrench might be either overstressed or damaged, it should immediately be removed from service until recalibrated.

KNOW YOUR TORQUE WRENCH! Flexible beam type wrenches, even though they might have a preset feature, must be pulled at right angles and the force must be applied at the exact center of the handle. Force value readings must be made while the tool is in motion.

Rigid handle type with torque limiting devices that can be preset to required values, eliminate dial readings and less responsibility falls on the operator.

IMPORTANT: WHEN MULTIPLIERS AND/OR SPECIAL TOOLS ARE USED TO REACH "HARD TO GET AT" SPOTS, MAKE CERTAIN TORQUE READINGS ARE PRECISELY CALCULATED.

TORQUE VALUES.

Torque values as shown in Table 1 are for nut-bolt combinations that have not been plated and have not had special lubrications applied to them. (Discount the residual lubricant present, that was applied at time of manufacture.)

NUT AND BOLT COMBINATIONS. (LUBRICATED AND WITH WASHERS.)

Torque values as shown in Table 2 are for nut-bolt combinations that have been plated or have had lubrication applied and in conjunction with use of flat or split ring type of washers.

CYLINDER HEAD BOLTS.

Torque values shown in Table 3 are to be used on all Cylinder Head Bolts.

TABLE 1

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1¼	1½
				TORQUE FOOT/POUNDS (MIN-MAX.)									
 CAP SCREW	S.A.E. 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	17 19	26 30	41 45	56 66	83 93	140 150	182 202	270 300	449 500	718 797
 CAP SCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	26 30	43 47	59 69	93 103	135 145	214 234	332 372	491 551	822 922	1327 1471
 CAP SCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium Carbon Steel or Low Alloy Heat Treated	27 31	46 50	65 75	100 110	140 150	220 250	338 378	523 583	747 833	1194 1323
 CAP SCREW	A.S.T.M.354BB STEEL												
 CAP SCREW	A.S.T.M. A-325			— —	— —	90 100	— —	180 200	305 355	465 525	710 790	1019 1134	1771 1973
 CAP SCREW	A.S.T.M. A-354-BC STEEL	125,000 P.S.I.	Low Alloy or Med. Carb. Quenched Tempered	30 34	50 54	71 81	109 119	147 167	239 269	377 427	574 644	1024 1053	1522 1695
 CAP SCREW	S.A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	39	59	96	140	189	310	490	735	1242	1989
 CAP SCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, quenched Tempered Roll Threaded	43	69	106	150	209	350	550	825	1372	2205
 CAP SCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	42 46	65 75	105 115	145 165	185 225	330 370	531 591	803 893	1331 1486	2153 2383
 SOCKET CAP SCREW	SOCKET HEAD CAP SCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I.	High Carbon Alloy Quenched Tempered	46	71	111	156	210	345	569	864	1804	2947
 CAP SCREW	N.A.S. 144 AIRCRAFT STD. MS 20000 MIL. STD.			50	81	121	176	240	395	629	964	1964	3147
 CAP SCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy Quenched Tempered	52 56	81 91	126 136	188 198	255 270	419 444	668 708	1025 1085	2105 2255	3355 3855

TABLE 2

FINE OR COURSE THREAD FASTENER	GRADE DESIGNATION	TENSILE STRENGTH MINIMUM	MATERIAL	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1¼	1½
				TORQUE FOOT/POUNDS (MIN-MAX.)									
 CAP SCREW	S.A.E. 2 A.S.T.M. A-307 STEEL	64,000 P.S.I.	Low Carbon Steel	15 17	23 27	39 41	50 60	74 84	126 136	163 183	242 272	384 435	617 703
 CAP SCREW	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	23 27	39 43	53 63	83 93	122 132	193 213	298 338	447 507	705 806	1148 1292
 CAP SCREW	A.S.T.M. A-449 S.A.E. 5 STEEL	105,000 P.S.I.	Medium Carbon Steel or Low Alloy Heat Treated	24	41	61	90	126	197	303	486	680	1098
 CAP SCREW	A.S.T.M.354BB STEEL			28	45	71	100	136	227	343	536	766	1228
 CAP SCREW	A.S.T.M. A-325			—	—	81 91	—	162 182	272 322	418 478	657 737	937 1052	1629 1831
 CAP SCREW	A.S.T.M. A-354-BC STEEL	125,000 P.S.I.	Low Alloy or Med. Carb. Quenched Tempered	27 31	45 49	63 73	98 108	132 152	223 253	338 388	522 592	942 1042	1400 1573
 CAP SCREW	S.A.E. 6 STEEL	133,000 P.S.I.	Med. Carbon Steel Quenched Tempered	35	52	86	126	170	278	439	558	1143	1830
 CAP SCREW	S.A.E. 7 STEEL		Med. Carbon Alloy, quenched Tempered Roll Threaded	39	62	96	136	190	318	499	758	1272	2046
 CAP SCREW	S.A.E. 8 STEEL	150,000 P.S.I.	Med. Carbon Alloy Quenched Tempered	38 42	58 68	94 104	130 150	164 204	305 345	477 537	721 811	1235 1379	1980 2210
 SOCKET CAP SCREW	SOCKET HEAD CAP SCREW ALSO N.A.S. AIRCRAFT STD.	160,000 P.S.I.	High Carbon Alloy Quenched Tempered	41	64	100	140	188	309	511	775	1623	2657
 CAP SCREW	N.A.S. 144 AIRCRAFT STD. MS 20000 MIL. STD.			45	74	110	160	218	359	571	875	1783	2857
 CAP SCREW	N.A.S. 624 NATIONAL AIRCRAFT STANDARD STEEL	180,000 P.S.I.	High Carbon Alloy Quenched Tempered	46 51	73 83	113 123	170 180	230 245	378 403	603 643	925 985	2898 2048	3028 3228

TABLE 3

BOLT SIZE (GRADE 5)	CYLINDER BORE DIA.	TORQUE VALUE - FT. LBS.
3/8 in.	2 in.	20
1/2 in.	3 in.	50
5/8 in.	4 in.	110
3/4 in.	5 in.	200
3/4 in.	6 in.	250
7/8 in.	6 in.	300
1 in.	7 in.	450

TABLE 4

NOMINAL SCREW SIZE	TORQUE JAM-NUT	TORQUE SET SCREW
1/2 in.	75 ft. lbs.	50 ft. lbs.
5/8 in.	150 ft. lbs.	100 ft. lbs.
3/4 in.	260 ft. lbs.	180 ft. lbs.
1	530 ft. lbs.	450 ft. lbs.

BOOM AND LIFT CYLINDER PIVOT SHAFTS.

Torque values as shown in Table 4 are to be used on all boom, lift and pivot shaft setscrews and jamnuts.

WIRE ROPE.

Wire rope is a precisely designed "machine" made up of many moving parts, each of which must be free at all times to move independently of all others. Were it not for this movement between wires and strands, we would have a rod or bar too stiff to operate over sheaves and drums.

This machine, treated with the respect it deserves during usage and with proper maintenance, can last for thousands of hours of use. Improper handling, usage and/or maintenance can ruin it in a few hours.

While most wire ropes are manufactured from finest grades of steel, nicks or scratches on the surfaces of the individual wires, kinking or severe bending can greatly reduce service life. This can happen with improper storage, transporting, uncoiling or other non-operational handling.

As with all precision machinery, a "Break In" period is advisable. Several slow operating cycles with moderate loads will give the rope an opportunity to seat itself on the drum and sheaves and enable the individual strands to become firmly aligned in place.

AVOID:

Kinking, which results in localized wear, is generally caused by allowing a loop to form in a slack line and then pulling the loop down to a tight, permanent set.

Overloading, resulting in complete fracture of the rope or crushing and distortion on the drums and sheaves. This is caused simply by working the rope with a load too near its breaking strength.

Dragging of the rope over a bank or some other obstruction which will score it, causing localized wear.

Improper seizing which permits strands to become loose, unbalancing the rope and throwing all of the load onto a few strands.

Improper spooling, which results in crushed and distorted ropes, comes from careless application and operation.

Whipping a line, which results in many wires broken square off. This is caused by jerking the line or running it loose.

WARNING

NEVER HANDLE WIRE ROPE WITH BARE HANDS AS ALMOST INVISIBLE FRACTURES CAN CAUSE SEVERE AND PAINFUL CUTS.

NOTE

WHEN WIRE ROPE IS REPLACED FOR ANY REASON, CONSIDERATION SHOULD BE GIVEN TO THE CONDITIONS UNDER WHICH IT WILL BE USED. REGULAR (RIGHT) LAY ROPE SHOULD ALWAYS BE USED TO MAINTAIN LEVEL WRAP ON THE HOIST.

Inspection.

WARNING

ALL FUNCTIONAL WIRE ROPE SHOULD BE VISUALLY INSPECTED EVERY DAY, PRIOR TO PUTTING CRANE INTO SERVICE.

The serviceability of wire rope cannot be overemphasized, for both the safety of personnel and machine operation, and as a preventative measure in safeguarding the load.

A thorough inspection of all functional wire rope should be made at least once a month, with a running record of the rope condition kept with the machine's service records.

Any deterioration, resulting in an appreciable loss of the design rated rope strength, should be carefully examined and its serviceability evaluated as to the potential of a possible safety hazard. The following conditions should justify speculation of wire safety and consideration for replacement.

1. Corrosion.
2. More than one broken wire in any one strand.
3. More than one broken wire near attach fittings.
4. Excessive wear and/or broken wires in rope sections under sheaves where rope travel is limited.
5. Evidence of noticeable reduction in original rope diameter after allowance for normal stretch and diameter reduction of a newly rigged rope.
6. Excessive abrasion, scrubbing, and peening of outside wires, pitting, bird-caging or other mechanical damage resulting in physical changes to the rope structure.

Sheaves, guards, guides, drums, flanges, etc., and any other surfaces that come in contact with the rope should be inspected for any damaged areas that could cause possible damage to the rope.

Unwinding. (Refer to Figure A-1.)

NOTE

IT IS RECOMMENDED THAT COIL OR REEL BE ROTATED AS ROPE IS UNWOUND.

Extreme care should be taken when unwinding rope from either a coil or a reel. By rotating the coil or reel, the possibility of the rope twisting or kinking is lessened. The illustrations in Figure A-1 depict the preferred methods of unwinding wire rope.

CAUTION

REGARDLESS OF THE METHOD USED, KEEP UNWOUND PORTION OF ROPE STRAIGHT DURING UNWINDING OPERATIONS.

Cutting.

The three preferred and most common methods of cutting wire rope are shearing, abrasive cutting, or flame cutting. The following procedures are recommended.

1. (Preformed.) Clamp rope on each side of cut mark; proceed with cutting.
2. (Non-preformed — less than 7/8-inch diameter.) Place two clamps on each side of cut mark; proceed with cutting.
3. (Non-preformed — 7/8-inch diameter or greater.) Place three clamps on each side of cut mark; proceed with cutting.

Proper seizing and cutting operations are not difficult to perform, and they insure that the wire rope will later do its

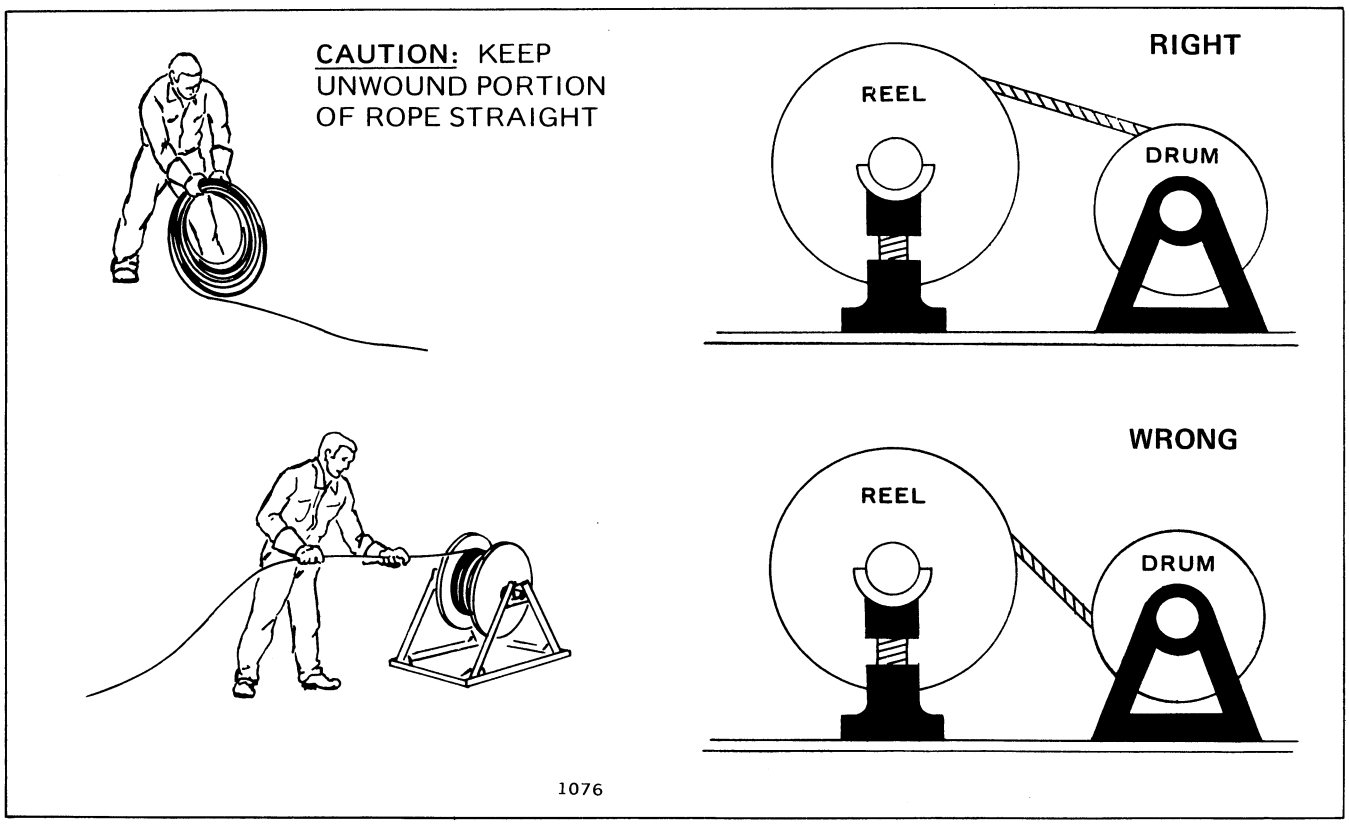

Figure A-1. Unwinding Wire Rope

job. When wire rope is carelessly or inadequately seized, especially in anticipation of cutting, ends become distorted and flattened and the strands loosen back within the rope. Later, when the rope is put to work, the load is unevenly distributed to the strands and the life of the rope is significantly shortened.

Flame cutting, which fuzes the ends of the wire together and abrasive grinding which results in a clean cut are considered to be most satisfactory.

Installing Rope on Hoist. (Refer to Figure A-2.)

CAUTION

IF ROPE IS WOUND FROM STORAGE REEL ONTO HOIST DRUM, REEL SHOULD BE ROTATED IN SAME DIRECTION AS HOIST TO AVOID REVERSE BENDING.

NOTE

WIRE ROPE SHOULD PREFERABLY BE STRAIGHTENED PRIOR TO INSTALLATION ON HOIST.

Install wire rope on hoist as follows:

1. Place shaft through the wire rope reel and mount on supports so that it can be rotated.

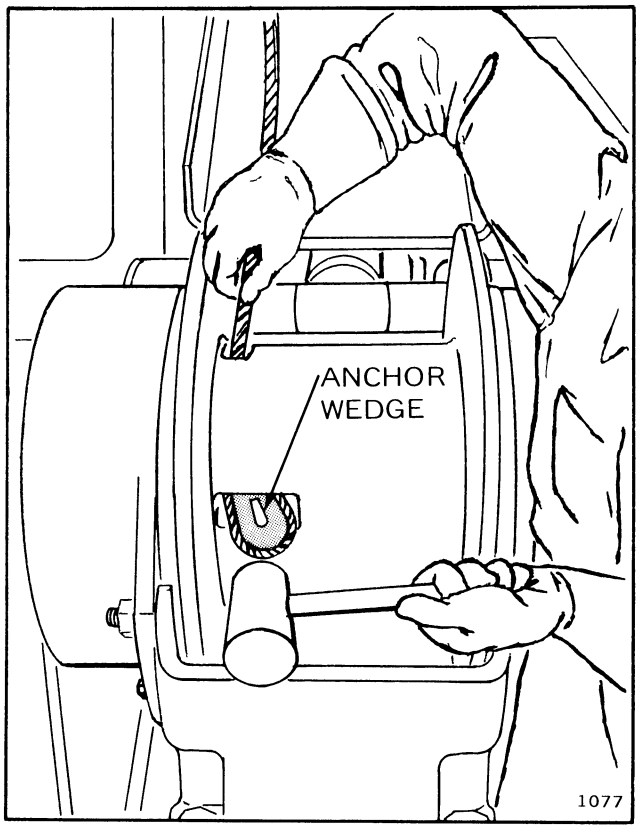

Figure A-2. Installing Rope On Hoist

2. Position reel so that rope can be removed from the top of the reel over the nose sheave and to the top of the hoist drum.
3. Position hoist drum with rope anchor slot on top.
4. Insert rope through slot and position around anchor wedge.

NOTE

END OF ROPE SHOULD BE EVEN WITH BOTTOM OF ANCHOR WEDGE.

5. Position anchor wedge in drum slot; pull firmly on free end of cable to secure wedge.

NOTE

IF WEDGE DOES NOT SEAT SECURELY IN SLOT, CAREFULLY TAP TOP OF WEDGE WITH MALLET.

6. Using power, wind rope on hoist using a block of wood against the storage reel flange to serve as a brake to achieve a taut wrap.
7. Install becket as applicable.

CABLE REEVING INSTRUCTIONS.

Multipart lines allow the operator to raise a greater load than permitted with the use of a single part line. Illustrated reeving shows 2-, 4-, and 6-part lines in relation to the number of sheaves in the boom nose and hook block. Accomplish desired cable reeving as follows:

REEVING.

CAUTION

WHEN REEVING WITH LESS THAN THE TOTAL NUMBER OF SHEAVES IN BOOM NOSE AND/OR HOOK BLOCK, REEVE CABLE OVER AND/OR UNDER CENTERMOST SHEAVES OF BOOM NOSE AND/OR HOOK BLOCK ASSEMBLIES TO EQUALLY DISTRIBUTE CABLE LOAD.

1. **Two-Part Line:**
   a. From point "A", reeve cable over sheave "1".
   b. From sheave "1", route cable under sheave "2"; secure becket.

2. **Four-Part Line:**
   a. Complete step (1) above.
   b. From sheave "2", cross over and route cable over sheave "3".
   c. From sheave "3", route cable under sheave "4"; secure becket.

3. **Six-Part Line:**
   a. Complete steps (1) and (2) above.
   b. From sheave "4", cross over and route cable over sheave "5)).
   c. From sheave "5", route cable under sheave "6"; secure becket.

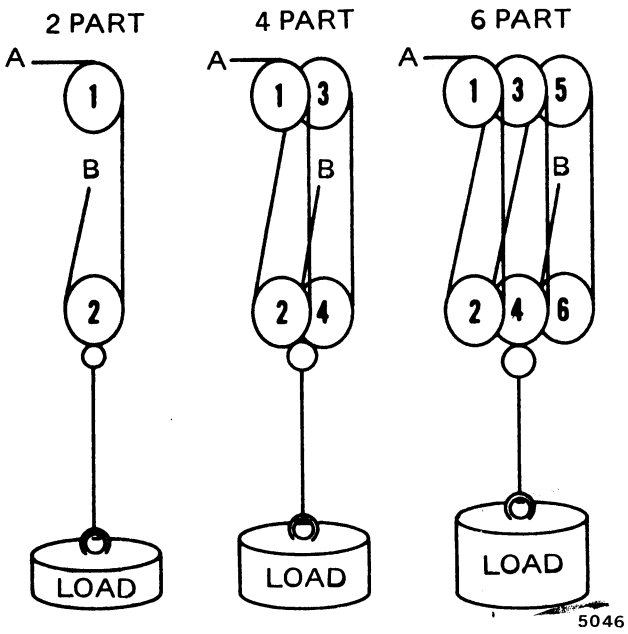

Figure A-3. Cable Reeving

NOTE

WHEN MORE PARTS OF LINE ARE REQUIRED, REEVING SHOULD FOLLOW THE SAME PATTERN SHOWN ABOVE. REFER TO OPERATOR'S HANDBOOK FOR DETAILED ILLUSTRATIONS.

LUBRICATION.

Wire rope is a machine and lubrication is as vital as putting oil in an engine crankcase. A lubricant serves two purposes: it reduces wear and protects the rope.

When wire rope is in use, the internal wire surfaces rub against each other, and the outside wires also wear against sheaves and drums. Lubrication reduces wear both on the inside and on the outside of the rope.

There is no set timetable governing the lubrication of wire rope. Lubrication intervals should be established around the working conditions to which the rope is subjected. Assure that the lubricant used has the following characteristics:

1. Free from acid or alkaline content.
2. Sufficient adhesive strength to remain on rope.
3. High film strength properties.
4. Oxidation resistant.
5. Ability to saturate between wires and strands.
6. Insoluble under methods of application.

Wire rope should be thoroughly cleaned prior to lubricating. Wire brushes, scrapers, or compressed air are the most efficient means. Assure that all old lubricant and any foreign materials are removed from the rope. There is no preferred wire rope lubrication method. The most practical method should be used, as necessary.

Lubricants in the Rope.

Wire ropes are thoroughly saturated with lubricant during manufacture. Fiber centers are soaked with it. Lubricant is applied around every wire of the strand, and around each strand in the rope.

Several types of lubricant are used in ropes. One is petrolatum, a clear, thin, penetrating lubricant. Another is wire rope compound, a heavy bodied grease used primarily to protect rope. Other special types developed by individual cable manufacturers are available under their trade names.

Oiling the Rope.

Lubricating wire rope in the field presents special problems. In the manufacturing process, the lubricant is applied hot to the separate wires and strands as they are formed into rope.

In the field, a lighter lubricant is required – one which will penetrate into the rope. It can be sprayed, brushed, poured on or applied in a bath when conditions permit.

Two important points of field lubrication are:

1. Clean the rope as thoroughly as possible before applying the lubricant.
2. Give the lubricant as much opportunity as possible to soak in.

The frequency of application depends on the nature of the operation and can be determined by inspection.

MAINTENANCE.

Shifting Wear Points.

Certain sections of the wire rope will always get more wear than others.

Rope on a drum with two or more layers will wear at the point where the rope starts each successive layer, and also at the points where the upper layer crosses the lower.

Crane ropes will fatigue at an equalizer sheave.

Hoist ropes will often fail from vibration fatigue at the point where they are dead-ended.

Because of these wear and fatigue points, it is good practice to move the rope at regular intervals in order to distribute wear. Just like shifting tires on an automobile.

Change of layer and cross-over points can be made by cutting a few feet of rope from the drum end and refastening. This cut should be at such distance from the end to move the change of layer at least one full coil from its original position and enough to move the cross-over points approximately one-quarter turn around the drum.

If applicable, a similar cut on the drum end of the crane rope should be long enough to move the static section on the equalizer sheave three sheave diameter lengths away.

Drag and slope ropes should be turned end for end when inspection shows the outer wires are worn one-third to one-half their diameter.