Technical Manual

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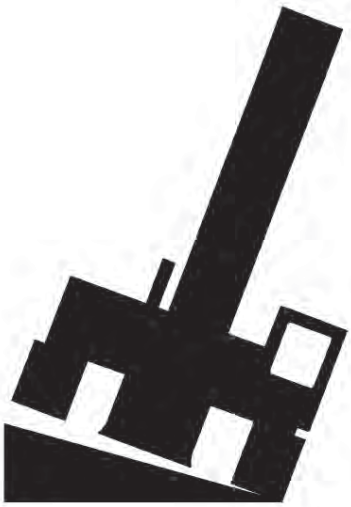
Section 5 Dust Control Systems

Section 6 Mast / Rotary drive / Pipe rack

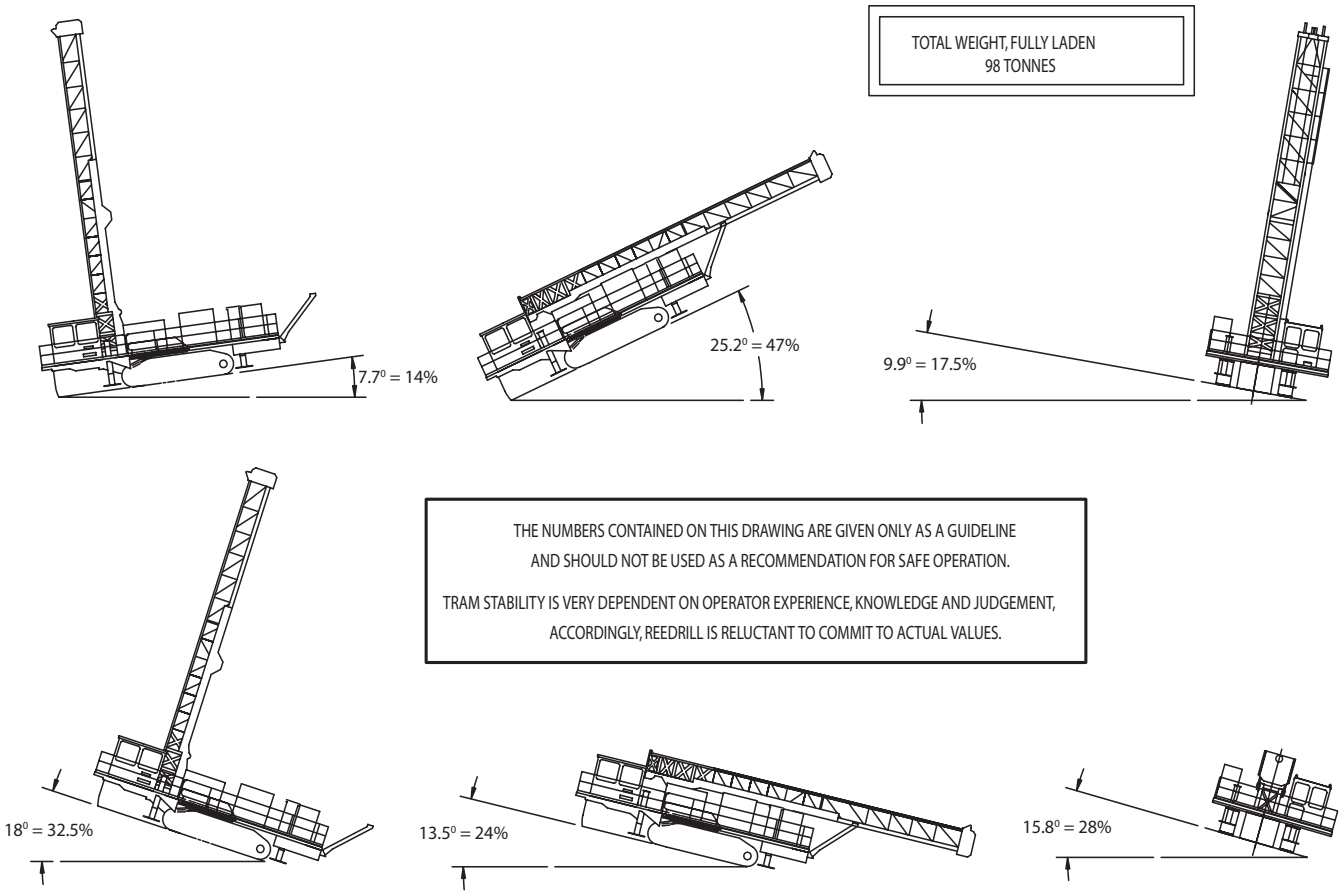
Safety

Machine Stability



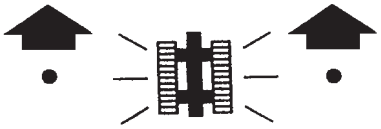
- The machine should never be propelled over areas that could potentially collapse or subside.
- Visual inspections of the path to be taken must be made
- All precautions relating to underground workings must be adhered to
- Never tram through areas of soft unconsolidated materials holding water
- If propelling on inclines is required, never travel across grades
- Do not tram the machine with the tower raised over rough or undulating ground
- Always ensure jacks are lowered onto solid stable ground

WARNING: Unit overturn <u>can</u> cause serious injury or death



Graphic Symbol Legend

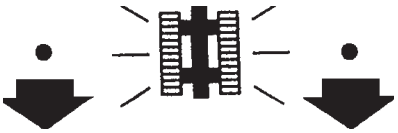
Oil Injection



Propel - FORWARD

Rotation - FORWARD

Pipe Rack Lock



Propel - REVERSE

Rotation - REVERSE

Pipe Rack Index

Holdback Pressure
(not used in SKF-12)

Rotation Pressure

Pipe Rack Swing

Pulldown System (Auto Feed)

Throttle - FAST

Throttle - SLOW

Pipe Rack Swing - Interlock

Pulldown System Pressure
- DECREASE

Tool Wrench - ENGAGE

PROPEL (Drill/Propel Switch)

Pulldown System Pressure
- INCREASE

Tool Wrench - RETRACT

Switch Panel

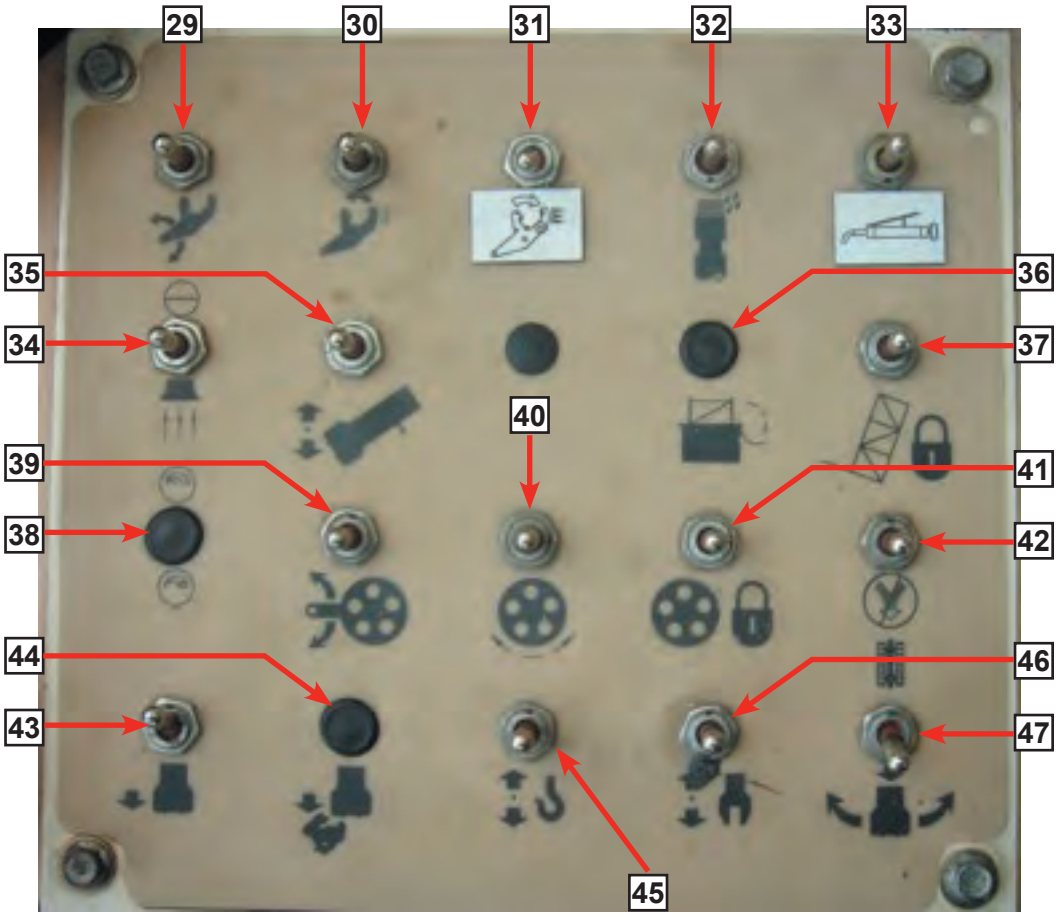


Fig 2-4 Switch Panel

The pulldown system switch engages and disengages the pulldown for drilling operations.

- Push switch up to disengage pulldown.
- Push switch down to engage pulldown.

44. Fast Down (NOT USED SKF-12)

Push switch down to activate "fast down". Use this feature to increase speed of rotary head coming down the mast.

45. Winch

- Push and hold switch up to raise winch hook.
- Push and hold switch down to lower winch hook.

46. Tool (Deck) Wrench

Switch retracts or extends the deck wrench to hold the drill pipe when breaking thread joints or when multiple pass drilling is required.

- Push and hold switch up to retract tool wrench.
- Push and hold switch down to engage tool wrench.

47. Drill / Propel Switch

WARNING: Drill mode must be selected if not propelling the machine or when the machine is unattended. Drill mode engages the propel brakes.

Engages the drill controls or propel system.

- Push switch up to engage the propel system.
- Push switch down to engage the drilling controls.

across the valve. Thus, the refrigerant that enters the valve as a hot high-pressure liquid exits it as a cold low-pressure liquid.
The flow rate will vary according to the heat load, sensed by the diaphragm capillary, and the suction pressure at the evaporator.
The TDR6 Series units utilise an externally equalised TX valve. The external equaliser tube is connected to the outlet of the evaporator and runs to the underside of the expansion valve diaphragm. This tube balances the pressure and temperature at the coil outlet thereby providing maximum coil efficiency.

2.4.4 Evaporator Coil

The evaporator coil is constructed from copper tubing, through which passes the H134a refrigerant, and aluminium fins for optimum heat transfer. The refrigerant evaporates as it passes through the copper tubes due to heat, which it absorbs from the hot air flowing over and around the fins and tubes. This absorption of heat reduces the temperature of the air passing through the coil, thus cooling the cab. The refrigerant boils off becoming a low-pressure gas.

2.4.5 Compressor

The function of the compressor is to pressurise the refrigerant in the system, thus concentrating the resultant rise in temperature. At the compressor the low-pressure gas is changed to a high pressure, high temperature gas. This pressure build-up is accomplished by having a restriction in the high-pressure side of the system. This restriction occurs at the metered orifice in the TX valve.
The compressor is normally belt driven from the engine crankshaft. An electromagnetic clutch is used to provide a means of stopping the compressor from pumping when refrigerant flow is not desired or when a malfunction develops within the system.

2.4.6 Compressor Service Valves

Two service valves are located on the top of the compressor cylinder head. The valves enable the connecting of system test gauges and also to isolate the compressor from the rest of the system to facilitate compressor replacement. The high (discharge) side service valve is quickly identified by the smaller discharge hose routed to the condenser, while the low (suction) side has a larger hose coming from the evaporator.
The valve is normally back-seated, (refer B in Figure 2.4), closing off the gauge port allowing normal system operation. The valve should be in this position before disconnecting any service equipment.
The valve should be in the mid position (refer C in Figure 2.4), when the system is operating and any service equipment is connected. Loss of refrigerant gas will occur if the valve is opened to this position without first connecting the service equipment.
The front-seated (A) position of the valve shuts off flow to both the gauge port and compressor. This position is used when isolation of the compressor from

2. The two in-line hot water taps, MUST be fitted onto the engine to allow for isolation of the hot water heating system when required. Hot water is usually tapped off the outlet pressure side of the water pump and returned to the suction side of the water pump, thermostat housing or some other convenient location on the engine block. Using the necessary adaptors, and a suitable thread tape or sealing compound, fit the taps to these two locations.

3. Using the hose clips supplied, connect the hot water hoses to the barbed fittings on the unit and then to the taps on the engine.

   Note: Before commencing a heating system check, ensure that the air conditioner cannot be operated by disconnecting the compressor clutch wire.

4. Refill the radiator to the correct level and start the machine. Ensure that the two taps on the engine are both turned on and that the unit is switched to heat and thermostat to warmer.

5. Operating the Main Control Switch in the FANS mode, select LOW FANS. Check for leaks at all connections. Efficient circulation of water will be indicated by a temperature increase in both heater hoses. Check for heated supply air entering cabin.

6. Turn off engine and Main Control Switch. Reconnect compressor clutch wire and refill radiator as necessary.

4.5 NITROGEN LEAK TESTING - GENERAL INSTRUCTIONS

Legislation on handling of refrigerants requires leak testing of the system following any dismantling of major components. The procedure to do this is as follows:-

1. Connect a cylinder of dry nitrogen to the compressor valve on either of the suction or liquid line connections.

   Note: It is important that the nitrogen charging set is supplied with a shut-off valve pressure reducing valve, cylinder pressure gauge, line pressure gauge and bleed valve.

2. Set the cylinder reducing valve to 1035 kPa (150 psig)
3. Open the nitrogen cylinder shut-off valve and charge the plant up to a test pressure of 1035 kPa (150 psig).
4. Close the cylinder shut-off valve.
5. All joints should be vibrated by tapping carefully with a rubber or soft hide-faced mallet.
6. Test for leaks with a soap and water solution.

6.1.4 Twelve Monthly Inspection

COMPONENT/SYSTEM	INSPECTION REQUIRED
Compressor.	Check oil level.
Thermostat.	Check correct setting.
Refrigerant pressure switches.	Check correct settings.

CARRY OUT FULL COMPONENT/SYSTEM PERFORMANCE TEST USING GAUGE MANIFOLD SET.

ATTENTION

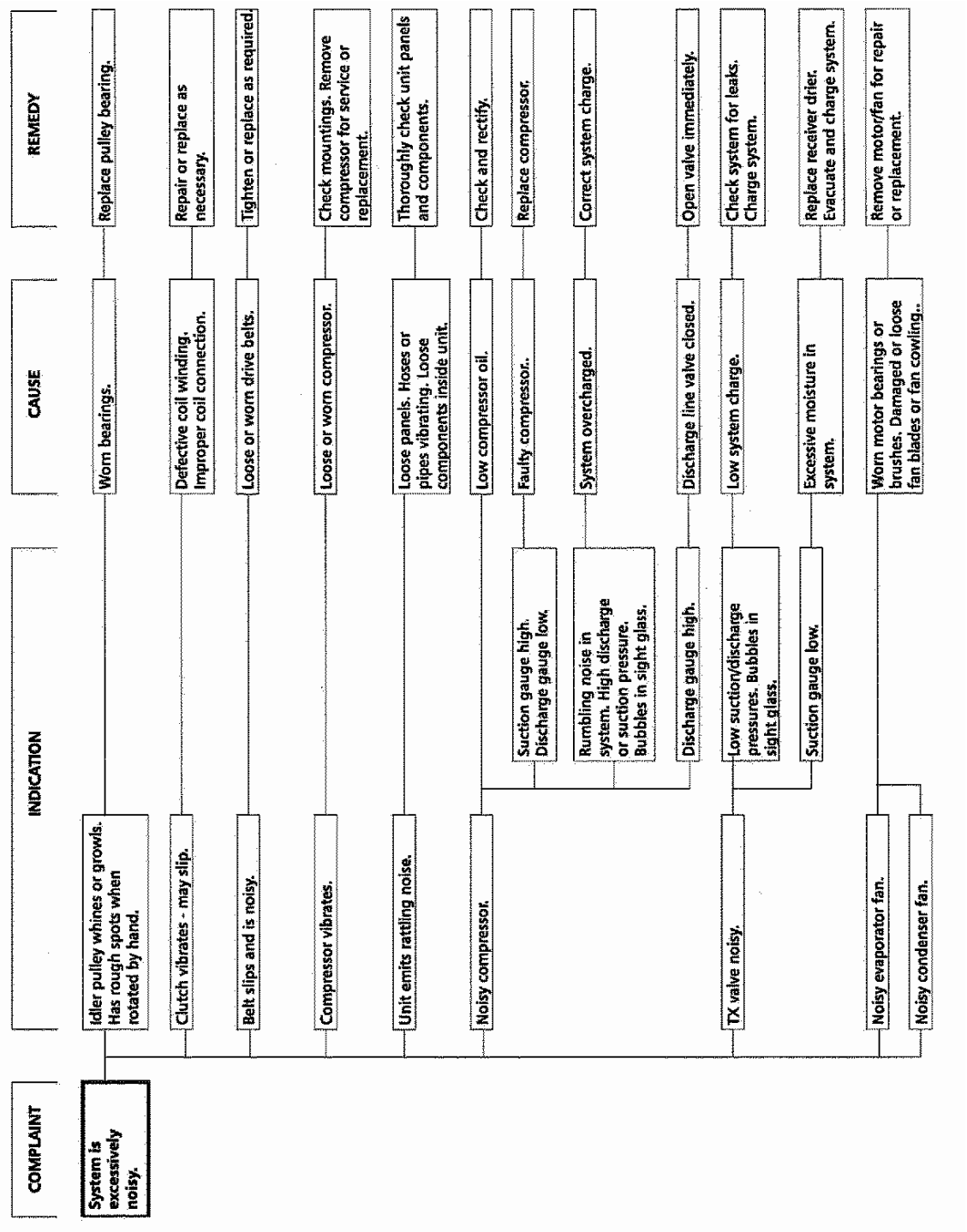
The air conditioning system must be run for a minimum of five minutes each week regardless of the season.

The compressor oil level should be checked whenever the refrigeration system is opened due to breakdown.

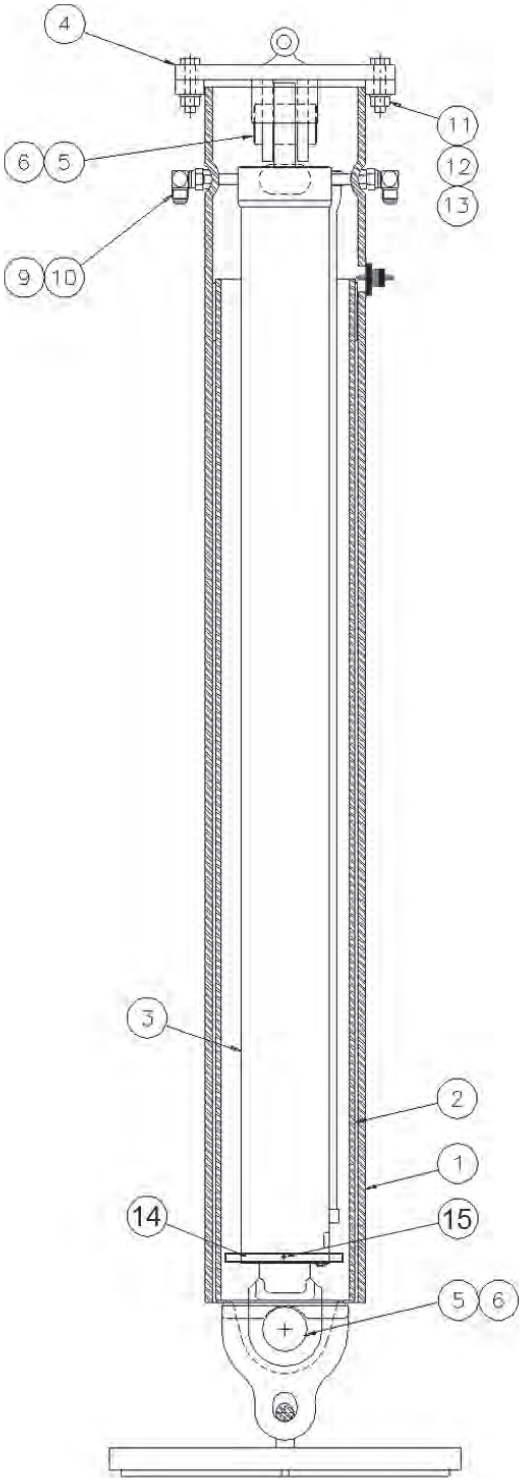
ATTENTION

All work carried out on Sigma Equipment should be done by qualified tradesmen who adhere to the relevant refrigeration codes of practise.

7.1.4 System Excessively Noisy



Leveling Jacks



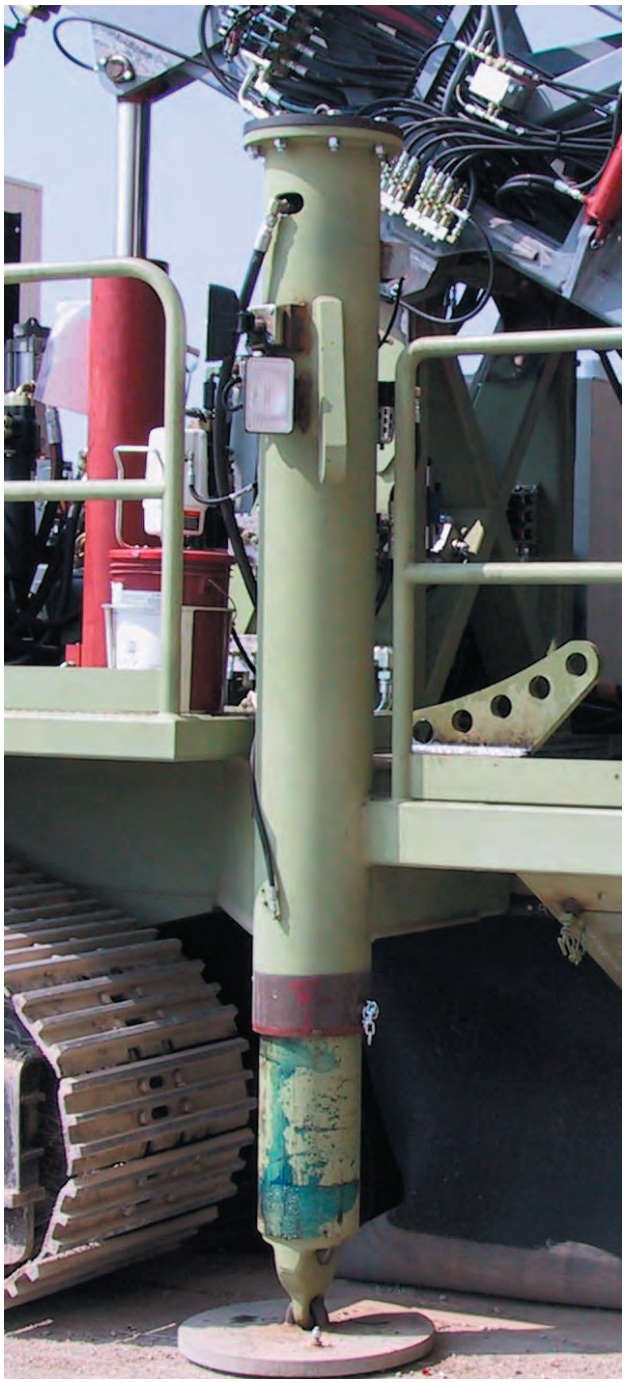


Fig 3-2 Left Rear Jack

Fig 3-1 Leveling Jack Cylinder (ref. 416075) - 4 Places

1. Outer Casing
2. Inner Casing
3. Hydraulic Cylinder
4. Cap
5. Pin (2)
6. Cotter Pin (4)
9. Adapter, Elbow (2)
10. Adapter, Straight (2)
11. Capscrew (8)
12. Hex Nut (8)
13. Flat Washer (8)
14. Guide Ring
15. Screw Allen (5/16 UNC x 1")

Track Chain

WARNING: Grease in the track adjusting cylinder is under high pressure. Grease coming out of the relief valve of the track adjuster is under high pressure and can penetrate the body causing personal injury or death.

When loosening the tension on the track, loosen the relief valve only one turn.

DO NOT visually inspect the relief valve to see if grease is being released from the track adjuster. Instead, watch the track to see if it loosens. If the track does not loosen after opening the relief valve, move the machine forward and backward to release the tension.

Separate Track Chain Assembly

1. Put the machine on a flat level surface.
2. Release the tension on the track assembly (see track tension adjustment). Access the track tensioner through the opening in the track side frame. Loosen relief valve for the track adjuster only one turn. If the track assembly does not loosen after opening the relief valve, move the machine forward and backward until the tension is released.

WARNING: To Prevent possible injury during removal of master pin, keep away from the area outside the track assembly near the master pin. The master pin may come out of the track links with force during the removal procedure.

3. Locate the master pin and position pin between the sprocket and support roller. It is easier to access the pin by removing the track shoes directly above the pin (fig. 3-12). Drive the pin out with a hammer and driving pin (fig. 3-10).
4. Remove the track chain in the direction of the sprocket (fig. 3-11).

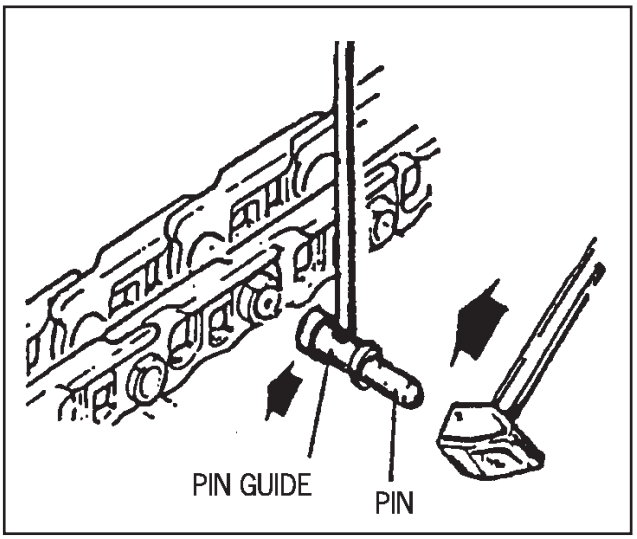


Fig. 3-10 Master Pin - removal

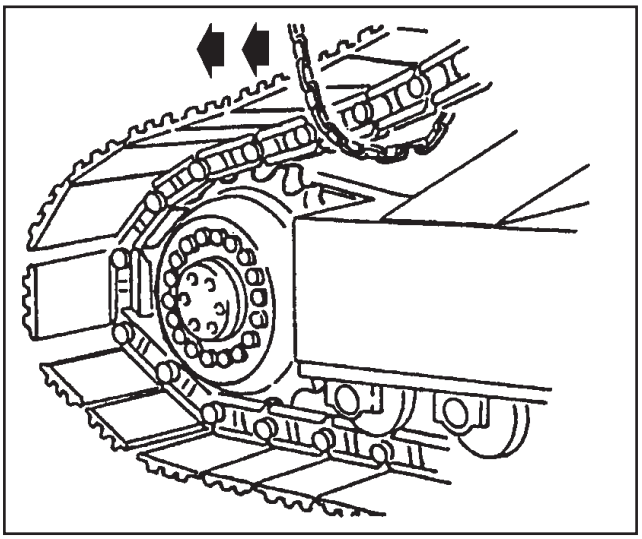


Fig. 3-11 Track Chain - removal

Final Drive

Final Drive - General Description

The final drive is a 3-stage planetary gear drive which is totally enclosed. The bearings are protected by special slide ring packings.

It has an internal multi-disc brake which is spring applied and released by hydraulic pressure. The brake is therefore, maintenance free and no repair work should be done on the brake except by factory authorized specialists. The brake unit should be exchanged for a complete unit.

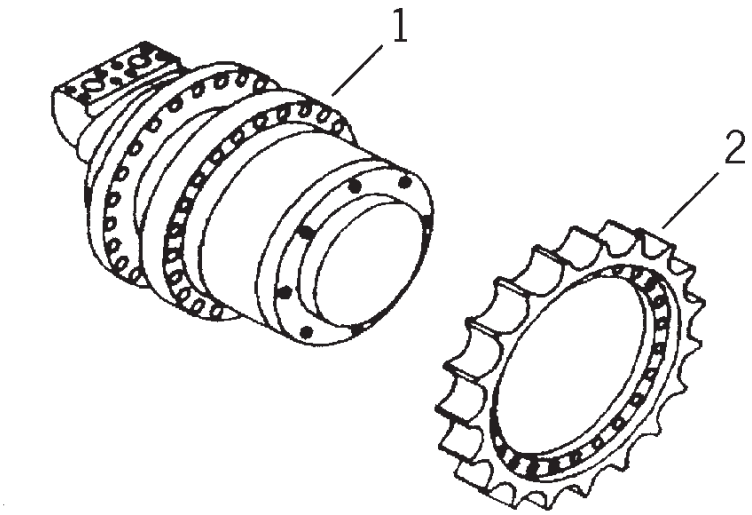


Fig. 3-30 Final Drive Assembly
1. Planetary Gear Drive
2. Drive Sprocket

Final Drive Assembly

Notes:

B.2 Safety symbols

Recognize safety information

This is the safety alarm symbol; whenever you find it in the manual or see it on the machine, you are being warned about potential danger of accidents or harm to personnel. Follow the do's and don't's to operate in total safety.

Understanding written warnings

Written warning (DANGER, WARNING or CAUTION) is used along with an alarm symbol.

DANGER or WARNING signs are used near danger zones, while CAUTION sign indicates general precaution.

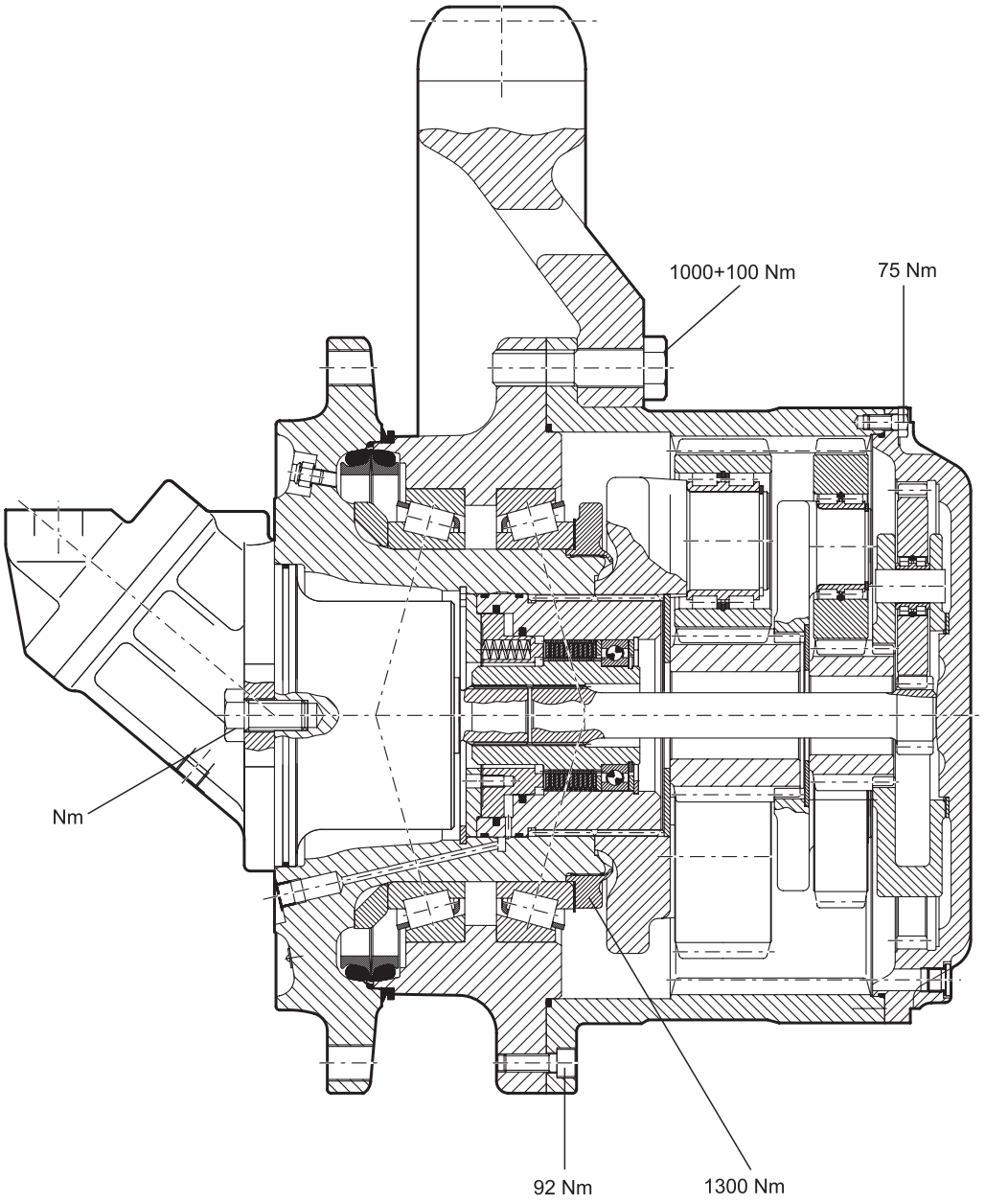
Follow safety instructions!

Read all suggestions given in this instruction manual very carefully.

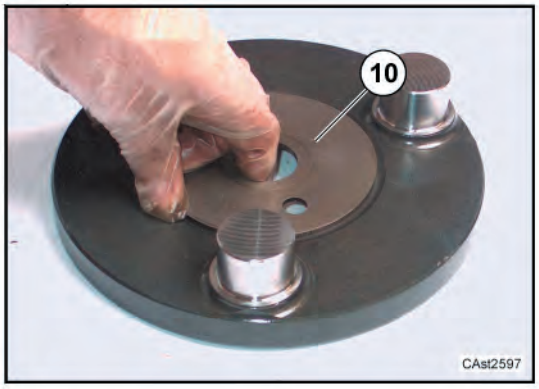
Unauthorized changes could endanger the functioning, work safety and work span of the transmission. If you do not understand this instruction manual, contact the nearest sales representative.

C.8 Tightening Torques

F100/.../K

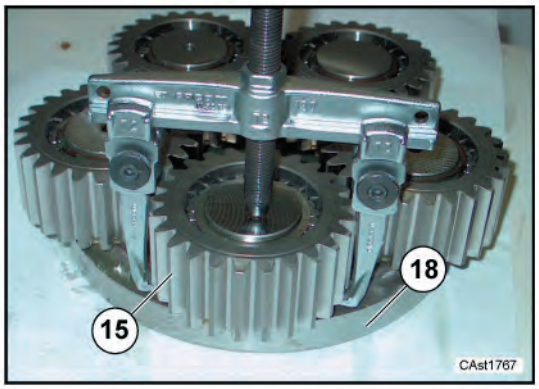


Final Drive Assembly

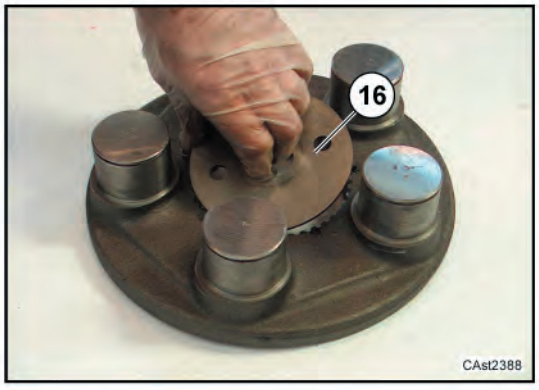


Remove washer (10).

Remove snap ring (14).

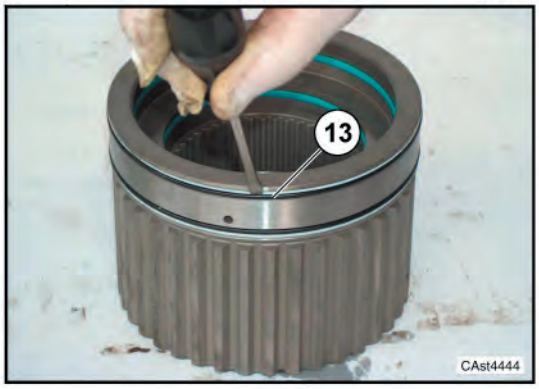


By means of an extractor remove planetary gears (15) from side gear carrier (18).

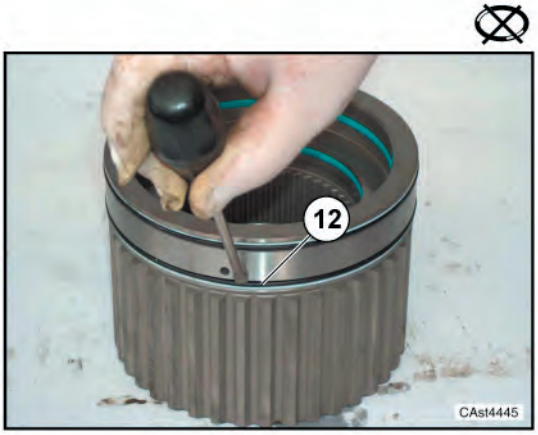


Remove washer (16).

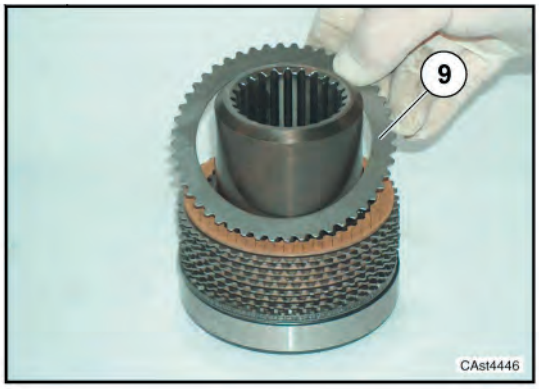
Final Drive Assembly



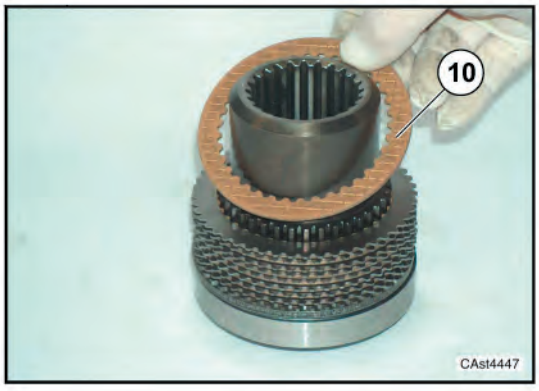
Remove gasket (13).



Remove gasket (12).

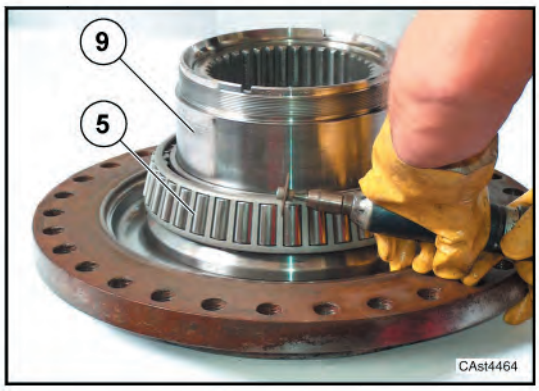


Remove steel discs (9).

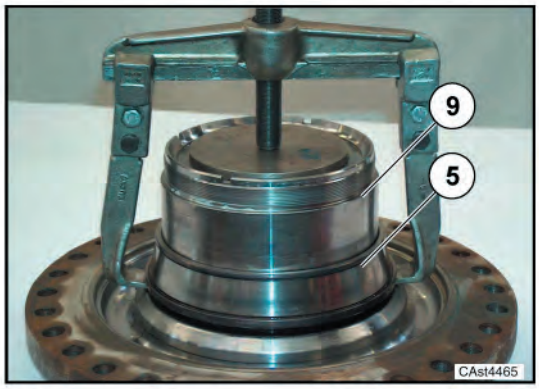


Remove sintered discs (10).

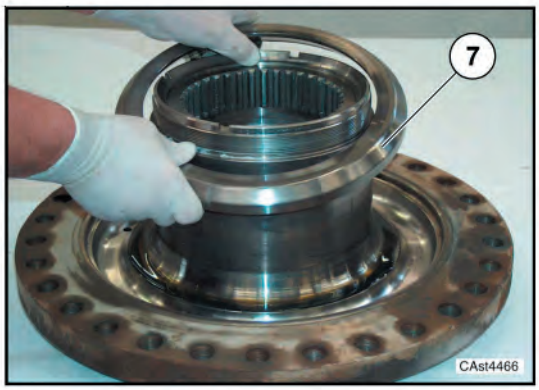
Final Drive Assembly



Remove bearing (5) from beam (9).



Remove internal ring of bearing (5) from beam (9).



Remove spacer (7).

Idler Unit

WARNING: DO NOT work on track system or undercarriage unless engine is off and controls are locked out and machine is on level ground.

MAKE SURE machine and components are well supported before servicing or replacing parts.

RELIEVE PRESSURE on hydraulic or pneumatic systems before loosening connections or parts.

WARNING: DO NOT attempt to replace the recoil spring.

Replacement of the recoil spring must be done by an authorized Intertractor dealer.

The recoil spring assembly is assembled with a force of several tons.

DO NOT put the recoil spring assembly under compression or release the tension by turning the tension rod.

Damaged threads on the tension rod or spring cap can cause the assembly to come apart with force, resulting in personal injury or death.

Removal and Disassembly

1. Release track chain tension and separate track chain. Follow instructions outlined previously.
2. Clean dirt from all parts. Using an adequate lifting device, pull out the complete idler unit (fig. 3-47).
3. If either the idler or tensioner is damaged, separate them and replace or repair as required.

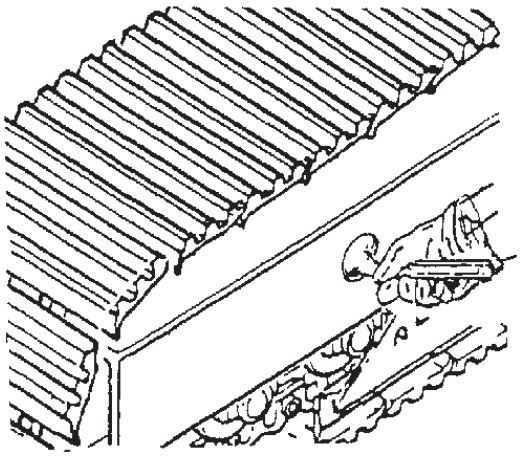


Fig. 3-46 Release Track Tension and remove track chain

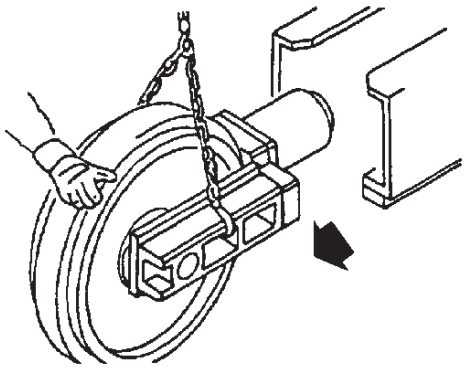


Fig. 3-47 Idler Unit - removal

Track Rollers

Track Roller - Test and Install

1. Check the end play. Check for air tightness by applying air pressure through the oil fill hole. Test pressure should be not more than 87 PSI (6 bar). Fig. 3-73.
2. If the air test is satisfactory, with no air leakage around the seals, fill roller with SAE 90 oil through the oil fill hole (fig. 3-74).
3. Hold the roller in such a way so the oil groove is at the bottom and the oil fill hole is at the top. Now apply air pressure into the roller as in step 7 so the oil is pressed into the seal retaining spaces (9). Fig. 3-75.

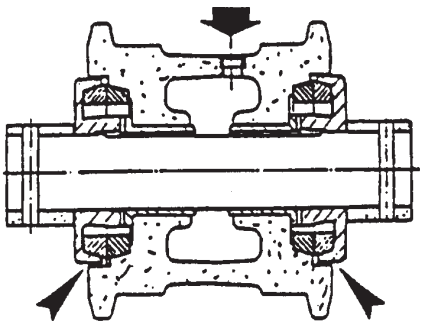


Fig. 3-73 Track roller - air leakage test

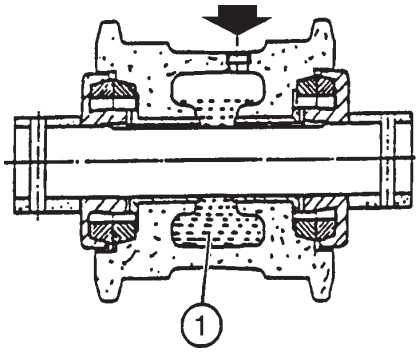


Fig. 3-74 Track roller - oil fill
1. Oil

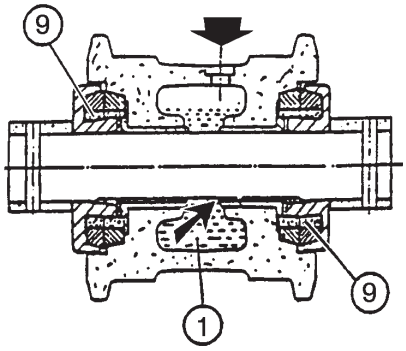


Fig. 3-75 Track roller - air/oil
1. Oil
9. Seal retaining spaces

4. After filling with oil, check for correct level (fig. 3-76).

- **MAX Oil Level -**
  Turn the roller so the oil fill hole is 40° from a horizontal line through the center. Oil should not spill out of the oil fill hole in this position.
- **MIN Oil Level -**
  Turn the roller so the oil fill hole is 10° from a horizontal line through the center. Oil MUST spill out of the oil fill hole in this position.

5. Put some loctite on the threads of the oil fill plug and install with a 6mm allen wrench (fig. 3-77).
6. Install track roller assembly on track frame (fig. 3-78). Torque capscrews according to "Metric Bolt Torque Specifications" in this section.
7. Remove supports and lower track frame onto track chain. Adjust track tension according to "Track Tension Adjustment" at the front part of this section.

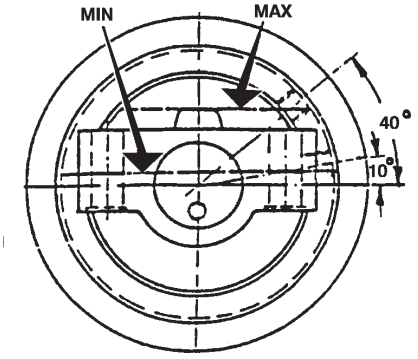


Fig. 3-76 Track roller - oil level

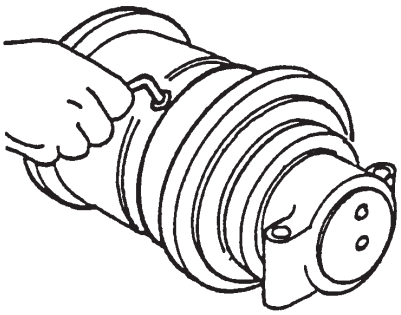


Fig. 3-77 Track roller - fill plug

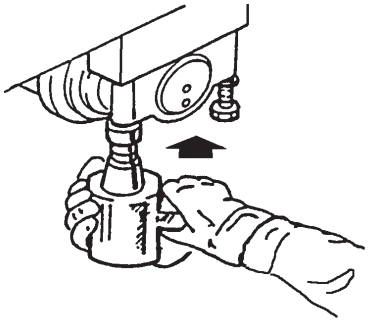


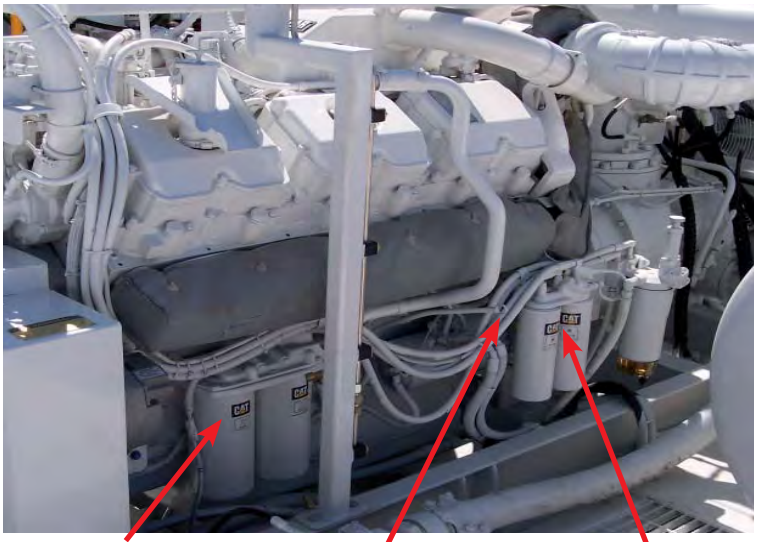
Fig. 3-78 Track roller - install

Engine and Drive Train Service Procedures

Caterpillar 3412E Engine

The Caterpillar 3412E engines take 68 litres of engine oil in the engine motor. The engine oil level must be checked at the beginning of every shift.
The engine has 2 Oil lters, 2 Fuel lters, 2 Air cleaner elements and 2 Engine Breathers which need to be changed at each service interval. For servicing and maintenance schedules see Topic 10.

NOTE: **Engine oil level MUST be checked at the beginning of each shift on the dip stick**



Engine Oil Filters Engine Oil Dipstick Fuel Filters

The engine is protected by the sensors and switches which are connected to the engine ECM which will shut the engine down if a fault occurs. The Faults are displayed by a red light in the operator cab which ashes a code to indicate which fault has occurred.

- Engine temperature sender –

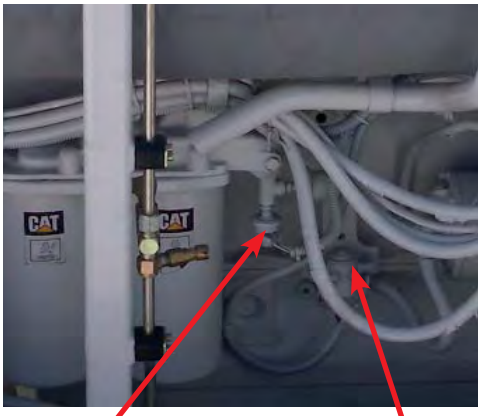
This reads the engine temperature and is connected to the gauge on the dash. It is totally separate to the shutdown circuit.

- Oil pressure sender –

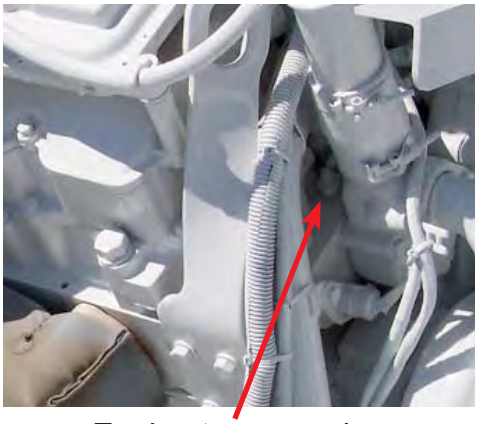
This measures engine oil pressure. This sender provides a reading of the engine oil pressure to the gauge in the cab. The sender has no visual or audible alarm and is totally separate to the shutdown circuit.

- Engine hour meter pressure switch–

When the engine is started this switch will turn the hour meter on. This does not read any critical engine conditions that will shut the engine down



Engine hour meter pressure switch Engine oil pressure switch



Engine temp sender

Hydraulic Pumps

Refer to Section 7 for all Hydraulic Pumps, Operation, Adjustment, Specifications and Repairs

Right Track & Feed Pump -	**Model AA4VG125**
Left Track & Rotation Pump -	**Model AA4VG125**
Fan - Auxilliary Pump	**Model A11VLO130**
Charge Pump	**Model P350**
Charge Pump - Water Injection/Dust Collector Pump	**Model P350 Double Gear Pump**

Overhaul of hydraulic piston pumps in the eld is not recommended. Special tools, expert knowledge and absolute cleanliness are essential. It is usually best to exchange the pump for a new or factory rebuilt unit. However, replacement of shaft seals, control units, charge pump and external adjustments may be done without dif culty. Refer to parts manual for your speci c machine and section 7 of this manual for pump adjustments.

High Pressure Compressor

2.2 Sullair Compressor Unit, Functional Description

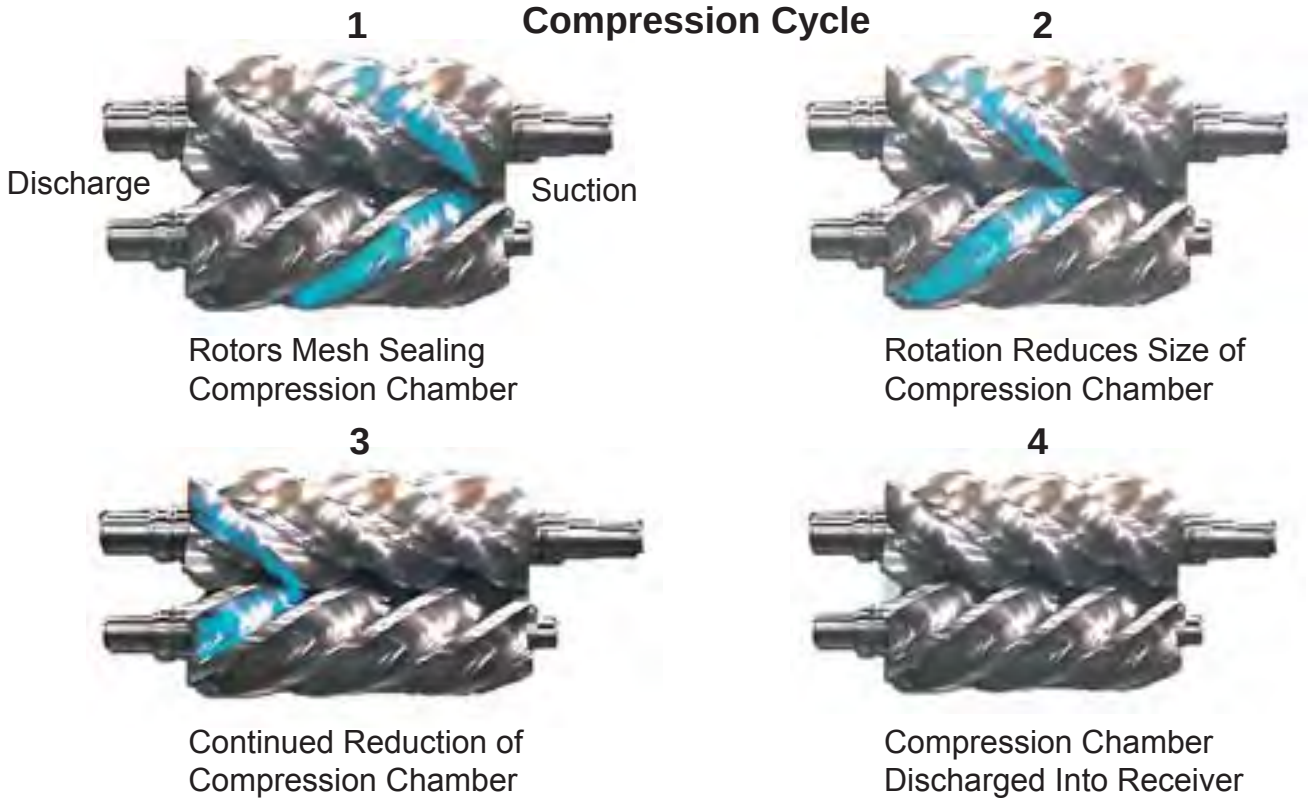


Fig. 4-12 2 Stage Rotary Screw Cycle

The high pressure compressor is a 2 stage positive displacement, ood lubricated type rotary screw air compressor.

As the rotors turn, air is drawn axially into the compressor when the rotors turn past the Intake port in the rst stage. At this point, the air is trapped between the rotor lobes and the Compressor housing. With the rotors turning, the lobes reduce the volume in the cavities, compressing the trapped air where it is then discharged into the second stage. This process happens again in the second stage of the compressor, where the air is further compressed to obtain a higher pressure.

NOTE: **Each Sullair rotary screw compressor uses oil as a lubricant/coolant medium (mineral or synthetic). Due to the many types of oil used in the marketplace, this manual will refer to oil as “fluid”.**

Fluid is injected into the compressor unit at each stage and mixes directly with the air as the rotors turn, compressing the air. The uid ow has three main functions:

1. As coolant, it controls the rise of air temperature normally associated with the heat of compression.
2. It seals the leakage paths between the rotors as well as between the rotors and stator.
3. It acts as a lubricating lm between the rotors allowing the male rotor to directly drive the female rotors, which are idlers.

After the air has been compressed in both stages of the compressor unit, it is discharged in the form of an air/ uid mixture. This mixture is routed through the discharge system where the uid is separated from the air. At this time the air ows to the service line and the uid is directed through the cooling and lubrication system in preparation for reinjection.

Compressor Operation

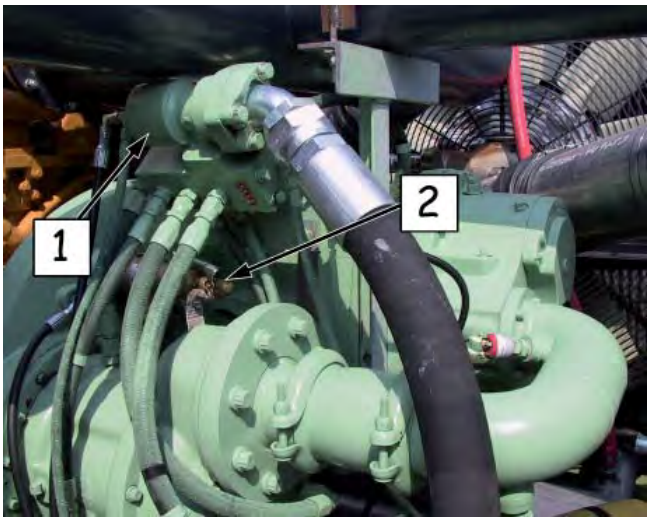


Fig. 4-19 1150/350 High Pressure Compressor

1. Fluid Stop Valve
2. Pressure Relief Valve (Compressor) (150psi)

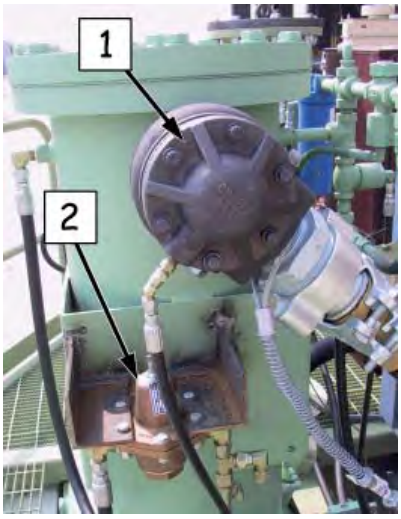


Fig. 4-20 Air/Oil Receiver Tank

1. Minimum Pressure Valve
2. Regulator for Dust Collector & Bit Lube System set @ 125psi (8.6 bar)

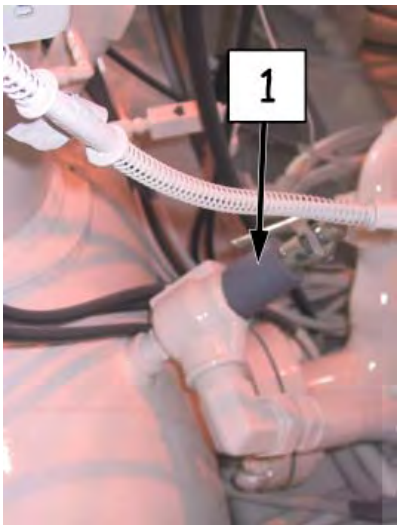


Fig. 4-21 Air/Oil Receiver Tank

1. Pressure Relief Valve (Fluid Sump) (400psi)

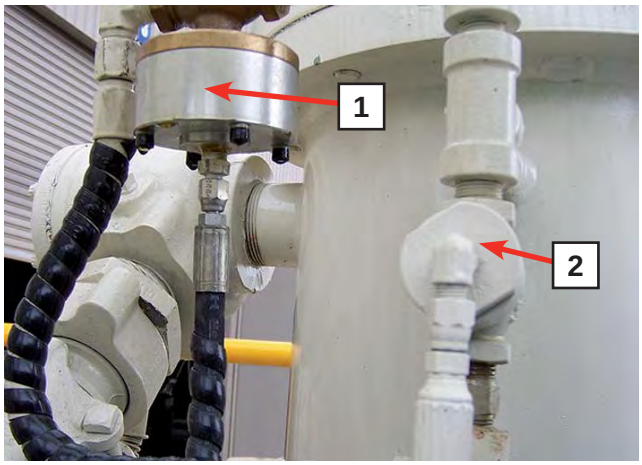


Fig. 4-22 Air/Oil Receiver Tank

1. Running Blowdown Valve
2. Shutdown Blowdown Valve

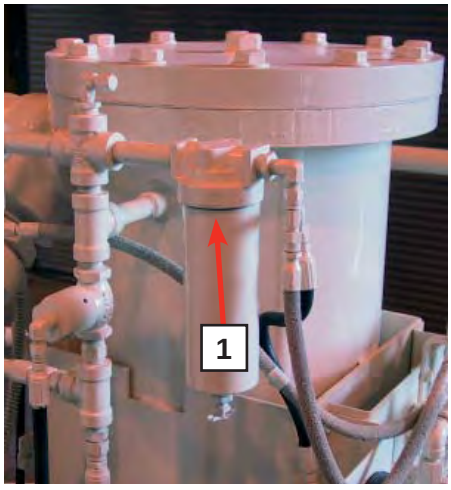


Fig. 4-22a Air/Oil Receiver Tank

1. Moisture Separator

Compressor Maintenance

Installation of Dust Shield, Gasket and V-Rings

1. Lightly coast inside of v-rings (S10) with lubricant provided in shaft seal lube kit. adjust inner v-ring (S10) axially with lip of ring facing out, to obtain a dimension of .10" from the face of the seat retainer (S1), (see item 2 in gure 4-1).
2. Install dust shield gasket (S8) using the six 1/4" capscrews (S16). Torque to 11 ft-lbs or 1.5 kg-M.
3. Install outer v-ring (S10) with lip toward dust shield gasket (S8) and continue to slide onto the shaft until compressed to .35" dimension. See gure 4-1

NOTE: Inner v-ring must NOT touch the seat retainer (S1).

Interstage Tube

Flexible Pipe Coupling Maintenance

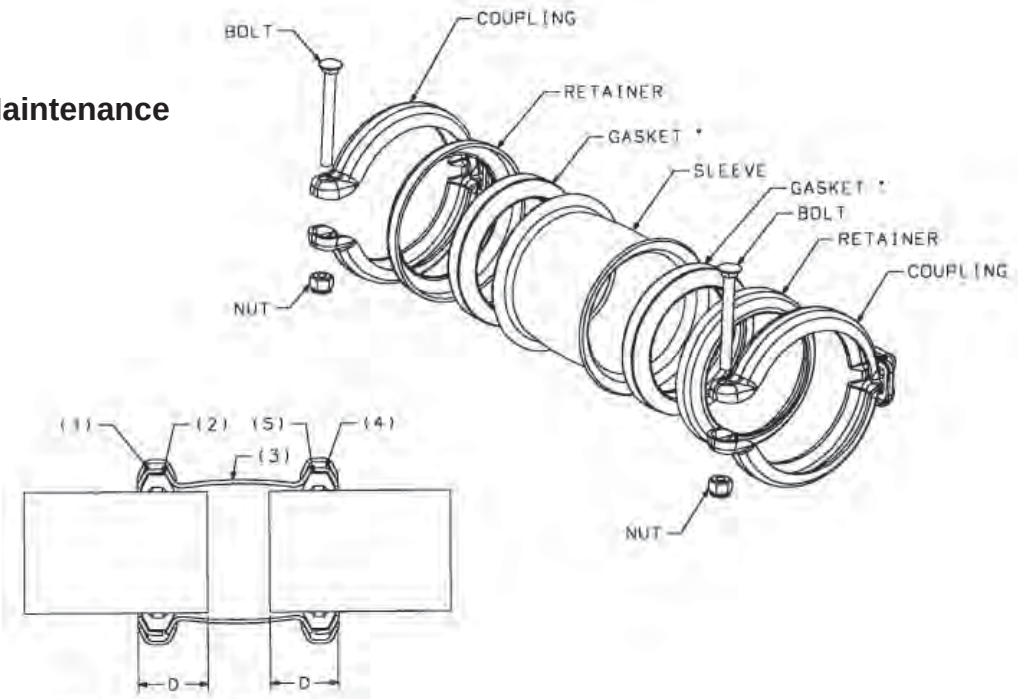


Fig. 4-31 Flexible Pipe Coupling

Pipe Size	Insertion Dept (D) Min.	Max.	Torque
3.5" (88.9mm)	1.70" (43.2mm)	2.40" (61mm)	180 to 200 in.-lbs (20.3 to 22.5Nm)

(1) Tighten as shown in chart or optionally of 1/2" (12.7mm) clearance between coupling lugs, whichever comes first.

Coupler Installation

1. Install both couplings as shown, encompassing the retainer, gasket and sleeve. DO NOT tighten either coupling until the entire joint has been assembled.
2. Tighten the nuts to the torque value shown in Table 2. RECOMMENDED ASSEMBLY TORQUE MUST BE MAINTAINED. Retightening of the coupler will be necessary if leakage occurs.

Special Notes

1. Assembly of the gaskets can be made easier by dipping the gaskets in water or the uid to be sealed. DO NOT USE THE RUBBER LUBRICANTS.
2. Flexible joints are not intended to support end loads caused by internal pressure or other forces causing pipe separation.

Compressor Maintenance

Compressor Fluid Filter

Routine Maintenance

Compressor Filters do not normally require special attention, other than visual inspection for uid leaks or Warnings displayed via the Vigilante.

1. If external leakage is noted at uid lines to the lter, replace o-ring at leak. For bowl seal leaks, check tightness of bowl tab nut (over tightening of tab nut will NOT stop uid leaks due to faulty bowl O-ring), check/replace the bowl O-ring if faulty. If leakage persists, check sealing surfaces for scratches or cracks; replace any defective parts.
2. A differential pressure device pops up red when the element requires changing. The indicator may pop up when using the machine before the hydraulic oil has reached operating temperature. Reset the indicator if this happens.

Fig 4-51

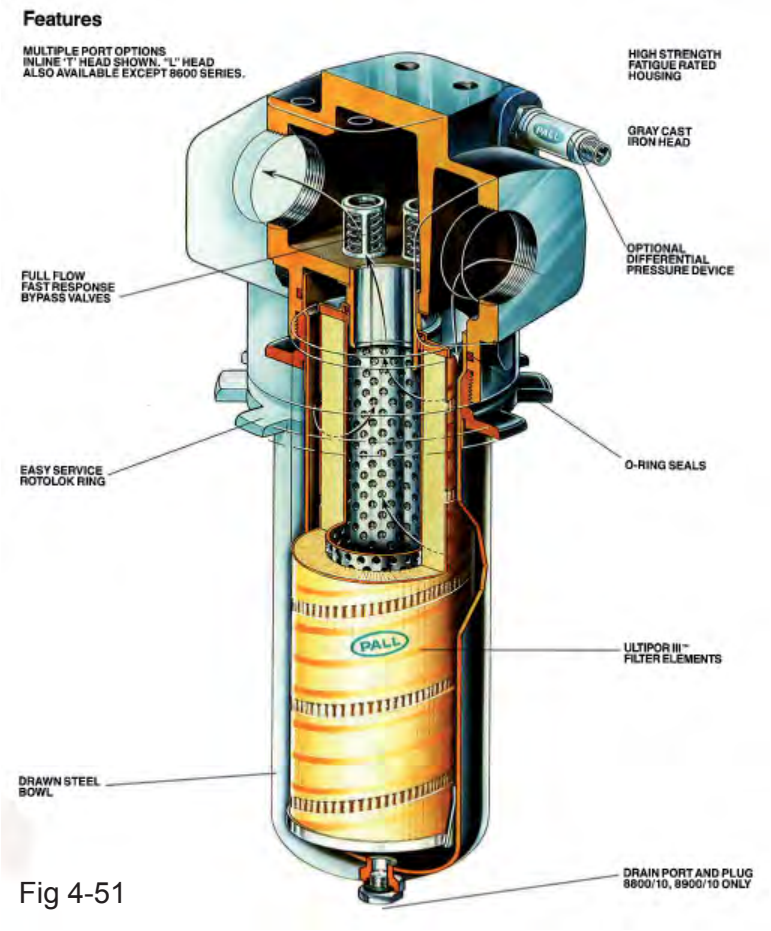


Fig 4-51

Fig 4-52 Bypass check valves (4)

NOTE: **When filter element is changed, it is important to check that all four (4) Bypass check valves are in place.**

This is done by looking up into the Filter head from the underneath side once the filter bowl and element have been removed.

Inspect/check all four (4) by-pass valves in housing for cracks, chips or damage.

There must be a by-pass check in all four (4) ports, if missing and the port is open then there will be no filtration occurring of the compressor fluid.

Compressor Maintenance

Running Blowdown Valve

This 2-way normally closed (N.C.) valve is piloted open by the system pressure regulators. The Blowdown Valve opens when the regulator pressure is reached and the air volume drawn through the closed inlet is vented to atmosphere.

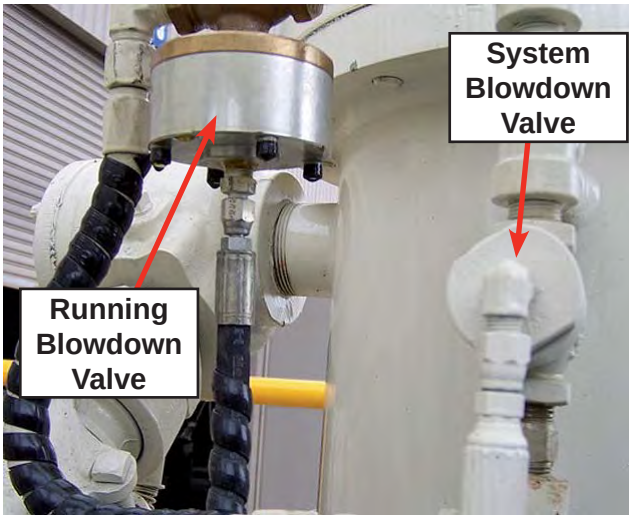


Fig. 4-63

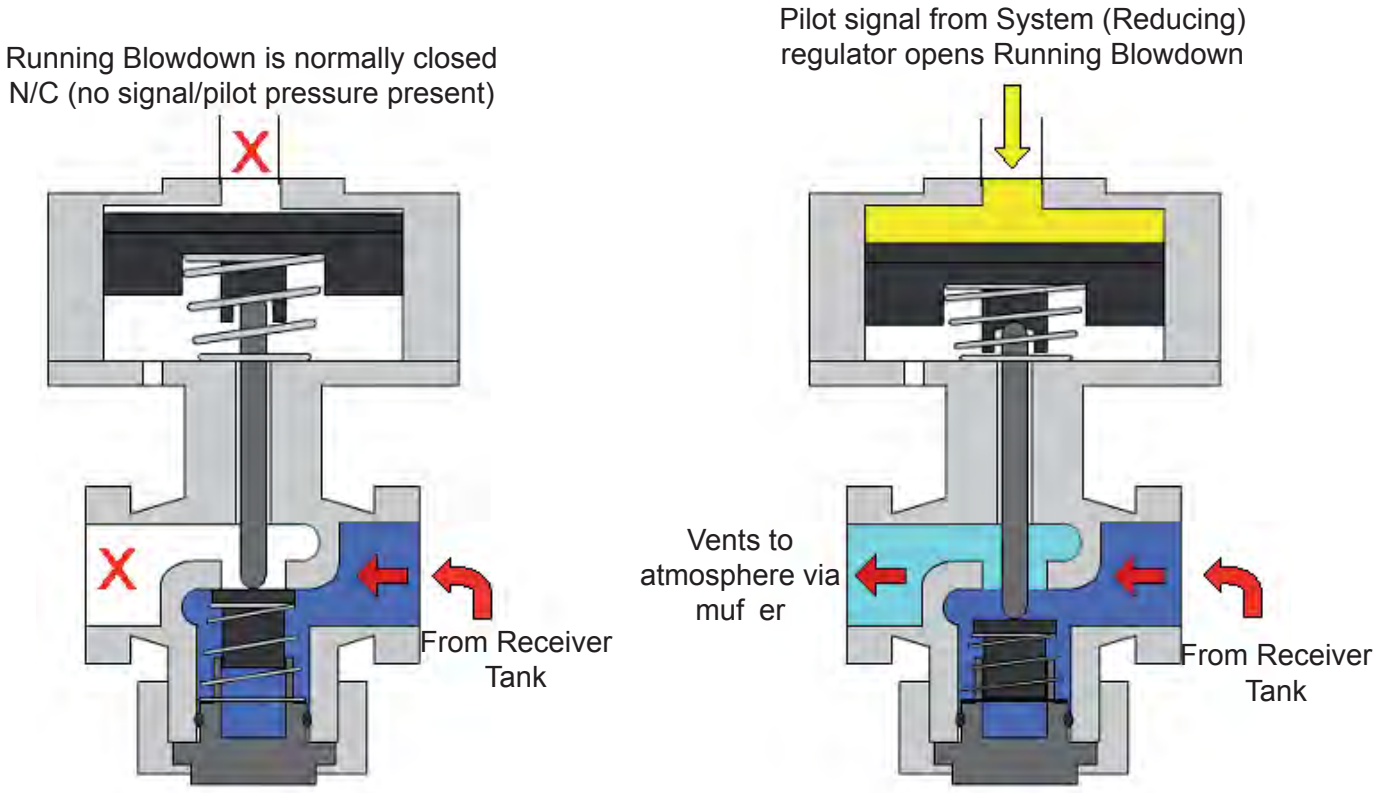


Fig. 4-65 Running Blowdown Valve Operation

If the valve fails to vent at all, check:

- Gland nut has not unscrewed and is tight
- Cup seal is clean and in good condition (not by-passing) through Tell-Tale vent

If the valve continuously vents check:

- The O-ring is OK on the poppet assembly (check body surface also)
- The spring is not broken

Radiator / Oil Cooler Repair

2

MAY 1997

CONTENTS

MESABI® Radiator Cores

DO NOT VOID WARRANTY. CONTACT L&M's CUSTOMER SERVICE DEPARTMENT PRIOR TO REPAIRS WHERE WARRANTY IS A POSSIBILITY.

MESABI® RADIATOR AND CORE 48-MONTH WARRANTY

L&M Radiator warrants the MESABI® Core and framework manufactured by L&M for a period of 18 months from date of invoice. Under this warranty, our obligation is limited to the repair or replacement (at our option) of products or parts manufactured by L&M that are proven to be defective in workmanship or material. L&M further warrants the MESABI® Core against seal leakage during normal use for 48 months from date of invoice on new cores with MESABI® fluorocarbon seals installed. Damage or leakage due to accidents, misuse, or corrosion is not warranted.

Warranty on components not manufactured by L&M Radiator shall be that of the individual manufacturers. Individual manufacturers operational and maintenance requirements must be met and their policies regarding shipment and inspection of claimed defective parts will apply.

L&M is not liable for consequential or incidental damages or costs. Consult factory before proceeding with warranty claims. This warranty supersedes all previously published warranties.

Models CSC 350 and CSC 500

Repair Instructions:
External Cleaning and Tube Removal

HELPFUL HINTS:

- Read this manual thoroughly
- Work in a clean environment
- Good Lighting is a must
- Use the proper tools and lube
- Call L&M customer service with questions

EXTERNAL CLEANING —

MESABI Aluminum Tube Air to Oil Cooler

To maintain efficiency and assure maximum life of a MESABI Aluminum Tube Oil Cooler, reasonable care must be taken when cleaning.

In some cases it may be best to blow out any dry dirt with shop air prior to washing core with the high pressure hot water washer. If there is any doubt about the cleaning method to be used, try the method on a portion of a single tube first, or contact an L&M manufacturing facility.

For general external cleaning, a high pressure hot water washer up to 1500 PSI can be used. Unlike conventional cores, you can and should get right up next to the core with the wand. Starting from the air exit side, place the high pressure washer nozzle next to the fin, concentrating on a small area, slowly working from the top down. Make sure you spray straight into the core, not at an angle. Continue washing until the exit water is free of dirt. Repeat from the opposite side.

Many radiator shops use a hot alkaline soap or caustic soda in their boil-out tanks with chemical additives. Soaking in high pH solutions may damage the aluminum alloy, depending on the exact characteristics of the solution. Solutions that are either too alkaline (pH>9.0) or too acid (pH<5.0) are not recommended.

Tube Stabilizer Bar Removal —

If your system was provided with tube stabilizer bars, remove them at this time.

Removing MESABI Tubes —

After a thorough cleaning as described above, blow dry the core section, then remove tube retainer from top portion of tube as shown in **Fig. 1**.

NOTE: Remember the proper orientation of the retainers and three cupped washers for reinstallation later.

With Installation Tool No. 42146, grasp center portion of tube as shown in **Fig. 2**. Rotate the tool so as to break the tube free from the seal, then raise the tube only enough to clear the lower header plate and swing tube out just far enough to allow tube to be pulled down and out of the upper header plate, as shown in **Fig. 3**

Remove all tubes in the row, repeating the above procedure.

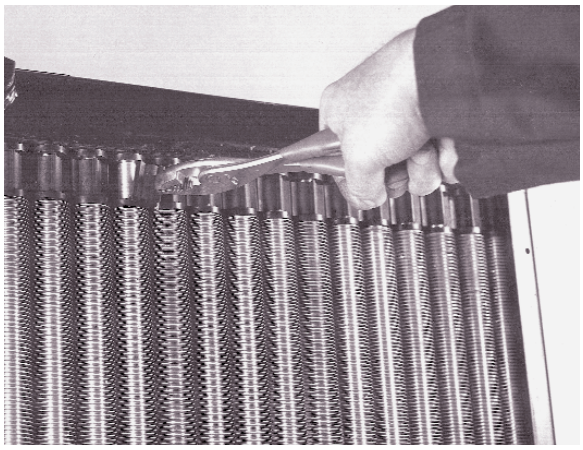


Fig. 1

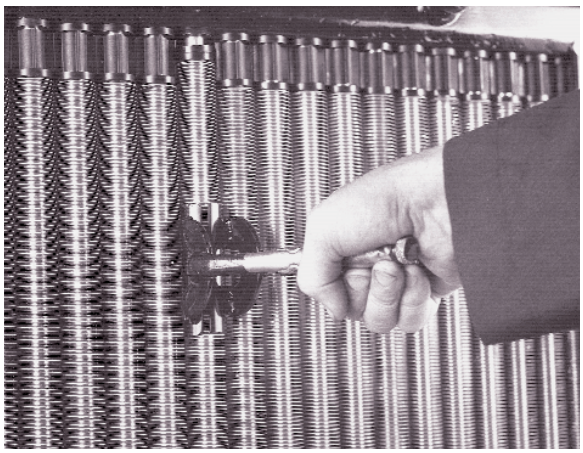


Fig. 2

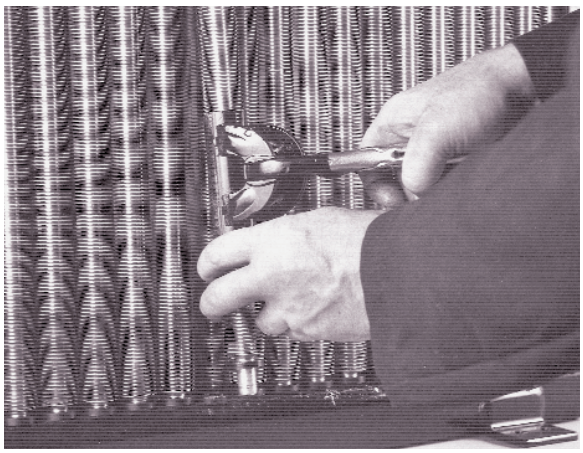


Fig. 3

Water Pump

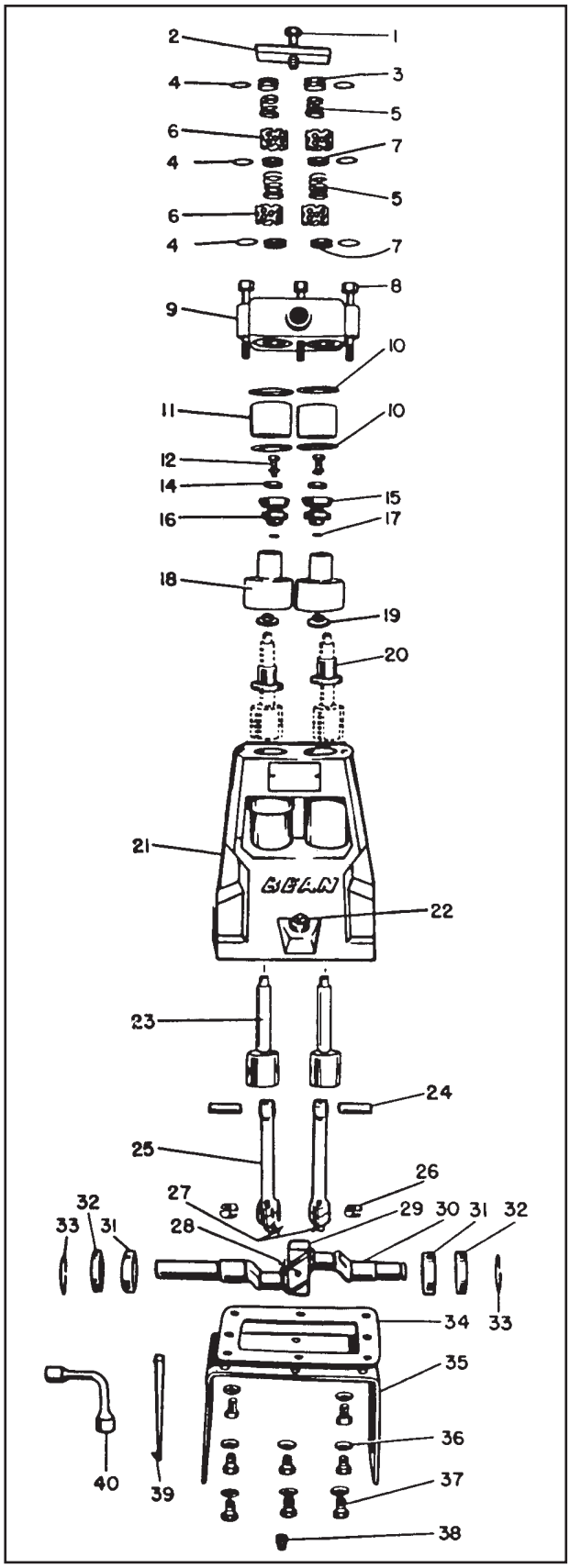


Fig. 5-4 Water Injection Pump (ref. 87252)

Item No.	Description	Qty.
1	Hex Capscrew, 1/2"-13 x 1-1/2	1
2	Clamp, Valve Cover	1
3	Valve Cover	2
4	O-Ring, 1-3/16" OD	6
5	Spring & Disc	4
6	Valve Cage	4
7	Valve Seat	4
8	Hex Capscrew, 3/8"-16 x 5"	3
9	Valve Chamber	1
10	Gasket Cylinder	4
10A	Ring Seal	2
10B	O-Ring	2
11	Cylinder	2
12	Capscrew, 5/16"-18	2
14	Packing Washer	2
15	Packing	2
16	Packing Holder	2
17	O-Ring, 3/4" OD	2
18	Umbrella	2
19	Washer, Umbrella	2
20	Sleeve, Crosshead	2
21	Case, Pump	1
22	Pipe Plug, 3/4"	1
23	Crosshead	2
24	Wrist Pin	2
25	Connecting Rod Assembly	2
26	Bearing Insert, Con. Rod	4
27	Machine Screw, #10-24 x 1/2"	2
28	Speed Nut	1
29	Oil Slinger	1
30	Crankshaft	1
31	Bearing	2
32	Oil Seal	2
33	Snap Ring	2
34	Gasket, Pump Base	1
35	Mounting Base, Pump	1
36	Cup Washer, 3/8"	6
37	Capscrew, 3/8"-16 x 3/4"	6
38	Pipe Plug, 1/4"	1
39	Valve Seat Remover	1

START UP CHECKLIST

How to Start A Pump

Always take special precautions when starting a pump for the first time or after any extended shutdown. Never assume that someone else has properly prepared the pump and system for operation. Always check each component of the system prior to every start-up.

The checklist that follows is intended to be a general guide for starting a pump in a typical installation. Every installation is different, and each will have different requirements to insure safe and successful operation. It is the responsibility of the operator to determine the correct start-up procedure for each installation.

1. Insure that the drain plug on the bottom of the pump crankcase has been installed and is tight. If the pump is equipped with a sight-glass to monitor the crankcase oil level, insure that it has been properly installed.

2. Check the oil level to insure that the pump is properly filled and that the oil has not been contaminated with water or other liquids. FMC pumps are not shipped with oil in the power frame and must be filled with the proper grade of oil prior to start-up. The A04 pump requires 1 quart (.95 liters) of oil. Use the chart provided on page 9 for help in selecting the correct type of oil for your service.

3. Insure that the pressure relief valve and all accessory equipment have been installed and properly adjusted and that all joints are tight.

4. Open suction line valve to allow fluid to enter pump.

5. Check to insure that power is off. Turn the pump over by hand to insure free, unobstructed operation.

6. Make sure that all guards are in place and secure. Verify that all personnel are in safe positions and that system conditions are acceptable for operation.

7. Start the pump. Whenever possible, use a bypass line for the flow to allow the pump to start in an unloaded condition (no back pressure). Slowly close the bypass line to bring the pump into full load conditions. Shut down immediately if flow becomes unsteady, pressure fluctuates, or if unusual sounds or vibrations are noted.

Trouble-Shooting Piston Pumps

This chart is designed to aid in the solution of pump and pump system problems. Once the problem has been identified, work through the possible causes and solutions until the problem has been corrected.

1. No flow from pump

- Tank is empty
- Inlet valve is closed
- Inlet strainer is clogged with debris
- Crankshaft is not turning

2. Insufficient pressure from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Oversize or worn nozzle on equipment
- Worn pump valves
- Excessive leakage from pump seals

3. Insufficient flow from pump ONLY

- Pump speed is too slow
- Relief valve improperly adjusted and by-passing fluid
- Worn pump valves
- Excessive leakage from pump seals

4. Insufficient flow OR pressure AND rough operation

- Valve problem:
  a. Pump valve stuck in open or closed position
  b. Valve assembly is damaged or unseated
  c. Valve seat is washed out
- All pump cylinders not primed
- Inlet strainer is clogged with debris
- Excessive gas in liquid due to:
  a. Air leaks in suction line or fittings
  b. High spots in suction line that allow formation of gas pockets
  c. Vortex in tank near inlet pipe opening
- Pump is cavitating due to:
  a. Insufficient NPSHa (tank head or charge pressure)
  b. Fluid viscosity is too high
  c. Inlet line is too long and/or too small diameter

Water Pump Motor

Shaft Seal Repair

5. Install 49 mm [1.937 in.] I.D. seal in ange.

6. It is recommended to apply a light coat of Loctite Primer NF in tapped holes of housing. Allow primer to air dry for at least 1 minute. Do not force dry with air jet; the primer will blow away.

   Use of primer is optional. With primer, Loctite curing time is approximately 15 minutes. Without primer curing time is approximately 6 hours.

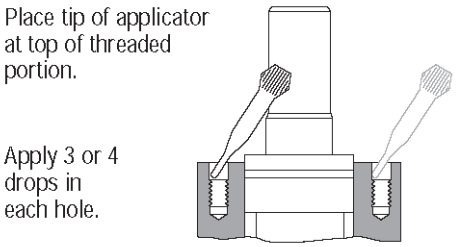


Figure 13

7. Apply 3 or 4 drops of Loctite sealant at top of thread for each of four holes in housing (see Figure 13). Do not allow parts with Loctite applied to come in contact with any metal parts other than those for assembly. Wipe off excess Loctite from housing face, using a nonpetroleum base solvent.

Do not apply Loctite to threads more than 15 minutes before installing screws. If housing stands for more than 15 minutes, repeat application. No additional cleaning or removal of previously applied Loctite is necessary.

8. Before installing ange and seal assembly over shaft, place protective sleeve or bullet over shaft. Then lubricate space between exclusion seal and pressure seal, as well as lips of both seals (see Figure 14).

Install ange. Rotate ange slowly while pushing down over shaft. Be careful not to invert or damage seals.

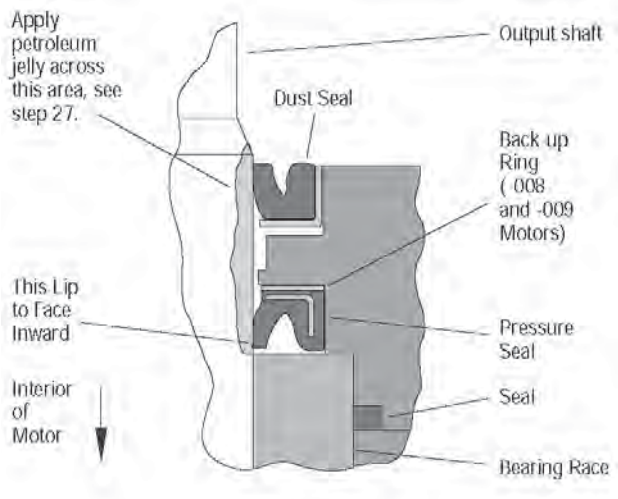


Figure 14

Hoist/Pulldown Cable Adjustment

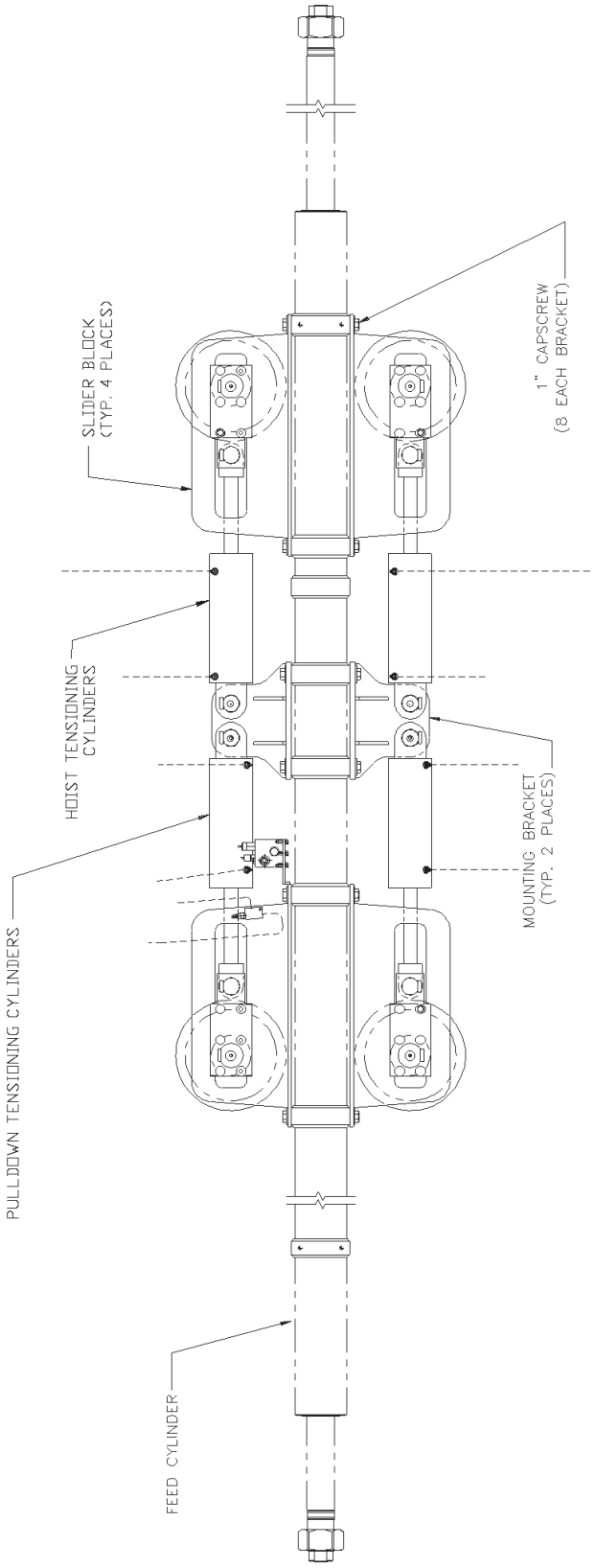


Fig. 6-1a Cable Tensioning Assembly (ref. 416114)

Rotary Drive Assembly

Rotary Drive - Removal from Mast

WARNING: BE SURE to relieve pressure on hydraulic or pneumatic systems before loosening connections or parts.

1. Remove drill pipe from rotary drive and lower rotary drive to bottom of mast.
2. Remove sub-adapter or shock sub from rotary drive shaft. You will have to grind the weld from the two chock bars (item 5, fig. 6-6b) before removing.
3. Cut off top stop blocks from slide weldments
4. Remove air connection (and air swivel if equipped) from rotary drive gearbox.
5. Tag and remove hydraulic hoses from rotation motor. Cap or plug all open fittings. Remove rotation motor. Weight of motor is about 140 lbs. (63 kg).
6. Support rotary gearbox with suitable lifting device in two places. Weight of gearbox is about 1560 lbs. (708 kg.). Cut lockwires (19) and remove the six capscrews (11) per side that hold gearbox to mast guides. Carefully slide gearbox forward to clear upper and lower stop blocks and be certain gearbox is properly balanced, then lift clear of mast.

Rotary Drive - Installation

1. Hoist rotary drive into position with suitable lifting device. Align unit between upper and lower stop blocks and slide into mast. Align the six bolt holes in the rotary drive with the holes in the right and left mast guides.
2. Install the six capscrews (11) and hardened washers (15) on each side and torque to 297 ft. lbs. (404 Nm). Install lockwires (19) as shown in fig. 6-6b. Order lockwire from parts book, or use 16 ga. stainless steel wire, type 304.

WARNING: BE SURE to install lockwires correctly, as per drawing.
NEVER reuse lockwires.
INSPECT lockwires daily to be sure none are broken or missing.

3. Weld stop blocks to slide weldments.
4. Install air swivel (if equipped) and air hose to rotary drive gearbox. Install rotation motor (22) along with all hoses and any other connections that were removed.
5. Start machine and check that rotary drive functions properly and there are no leaks. Install sub adapter or shock sub and tighten joint. Weld new chock bars (5) in place according to fig. 6-6b.

NOTE: Ensure Upper and Lower stop blocks are in contact with the Rotary Head. Shim or replace stop blocks if required.

Cotta Service	Repair Manual	Cotta Service

SYMBOL EXPLANATION

ATTENTION

You will find this symbol in this Repair manual on passages, which require your special attention!

NOTE: **NOTE**

You will find this in this Repair manual on passages, which include a note concerning the disassembly and reassembly sequence!

Rotary Drive Gearbox

Cotta Service	Repair Manual	Cotta Service

Fig.13

Loosen hex head screws (12 pcs.) and cap screws (3 pcs.).
Remove Gearbox cover using jack screws and hoist.

Gearbox cover must be brought up evenly!

Note: Output bearing cone will come off with cover.

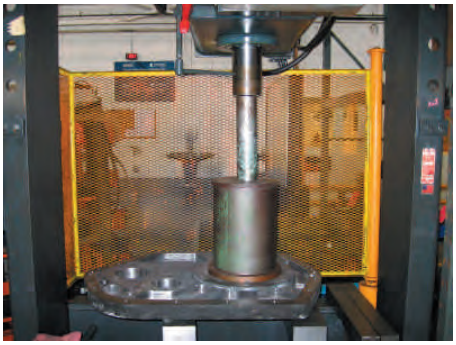


Fig.14

Remove output bearing cup and from cover.

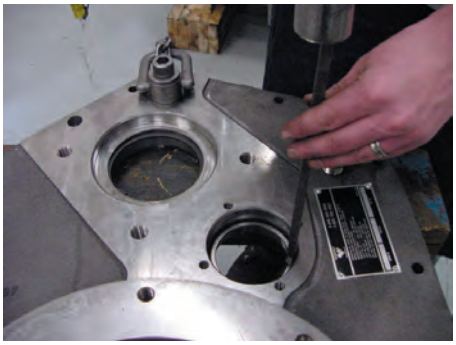


Fig.15

Remove bearing cup from intermediate bore.

Fig.16

Remove snap ring from input shaft bore.

Fig. 25

Install roll pins (2) fixing the gearbox halves.

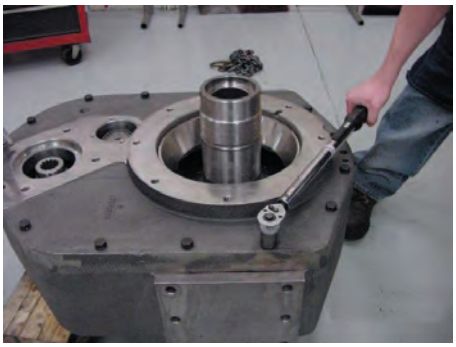


Fig. 26

Wet cap screws (3) and hex head screws (12) with sealing compound.(Loctite no. 242)
Screw in cap screws, and hex head screws with lock washers, and tighten firmly.

Torque limit (1/2 x 13)……73 ft. lbs.

Note: Replace lock washers at each assembly.

Fig. 27

<u>Output shaft bearing Assembly:</u>

Wet bearing cup with oil and install output bearing cone onto shaft.

Note: It is important to insure the gearbox is level and square to the output shaft when installing this bearing cone to insure it seats down fully into the cup.

Fig.28

Install first locking nut onto the output shaft and tighten per the following procedure found on the Assembly drawing.

Set preload to .002 / .004 per the following instructions: Tighten locknut enough to achieve .000 end play. Rotate locknut 1/64 to 1/32 turn. (5.625 deg. / 11.25 deg.)

Fig. 62

Wet outer surface of seal with spirits.
Install 2nd part of seal into Gearbox case until contact is obtained.

Fig. 63

Apply a thin film of clean oil to the 2 steel surfaces of the seal.

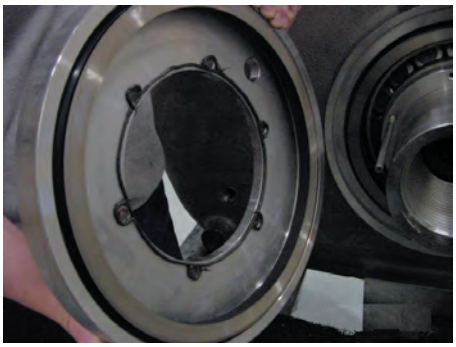


Fig. 64

Cover mounting surface of seal plate with RTV (Loctite no. 598)

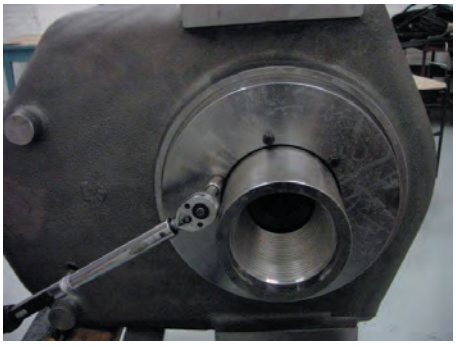


Fig. 65

Wet hex head bolts with sealing compound. (Loctite no. 242)
Assemble seal plate to spacer and screw in hex head screws and lock washers. and tighten firmly.

Torque limit (3/8 x 16)……28 ft. lbs.

Winch Assembly

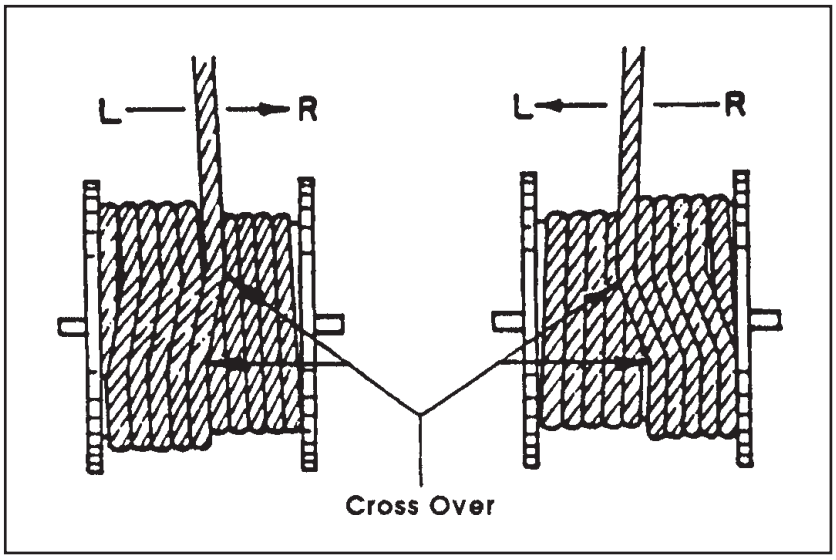


Fig. 6-11 Wire Rope Cross-Over

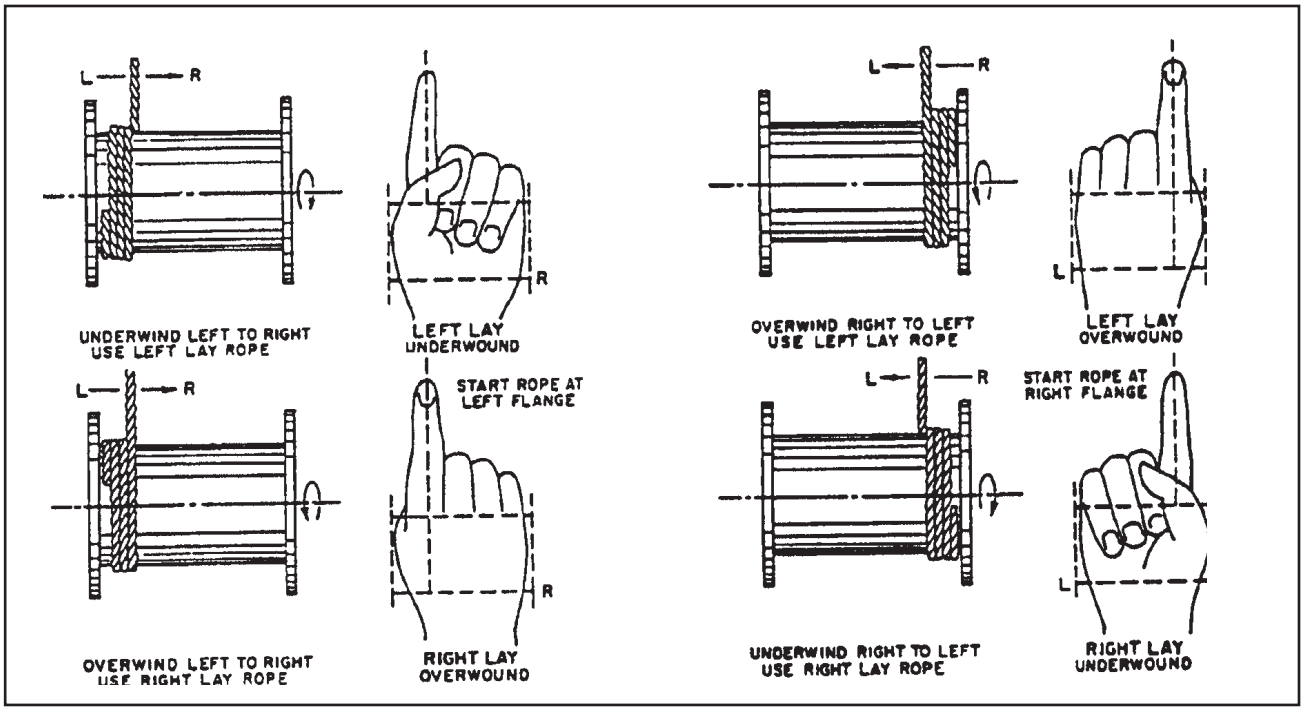
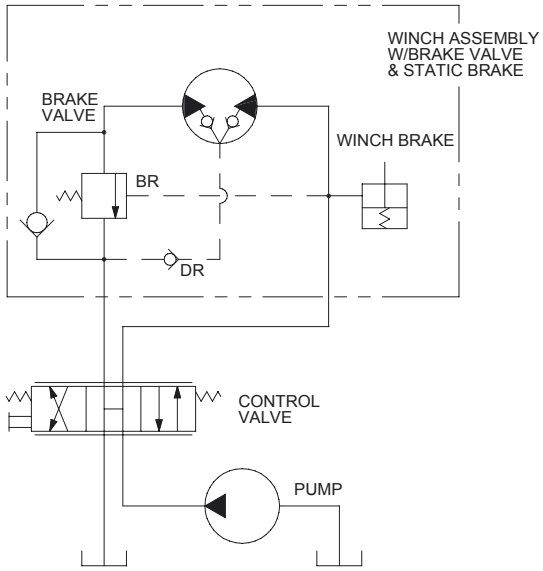


Fig. 6-12 Diagram showing how to determine wire rope "lay"

Hydraulic Winch



7. The winch directional control valve must be a three position four way valve with a motor spool such that when the valve is in the center position both work ports are open to tank (open center, open port).

8. High quality hydraulic oil is essential for satisfactory performance and long hydraulic system component life.

   Oil having 150 to 330 SUS viscosity at 100°F (38°C) and viscosity index of 100 or greater will give good results under normal temperature conditions. The use of an oil having a high viscosity index will minimize cold-start trouble and reduce the length of warm-up periods. A high viscosity index will minimize changes in viscosity with corresponding changes in temperature.

   Maximum cold weather start-up viscosity should not exceed 5000 SUS with a pour point at least 20° F (-7° C) lower than the minimum temperature.

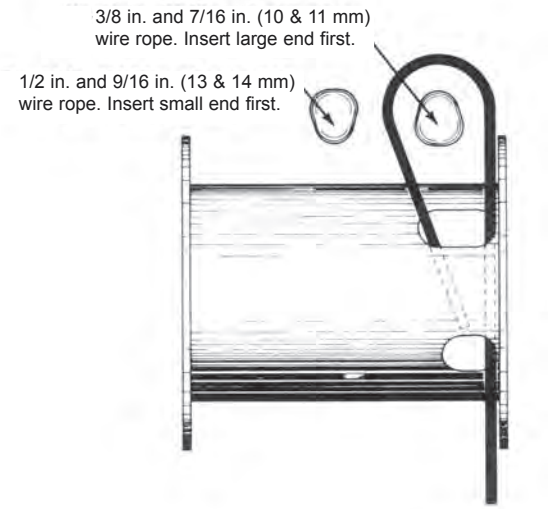
   Under continuous operating conditions the temperature of the oil at any point in the system must not exceed 180° (82°C). Optimum oil temperature is generally considered to be 120-140°F (49-60°C).

   In general terms; for continuous operation at ambient temperatures between 50 and 110°F (10 to 43°C) use SAE 20W; for continuous operation between 10 and 90°F (-12 to 32°C) use SAE 10W; for applications colder than 10°F (-12°C), contact the BRADEN Service Department. The use of multi-viscosity oils is generally not recommended.

9. The hydraulic oil filter should have a 10 micron nominal rating and be full flow type.

A regular program of preventive maintenance for your

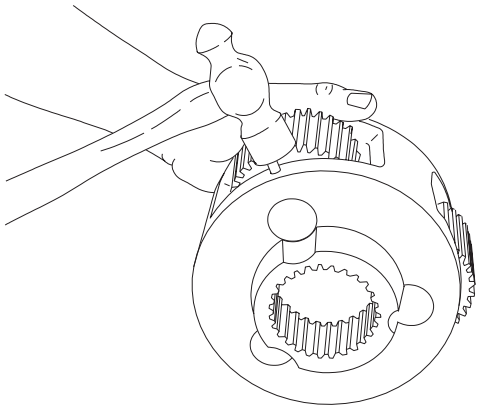
WIRE ROPE INSTALLATION



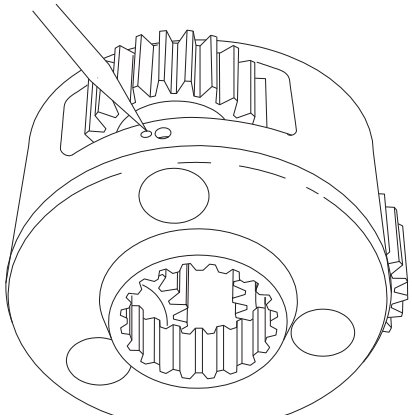
NOTE: Standard cable anchor or wedge shipped with the winch will anchor 3/8 to 9/16 in. wire rope (Part No. 74780). For 1/4 and 5/16 in. wire rope, use Part No. 24119. For 5/8 and 3/4 poly rope ONLY, use Part No. 26095.

Take the free end of the wire rope and insert it through the small opening of the anchor pocket. Loop the wire rope and push the free end about 3/4 of the way back through the pocket. Install the wedge, then pull the slack out of the wire rope. The wedge will slip into the pocket and secure the wire rope into the drum. The anchor is designed to accommodate several different sizes of wire rope. You may anchor 3/8 in. and 7/16 in. (10 & 11 mm) wire rope by inserting the wedge, large end first. 1/2 in. and 9/16 in. (13 & 14 mm) wire rope may be anchored by inserting the wedge, small end first.

Hydraulic Winch



3. Carefully align the pin hole in the carrier with the hole in the planet gear shaft and drive the roll pin into place. Always use NEW roll pins.



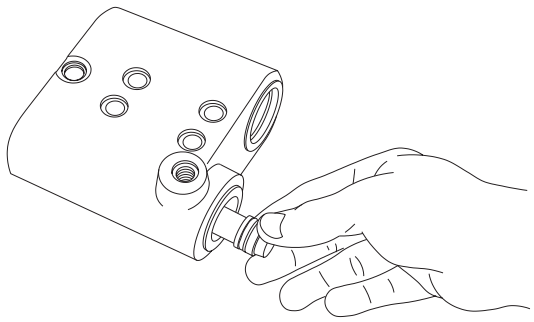
4. Note that the roll pin is slightly recessed in the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole so the pin will not back out. Repeat these steps for each of the three planet gears.

PRIMARY PLANET CARRIER

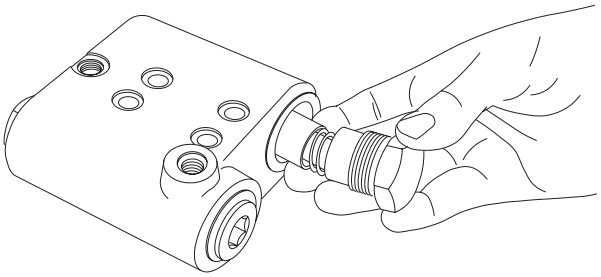
1. To service the primary planet carrier, the steps are the same as for the output carrier except there is only one bearing for each gear and no bearing spacer.

NOTE: All BG8 winches have a round thrust plate between the primary and output sun gears. In winches with a 23:1 ratio, the plate is not contained in the primary planet carrier. In all other ratios, the thrust plate is captive in the carrier assembly.

Hydraulic Winch



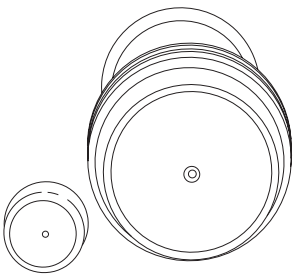
4. Remove spool plug and carefully remove spool assembly.
5. Remove the damper piston from the spool. The piston will come out slowly, because of a partial vacuum formed as it is removed. Use extreme care to avoid damaging the polished surfaces of the piston or spool.



6. Remove the check valve spring retainer, spring and check valve poppet. Check spring free length. Replace spring if less than 1-1/2 in. (38.1 mm) long.

CLEAN AND INSPECT

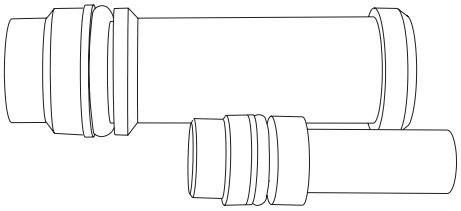
1. Discard all O-rings and back-up rings. Clean all parts in solvent and blow dry. Inspect polished surfaces of spool and damper piston for damage that may cause binding or leakage. Inspect spool bore in valve housing for damage or scoring. Inspect check valve seat in valve housing and check valve poppet. If the spools, bores or valves are damaged, the entire valve must be replaced as these parts are not serviced separately.



2. Inspect the .020 inch orifice in the end of the spool and the pilot orifice to be certain they are open.

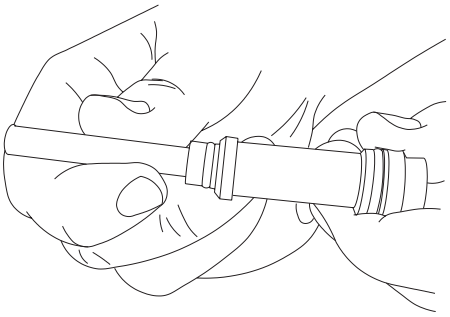
ASSEMBLY

1. Install new O-rings on the plug and spring retainers.



2. Install new O-rings and back-up rings on the spool and damper piston as shown. It is important that each back-up ring is on the correct side of its O-ring. Take care not to cut the O-rings during assembly. Let the spool and damper piston set for ten minutes before installing them in their respective bores. This will allow the O-rings to return to their original size after being stretched.

3. Lubricate the spool and damper piston O-rings with hydraulic oil. Carefully install the damper piston into the spool.



4. Lubricate the spool bore and spool O-rings with hydraulic oil. Carefully install the spool into the valve housing. Always install the spool from the plug end as shown to minimize the possibility of damaging the O-ring. Install the plug, spool spring and spring retainer.

5. Install the check valve poppet, spring and check valve spring retainer.

6. Install the motor drain check ball, spring and elbow fitting.

7. Install the pilot orifice into the valve housing.

8. The brake valve is complete and ready to be installed on the winch motor.

Carousel Pipe Rack

Carousel Top Tube Bearing - Replace

1. With mast in horizontal position and all pipe removed as described previously, support top tube (3) and carousel pipe support (2) with a suitable lifting device.
2. Mark position of top tube at the joint. Separate the top tube from the carousel pipe support by removing the six capscrews (71) at the joint (fig. 6-20).
3. Remove the safety wire (22), four capscrews (32) and flat washers (43) that hold the end cap (8) to the mounting plate. Remove top tube with end cap.
4. Drive the bearing (14) out of the end cap (8). There is a lip on end cap at top where it bolts to the mounting plate, so the bearing must be driven out the bottom.
5. Install new bearing into end cap. Clean upper portion of top tube and apply grease to tube and bearing before installation.
6. Hoist top tube into position with end cap and bearing installed. Line up mark made before disassembly and install all capscrews, but do not tighten.
7. Tighten all capscrews and torque to standard specifications. Install new safety wire (22) on the end cap capscrews (32).

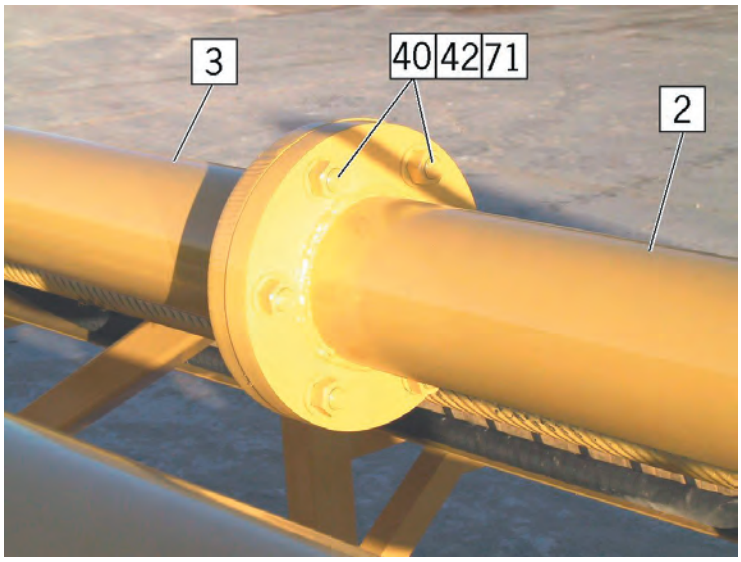


Fig. 6-20 Top Tube & Carousel Support
2. Carousel Support
3. Top Tube
40. Nut (6)
42. Hardened Washer (6)
71. Capscrew (6)

Hydraulic Symbols

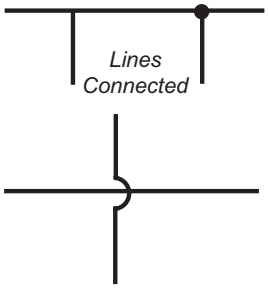
BASIC BUILDING BLOCKS HYDRAULIC SYMBOLS

Working Line

Pilot Line

Drain Line

Enclosure Line



Lines Connected

Lines Crossing

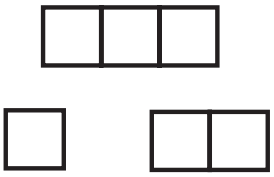
Flexible Line

Vented reservoir

Sealed Reservoir

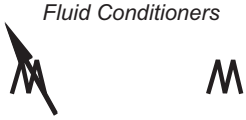
Arrows show Adjustability, Variabilty or Direction of Flow

Circles or Partial Circles Indicate Pumps or Rotary Actuators



Squares or combinations of Squares indicate Valves

Fluid Conditioners

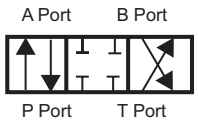


Springs

An arrow thru the spring indicates an adjustment

DIRECTIONAL VALVE SYMBOLS

3 POSITION – 4 WAY VALVES



Closed Centre Closed Port (Cylinder Spool)

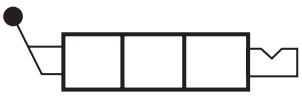
Closed Centre Open Port (Motor Spool)

Open Centre Closed Port

Open Centre Open Port

Lever Actuated Spring centred

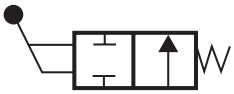
Direct Solenoid Actuated Spring Centred



Lever Actuated Neutral Detent

Pilot Actuated Spring Centred

2 POSITION – 1 WAY VALVE



Spring Offset Normally Open

2 POSITION – 4 WAY VALVE

Spring Offset Pilot Actuated

Spring Offset Solenoid Actuated

Dentented Lever Actauted

Right Track, Left Track/Rotation Pumps

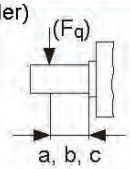
Technical Data

AA4VG Specifications *(Theoretical values; rounded)*

Size					40	56	71	90	125	180
Displacement	Variable pump		$V_{g\,max}$	cm^3/rev	40	56	71	90	125	180
				in^3/rev	2.44	3.42	4.33	5.49	7.63	10.98
	Charge pump		V_{gH}	cm^3/rev	8.4	11.1	18.7	18.7	25.7	36.9
				in^3/rev	0.51	0.68	1.14	1.14	1.56	2.25
Speed	max. rpm at $V_{g\,max}$		$n_{max\,cont}$	rpm	4000	3600	3300	3050	2750	2400
	limited max. rpm ①		$n_{max\,limit}$	rpm	4200	3900	3600	3300	3100	2900
	intermittent max. rpm ②		$n_{max\,Interm}$	rpm	5000	4500	4100	3800	3450	3000
	minimum rpm		n_{min}	rpm	500	500	500	500	500	500
Flow	at $n_{max\,cont}$ and $V_{g\,max}$		Q_{max}	L/min	160	202	234	275	344	432
				gpm	42.3	53.4	61.8	72.7	90.9	114.1
Power	at $n_{max\,cont}$	Δp = 400 bar	P_{max}	kW	107	134	156	183	229	288
		Δp = 5800 psi		hp	144	180	209	245	307	386
Torque	at $V_{g\,max}$	Δp = 400 bar	M_{max}	Nm	254	356	451	572	795	1144
(without charge pump)		Δp = 5800 psi		lb-ft	187	263	333	423	586	844
		Δp = 100 bar	M	Nm	63.5	89	112.8	143	198.8	286
		Δp = 1450 psi		lb-ft	46.8	65.6	83.2	105.5	146.6	210.9
Moment of inertia (about drive axis)			J	kgm^2	0.003	0.0051	0.0072	0.0106	0.0164	0.0323
				$lb\text{-}ft^2$	0.0712	0.1210	0.1709	0.2515	0.3892	0.7665
Weight (standard model without through drive)			m	kg	31	38	50	66	80	104
				lbs.	68	84	110	145	176	229

① Limited maximum rpm: – at half corner power (e.g. at $V_{g\,max}$ and $p_N/2$)
② Intermittent maximum rpm: – at high idle speed
– during engine overspeed: Δp = 70–150 bar (1015–2176 psi) and $V_{g\,max}$
– with reversing loads: Δp < 300 bar (4350 psi) and t < 5 seconds
V_g = Displacement (cm^3 or in^3) per revolution
Δp = Differential pressure
n = Speed (rpm)

Input Drive *(Permissible axial and radial loading on drive shaft)*

Size					40	56	71	90	125	180
Distance of F_q (from shaft shoulder) 		a		mm	17.5	17.5	20.0	20.0	22.5	25.0
		a		in	0.69	0.69	0.79	0.79	0.89	0.98
		b		mm	30	30	35	35	40	45
		b		in	1.18	1.18	1.38	1.38	1.57	1.77
		c		mm	42.5	42.5	50	50	57.5	60
		c		in	1.67	1.67	1.97	1.97	2.26	2.36
Max. permissible radial load at distance	a		$F_{q\,max}$	N	3600	5000	6300	8000	11000	16000
	a			lbs.	809	1124	1416	1798	2473	3597
	b		$F_{q\,max}$	N	2891	4046	4950	6334	8594	12375
	b			lbs.	650	910	1113	1424	1932	2782
	c		$F_{q\,max}$	N	2416	3398	4077	5242	7051	10150
	c			lbs.	543	764	917	1178	1585	2282
Max. permissible axial load 			$\pm F_{q\,max}$	N	1500	2200	3500	3500	4800	6000
				lbs.	337	495	787	787	1079	1349

Filtration Options

Many factors influence the selection of a filter to achieve the desired cleanliness level, including: dirt ingression rate, required cleanliness level, and system complexity. We have found the following filter Beta (ß) ratios (ISO 4572) to be satisfactory:

Suction Filtration.....$ß_{10} \geq 2.0$ & $ß_{30} \geq 100$
Charge Pressure Filtration.....$ß_{10} \geq 10.0$ & $ß_{20} \geq 100$

Machine testing is necessary to confirm the ability of the selected filter to maintain the desired fluid cleanliness levels.

Charge Flow Suction Filtration (standard model)**...S**

Filter type: . . . . . Filter **without** bypass

Filter element pressure drop:
at V= 141 SUS (30 cSt); $n = n_{max}$ . . . . . Δp≤0.1 bar (1.5 psi)
at V=4635 SUS (1000 cSt); n=1000 rpm. . Δp≤0.3 bar (4.5 psi)

Min. pressure at charge pump inlet port (S):
at V= 141 SUS (30 cSt). . . . . p≥0.8 bar abs. (6.3 in-Hg.)
at cold start . . . . . p≥0.5 bar abs. (15.2 in-Hg.)
The filter should be fitted with a ΔP indicator and/or switch.

Right Track/Pulldown, Left Track/Rotation Pumps

Hydraulic Centering

When the control module is replaced, it is generally necessary to center the new module. Follow the steps listed below:

1. Install a 0-6000 PSI (0-414 bar) hydraulic pressure gauge into ports M_A & M_B.
2. Install a 0-600 PSI (0-41 bar) hydraulic pressure gauge into ports X_1 and X_2.
3. Disconnect and plug the X3 port (fig. 7-6c) for the rotation torque control (if used).
4. Loosen the lock nut on top of the control module with a 4mm allen wrench. Use a 4mm allen wrench to turn the adjusting screw. The adjustment screw is an eccentric, therefore turning the screw more than 90° in either direction will have no further effect, and could cause damage to the eccentric pin.
5. The neutral position is correctly adjusted when:
   A. Approximately equal pressures are at X_1 and X_2 ports.
   B. The hydraulic motor does not turn when the brake is released.
   C. Charge pressure registers equal at M_A & M_B ports when the pump is deadheaded.

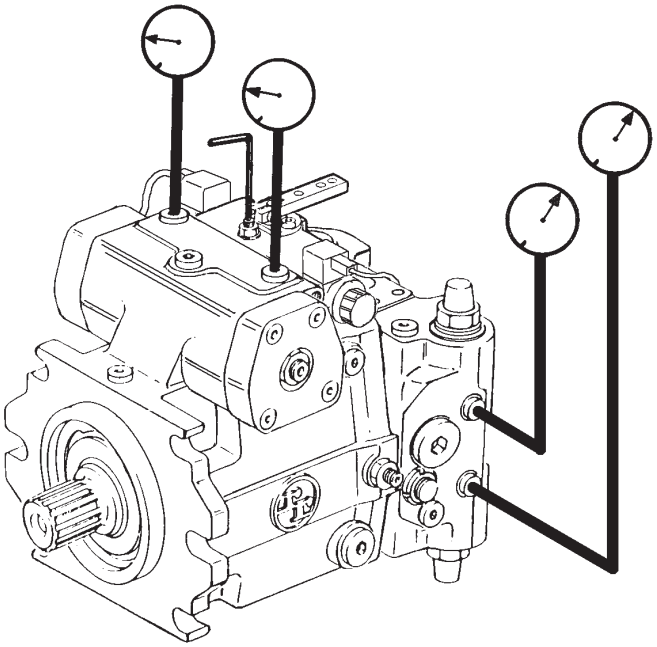


Fig. 7-7a Hydraulic zero position - with EP pump control.

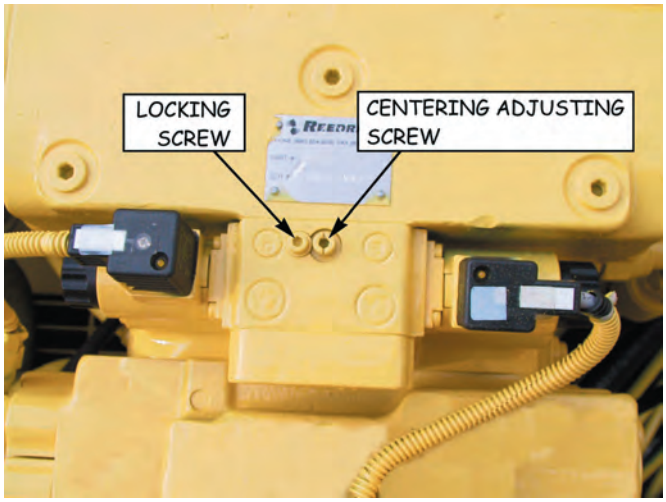


Fig. 7-7b Hydraulic Centering Adjusting Screw - with EP pump control.

NOTE: **Use one gauge and swap between ports X1 and X2. Even new gauges may not read indentical pressures.**

Hydraulic Piston Pumps - Troubleshooting

3...Transmission Drives in One Direction Only

3.1	With control lines lines switched does pump drive in opposite direction only?	No	Proceed to step 3.2.
		Yes	Control signal from one side does not work properly. Repair as necessary.
3.2	With control lines still switched does pump drive in initial direction only?	No	proceed to step 3.3.
		Yes	Problem is one side of control module or the pump. Proceed to step 3.3.
3.3	Is there control pressure or current from both control lines?	No	Correct control signal problem.
		Yes	Proceed to step 3.4.
3.4	Check flushing valve (If Installed). Is shuttle spool stuck in one position?	No	(Not installed) Proceed to step 3.5.
		Yes	Remove flushing valve and clean or replace.
3.5	Switch relief valves. does transmission drive in other direction only?	No	Proceed to step 3.6.
		Yes	Repair or replace relief valve on nondriving side.
3.6	Replace control module and reconnect control lines. Does pump operate properly?	No	Replace or repair pump.
		Yes	Operate transmission.

4...Transmission Drives in the Wrong Direction

4.1	Pump with HD control.	Switch control lines on ports Y_1 and Y_2.
4.2	Pump with EP Control.	Switch electrical connectors on solenoids A & B.
4.3	Pump with HW Control.	Rework linkage or cable to give correct drive direction.

5...Pump Does Not Find or Hold Neutral (Also refer to pages 23 & 24)

5.1	Does pump return to neutral with control lines removed?	No	Proceed to step 5.2.
		Yes	Check control for electrical signal problem (EP control) or back pressure in the pilot lines (HD Control).
5.2	Check mechanical centering of pump and control per pages 24 & 25. Does pump return to neutral with control lines removed?	No	Repair or replace pump.
		Yes	Replace control module if needed. Operate transmission.

6...Transmission Drives at a High Noise Level

6.1	Are the drive gearboxes filled with correct grade of oil?	No	Fill gearbox with correct grade of oil to the prescribed level.
		Yes	Proceed to step 6.2.
6.2	Is the drive coupling correctly installed and aligned?	No	Install coupling per manufacturer's instructions and tolerances.
		Yes	Proceed to step 6.3.
6.3	Is rigid piping connected to the pump and motor?	No	Proceed to step 6.4
		Yes	Install short length of hose between pressure ports and the system piping.
6.4	Is the suction pressure at the charge pump inlet within recommended limits?	No	Return to step 1.7.
		Yes	Proceed to step. 6.5.
6.5	Is there air in the hydraulic oil? This may be indicated by foaming or milky colored oil.	No	Proceed to step 6.6.
		Yes	Deaerate the oil and inspect system for cause of air induction.
6.6	Is the hydraulic motor operating at excessive speed?	Yes	Check motor sizing in relation to available oil flow from the pump. Check motor minimum displacement. See page 20.

Diverter Valve

Closed Loop Pump Circuit:

- The Drill/Tram Pump circuit consists of two independent closed loop systems that operate the rotary drive head motor, pulldown cylinder, and the two track assemblies.
- One pump operates the Right Track/Pulldown circuit. One pump operates the Left Track/Rotation circuit.

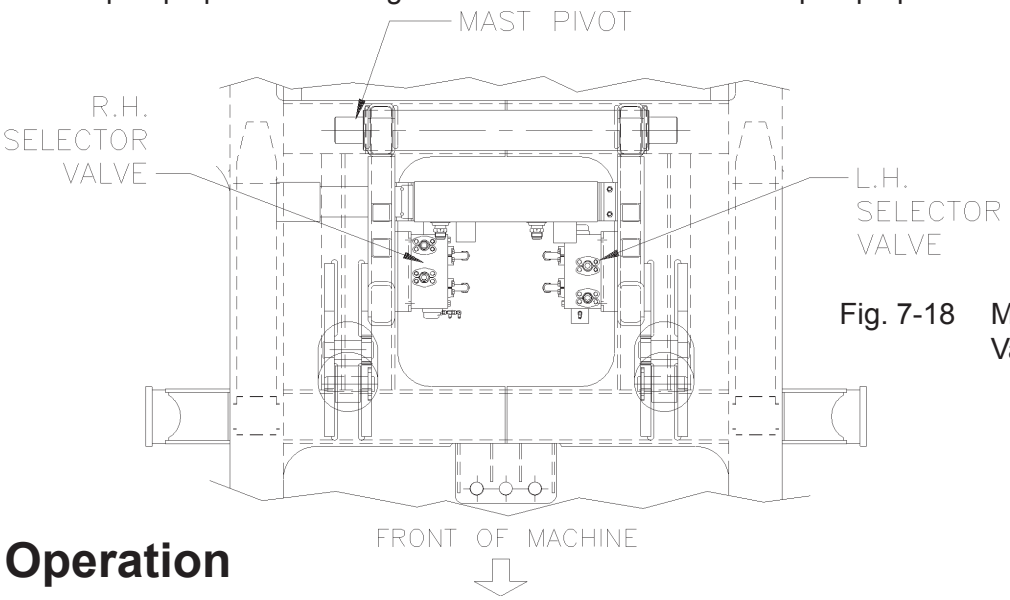


Fig. 7-18 Main Frame showing Selector Valve mounting location.

Operation

When the Drill/Tram switch on the switch panel in the operator's cab is in TRAM mode:

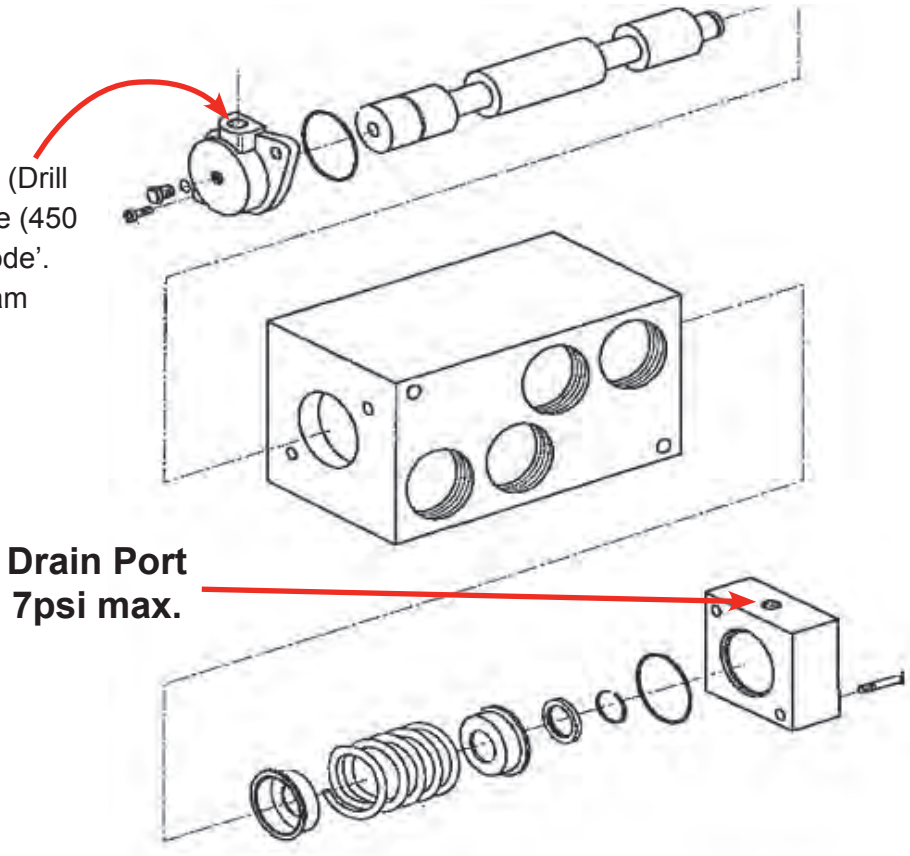
Drill/Tram Valve (V17) in pilot control manifold (fig. 7-17) is de-energized, thus, oil is directed through the selector valves (fig. 7-18) to the tram motors.

When the Drill/Tram switch is in DRILL mode:

Drill/Tram Valve (V17) is energized. Pilot pressure then shifts the selector valve, and oil is routed to the rotation motor from the right hand selector (diverter) valve, and to the pulldown cylinder from the right hand selector (diverter) valve.

Diverter Valve

Pilot port Connected to Port 1 on V17 (Drill tram solenoid) valve. Charge pressure (450 psi) applied to this port in the ‘Drill mode’. Case pressure (7 psi max.) in the ‘Tram mode’



Rotary Drive Gearbox Motor

Variable Displacement Motor AA6VM

Technical Data

Fluid Recommendations

The AA6VM motor in the standard design, should be used with good quality, petroleum oil based, anti-wear hydraulic fluids. More detailed information regarding the selection of hydraulic fluids and their application limits can be found in our Data Sheets RA 90220 *(Petroleum Oil)*, RA 90221 *(Biodegradable Fluids)* and RA 90223 *(Type HF-Fire Resistant/Synthetic Fluids)*.

When operating with environmentally compatible fluids *(Biodegradable)* or fire resistant fluids *(Type HF Synthetic)* possible reduction of the operating specifications may be required. Please consult us and your fluid supplier.

Operating Viscosity Range *(See Selection Diagram)*

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity *(at normal operating temperature)* be selected from within the range.

Optimum Viscosity (ν_{opt})	80–170 SUS (16–36 mm²/s)

Viscosity Limits

The limiting values for viscosity are as follows:

Maximum Viscosity (ν_{max})	7400 SUS (1600 mm²/s)
Only for short periods during cold start-up (t_{min} = -40°F/C)	
Absolute Minimum Viscosity (ν_{min})	42 SUS (5 mm²/s)

Operating Temperature Range

Min. operating temp.	-13°F (-25°C)
Absolute min temp.	-40°F (-40°C)
Max. operating temp. for short duration	240°F (115°C)

Please note that applications with low start-up temperatures -40...-15°F (-40...-25°C) may require special installation positions, please consult us.

Notes on Hydraulic Fluid Selection

In order to select the correct fluid, it is necessary to know the normal operating temperature in the circuit in relation to the ambient temperature - In an open circuit, the reservoir temperature and in a closed circuit, the loop temperature.

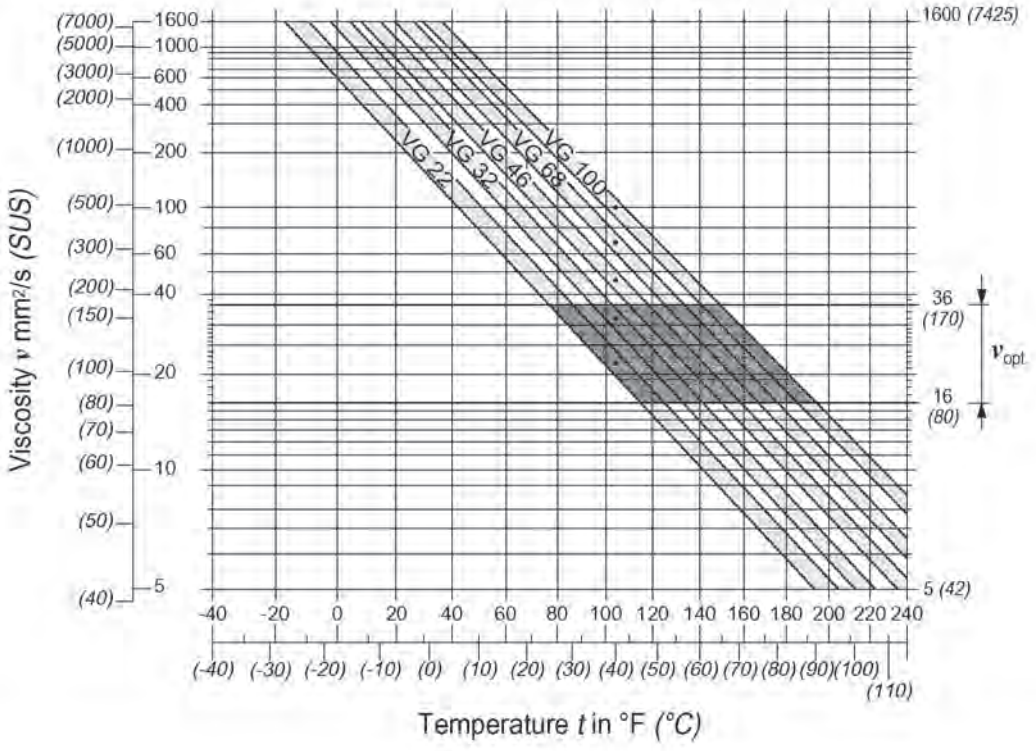
The hydraulic fluid should be selected so that, within the operating temperature range, the fluid viscosity is within the optimum range ν_{opt} *(see shaded area of the fluid selection diagram)*. We recommend that the higher viscosity grade is selected in each case.

Example: At an ambient temperature of X°, the operating temperature in the reservoir is 140°F (60°C). In the optimum operating viscosity range ν_{opt}, (shaded area), this corresponds to viscosity grades VG46 or VG68, VG68 should be selected.

Important: The leakage fluid *(case drain fluid)* temperature is influenced by pressure and speed and is typically higher than the circuit temperature. However, maximum temperature at any point in the system must be less than 240°F (115°C).

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperature, please consult us.

Selection Diagram



Rotary Drive Gearbox Motor

Variable Displacement Motor AA6VM

Troubleshooting Procedure

2. Transmission Drive is Sluggish or Erratic

2.1	Is the control medium in good condition? For example: control medium is not in good condition if: The hydraulic pilot pressure lines have air in them, the manual control cable or linkage is sticking, or the electrical control current is fluctuating. (pump and/or motor)	No Yes	Rectify the control fault. Bleed pilot lines. Lubricate or free the cable or linkage. Check control current. Proceed to step 2.2.
2.2	Are the brakes fully released?	No Yes	Check brake release circuit or mechanism. Proceed to step 2.3.
2.3	Is the pump stroking time correct for the application?	No Yes	Correct pump stroking time. Proceed to step 2.4.
2.4	With hydraulic pilot control, is the contol curve of remote pilot valve correctly matched to the motor?	No Yes	Change spring to suit. Proceed to step 2.5.
2.5	Does the charge pressure fluctuate more than 30 psi when stroking the pump?	No Yes	Proceed to 2.9 Proceed to step 2.6.
2.6	If the charge pump output is used to operate auxilary functions, do these other functions cause fluctuations in charge pressure?	No Yes	Proceed to 2.8 Proceed to step 2.7.
2.7	Isolate the auxilary function and run the transmission. Are the charge pressure fluctuations reduced or eliminated?	No Yes	Proceed to 2.8 Operate transmission and return to step 2.1.
2.8	Are there system pressure fluctuations which are syncronous with the charge pressure flucuations?	No Yes	Proceed to step 2.9. Determine the cause of system pressure fluctuations.
2.9	Is the motor stroking time correct for the application?	No.	Add motor stroking time adjustment valve or orifice to the variable motor, or modify the control circuit to provide desired stroking time.

3. Transmission Drives in One Direction Only

3.1	Is it possible that the control signal to one side of the pump does not work properly?	No Yes	Proceed to step 3.2. Refer to pump sevice manual.
3.2	Check flushing valve (if installed). Is shuttle spool stuck in one position?	No Yes	(Not installed). Remove flushing valve and clean or replace.
3.3	Switch releif valves. Does the transmission drive in the other direction only?	No Yes	Proceed to step 3.4. Repair or replace releif valve on non-driving side.
3.4	Actuate control. Does the transmission run in both directions?	No Yes	Check for mechanical faults in the drive beyond the motor shaft. Operate the transmission.

4. Transmission Drives in the Wrong Direction

4.1	To change direction at pump:		Switch the control signal lines or linkage to the pump control module or stroker.
4.2	To change direction at motor:		Switch the high pressure lines at ports A and B.

Auxiliary Functions/Fan Circuit

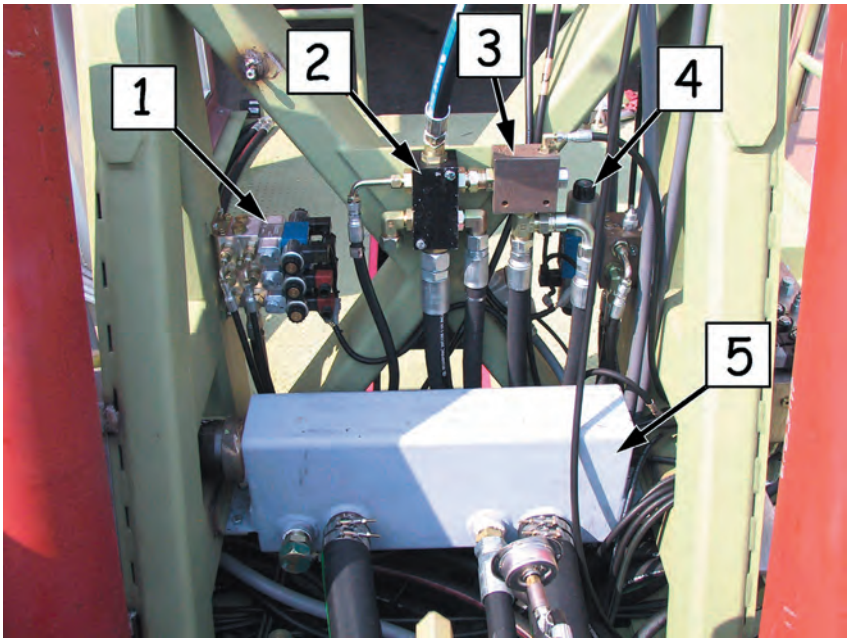


Fig. 7-10 Mast "A" Frame (viewed from engine end)

1. 3-Bank Valve (416699), Main Air, Skirt Lifters, Trap Door
2. Auxiliary Manifold (1412986)
3. Check Valve for Cooler Fans (427241)
4. Dust Collector/Water Injection Valve (410089)
5. Suction Manifold (416567)

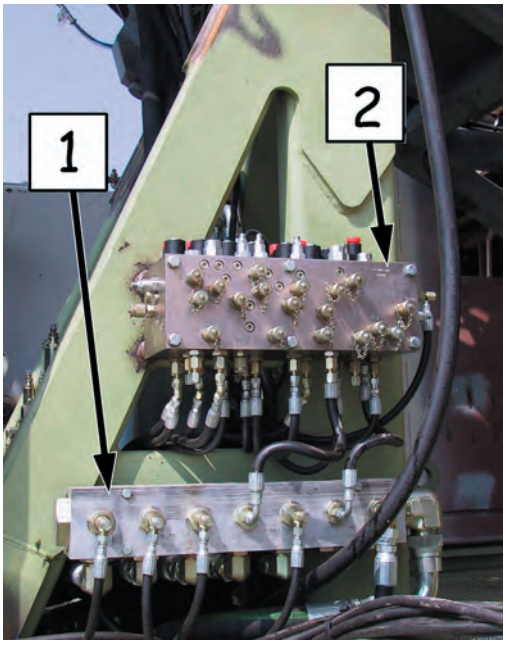


Fig. 7-10a Mast "A" Frame (viewed from left side)

1. Case Drain Manifold (401065)
2. Pilot Control Manifold (426787)

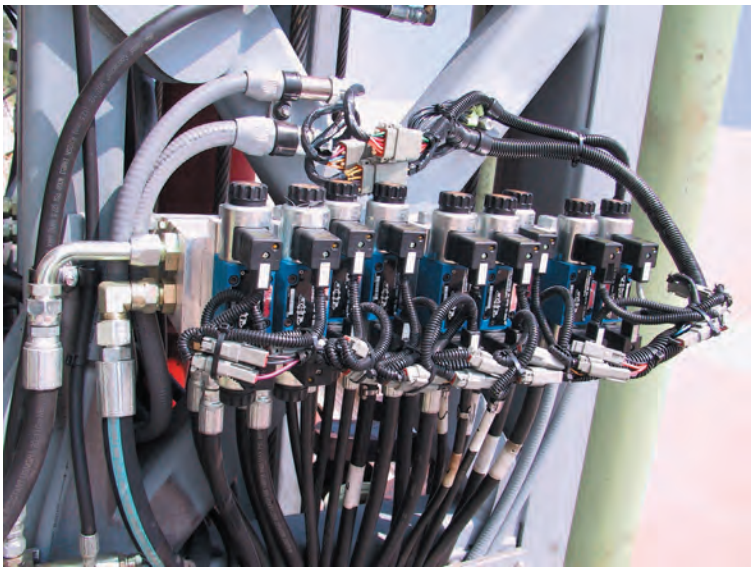


Fig. 7-23 9 Bank Auxiliary Valve mounted on mast

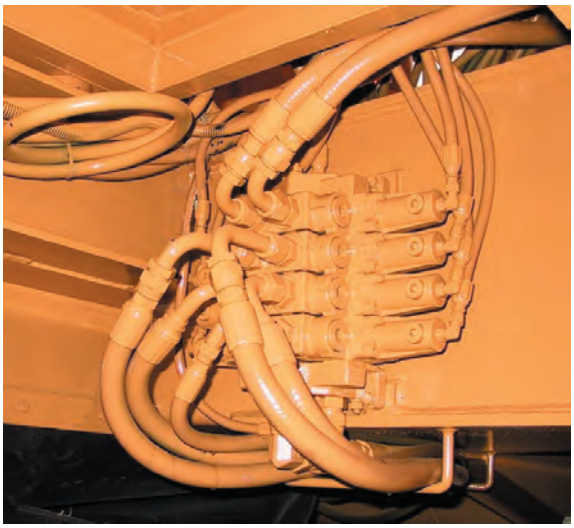


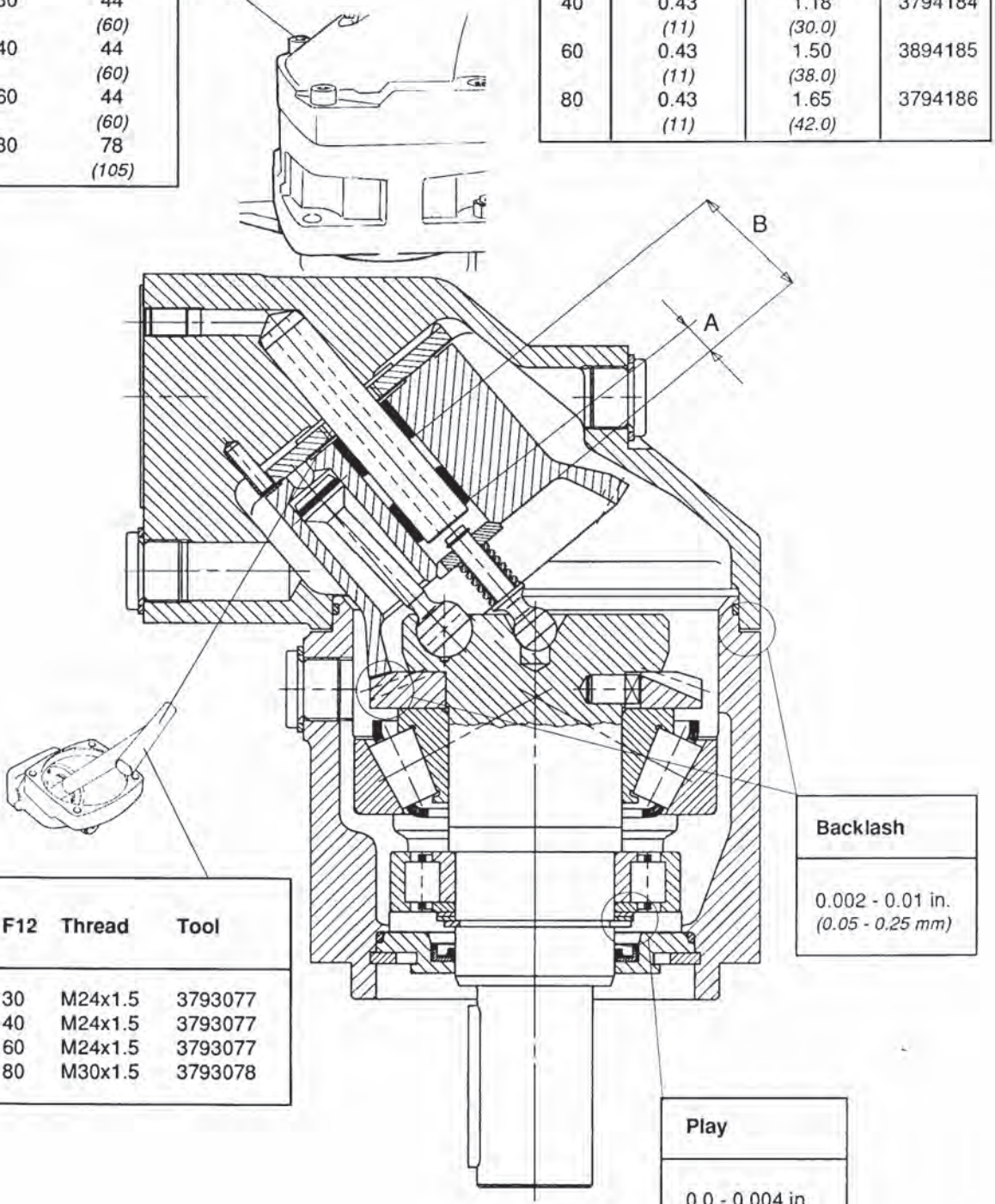
Fig. 7-14 Mast Elevate & Jack Control Valve 410091 (mounted under operator's cab)

Cooler Fan Motor

Specifications and Tools

F12	Ft.lb ± 7 *(Nm ± 10)*
30	44 *(60)*
40	44 *(60)*
60	44 *(60)*
80	78 *(105)*

F12	A±0.01 in. *(A±0.25 mm)*	B±0.01 in. *(B±0.25 mm)*	Tool
30	0.43 *(11)*	1.25 *(31.8)*	3794183
40	0.43 *(11)*	1.18 *(30.0)*	3794184
60	0.43 *(11)*	1.50 *(38.0)*	3894185
80	0.43 *(11)*	1.65 *(42.0)*	3794186



F12	Thread	Tool
30	M24x1.5	3793077
40	M24x1.5	3793077
60	M24x1.5	3793077
80	M30x1.5	3793078

Backlash
0.002 - 0.01 in. *(0.05 - 0.25 mm)*

Play
0.0 - 0.004 in. *(0.0 - 0.1 mm)*

3

Leveling Jack Cylinders

Jack Counterbalance Valves

The function of the counterbalance valves on the leveling jacks (fig. 7-15) is to ensure that the drill stays in the intended position for drilling when the jacks are extended. To determine if the counterbalance valves are functioning correctly, the following procedure should be used.

1. Raise the machine off of the ground and level.
2. Shut down the engine.
3. Measure distance from some point on machine to ground. Check again after a couple hours or overnight if possible. If measurement is less, then valve needs to be adjusted or replaced.

Jack Counterbalance Valve Adjustment

While the valves are preset at the factory at 3250 PSI (224 bar) they may be adjusted if drifting is encountered. The counterbalance valves can be reached through the cutout in the jack casing (fig. 7-15). One is for RETRACT and the other for EXTEND. Be sure you are adjusting the right one.

1. Loosen the jam nut and back out the adjusting screw 1/4 turn (remember, COUNTERCLOCKWISE adjustment INCREASES PRESSURE on counterbalance valves). Tighten jam nut and retest. If no difference is noted after one full turn of the adjusting screw, then valve must be replaced. DO NOT exceed one full turn. If counterbalance valve is backed out too far, it will relieve pressure. When valve is adjusted correctly, tighten jam nut.
2. If drifting is still encountered, the valve must be replaced.

NOTE: **If in the above test, the unit does not start lowering, but does so during normal operations, then the jack cylinder most likely is bypassing or leaking internally, and further diagnostics and repair or replacement will be necessary.**

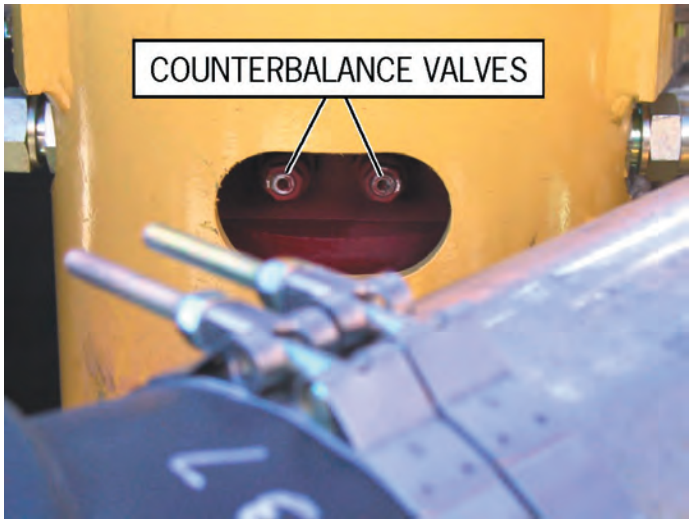


Fig. 7-15 Outer Jack Casing

Carousel Rotate Motor

Reassembly

34 Align the notch on the outside of the valve plate with the notch on the Geroler as shown in Figure 12.

Timing Step # 2 — Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler.

Timing Step # 3 — Locate any one of the side openings of the valve and align this opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Install the valve by rotating it clockwise until the spine teeth engage (1/2 spine tooth max.). This will provide the proper rotation when pressurized as shown in Figure 13.

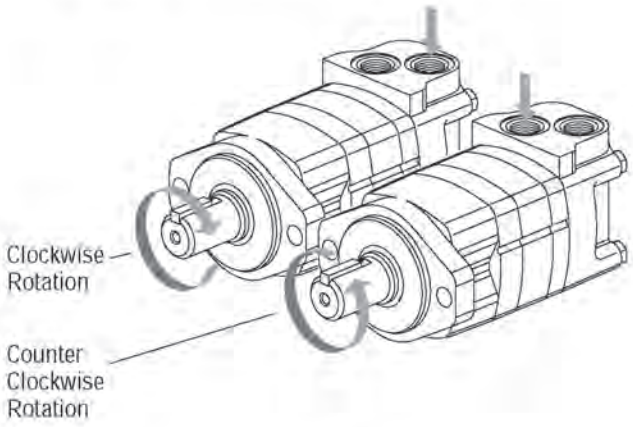


Figure 13

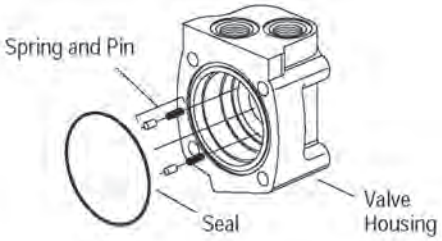


Figure 14

35 Install 2 springs and 2 pins in the holes located in the bore of the valve housing, as shown in Figure 14.

36 Apply a light film of petroleum jelly to the 76,0 [3.00] diameter seal. Install seal in the valve housing.

37 Apply petroleum jelly to inner and outer face seals. Install seals on balance ring as shown in Figure 15.

Important: Install face seals in the positions shown in Figure 15, or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.

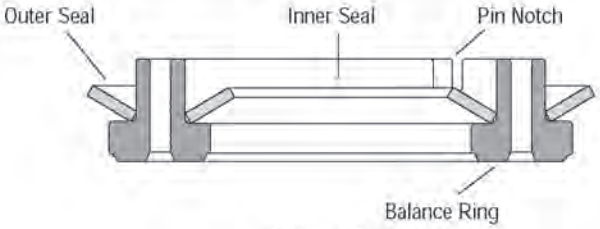


Figure 15

38 Align pin notches in balance ring with pins in bore of valve housing. Install balance ring assembly in valve housing.

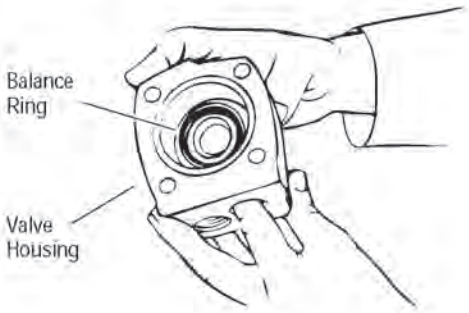


Figure 16

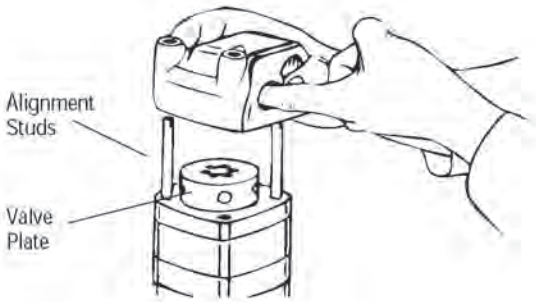


Figure 17

39 Insert your finger through port of valve housing. Apply pressure to side of balance ring as shown in Figure 16. Hold ring in position until valve housing is in place against valve plate (see Figure 17).

Note: After installing the valve housing on the valve plate check for proper placement. Push down on the valve housing. You should get a slight spring action.

Pilot Control Manifold

V07 Pilot Operated Directional Valve (Rotation Torque Control On/Off)

Piloted at Port 1 from the drill tram solenoid **(V17)**, this valve switches the rotation pressure (Torque Control) on in the drill mode by allowing pressure from **Mb** Port on the L/H tram/rotation pump through Ports 2 &3, then on to the maximum rotation pressure relief.

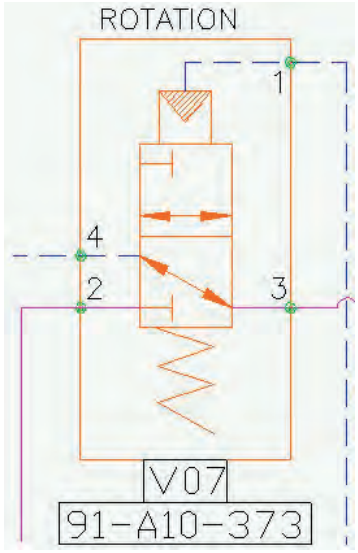
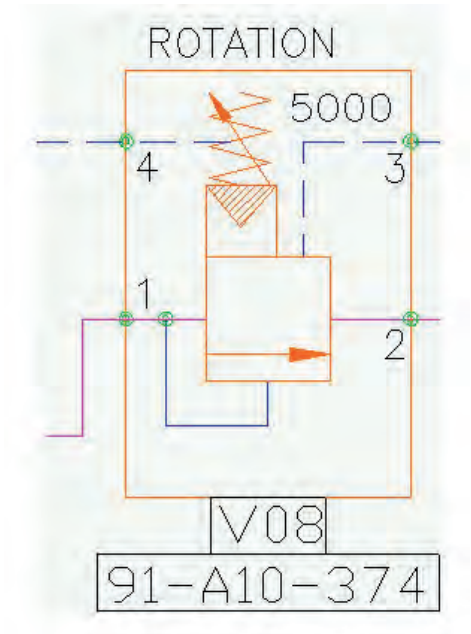


Fig. 7-10j V07 Piloted Operated Directional Vale (Rotation Torque Control ON/OFF)

V08 Maximum Rotation Pressure Relief

This pilot operated vented relief is set to the highest rotation pressure required to provide enough rotation torque to turn the drill bit during the drilling process. Usually set at 4000psi, this provides 80% of pump pressure in the forward direction only, so reverse rotation pressure (5000psi) is capable of breaking out pipe joints. Venting Port 3 through the rotation torque control relief in the cab can remotely lower this setting. When the relief setting is reached, pressure from **Mb** on the L'H tram/rotation pump is directed to **X3** on the servo of the L/H tram/rotation pump, which then de-strokes the pump.



V08. Setting to 4000psi

1. Engage the deck wrench onto the spanner flats of a drill pipe or sub adaptor.
2. Forward rotate to stall the rotation.
3. Increase the setting of the rotation torque control valve in the operators cab until the pressure stops rising or 4100psi rotation pressure is reached.
4. Adjust V08 relief until the rotation pressure gauge reads 4000psi.
5. Decrease the rotation torque control valve setting until the pressure begins to reduce. Any pressure up to 4000psi can now be selected.

Fig. 7-10K V08 Maximum Rotation Pressure Relief Valve

Dust Collector/Water Injection Circuit

Pressure Adjustment

1. Shut down machine and relieve standing pressure (see beginning of section 7).
2. Block flow to dust collector and/or water injection pump.
3. Install a 6000 PSI (414 bar) gauge in the relief valve (fig. 7-28) or, if machine is equipped with a hydraulic pressure test station, turn knob to DUST COLLECTOR.
4. Start machine and allow time for system to warm up. Loosen lock nut on relief valve and turn adjusting screw (fig. 7-28a) to get a reading of 2000 PSI (138 bar). Tighten lock nut.
5. Shut down machine and relieve standing pressure. Hook up hoses that were removed in step 2 and remove gauge. Tighten all connections and fittings.

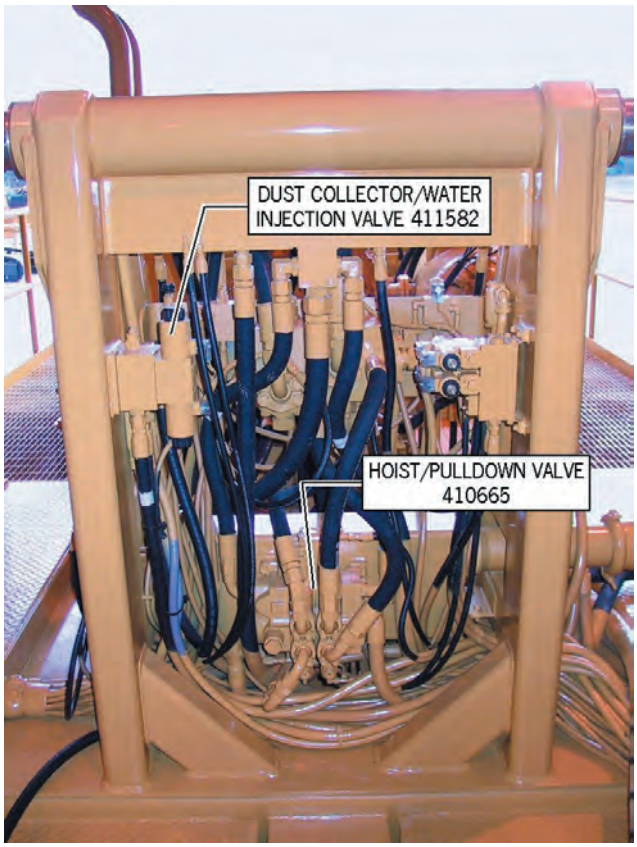


Fig. 7-28 Dust Collector/Water Injection Relief Valve 411582.

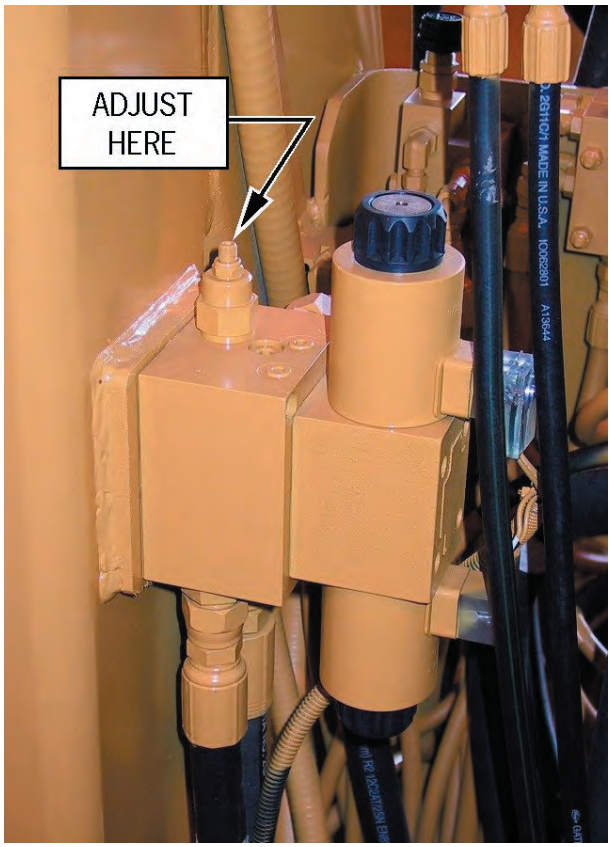


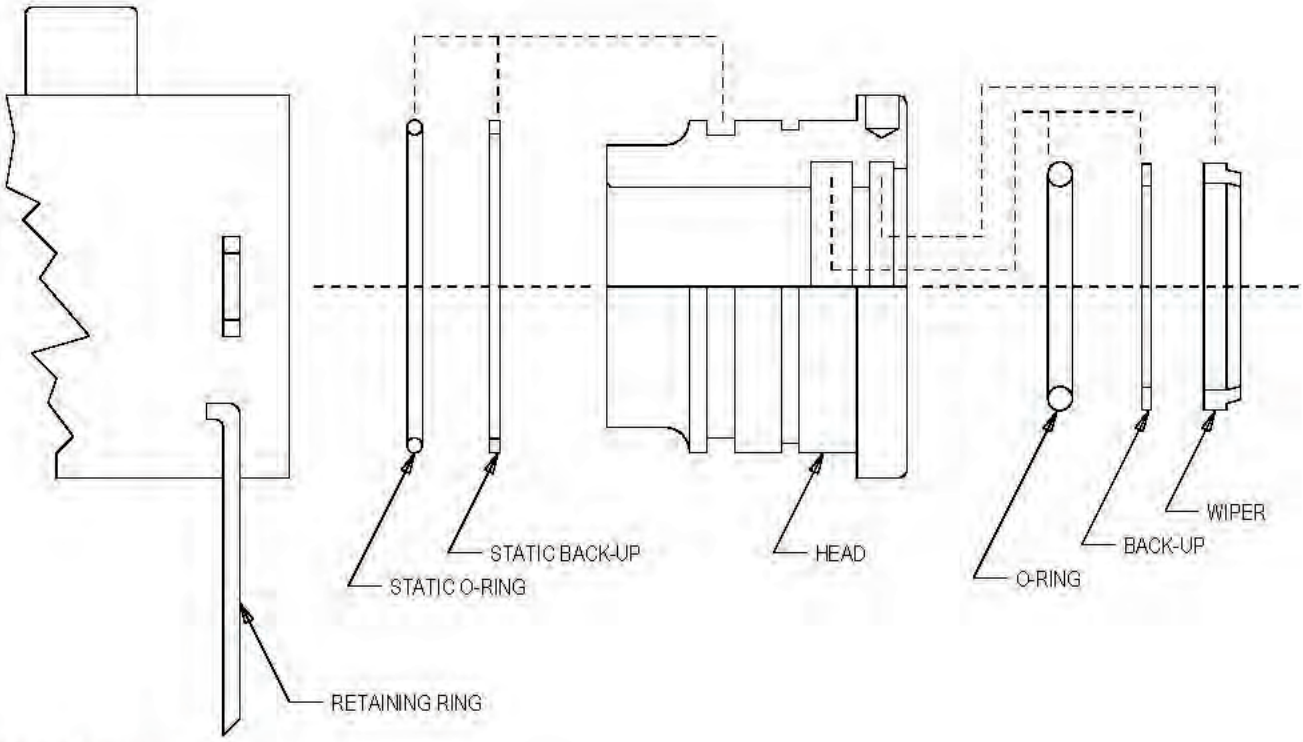
Fig. 7-28a Dust Collector/Water Injection Relief Valve Adjustment

Hydraulic Cylinder Repair

M Head

General

The M series head uses aluminum material and has a nitrile o-ring and back-up as the primary sealing element. The wiper is a standard type D polyurethane. The head is retained within the tube by means of a square retaining ring, half of which is engaged by the head and the other half by the tube. General procedures for teardown, inspection, and rebuild are contained in the General Procedures Maintenance Manual. See your Texas Hydraulics Sales Engineer if you have any questions.



Teardown

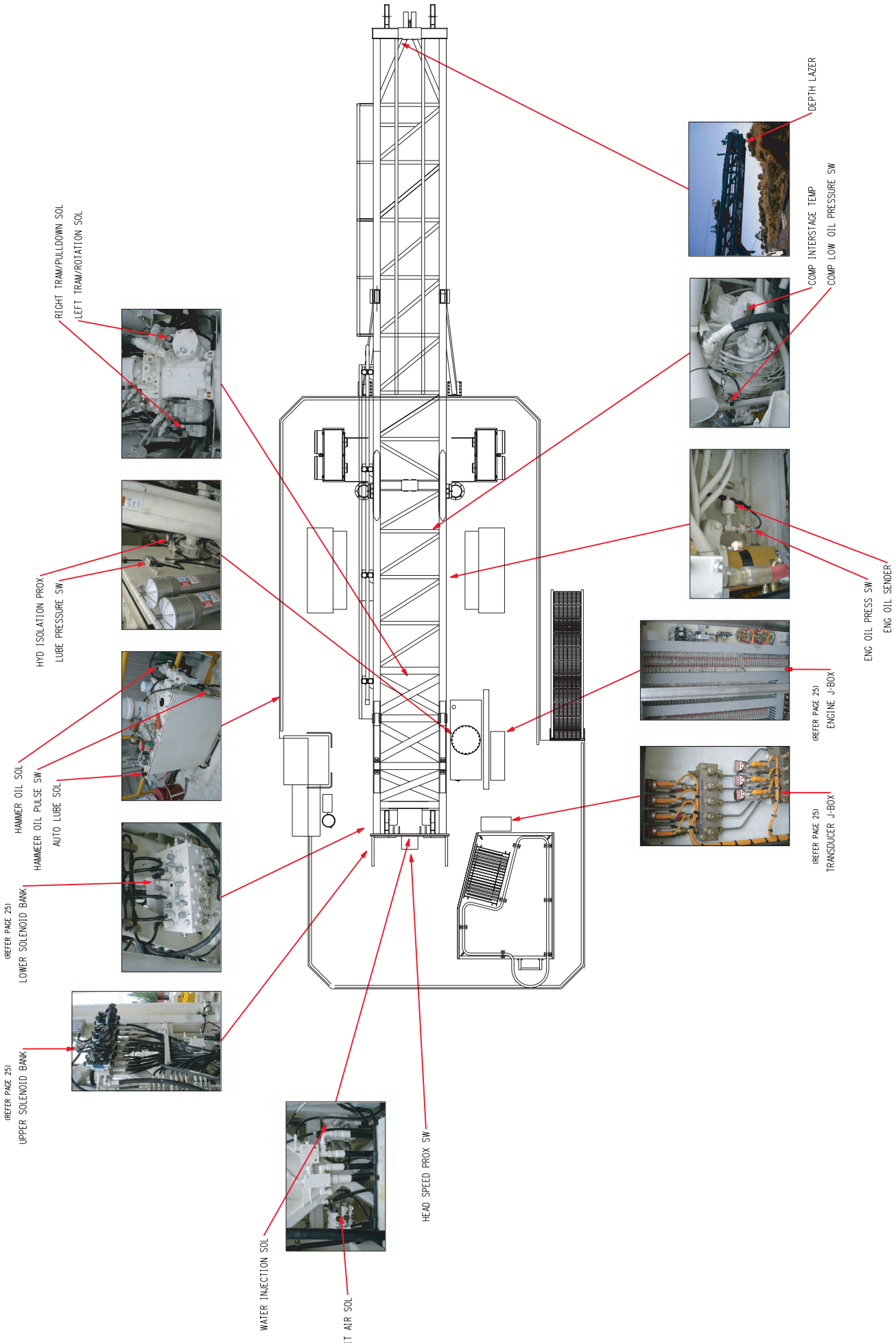
Remove the head retaining device as follows: Insert a spanner wrench into the holes provided. Rotate the head clockwise until the edge of the retaining ring appears in the milled opening of the tube. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter-clockwise until the retaining ring is completely removed.

Rebuild

Lubricate the head and all seals with hydraulic fluid prior to installation. Push the rod o-ring seal followed by the backup into its groove. Be sure that the o-ring seal does not twist and that the backup is on the correct side of the o-ring seal. Using round-nose pliers or special installation tools, twist the wiper into a "C" shape and allow it to snap into groove. Install the static o-ring and backup into the static seal groove verifying that the backup is closest to the retaining ring groove. If possible, the head/seal assembly should sit for at least one hour to allow the seals to elastically restore.

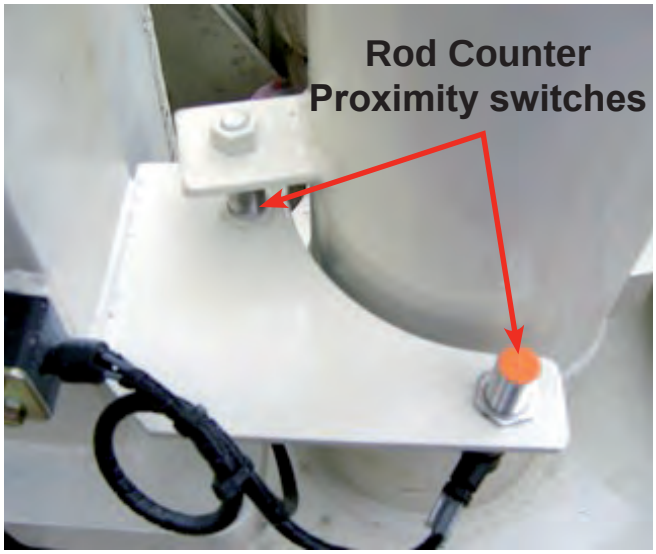
NOTE: When installing the head, pay careful attention to the retaining ring hole to insure that the static seal on the head does not extrude into the slot. Insert the spanner wrench into the holes provided and rotate the head until the retaining ring hole is visible through the slot milled in the tube. Insert the retaining ring hook into the hole and rotate the head 1-1/4 turns until the retaining ring is completely pulled into the tube and the ends are covered.

Electrical Components



Electrical Components

Laser Depth System



- **The Rod Counter proximity switch** is used to detect that a rod has been either added or subtracted. It does this by detecting the pipe rack position. When the Pipe Rack is swung under the Head and then moved back into the parked position, a flag in the PLC is “set”.
- After the Rod counter flag has been “set”, the Laser then determines the position of the Head.
- With the Head above the “midpoint” and the Deck Wrench is operated -- then a rod will be ADDED.
- If the Head moves down to a set point approx 200mm above “deck wrench” position without the Deck Wrench being operated -- then the rod will be SUBTRACTED.

Pipe in Hole Detection

This option inhibits the movement of the **MAST**, **JACKS** and **TRAMMING**.

All of the following 3 conditions must be met to verify that the pipe is out of the hole.

1. The Rods on string must be 1 or less (the last rod in the string will still be on the head).
2. The depth must equal zero (the actual depth must have counted all the way back to zero).
3. The head must be above the “Pipe in Hole” set point (the head must be at the top of the mast).

Tram Protection

The **Pipe in Hole** is deemed to be clear to Tram only after **ALL THREE** above conditions are met OR the Override function is operated on the Touchscreen.

The operation of the Tram Override function (on the Tram Screen) is logged on the screen and memory. The Tram Override function will self reset when the operator switches back to drill mode for the next hole or whenever the drill is first started.

Mast and Jack Lowering Protection

The Pipe in Hole is deemed to be clear to Tram only after ALL THREE above conditions are met OR the Override function is operated on the Touchscreen.

The operation of the Pipe in Hole Override function (on the Drill Screen) is logged on the screen and memory. The Pipe in Hole Override function will self reset when the operator switches to tram mode for the next hole or whenever the drill is first started.

NOTE: **All “OVERRIDE” operations and buttons are operated with the full understanding and acceptance of the system or operation to be overridden. Overriding any system has the potential for component or machine damage, this procedure must be done only after fault evaluation and with due care.**

WARNING **You should never attempt to raise the jacks with the drill pipe in a drill hole. For this reason the PLC should prevent jack cylinders from functioning until the “Pipe in Hole” sensor registers that the drill string is clear of the drill hole.**

Electrical Components

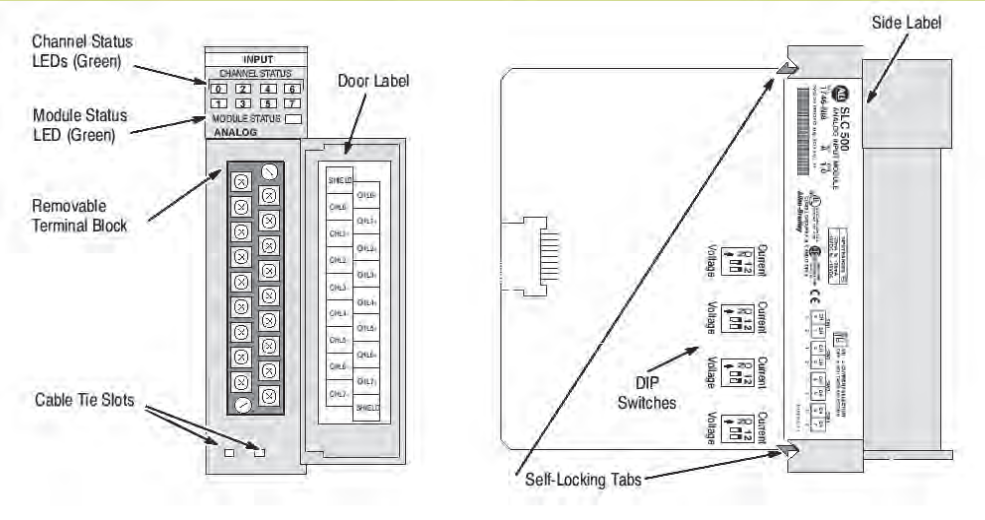
DRILL ELECTRICAL GUIDE

Replacing a Faulty Card

Turn off power to PLC.
Disconnect connector from card (2 screws at each end will jack connector from card).
Remove faulty card and check if it has any Dip Switches that need to be set on new card
Set any Dip Switches if required and install new card.
Replace connector & secure with screws.
Turn power back on to PLC.

Analog Card Configuration

When replacing an analog card the dip switches ***must*** be set correctly (4 or 8 channel card only)



DRILL ELECTRICAL GUIDE

ACKNOWLEDGEMENTS

This manual has been produced with excerpts of documents provided by the following vendors

Digital Proface
Allen Bradley
IFM
Red Lion
Crouzet
Astech

DISCLAIMERS

General

This is a generic guide in content and should not be used as a site specific manual. It is prepared to assist in the understanding of the fundamental operation of a Drill PLC System only and does not cover the operation and maintenance of the drill itself, which is contained in the Reedrill Operation and Maintenance Manuals.
It is assumed that personnel using this guide are:

5. Trained and competant to carry out the work being performed.
6. Has completed the required approved Risk Assessments and deemed safe to perform the associated work.
7. Is familiar with the operation of the drill.
8. Has read and understood the relevant operation and maintenance manuals provided with the drill.

No Warranty is given that the information contained herein is free from error or omissions.
Accordingly, CAED Pty Ltd and/or Metso Reedrill disclaim liability for any act done or omission made in reliance on the information in the Guide and any consequences of any such act or omission.

Override Features

All “OVERRIDE” operations and buttons are operated with the full understanding and acceptance of the system or operation to be overridden.
Overriding any system has the potential for component or machine damage, this procedure must be done only after fault evaluation and with due care.

Further Information

Vendor documents have been included to provide further information on device specific components used. Refer to the Reedrill Operator and Maintenance Manual for complete and detailed as built machine operation and standards.

Electrical Components

Alarm Centre (AC)

Alarm Centre corresponds to the distance threshold of the switching output. Alarm Centre is input in meters. On negative or positive excession of the pre-set switching threshold, the alarm output will switch from „High“ to Low“ or vice versa depending on the alarm hysteresis setting.

„High“ corresponds to about VCC – 1 V, „Low“ to 0 V.

Alarm Hysteresis (AH)

Alarm Hysteresis defines the response hysteresis of the switching output. Alarm Hysteresis settings are made in units of a meter. The value of a hysteresis setting corresponds to the delay in switching (in m), its mathematical sign describes the logic level.

Range Beginning (RB)

Range Beginning corresponds to the lower range limit of the analog output. Range Beginning settings are made in units of a meter. Range Beginning corresponds to a current of 4 mA.

Range End (RE)

Range End corresponds to the upper distance limit of the analog output. Range End settings are made in units of a meter. Range End corresponds to a current of 20 mA.

Trigger Delay (TD)

Trigger Delay consists of two sub-parameters – the actual delay, i.e. the waiting time, and the trigger level.

Delay corresponds to the time from the point when a trigger signal is received to the moment at which a measured value is output. It may take on a maximum value of 9999 ms. The trigger level allows you to define if measurement is to be triggered at a low-high flank (0) or a high-low flank (1).

Your selections for trigger delay and trigger level must be separated byspace (20h). (see section 11. “Transmission Protocol”)

Baud Rate (BR)

For baud rate, the following settings are available: 2400, 4800, 9600, 19200, 38400. Faulty inputs are automatically rounded to the nearest available baud rate. The data format is fixed. It includes eight data bits, no parity and one stop bit.

Autostart (AS)

Allows you to define a function which the LDM 40 A is to carry out when voltage supply becomes available. All inputs are possible. For example, if ASDT has been parameterised, the LDM 40 A will start with distance tracking immediately after power is available.

Distance Offset (OF)

With the help of this parameter the user may conveniently define a zeropoint of his/her measuring setup.

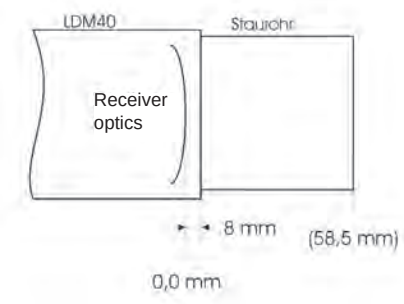


Fig. 4 Front edge of LDM 40 A

Zero point of the LDM 40 A (OF = 0.000000e+00) coincides with the front edge of the receiving lens.

Electrical Components

Combined Pressure Sensor

Operating Instructions

Safety instructions

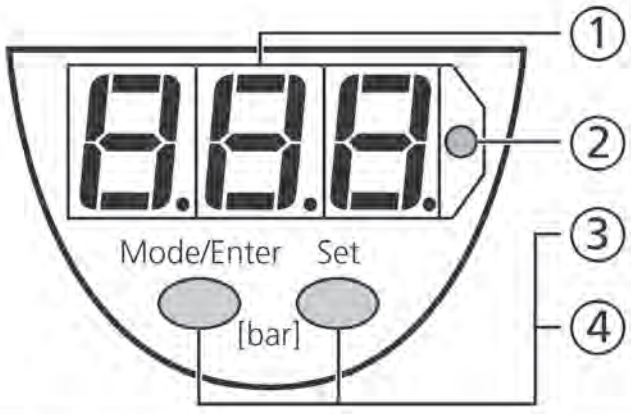
Please read the product description prior to installing the unit. Please check that the product is suitable for your application without any restrictions.

If the operating instructions or the technical data are not adhered to, personal injury and/or damage to property may occur.

Please check in all applications that the product materials (see Technical data) are compatible with the media to be measured.

For gaseous media the application is limited to max. 25 bar.

Controls and visual indication



①	LED display	display of the system pressure, display of parameters and parameter values
②	LED red	switching status; lights if the output has switched
③	Mode / Enter button	selection of the parameters and acknowledgement of the parameter values
④	Set button	setting of the parameter values (scrolling by holding pressed; incremental by pressing briefly)

Electrical Components

Rod Counter Prox Switch

Inductive Proximitiy Switch With Setting Aid

Installation Instructions

Function and features

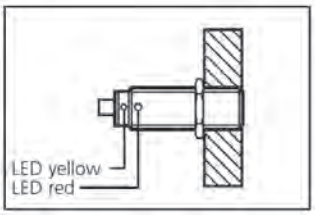
This proximity switch detects metals without contact and indicates their presence by providing a switched signal.
The nominal sensing range (Sn) can be seen in the type designation on the type label on the unit; operating distance (Sa) 0 ... 0,81 x Sn; (values based on standard measurement with mild steel; a shorter sensing range for other metals).

Electrical connection

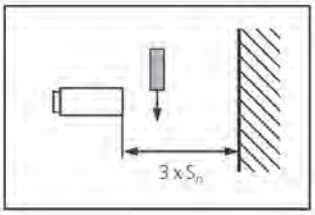
⚠ Disconnect power before connecting the proximity switch. Connection strictly to the indications on the type label.
The unit can be used as normally open (⌐) or as normally closed (¬).

Installation

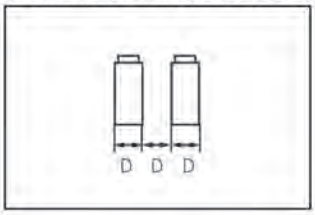
Mounting by means of a mounting device.
Adjust the unit. Adjustment is correct when the red LED **does not** light.
Secure by means of the nuts provided so that it cannot work loose.
Flush installation.

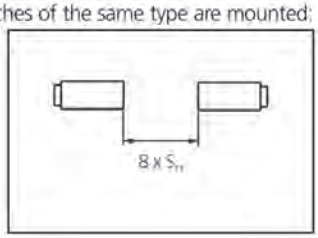


Open space around the sensing face when mounted in metal:



Minimum distance when several switches of the same type are mounted:





Operation

Check the safe functioning of the switch.
Display by LEDs:
- The yellow LED is lit when the output is switched.
- The red LED is lit is lit in case of faulty adjustment.

	output function		
LED yellow LED red	— —	☼ —	No object in the detection range.
LED yellow LED red	☼ —	— —	Safe detection of the object.
LED yellow LED red	☼ ☼	— ☼	Unsafe detection of the object (readjust the unit).

The operation of the proximity switch is maintenance-free.
For perfect functioning make sure that:
- the sensing face and the open space are kept free of metal deposits and foreign bodies, particularly for installation with the sensing face facing upwards;
- EMC: The unit conforms to the requirements of EN 60947-5-2.

General Locator - SKF-12

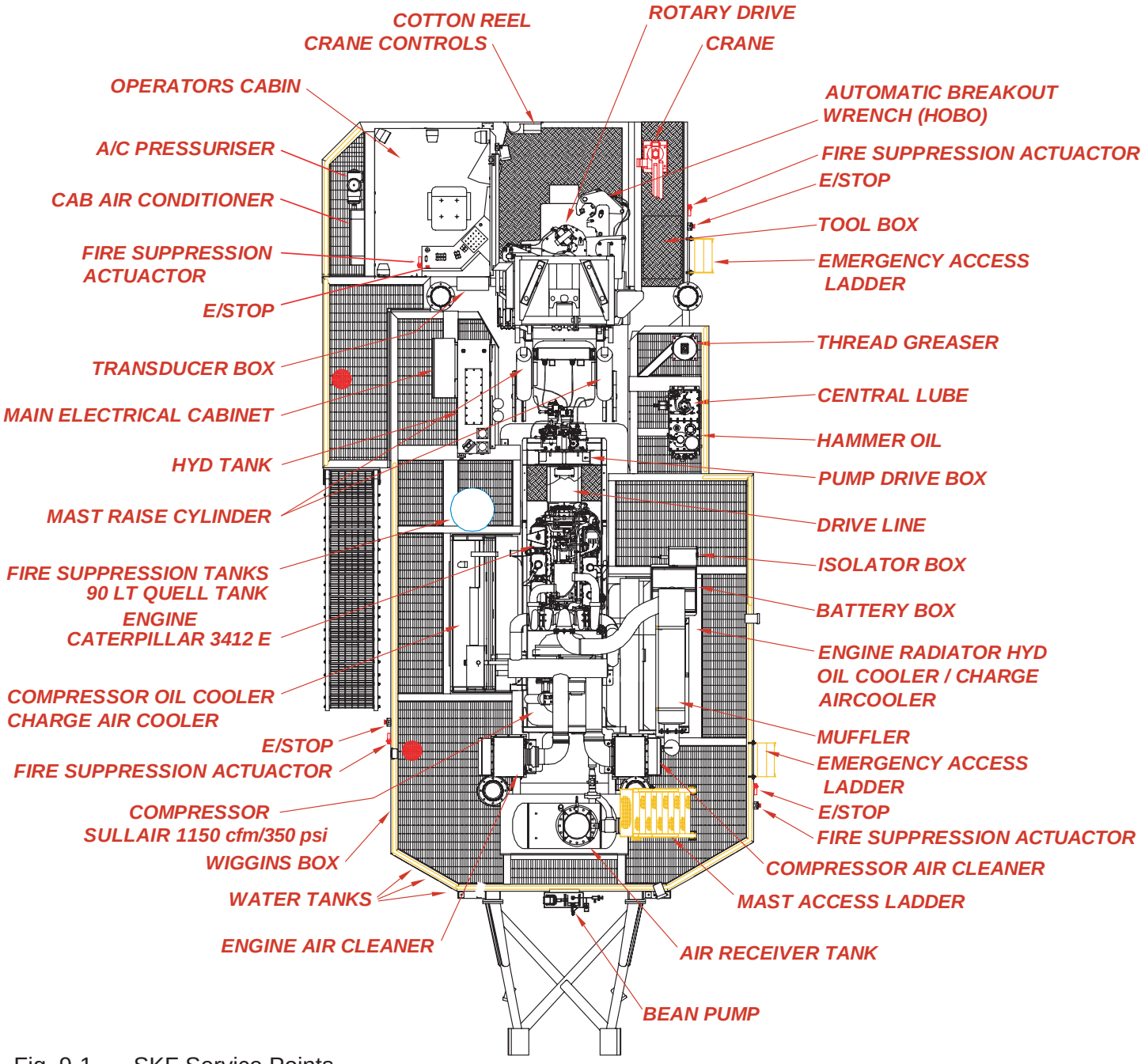
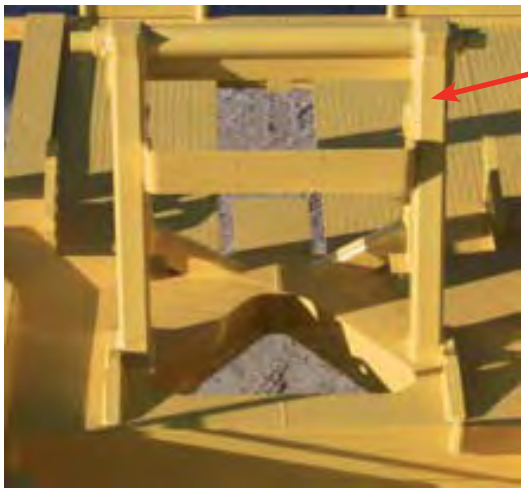
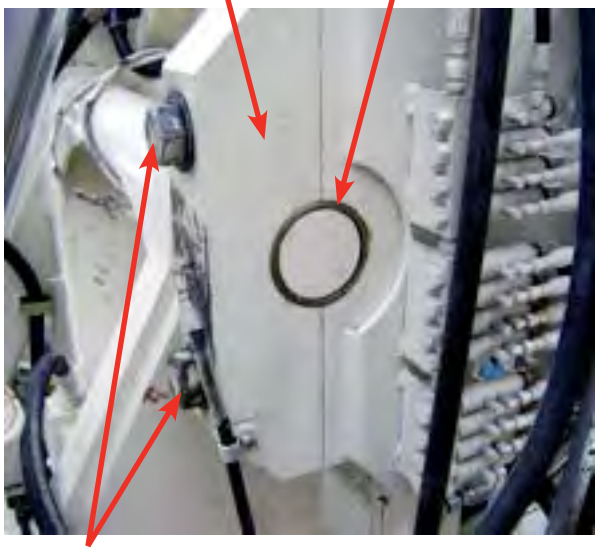


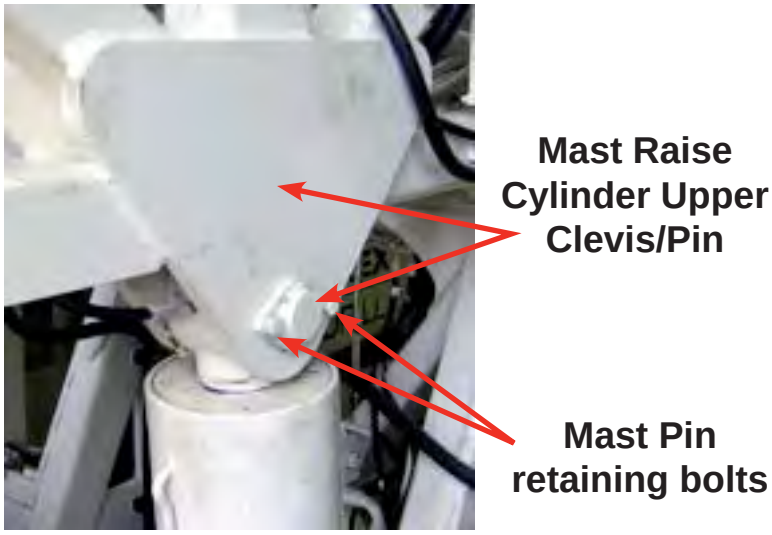
Fig. 9-1 SKF Service Points

Lubrication And Preventative Maintenance

A-Frame And Mast Pivot Point Checks and Maintenance







10hrs/Daily

- Check Mast A-Frame For Security And Damage
- Check Mast Raise Cylinder Pins For Security/Damage
- Check Pivot Caps For Security

500hrs

- Check Torque On Mast Pivot Cap Bolt (1363 ft/lbs)
  (Replace bolts if any movement is encountered to achieve correct tension)
- Check Condition Of Pivot Bushes

Lubrication And Maintenance Chart

Lubrication Service

1. Park the machine on a level surface
2. Rack rods and lower the head
3. Shut down engine
4. Relieve all hydraulic system pressure
5. Relieve all pneumatic (air system) pressure
6. **Isolate the machine**

Item	Task	Comments & Initials
1	**Engine Oil Filters** 1. Drain and replace engine oil. 2. Change engine oil filter 3. CHECK for oil leaks	
2	**Engine Fuel Filters** 1. Drain engine fuel water trap. 2. Change secondary fuel filter 3. Drain sediment from the fuel tank.	
3	**Engine Cooling System** 1. CHECK coolant, Level / Leaks 2. CHECK radiator cap condition. (p/n 0098489). 3. CHECK coolant level. 4. CHECK the condition of the radiator and clean if required. 5. CHECK system for any coolant leaks.	
4	**Engine Air Cleaner** 1. Remove primary element. 2. CHECK the safety element. 3. CHECK induction pipe-work for dust intrusion. 4. Remove the vacuator cups (1 used). 5. Clean the air cleaner housings 6. Fit clean primary elements 7. Clean the cups and refit. 8. Clean engine breather	

Lubrication And Maintenance Chart

Lubrication Service

1. Park the machine on a level surface
2. Set parking brake
3. Rack rods and lower the head
4. Shut down engine
5. Relieve all hydraulic system pressure
6. Relieve all pneumatic (air system) pressure
7. **Isolate the machine**

Item	Task	Comments & Initials
1	**Engine Oil Filters** 1. Drain and replace engine oil. 2. Change engine oil filter 3. CHECK for oil leaks	
2	**Engine Fuel Filters** 1. Drain engine fuel water trap. 2. Change primary fuel filter 3. Change secondary fuel filter 4. Drain sediment from the fuel tank.	
3	**Engine Cooling System** 1. CHECK coolant, Level / Leaks 2. CHECK radiator cap condition. (p/n 0098489). 3. CHECK coolant level. 4. CHECK the condition of the radiator and clean if required. 5. CHECK system for any coolant leaks.	
4	**Engine Air Cleaner** 1. Remove primary element. 2. Remove the secondary element. 3. CHECK induction pipe-work for dust intrusion. 4. Fit air cleaner protection plugs. 5. Remove the vacuator cups (1 used). 6. Clean the air cleaner housings 7. Change the safety element 8. Fit clean primary elements 9. Clean the cups and refit. 10. Clean engine breather	

Lubrication And Maintenance Chart

Lubrication Service - continued from previous page.
Refer safety conditions at the beginning of the section on page 6.

Item	Task	Comments & Initials
5	**Hydraulic System** 1. CHECK hydraulic filter indicators (these may pop when the fluid is cold). 2. Change charge system filters 3. Change return oil filters 4. Change hydraulic loop filters 5. CHECK hydraulic hoses for oil leaks or abrasion damage. 6. CHECK hydraulic oil level. 7. Change hydraulic tank breather	
6	**Hydraulic Oil Cooler** CHECK the condition of the compressed air system oil cooler and clean if required.	
7	**Hydraulic Pump Drive Gearbox** 1. Drain and replace pump drive gearbox oil.	
8	**Compressed Air System – Air Cleaner** 1. Remove primary element. 2. Remove the secondary element. 3. CHECK induction pipe-work for dust intrusion. 4. Fit air cleaner protection plugs. 5. Remove the vacuator cups (1 used). 6. Clean the air cleaner housings 7. Change the safety element 8. Fit clean primary elements 9. Clean the cups and refit.	
9	**Compressor Oil Cooler** 1. CHECK the condition of the compressed air system oil cooler and clean if required.	
10	**Compressor Oil Level** 1. Change compressor lubrication oil filter 2. Change compressor oil 3. CHECK the air system (pneumatic hoses) for leaks 4. Clean Separator scavenge tube stainer 5. Check air inlet valve oil level- top up with compressor oil	
11	**Mast** 1. CHECK integrity of mounting hardware and welded joints. 2. CHECK mast pivot pins and bushes for wear and lubrication. 3. CHECK torque of mast pivot cap bolts – any movement at all replace bolt lubricate threads and tension to 2371 ft/lb 4. Check carousel for damage and security	

Lubrication And Maintenance Chart

Lubrication Service - continued from previous page.
Refer safety conditions at the beginning of the section on page 6.

Item	Task	Comments & Initials
11	**Mast** 1. CHECK integrity of mounting hardware and welded joints. 2. CHECK mast pivot pins and bushes for wear and lubrication. 3. Remove and replace mast pivot cap bolts –lubricate threads and torque to 2371ft / lb	
12	**Rotary Gearbox (head)** 1. Drain and replace the rotary gearbox oil (85/140). 2. Air swivel, CHECK for leaks. 3. Shock sub (if fitted) lubricate 4. Rotary motors, check integrity 5. Rotary drive spindle, CHECK PRE LOAD 0.002 to 0.004”. Refer service manual and parts catalogue for details. 6. Rotary head wear pads, CHECK wear, replace as required, part # 0410860. Refer service manual and parts catalogue for details. 7. CHECK Rotary head mounting bolts 8. Check split pins on rope anchors for security	
13	**Pulldown Assembly** 1. CHECK and REPORT on the condition of the pulldown ropes. Adjust the pulldown ropes (if required) as per the service manual. 2. Change the Permalubes (Part # SIMAL01 x 4). 3. CHECK Travelling sheave mount bolts and feed cylinder wear pad bolts	
14	**Winch** 1. CHECK condition of the rope and hook. 2. Drain and replace oil (85/140)	Not in use
15	**Water Pump – Drill System** 1. Drain and replace oil in water pump 2. Clean the water pump strainer. 3. CHECK the condition of the coupling, (Part # 0043880K).	
16	**Undercarriage** 1. Clean and check the condition of the, tracks, rollers and sprockets. 2. CHECK the integrity of the track frame and axle mounting frame hardware.	
	3. Drain and replace the track drive gearbox oil (85W140)	Left / Right
	4. CHECK track chain adjustment and RECORD current dimension. RECORD adjusted dimension (refer service manual for details).	

Torque Values for Split Flange Connections

The following chart provides the tightening torques for split flange connections used in hydraulic systems. Split flanges and fitting shoulders should fit squarely. Install all bolts, finger tight and then torque evenly.

NOTE: Over-torquing bolts will damage the flanges and/or bolts, which may cause leakage.

		Bolt Torque	
Flange Size in Inches (*)	**Bolt Size in Inches**	**Newton Meters (N m)**	**Pound-Force/Foot (lbf.-ft.)**
1/2	5/16	20-24	15-18
3/4	3/8	30-37	22-27
1	3/8	37-47	27-35
1-1/4	7/16	47-61	35-45
1-1/2	1/2	62-79	46-58
2	1/2	75-88	55-65
2-1/2	1/2	107-123	79-91
3	5/8	187-203	138-150
3-1/2	5/8	159-180	117-133

NOTE: (*) Inside diameter of hydraulic tube or hose fitting

Palfinger Hydraulic Crane
Visual Inspections

2.1-1

-1 Daily Visual Inspection

Check the crane and its mounting once daily for visible defects, damages or alterations.

Carry out this inspection very carefully every time: alterations or damages not detected because of carelessness or old habits are a major source of accidents.

Carefully check:

- Screw fittings, connections, and other parts of the hydraulic system for damages or oil leaks.

Leaks of hydraulic oil may lead to dangerous accidents and cause considerable environmental damage and pollution.

- Whether bolts and screw fittings are properly fixed.
- For defective bolt connections
- The smoothness and the return motion of hand levers.
- Load bearing parts, accessories, load holding attachments (grab, winch etc.) for cracks and damages.
-
-
-
-
-

When such defects are detected, immediately cease operation of the crane.

-2 Daily Functional Tests of Safety Devices

If your crane is equipped with safety devices such as an emergency cut-off, an overload protection system or a rope winch limit stop, always carry out a function test on them before operation.

If the safety devices do not work, operation of the crane is strictly prohibited.

Carry out this inspection very carefully every time: carelessness and old habits are a major source of accidents.

Palfinger Hydraulic Crane
Optional Features

4.3-1

-1 Load Holding Attachments and Accessories

You can operate your crane with a variety of attachments such as mechanical extensions, special suspension, pallet fork, nylon straps, ropes, etc.

For more details, simply ask your PALFINGER service workshop.

Pay attention to the following:

- The capacity and dimensions of the attachment must be compatible with the crane.
- There must be, on the attachment, a symbol plate indicating: name of manufacturer, model, serial number, dead weight, operating pressure, volumetric capacity, admissible load and year of production.
- Carefully read the content of the operator's manual for the respective accessory.
- Before operating, ensure the attachment is always properly fixed on the crane.
- The overall max. admissible load is determined by the lowest max. admissible load of either the crane or the attachment.

Auxilary Crane

Palfinger Hydraulic Crane

PALFINGER Technical Information	PC 1300 Specifications	Page DT0130/03
		Page 01
		Edition 1/03/99

Max. Hubmoment: *Lifting moment:* Couple de levage:	12 kNm (1.2 mt) 8680 ft.lbs
Max. Hubkraft: *Max. lifting capacity:* Max. force de levage:	1140 kg 2510 lbs
Max. Hubkraft (CE): *Max. lifting capacity (CE):* Max. force de levage (CE):	990 kg 2180 lbs
Max. hydraulische Reichweite: *Max. hydraulic outreach:* Portee hydraulique maximale:	2.7 m (8' 10 9/16")
Max. Reichweite: *Max. outreach:* Max. portee:	3.5 m (11' 6 1/16")
Schwenkbereich: *Slewing angle:* Angle de rotation:	340° 340°
Schwenkmoment: *Slewing torque:* Couple de rotation:	3.2 kNm (0.33 mt) 2390 ft.lbs
Max. Betriebsdruck: *Operating pressure:* Pression d' utilisation:	19 MPa (190 bar) 2755 psi
Empfohlene Fördermenge der Pumpe: *Recommended pump capacity:* Debit de pompe recommande:	6 l/min 1.3imp. gal./min (1.6US gal./min)

Hydr. Ausschübe: *Hydr. boom extensions:* Extensions hydrauliques:	1	2	3	4	5	6
Max. Reichweite: *Max. outreach:* Max. portee:		2.7m 8' 10 5/16"				
+V		3.5m 11' 5 13/16"				
+V						
+V						
+V						
Krangewicht *Crane weight* Poids grue		165kg 364 lbs				
+2/4						
+V		177kg 390 lbs				
+V						
+V						
+V						

Konstruktionsänderungen vorbehalten, fertigungstechn. Toleranzen müssen berücksichtigt werden.
Subject to change, production tolerances have to be taken into account.
Les tolerances relatives a la technique de production doivent etre prises en cons consideration.

Lube Pump Air Motor

WARNING

ALWAYS check equipment for proper operation before each use, making sure safety devices are in place and operating properly. DO NOT alter or modify any part of the equipment as this may cause a malfunction and result in serious bodily injury.

BEFORE CONNECTING AIR MOTOR TO AIR LINE

LINCOLN SERIES III AIRMOTORS are fully pneumatic and require a minimum specified size of air supply hose for proper operation. Check specification for minimum ID. of the air supply hose and select corresponding sizes of air controls and accessories for non-restrictive air flow. Lincoln filter, regulator with gauge and lubricators are available as combination units (FRL).

For 3/8" air line - Model 85387-6
For 1/2" air line - Model 85387-8
For 3/4" air line - Model 85387-12

If quick disconnect coupling should be used, install supplied coupler to insure proper airmotor operation.

NOTE: Whenever flammable materials are pumped, ground Airmotor according to Local Codes.

OPERATING PRECAUTIONS

Use Lincoln replacement parts to assure compatible pressure rating.

Heed ALL warnings.

DO NOT OPERATE Airmotor in excess of recommended pressure range.

Disconnect air line and relieve (vent) pressure when Airmotor sits idle for long periods of time and before servicing.

WARNING

ALWAYS read and follow the fluid and solvent manufacturer's recommendations regarding the use of protective clothing and equipment.

WARNING

To reduce the risk of serious bodily injury or property damage. NEVER exceed the maximum air or fluid working pressure of the lowest rated system component.

ATTACHING AIRMOTOR TO PUMPTUBE

1. Tightly attach the tie rods (Item 41) to the Airmotor lower casting. Use short threaded end of tie rods.
2. Mount Airmotor on top of pump tube outlet and tightly connect pump tube coupling nut to Airmotor Piston Rod (Item 5).
3. Hand tighten tie rods to the pump tube with four nuts (Item 42) supplied with Airmotor.
4. Connect air supply and slowly cycle pump several times using only enough air pressure to operate pump without stalling.
5. STOP pump on "UP" stroke and tighten four nuts to securely fasten Airmotor to pump tube.

SERVICE AND DISASSEMBLY PROCEDURE

WARNING

Always disconnect air supply to Airmotor and relieve pressure before checking, servicing, or repairing any part of Airmotor

TOOLS REQUIRED

1. 7/64 (.109) Hex Wrench
2. 5/32 (.156) Hex Wrench
3. 3/16 (.189) Hex Wrench
4. 3/4 (.750) Open End Wrench (for 6" Airmotor)
5. 15/16" (.937) Open End Wrench (for 8" Airmotor)
6. 1/2" (.500) Open End Wrench (for 4-1/4" and 3" Airmotor)
7. 1-1/8" (1.125) Open End Wrench (for 10" Airmotor)
8. Pliers

The modular design of the Airmotor and accessibility of vital operation parts make service available without taking Airmotor out of line or without complete disassembly.

Power Valve

1. Remove four screws (Items 27 & 34) with 3/16" hex wrench (2 on each side).
2. Remove End Caps (Items 10 & 14).
3. Push out Valve Spool (Item 13).
4. Remove Spool Bumpers (Item 9) (One from each end).
5. Remove "O" Ring (Item 11) (One from each end of valve body).
6. Remove four Screws (Item 37) with 3/16" hex wrench and lift valve body (Item 12).
7. Remove Gasket (Item 15) to complete valve disassembly.
8. To REASSEMBLE, REVERSE procedure.

Pilot Bar Subassembly

1. Remove four Screws (Item 23)(two on each end) with 3/16" hex wrench and pull out Pilot Bar Subassembly.
2. Remove two Screws (Item 39), with 7/64" hex wrench and lift out Valve Body (Item 17).
3. Remove four Screws (Item 40)(two on each side of Pilot Bar) and lift off Upper Bracket (Item 31) and Lower Bracket (Item 32).
4. Remove Air Signal Valves (Item 20).
5. To REASSEMBLE, REVERSE procedure.

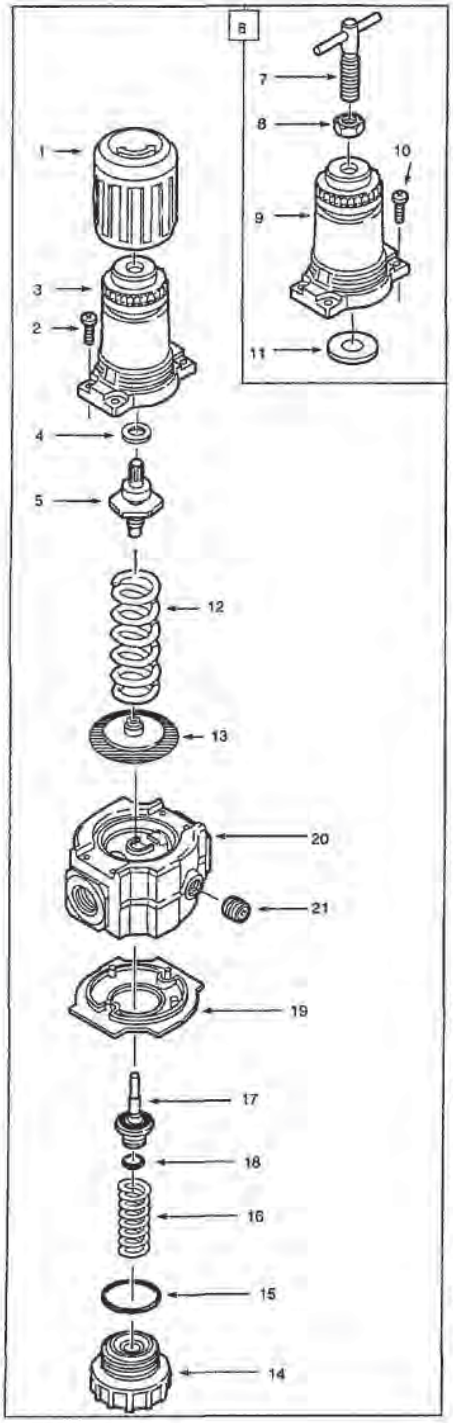
Cylinder Tube and Muffler

1. Remove Air Brakes Subassembly (See previous instructions).
2. Remove two Screws (Item 30) with 3/16" hex wrench and pull off Mufler (item 29).
3. Remove Gasket (Items 28).
4. Remove four Nuts (Item 26) with open end wrench.
5. Lift upward and remove Upper Casting (Item 8).
6. Remove four Tie Rods (Item 25).
7. Remove Air Tube (Item 7).
8. Lift upward and remove Cylinder Tube (Item 6).
9. Remove Piston and Piston Rod (Item 5).
10. Remove four Connecting Rods (Item 41) with open end wrench.
11. To REASSEMBLE, REVERSE procedure.

NOTE: Align two holes on the the Cylinder Tube (Item 6) with two holes on the Pilot Bar (Item 24) before tightening Tie Rods (Item 25) so that proper seal with "O"-rings is acheived.

Auto Lube System

Regulator Maintenance and Repair



TECHNICAL DATA
Fluid: Compressed air
Maximum pressure: 300 psig (20 bar)
Operating temperature: 0° to 175°F (-20° to 79°C)*

* Air supply must be dry enough to avoid ice formation at temperatures below 35°F (2°C).

Main ports: 1/2" PTF
Gauge ports: 1/4" PTF
Outlet pressure adjustment ranges:
Model 602009: 5 to 150 psig (0.3 to 10 bar)**
Model 602008:10 to 250 psig (0.7 to 17 bar)**

**Outlet pressure can be adjusted to pressures in excess of, and less than, those specified. Do not use these units to control pressures outside of the specified ranges.

Materials:
Body: Aluminum
Bonnet: Aluminum
Valve: Brass
Elastomers: Nitrile
Bottom Plug: Acetal

REPLACEMENT ITEMS AND ACCESSORIES
Service Kit (13, 15, 16, 17, 18)
Tamper resistant cover (knob adjustment only)

PANEL MOUNTING DIMENSIONS
Panel mounting hole diameter: 2.06" (52 mm)
Panel thickness: 0.06" to 0.25" (2 to 6 mm)

INSTALLATION
1. Install regulator in air line at any angle -
   - upstream of cycling valves,
   - with air flow in direction of arrow on body,
   - as close as possible to the device being serviced.
2. Connect piping to proper ports using pipe thread sealant on male threads only. Do not allow sealant to enter interior of regulator.
3. Install a pressure gauge or plug the gauge ports. Gauge ports can also be used as additional outlets for regulated air.
4. Install a general purpose filter upstream of the regulator.

ADJUSTMENT
1. Turn adjustment clockwise to increase pressure setting. Turn adjustment counterclockwise to decrease pressure setting.
2. Always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired pressure.
3. KNOB ADJUSTMENT. Push knob down to lock pressure setting. Pull knob up to release. Install tamper resistant cover (see ***Replacement Items and Accessories***) to make setting tamper resistant.
4. T-BAR ADJUSTMENT. Tighten lock nut (8) to lock pressure setting.

DISASSEMBLY
1. Shut off inlet pressure. Reduce pressure in inlet and outlet lines to zero.
2. Turn adjustment (1 or 7) fully counterclockwise.
3. Unit can be disassembled without removal from air line.
4. Disassemble in general accordance with the item numbers on exploded view.

CLEANING
1. Clean parts with warm water and soap.
2. Rinse and dry parts. Blow out internal passages in body with clean, dry compressed air.
3. Inspect parts. Replace parts found to be damaged.

ASSEMBLY
1. Lubricate o-rings, valve stem (17), tip of adjusting screw (7), and the outer circumference and both sides of the thrust washer (4) with a light coat of good quality o-ring grease.
2. Assemble the unit as shown on the exploded view.
3. Torque Table

	Inch-Pounds (N-m)
2, 10 (screw)	25 to 35 (2.8 to 3.9)
14 (bottom plug)	20 to 30 (2.3 to 3.4)

WARNING
These products are intended for use in industrial compressed air systems only. Do not use these products where pressures and temperatures can exceed those listed under ***Technical Data***.

If outlet pressure in excess of the regulator pressure setting could cause downstream equipment to rupture or malfunction, install a pressure relief device downstream of the regulator. The relief pressure and flow capacity of the relief device must satisfy system requirements.

The accuracy of the indication of pressure gauges can change, both during shipment (despite care in packaging) and during the service life. If a pressure gauge is to be used with these products and if inaccurate indications may be hazardous to personnel or property, the gauge should be calibrated before initial installation and at regular intervals during use.

Do not use these products with fluids other than air, for non industrial applications, or for life-support systems.

Pipe Thread Lubricator

TROUBLESHOOTING

If the following procedures do not correct the problem, contact a factory authorized service center. When submitting equipment to be repaired, be sure to state the nature of the problem and indicate if a repair cost estimate is required.

PROBLEMS

AIRMOTOR DOES NOT OPERATE.

- Check air supply to pump.
- Check for broken trip rod.
- Broken toggle or foreign object lodged in priming tube. Check for rust, worn or scored parts.

AIR SEEPAGE FROM AIR EXHAUST WHILE PUMP IS NOT OPERATING

- Check valve slide **(59)**, seat and gasket. Check trip rod packing **(67)** and gasket **(33)** for cut or damaged packing.

LOSS OF PRESSURE, VOLUME OR CONTINUOUS OPERATION OF PUMP WHEN NOT IN NORMAL USE.

- Remove and clean lower inlet checks. Check for foreign material.
- Inspect sealing surfaces between upper and lower inlet checks. Replace if rough or pitted.
- Replace shovel rod if rough or pitted. Replace shovel rod packing **(40)**.
- Inspect lubricant supply line for leaks or breaks.

LUBRICANT LEAKING FROM WEEP HOLE IN OUTLET CASTING.

Replace O-ring **(39)** and U-cup **(42)**. Make sure gland nut **(23)** is tight.

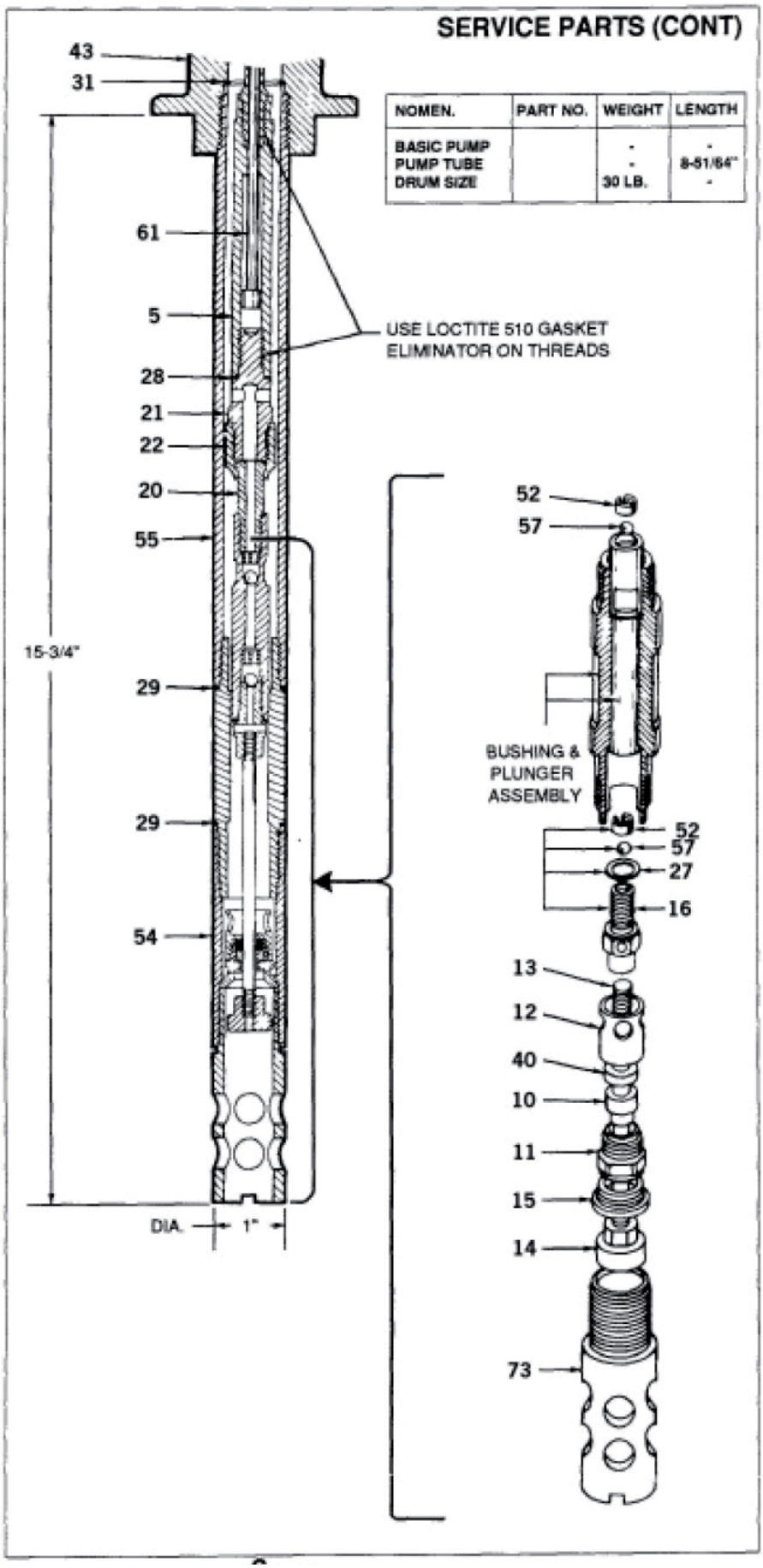
EXCESSIVE AMOUNT OF AIR IN LUBRICANT OR EXCESSIVE AMOUNT OF LUBRICANT COMING FROM AIR EXHAUST.

> **NOTE**
> Some lubricant exhausts with air normally.

- Replace gland packing **(37)**, gland gasket **(30)**, O-ring **(39)** and U-cup packing **(42)**.

SERVICE PARTS (CONT)

NOMEN.	PART NO.	WEIGHT	LENGTH
BASIC PUMP		-	-
PUMP TUBE		-	8-51/64"
DRUM SIZE		30 LB.	-



Hammer Oil System

⚠ WARNING

INJECTION HAZARD

Fluid from the dispensing valve, leaks, or ruptured components can inject fluid into your body and cause extremely serious injury, including the need for amputation. Fluid splashed in the eyes or on the skin can also cause serious injury.

- Fluid injected into the skin may look like just a cut, but it is a serious injury. **Get immediate surgical treatment.**
- Do not point the dispensing valve at anyone or at any part of the body.
- Do not put your hand or fingers over the end of the dispensing valve.
- Do not stop or deflect leaks with your hand, body, glove or rag.
- Use only extensions and no-drip tips that are designed for use with your dispensing valve.
- Tighten all fluid connections before you operate this equipment.
- Check the hoses, tubes, and couplings daily. Replace worn or damaged parts immediately. Do not repair high pressure couplings; you must replace the entire hose.

HAZARDOUS FLUIDS

Improper handling of hazardous fluids or inhaling toxic fumes can cause extremely serious injury, even death, due to splashing in the eyes, ingestion, or bodily contamination.

- Know the specific hazards of the fluid you are using.
- Store hazardous fluid in an approved container. Dispose of hazardous fluid according to all local, state, and national guidelines.
- Always wear protective eyewear, gloves, clothing, and respirator as recommended by the fluid and solvent manufacturer.

FIRE AND EXPLOSION HAZARD

Improper grounding, poor ventilation, open flames or sparks can cause a hazardous condition and result in a fire or explosion and serious injury.

- Ground the equipment. Refer to **Grounding** on page 6.
- If there is any static sparking or you feel an electric shock while you use this equipment, **stop dispensing immediately.** Do not use the equipment until you identify and correct the problem.
- Provide fresh air ventilation to avoid the buildup of flammable fumes from solvents or the fluid being dispensed.
- Do not smoke in the dispensing area.

MOVING PARTS HAZARD

Moving parts can pinch or amputate your fingers.

- Keep clear of all moving parts when you start or operate the pump.
- Before you service this equipment, follow the **Pressure Relief Procedure** on page 7 to prevent the equipment from starting unexpectedly.