



Technical Manual

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SAFETY PRECAUTIONS

The owner and/or operator must replace any and all safety and warning product graphics if they are defaced or removed from the machine.

Before doing any work on the machine, a qualified electrician must lock out or remove the electric power supply from the machine and tag it so personnel are aware that someone is working on the machine.

Do not start an engine indoors unless adequate exhaust ventilators are provided. Once an engine is running, move the machine outdoors as soon as possible.

Keep hands, feet, and clothing away from rotating parts.

Do not move or operate the machine without knowing the location and purpose of all personnel, plus test or support equipment, in or near the machine.

Think before you act. Carelessness is one luxury the service man cannot afford.

Do not wear rings, wrist watches or loose fitting clothing when working on machinery. They could catch on moving parts causing serious injury. Never adjust and/or service a machine in bare feet, sandals or sneakers.

Always wear safety glasses when using a hammer, chisel or other tools that may cause chips to fly.

Excessive or repeated skin contact with sealants or solvents may cause skin irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water.

Never utilize the machine air or hydraulic systems for support when working on the machine. Deactivate and isolate the system prior to performing maintenance.

Equipment should be parked on level ground at all times during machine servicing and periods of idleness.

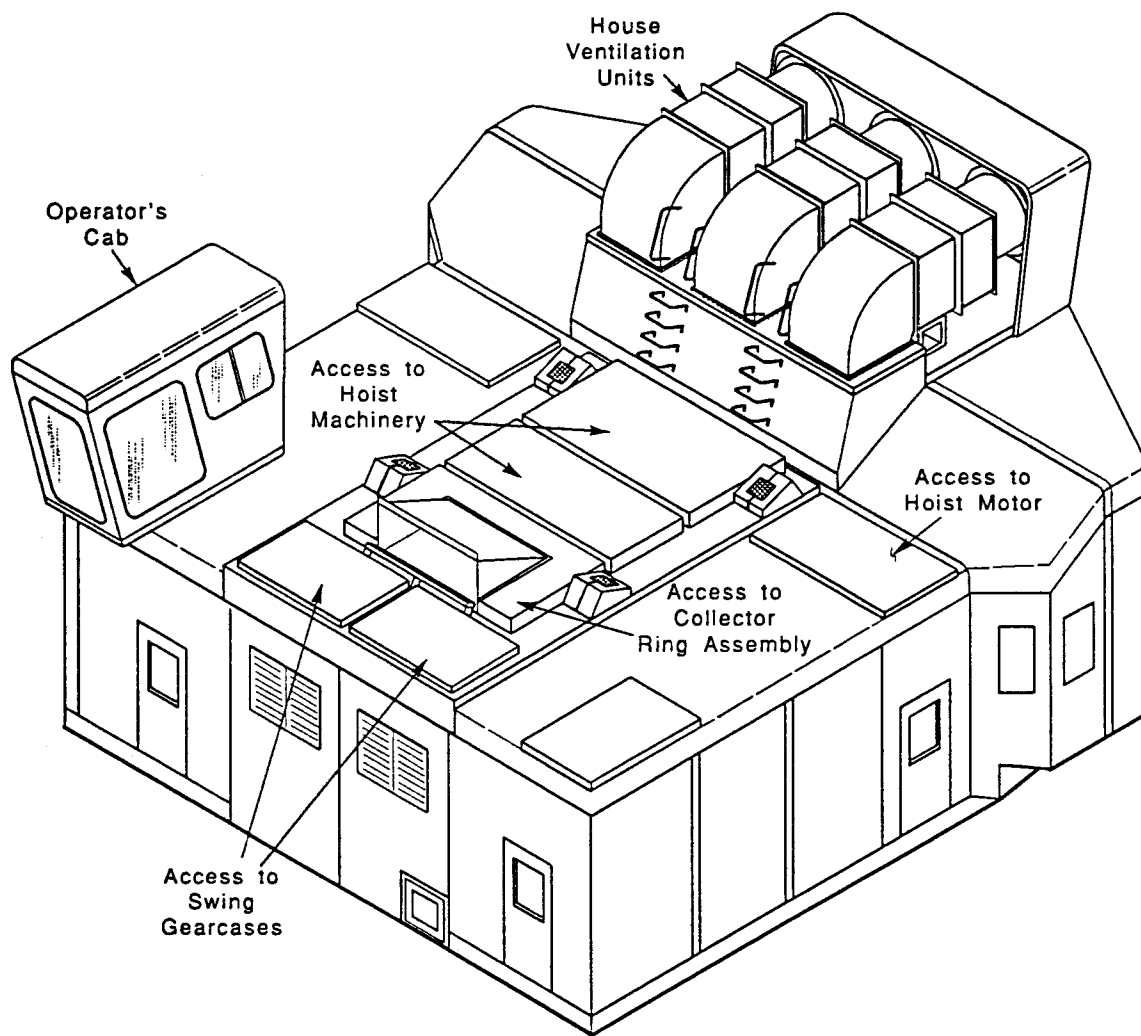
Cranes and hoists must be of sufficient capacity to lift the heavier components (gear cases, dipper/bucket, boom, etc.) and have an ample safety margin.

Be sure heavy items are properly supported from cranes or hoists before removing supporting members from machine.

Have sufficient service personnel available when removing or installing large heavy items to maintain control at all times.

Always use safety stands in conjunction with hydraulic jacks or hoists. Do not rely on the jack or hoist to carry the load, they could fail.

Use safety catch on all hoist hooks. Do not take a chance, the load could slip off of the hook.



301-M MACHINERY HOUSE NOMENCLATURE

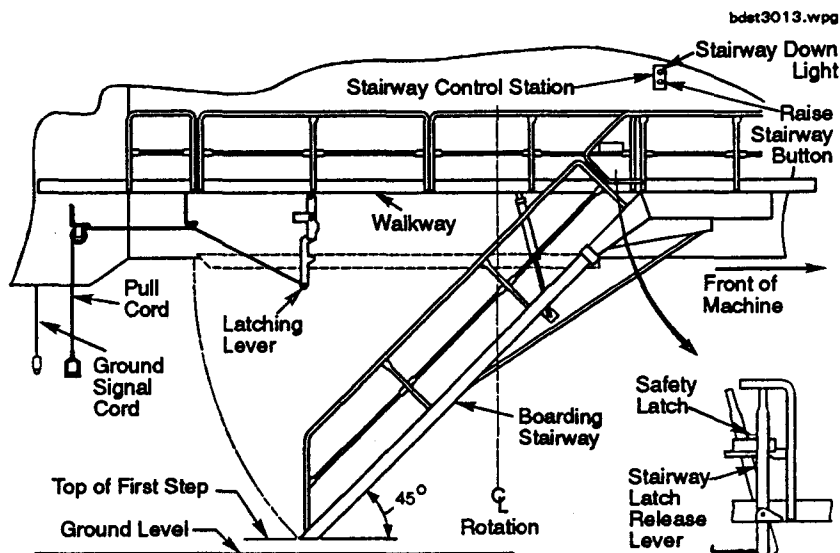
Operation

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BOARDING STAIRWAY

The stairway for boarding the machine is normally located on the right side of the machine. The stairway *must* be in the up and latched position during operation. When the machine has an optional stairway on the left side, both stairways must be in the up and latched position during machine operation.



PULL CORD: Lowers the walkway to ground level.

GROUND SIGNAL CORD: Raises the walkway from the ground AND activates the audible alarm in the cab.

LATCH RELEASE LEVER: Controls walkway lowering from head of stairway.

LEVER SAFETY LOCK: Prevents the operation of the latch release lever.



CAUTION! The lever on the walkway handrail must be returned to its original position manually, and the hinged, safety lock manually returned to its locked position, to prevent accidental lever movement resulting in the stairway lowering.

STAIRWAY CONTROL STATION: A Green light indicating the stairway is down. Push the button to raise the stairway.



DANGER: Never board the stairway until it is completely lowered. Boarding the stairway while it is in motion can cause personal injury.

LOWER LIMIT: Prevents L.E. activation and lights the red ladder down indicator on the cab annunciator panel.

UPPER LIMIT: Prevents accidental lowering while the machine is in operation. Activates the green indicator on the control station when the ladder is down.

NOTE: When the ladder is in the *UP* position, the control valve is energized 42 seconds after L.E. is activated, to prevent inadvertent lowering of the ladder while the machine is in operation.

- **FINAL HOIST LIMIT** - The dipper has been raised to an unacceptable position, the hoist motion has stopped and the brakes set automatically. Indicates one of the following:

- Motion limit controller is not properly calibrated.
- Hoist control malfunction.

To clear the limit:

Slowly and with caution, to prevent continued raising of the dipper, push in and hold the **EXCITATION START** button and slowly **LOWER** the hoist until the fault clears.

GROUND FAULT - Indicates a ground or earth leakage exists in one of the following:

- High Voltage Circuit
- Drive Bus
- Auxiliary Bus
- Lighting Bus
- One of the Power Converters

To pin point the malfunction see the auxiliary panel door in the right wing for the circuit which has an earth leakage fault.

HOIST MOTOR OVERTEMP - The hoist motor is too hot. Leave the blowers on and rest the hoist motion until the light goes out.

CROWD MOTOR OVERTEMP - One or both of the crowd motors is too hot. Leave the blowers on and rest the crowd motion until the light goes out.

SWING MOTOR OVERTEMP - One or both of the swing motors is too hot. Leave the blowers on and rest the swing motion until the light goes out.

PROPEL MOTOR OVERTEMP - One or both of the propel motors is too hot. Leave the blowers on and rest the propel motion until the light goes out.

BOARDING SIGNAL (flashes) - Somebody is pulling one of the ground signal cords.

CENTRAL PROCESSING UNIT (CPU) - Light indicates a malfunction in the Series 6 computer and the machine has been shut down.

POWER CONVERTER FAULT - One of the power converters has been shut down due to a fault. See the auxiliary cabinet door on the right wing for the identity of this power converter.

STOP ALL MOTIONS - A major fault has been detected in the electrical system and the shovel will be automatically stopped in approximately five (5) seconds. Place the dipper in a safe position, preferably on the ground, as quickly as possible.

2.4 OPERATOR CONTROLS in the MACHINERY HOUSE

The controls used for start-up and/or shutdown of the machine are located in the machinery house. The panel with these controls is mounted on the outside of the motor control center No.1 at the rear of the right wing. Refer to the included illustration. This panel contains the following:

PROPEL ETM - A meter which shows the machine time in the PROPEL mode.

MACHINE ETM - an elapsed time meter that shows total machine operating hours with excitation (L.E.) on.

AUXILIARY BUS - an A.C. voltmeter that indicates the voltage on the secondary side of the auxiliary transformer.

MAIN CONTACTOR AND RPC FANS - two pushbuttons for control of power to the main transformer which supplies power to the machine's operating drives, and for starting the Reactive Power Compensator Power Conversion Module fans.

- **CLOSE** button closes the contacts in the contactor, energizes the transformer and starts the RPC fans; its green indicator shows they are "on" when lit.

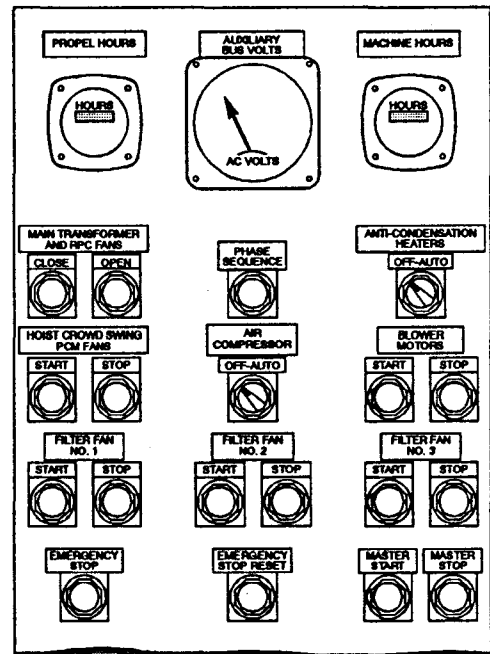
NOTE: This control is inoperative unless the green indicator in the **EMERGENCY STOP RESET** pushbutton (see below) is lit.

- **OPEN** button opens the contacts in the contactor, de-energizes the main transformer, and stops the RPC PCM fans.

PHASE SEQUENCE - a red indicating light which, if illuminated, indicates a phase sequence error in the power supply. Electrical interlocks will prevent machine start-up if phase reversal exists. This has a "push to test" feature for checking the light.

ANTI-CONDENSATION HEATER - a two position selector switch. **AUTO** position, automatically energizes the heaters when the machine is shut down. **OFF** position turns them off. These heaters should be used during periods of high humidity or low temperatures. (See illustration).

PCM FANS - **START** and **STOP** pushbuttons for control of the cooling fans for the power convertor modules. The green indicator in the **START** button show they are energized.



STARTING PANEL

Section 3

Lubrication

3.1 LUBRICATION PRINCIPLES

The proper lubrication of this machine is vital to its successful, continued operation. Application of the *CORRECT* lubricant in the *CORRECT* amount at the *CORRECT* place as part of a *PROVEN* maintenance program is required to keep the machine operating at a level of productivity that will make your mining operation profitable. Proper lubrication will provide better component service life and reduce repairs and downtime. When not properly lubricated, moving parts wear quicker and fail sooner.

The major portion of this machine is lubricated by an automatic system that dispenses lube to selected points at pre-selected, timed intervals during machine operation. This system is covered in more detail further on in this section. It is important to the operation of this auto lube system that you become familiar with it and understand its operation so you can maintain and service it and keep it operable. It is also necessary that you periodically inspect on a regular basis the lubed points for lubricant application to insure the system is performing its job.

Some components, due to their location and function, can not be readily covered by the auto lube system. A listing of these manually lubed areas that shows the lube application frequency is given in this section. You should become familiar with these points so you can service them properly at the intervals listed. A listing of the parts covered by the automatic lubrication system is also included.

Per Marion standard, the *Lubrication Fittings* used for manual service are the hydraulic type, push-on fittings, having .125 inch or .250 inch NPT threads.

Bushings and Bearings operating in a highly contaminated atmosphere (dust, grit, etc.) should be lubed until clean grease seeps out around the journal or seal, or comes out the purge fitting if one is provided.

Overfilling an anti-friction bearing can cause it to run excessively warm. After lubing anti-friction bearings, especially those that are sealed such as in electric motors, remove the pressure fitting, or the relief plug when provided, and allow the bearing to purge itself of any excess lube during the first 10-15 minutes of operation. Replace the fitting or plug after that time.

Grease in a bearing generally deteriorates gradually, not suddenly. Only a small amount needs to be added to it at regular intervals to maintain the proper lubricant level. Adding a small quantity of grease to the bearing every 600 operating hours, unless otherwise specified, is adequate.

AUTOMATIC OPERATION

An automatic lubrication cycle for any of the 5 auto lube circuits is defined as the time from the start of one lubrication cycle to the start of the next.

FAULT DETECTION AND INDICATION

This automatic lubrication system is continuously monitored and indications are given for the following:

- Machine operating mode.
- Lubrication in process.
- Lubrication system fault.
- Programmable controller fault.
- Air pressure fault.

The PC monitors the auto lube system when power is *ON*. Indications are provided by lights. Fault lights are accompanied by an audible alarm. Fault annunciation is provided on the front of the auto lube control panel, the operator annunciator panel in the cab and on the monitor annunciator panel on the auxiliary cabinet.

Each of the 5 auto lube supply circuits contains an alarm time (the crawlers lube has two). If the pressure switch contacts in the lube circuit being serviced do not open before the programmed alarm time, a fault is announced. The air solenoid valve for the lube pump and the control valve for the lube supply circuit are de-energized.

A fault will be indicated on the annunciator panel and OIT in the operator's cab, on the auxiliary cabinet and the lube control panel. A flashing pressure switch light on the lube control panel indicates a fault and the circuit(s) in which the fault has occurred. The pressure switch light will be *ON* (steady) when the circuit(s) is cycling. When *ON*, the air pressure fault light indicates that the lube pump air pressure is too high.

Using the Annunciator *SILENCE* button on the operator console in the cab to silence the alarm horn will also reset the fault. This will allow the auto lube control to automatically cycle the affected system again when its interval cycle timer counts out. Pressing the *SILENCE HORN* button on the auto lube control panel will only silence the alarm horn. The affected lube supply system will not reset and the fault indicating light(s) will remain on. The faulted circuit may be started in either situation by using the manual cycle sequence.

PROGRAMMABLE CONTROL

The autolube system is controlled by a programmable controller located in the auxiliary cabinet on the R.H. wing. An operators interface terminal (OIT) on the front of this cabinet or in the operator's cab provides access to the programmable controller for resetting the cycle and alarm times. For instructions, refer to the *ELECTRICAL SERVICE MANUAL* for this machine.

AIR OPERATED LUBE PUMPS

NOTE: The AIR PRESSURE REGULATOR and AIR SOLENOID VALVES used in this automatic lubrication system are covered in Section 5 - *THE COMPRESSED AIR SYSTEM* in this manual. Refer to it for more detailed information.

The pumps supplied in this system are Lincoln Power-Master 4 Model 1910. This is a reciprocating pump powered by an airmotor. It has a 50:1 lubricant to air pressure ratio. Each airmotor is equipped with mufflers.

WARNING

DO NOT exceed the 200 PSI working pressure of the airmotor or the lowest rated component in your system.

DO NOT alter or modify any part of this equipment.

DO NOT operate this equipment with combustible gas.

DO NOT attempt to repair or disassemble the equipment while the system is pressurized.

TIGHTEN all fluid connections securely before using this equipment.

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

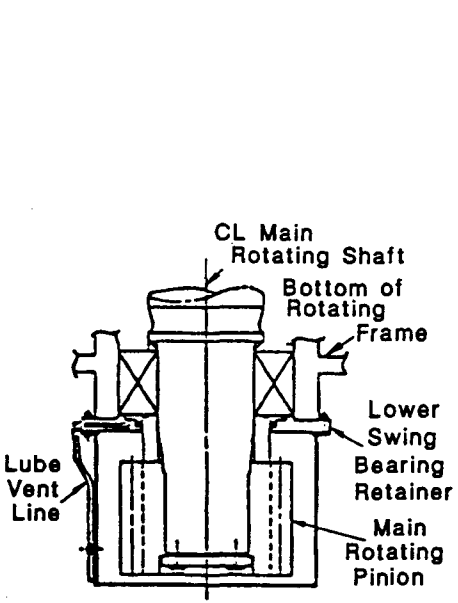
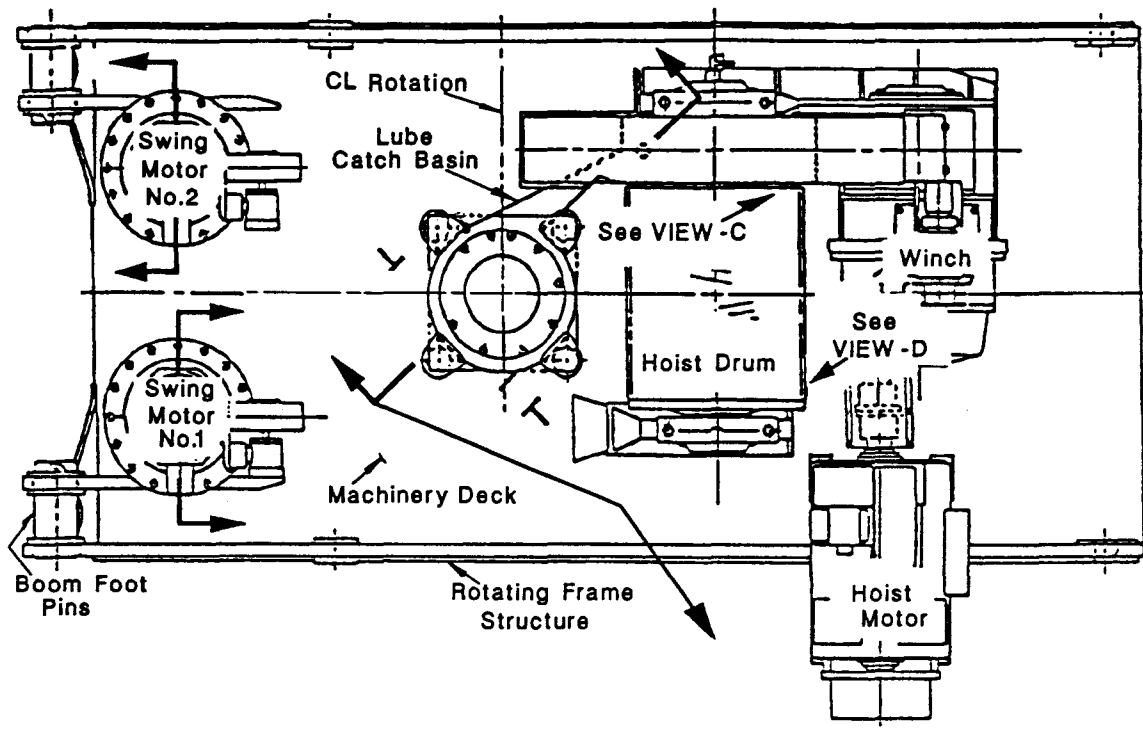
CHECK all equipment regularly and repair or replace worn or damaged parts immediately.

IMPORTANT: Failure to heed these warnings including misuse, overpressurizing, modifying parts, using incompatible chemicals and fluids, or using worn or damaged parts, may result in equipment damage and/or serious personal injury, fire, explosion or property damage.

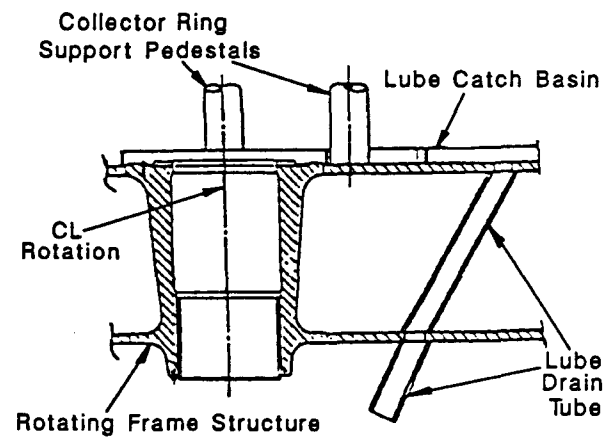
These pumps are durable and will give adequate service life. When a pump will not stall with its lube discharge port blocked (plugged), then the pump should be rebuilt. Kits are available to rebuild the pumps. Refer to the Parts Book for parts information.

OPERATING PRECAUTIONS:

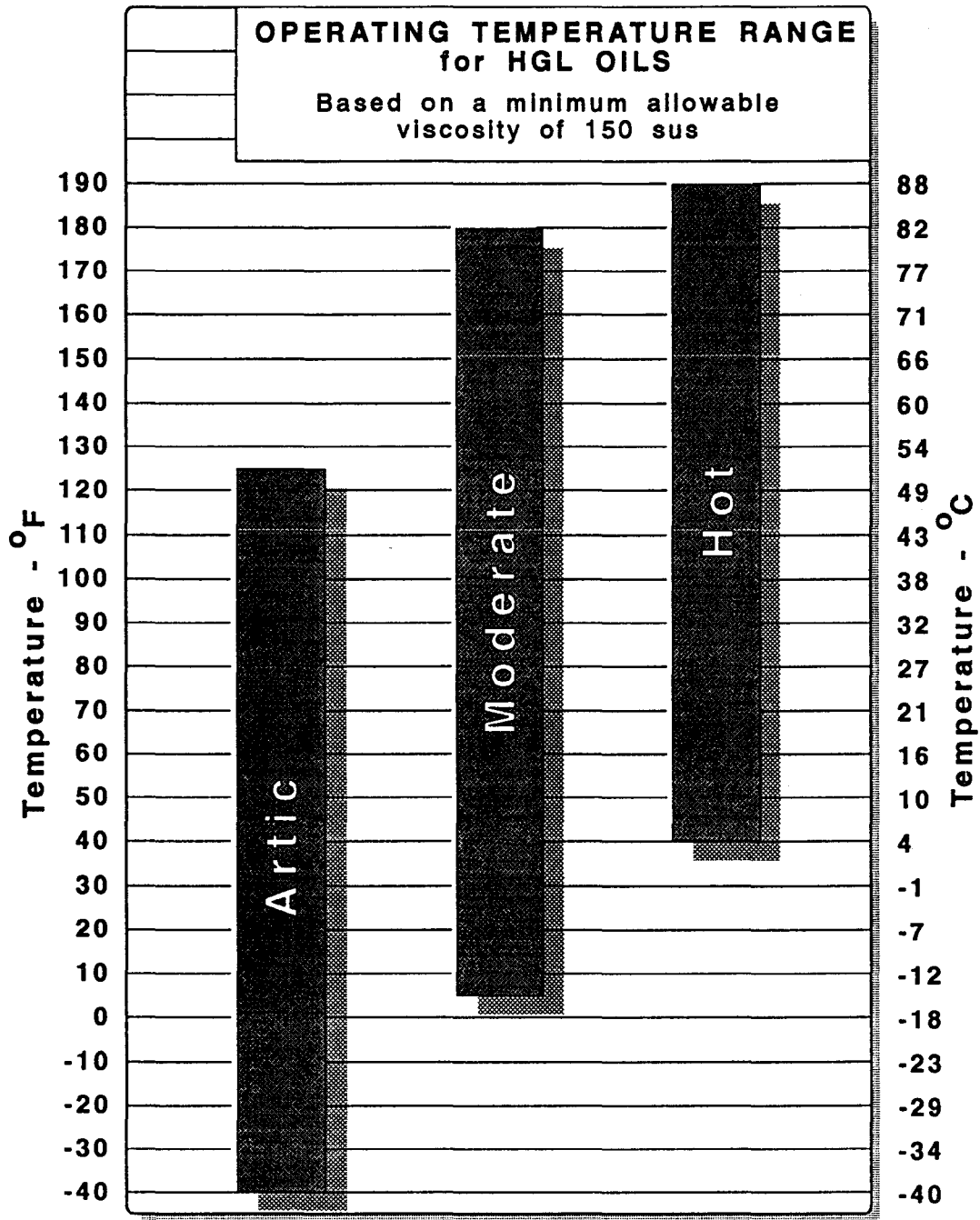
- The pump service life and efficiency will be reduced if the pump strokes per minute exceed 75.
- Add an air line restriction to limit the strokes if required.
- Before servicing or cleaning the pump, disconnect the air lines and bleed off the system pressure.
- To prime the pump, open the output line and *slowly* cycle the pump until all air is pushed out of the lines and lube fills the pump tube. Check that the pump will stall at operating pressure.



**Section A-A
 SWING BEARING
 LUBE VENT
 (Typical 2 places)**



**DRAINAGE SYSTEM for the
 HOIST MACHINERY
 and CENTER JOURNAL LUBE**



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OIL TEMPERATURE

Gear Lubricant	°F		°C	
	Min.	Max.	Min.	Max.
HGL Arctic	-40	+122	-40	+50
HGL Moderate	+5	+180	-15	+82
HGL Hot	+40	+190	+4	+88

MANUAL LUBE POINTS - (continued)

NAME OF PART	TYPE	NO. OF POINTS	LOCATION	LUB. SYM.	METHOD & FREQUENCY
Motor Couplings	Steelflex	2	Fill through Plug in Covers	LTG	Keep Full; Check Qtrly. (1250 hrs.)
Crowd Gearcase CAPACITY - 6.3 U.S. gal. ea. (24 liters) With Oil Cooler - 14.3 U.S. gal.(54 liters)	Planetary	2	Fill through Top Plug Hole to Oil Level Plug in Side of Case	HGL	Check Weekly (100 hrs.); Change Semi-Annually (2500 hrs.)

NOTE: Change oil in new or rebuilt crowd gearcase after initial 100 hours (1 week) of machine operation. Thereafter, change it every 2500 hours or as indicated by oil sample analysis. Maximum replacement interval is once per year. Flush gearcase before refilling it with new oil.

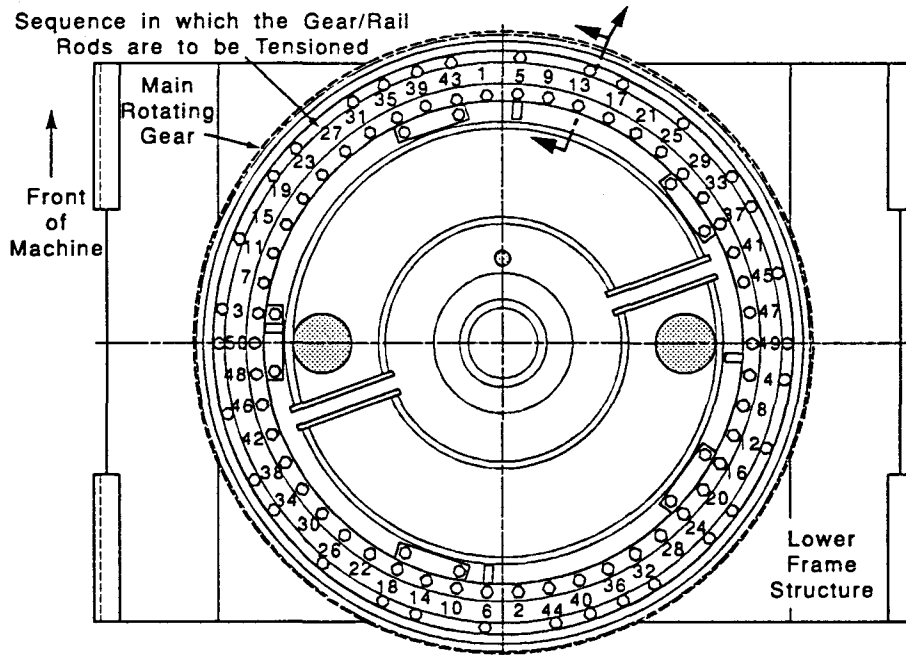
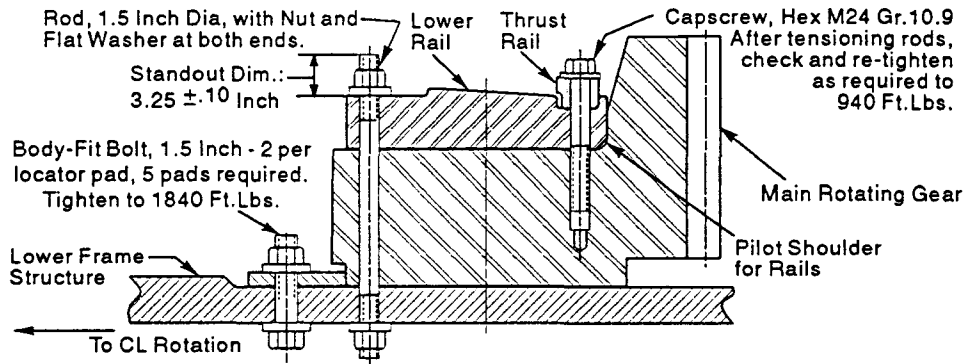
DIPPER/HANDLE

Hoist Rope Sheaves	Steel Bushing	2	End of Pin	MPG	Twice per Shift (4 hrs.)
Dipper Door Hinges	Bushing	2	End of Pin	MPG	Twice per Shift (4 hrs.)
Trip Lever	Plain	2	Through Boss	MPG	Twice per Shift (4 hrs.)
Trip Chain Shackle Pins	-	2	Apply to Part	MO	Twice per Shift (4 hrs.)
Dipper Door Latch Bar	-	3	Apply to Surfaces	MO	Twice per Shift (4 hrs.); Keep Coated
Trip Rope Shackle Pin	-	1	Apply to Part	MO	Twice per Shift (4 hrs.)
Trip Rope	Wire	1	at Trip Lever	WRL	As Needed
Trip Lever Pin @ Latch Bracket	-	1	Apply to Part	MO	Keep Coated; at least Weekly (150 hrs.)
Dipper to Handle Pins	Plain	4	End of Pin	MPG	Before Removal or Qtrly. (1250 hrs.)

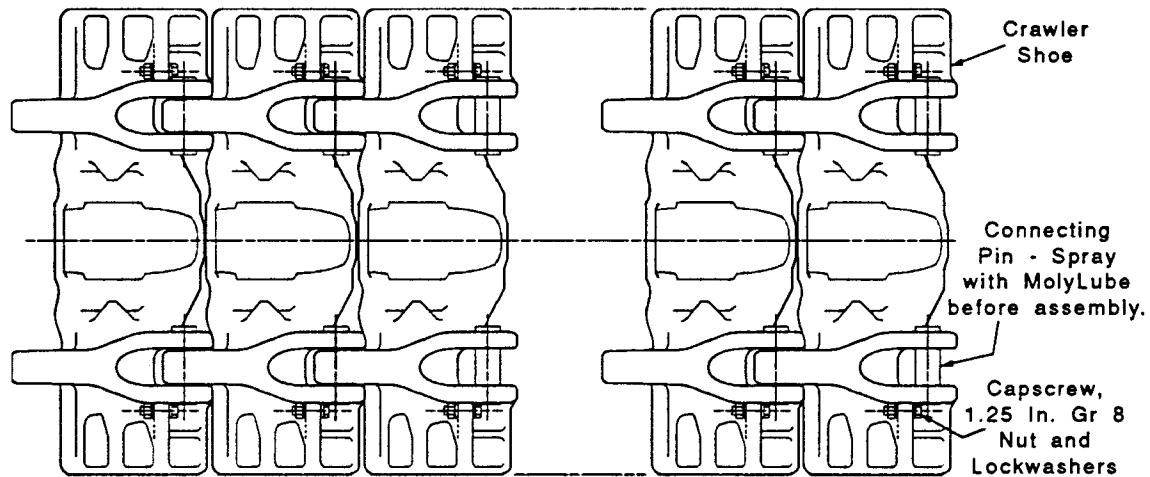
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PROCEDURE FOR USE OF HYDRAULIC TENSIONER ON RODS:

1. Seat the rails against the pilot shoulder in the gear with equal gaps between the rail ends.
2. Install capscrews through the rails into the gear. Tighten to 940 Ft-lbs. before tensioning the rods.
3. Install the 1.5 In. rods to the standout dimension. See the section view. Rod threads should be clean and the fit of the nuts on the rods should be very free.
4. For hydraulic tensioner operation, refer to Section 10 - OPERATION AND MAINTENANCE, INSERT TYPE JACKING TOOL. During all tensioning operations, observe the operation of the tensioner to be sure that maximum stroke is not exceeded.
5. Tension the gear/rail rods in 4 steps:
 - 5.1 Tension the rods to 70,000 Lbs., ref. 1750 Ft-lbs., in the sequence shown. Turn the nut down using the tensioner drive gear mechanism. When the nut bottoms, seat it with a firm twist of the drive gear.
 - 5.2 Re-tension the rods in sequence to 100,000 Lbs., reference 2500 Ft-lbs. and tighten the nut.
 - 5.3 Before moving on to the next rod, relax the tensioner, wait one minute, then bring the tensioner back to 100,000 Lbs. and tighten the nut. If necessary, repeat the procedure in steps 5.2 and 5.3 for each rod in the sequence shown until all the rods are tensioned to 100,000 Lbs.



MAIN ROTATING GEAR INSTALLATION



CRAWLER BELT ADJUSTMENT - BELT TENSION

1. Propel the machine forward on level ground until most of the slack in the crawler belt is on top of the crawler.
2. Safely park the machine. Remove the auto lube line from the end of the front idler shaft.
3. Position 2 identical hydraulic jacks to the rear of the adjusting blocks on each side of the front idler in the crawler side frame. Seat the jack ram into the counterbore provided in the adjusting block.
4. Remove the 2 shim retainer bars on each side to free the shims, and remove the shims from the storage space in front of each adjusting block.
5. Extend both hydraulic jacks in unison to move the front idler assembly forward to tighten the belt. Do not permit the adjusting blocks to mis-align in the side frame.
6. Tighten the belt until all slack is removed and the crawler shoes start to lift off any slide bar.
7. Insert shims into the space on each side behind the adjusting blocks until a gap of 1.5 inches (38 mm) exists between the shims and the blocks.

NOTE: Shims of the same thickness and quantity must be used in the space on each side to maintain correct idler alignment in the crawler.

8. Release both hydraulic jacks and remove them from the crawler.
9. Put the remaining shims in the storage space in front of each adjusting block. Reassemble the shim retainer bars to the crawler. Reconnect the auto lube line.

FRONT IDLER ROLLER

The front idler roller carries the machine weight in conjunction with the load rollers. Each roller turns about the idler shaft on bronze bushings. The idler shaft mounting consists of slide blocks which can be moved to the front or rear to compensate for crawler belt wear. Shims located on either side of each slide block are used to maintain the roller position. To remove the front idler:

1. Park the machine in a level area leaving several inches of clearance under the front idler to be removed.
2. Rotate the rotating frame to provide crane access to crawler belt and idler.
3. Remove the shim retainer bars, lube lines and shims ahead of the slide blocks.
4. Using the jacks provided, push the slide blocks forward to allow removal of the remaining shims.
5. Release the belt tension by slowly releasing the jack pressure to allow the slide blocks to move to their rearmost position.

NOTE: Each jack must be released at the same rate to prevent binding.

6. Separate the crawler belt behind the top of the idler and lay shoes out on the ground.



DANGER: Secure the crawler belt before separating it so unexpected movement under its own weight is prevented. Failure to secure the belt could result in bodily injury or death.

7. Support the idler (approx. 5100 Lbs.) with a crane and remove the locking pins, slide blocks and shaft. The spacers and thrust washers will fall out as the shaft is removed.



CAUTION: Stand clear of the area as the shaft is removed to prevent injury.

8. Lift the idler clear of the crawler frame.
9. Inspect all parts for wear or damage. Replace or repair as required.
10. Installation of the front idler is the reverse of removal.

NOTE: Install the idler shaft with the groove toward the front of the crawler and the lube hole up.

11. After installation, lubricate and check auto-lube. Adjust belt tension.

21. Reassembly is the reverse of disassembly.

- a. Replace all seals and bearings.
- b. Coat the internal and external spline surfaces and all pilot surfaces with Molylub-Alloy grease paste (P/N 480206-3) or an equivalent.
- c. The inner race for the outboard bearing on the main propel shaft may be heated to fit it to the shaft. Use a dry heat source and do not heat the race over 250° F (121° C). Allow the race to cool to ambient temperature before installing the rest of the bearing.
- d. Lube access on both bearing retainers of the main propel shaft must be installed on a horizontal centerline toward the front of the crawler.
- e. Shim the gaps as indicated on the accompanying sketches.
- f. Pack the rear of the spline cavity in the propel gearcase for the main propel shaft with 1 pint (.5 liter) of Molub-Alloy grease paste (P/N 480206-3) or an equivalent.
- g. Fill the bearings and cavities manually with MPG lube at assembly. Reconnect and purge the lube line.
- h. Observe the match marking when installing the sprocket and propel gear case, and when assembling the propel motor coupling.
- j. Propel motor coupling reassembly can be assisted by releasing the brake with the manual override on the air control valve to allow the motor shaft to rotate freely.

22. Reconnect the crawler belt and adjust the belt tension. Reinstall the walkway to the front of the wing.

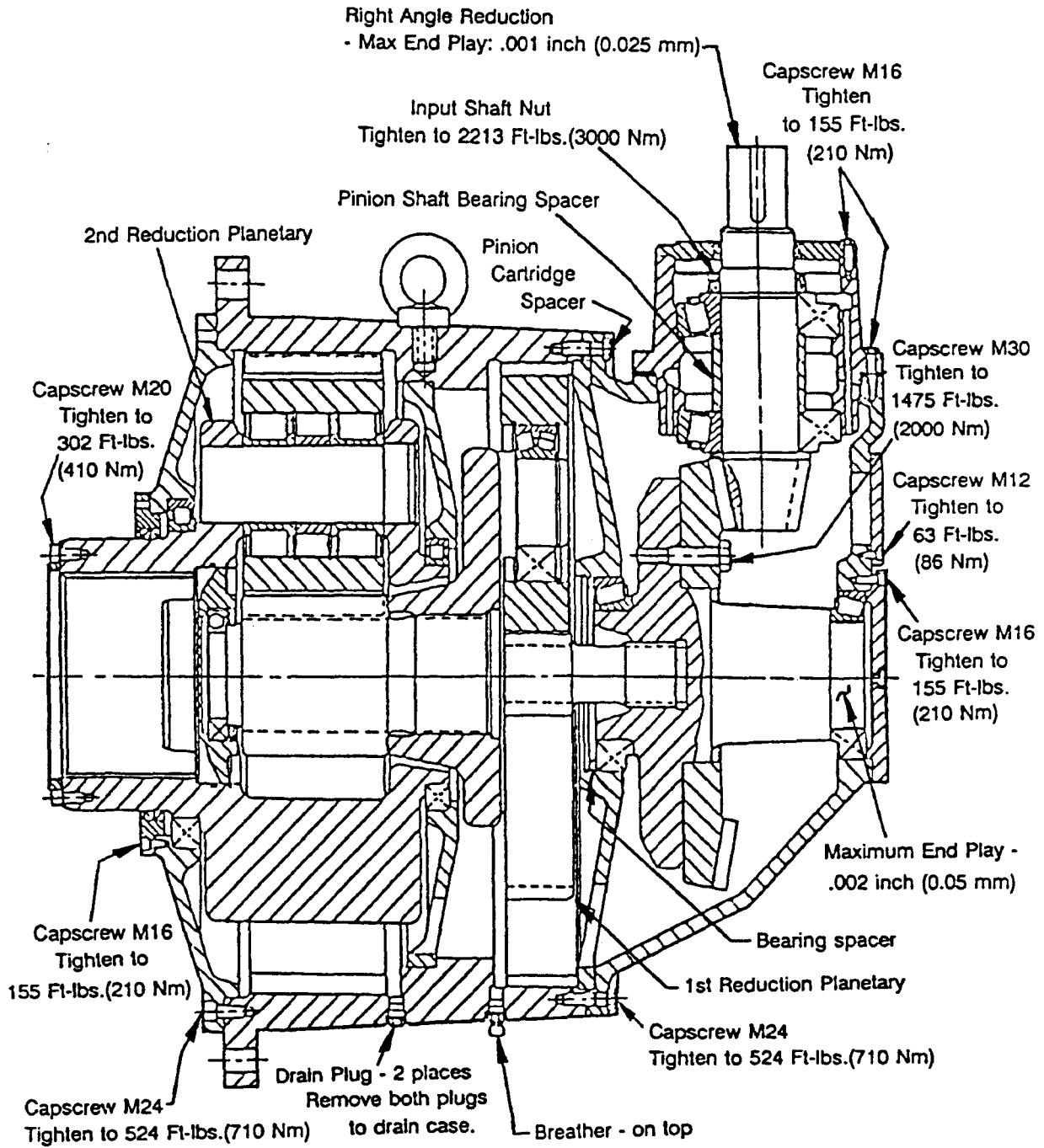
23. Have a qualified electrician reconnect the trail cable to the machine.



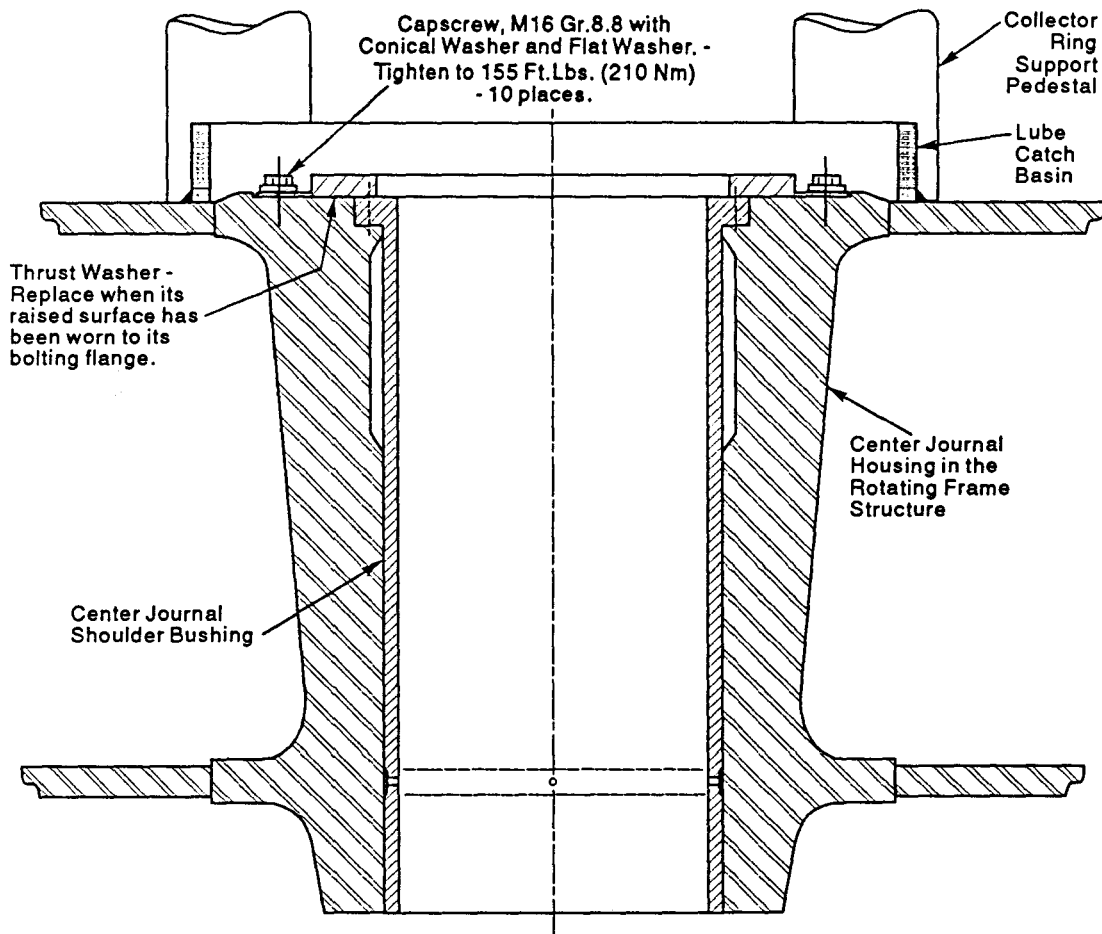
DANGER: HIGH VOLTAGE. Only qualified personnel are permitted to perform this operation. Failure to comply, could result in bodily injury or death.

NOTES:

1. Bearing spacer - grind to obtain a pre-load of .002 inch (.050 mm).
2. Bearing spacer - grind to obtain a pre-load of .001 inch (.025 mm).
3. Cartridge spacer - Grind to fill the gap after adjusting the tooth pattern.



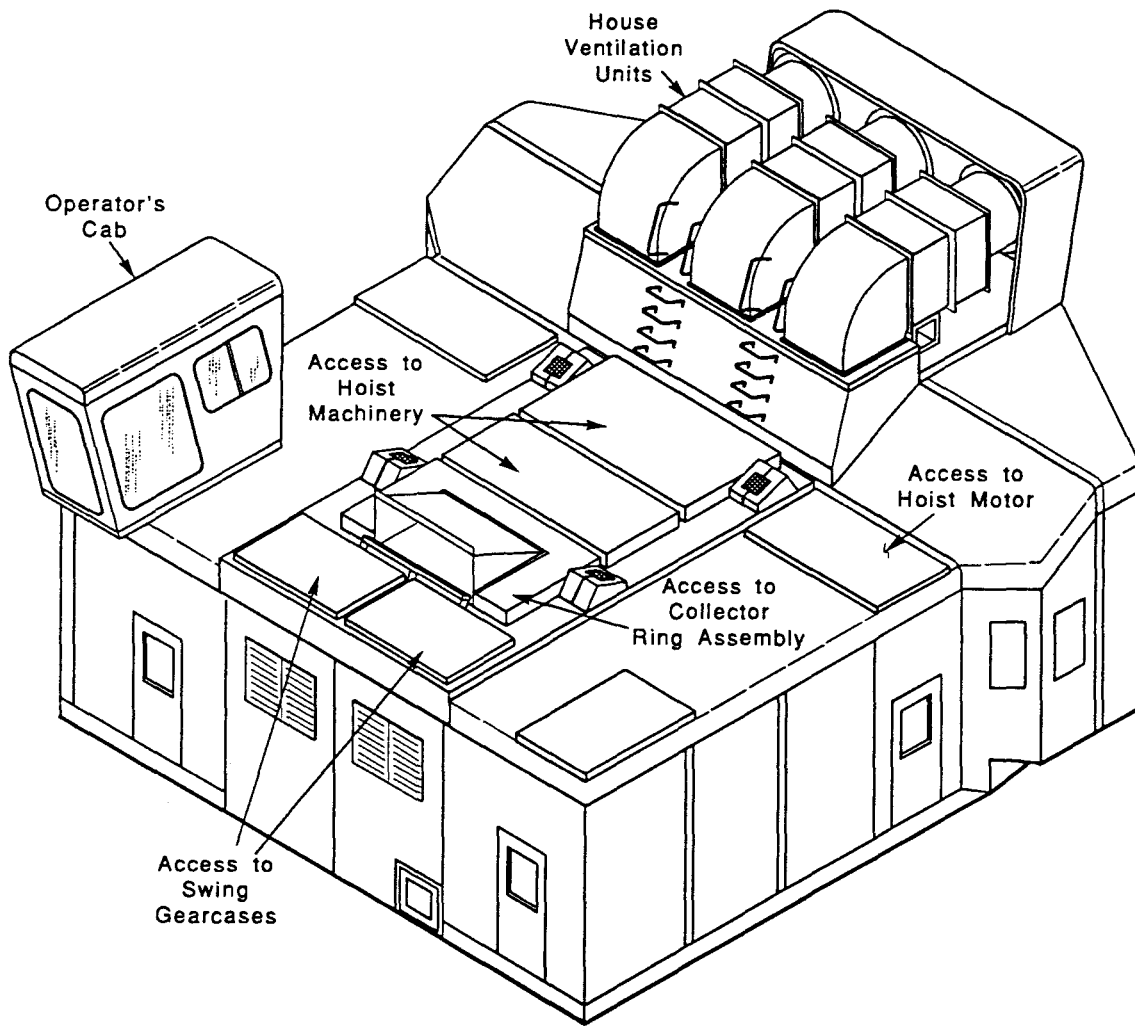
PROPEL GEARCASE - Section View



**CENTER JOURNAL BEARING BOSS
on the ROTATING FRAME**

CENTER JOURNAL THRUST WASHER REPLACEMENT

1. Park machine safely on level ground. Remove 3 center journal nut guards.
2. Rotate the machine as needed to align the jacking bracket on the deck with the jacking lug on the side of the center journal nut.
3. Assemble the hydraulic ram and special jacking equipment to the nut and jacking bracket.
4. Set the brakes.



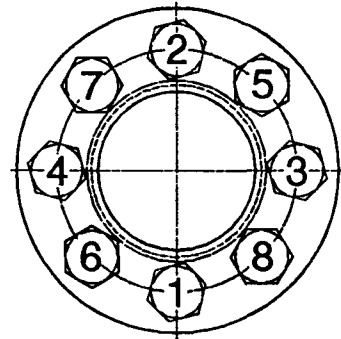
301-M MACHINERY HOUSE

GEARCASE STRUCTURE CAPSCREWS

1. Pretension:

- A. Tension 35 of the 37 capscrews to 95,000 Lbs. (reference 2770 Ft-lbs.) in the sequence shown. Turn the nut down using the tensioner drive gear mechanism. Seat it firmly when it bottoms. During tensioning, observe the operation of the tensioner to be sure maximum stroke is not exceeded.
- B. The capscrews at points #36 and #37 are fitted with a tensioning nut. Use the following procedure to tension these capscrews:

- Step 1 - Seat the nut firmly and using a small wrench, tighten the jack screws per the sequence in Figure 1.
- Step 2 - Tighten the jack screws to 38 Ft.Lbs. using the sequence in Figure 1.
- Step 3 - Tighten the jack screws to 56 Ft.Lbs. using the sequence in figure 2.

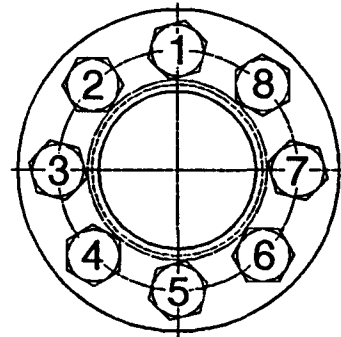


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Figure 1.

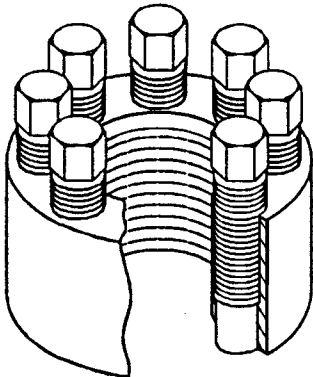
2. Final Tension:

- A. For capscrews #1 through #34, tension the #1 capscrew to 136,000 Lbs. (ref. 3967 Ft.Lbs). Turn the nut down. Relax the tensioner, wait one minute, then bring it back to load without shifting it. Turn the nut down if possible. Repeat this procedure for the remaining 34 capscrews in the sequence shown.



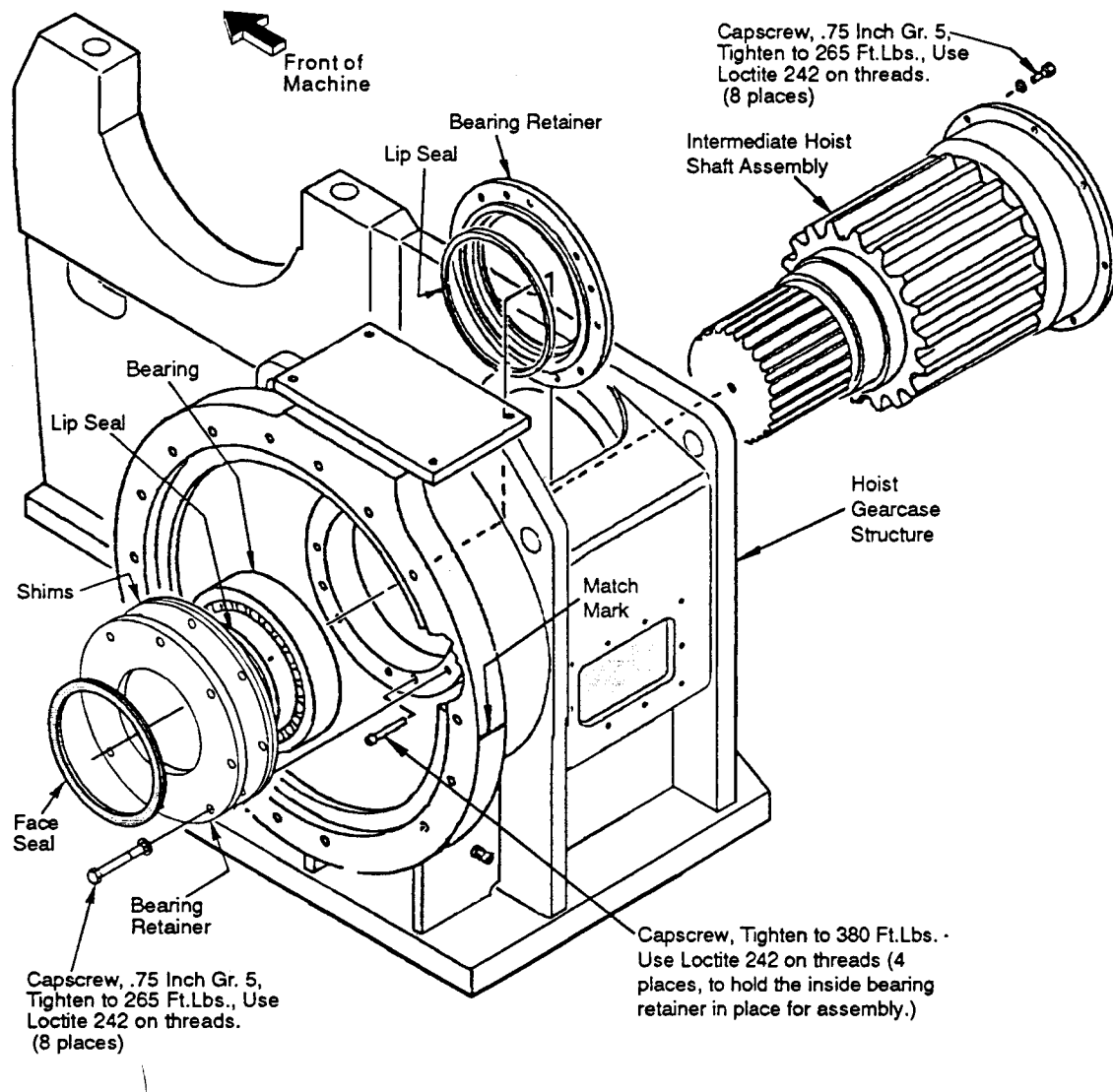
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Figure 2.



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After the 34 capscrews have been tensioned to 136,000 Lbs., check the tension in capscrews #1 and #2. If additional turning of the nut is possible when the tensioner is brought up to 136,000 Lbs.(ref. 3967 Ft.Lbs.) continue to check all capscrews.



INTERMEDIATE HOIST SHAFT and PEDESTAL

INTERMEDIATE HOIST SHAFT

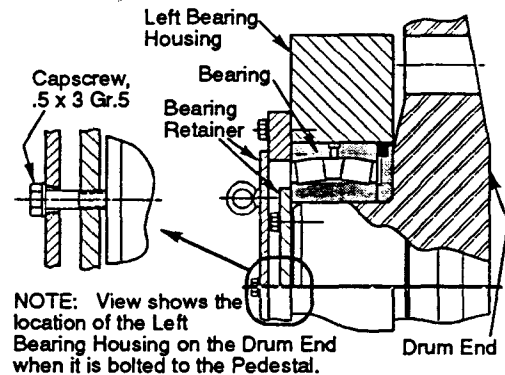
To remove the Intermediate Hoist Shaft:

1. Park the machine in an open level area with the dipper resting on grade & the hoist ropes slackened.
2. Set all brakes & shut down the machine. Have a qualified electrician isolate the hoist rope winch.
3. Block the drum to prevent rotation.
4. Remove the hoist gear case. Refer to procedure for hoist gear case removal.

8. Remove 3 hatch covers from the center roof section and remove the 2 house arches above the drum.
9. Remove the 2 top sections of the hoist gear guard and the guard on the left end of the drum assembly.
10. Remove the lube line fitting from the center of the left bearing retainer and install a .5 inch x 2.5 inch long capscrew with a hardened flat washer into the end of the shaft through the retainer to hold the bearing housing on the drum shaft during its removal.

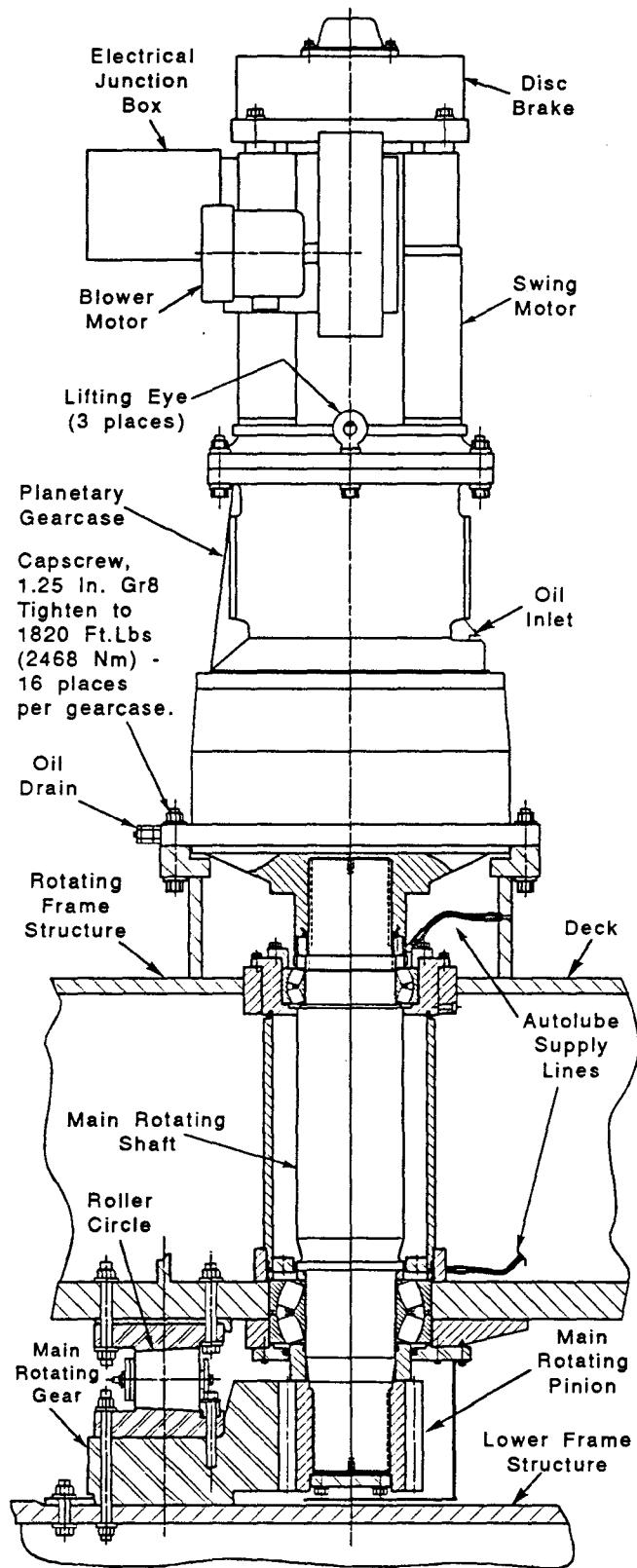
11. Remove the rope winch from the hoist gearcase.
12. Remove the 4 rods which attach the bearing housings to the pedestals. Refer to the procedure for loosening the tensioning nuts on page 4.6.7.

NOTE: The bottom nut on the pedestal rods were assembled with loctite on the threads.



13. Attach lifting equipment of proper rating to the drum shaft.
14. Lift the drum assembly through the roof openings. Be aware of shims at the left bearing housing between it and the pedestal, both on top and in the front vertical contact surface. The drum must move to the left and to the rear to clear the house and gantry structure. Also, rotate the drum assembly slightly as it passes through the roof hatch to allow the gear teeth to clear.
15. Set the drum assembly on cribbing.
16. Reassembly is the reverse of disassembly:
 - a. Shim at the left pedestal as needed to obtain the proper gear contact pattern. Backlash should be .028" (.71 mm) to .088" (2.24 mm).
 - b. Coat the gear and pinion with OGL lube after checking the contact pattern.
 - c. Adjust the floating bearing housing to be 1.97 inches from the drum end bolting surface. Refer to View - A on page 4.6.23.

NOTE: Remove the retainer bolt from the left hand housing & reconnect the lube line.



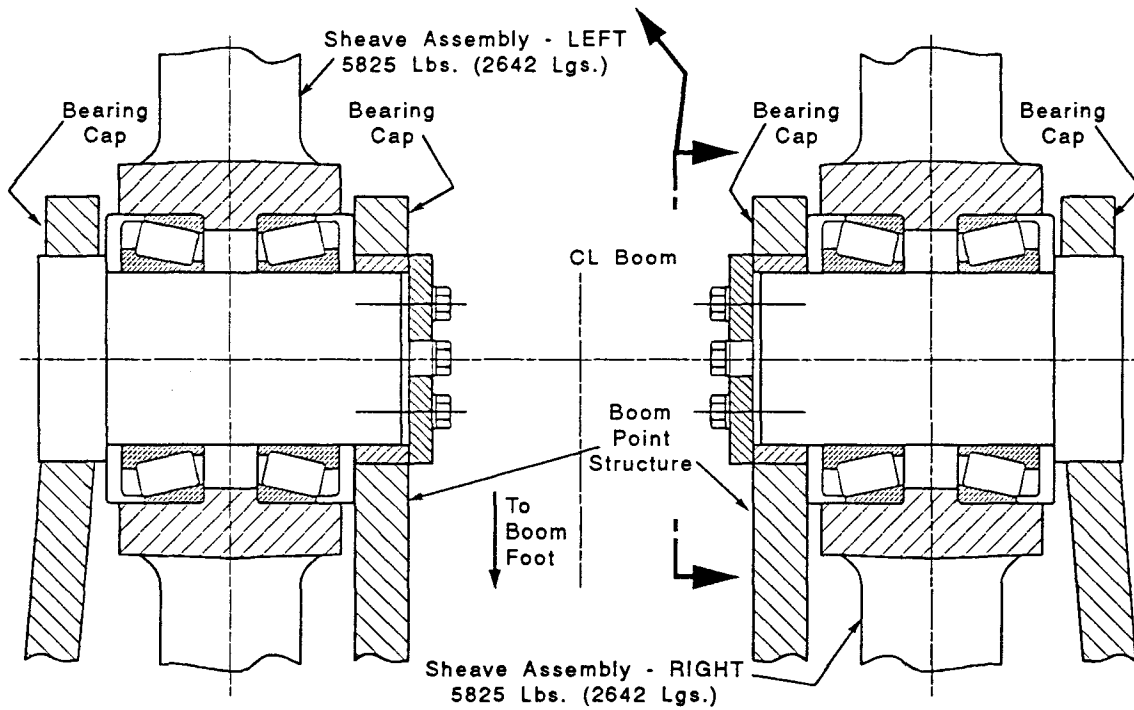
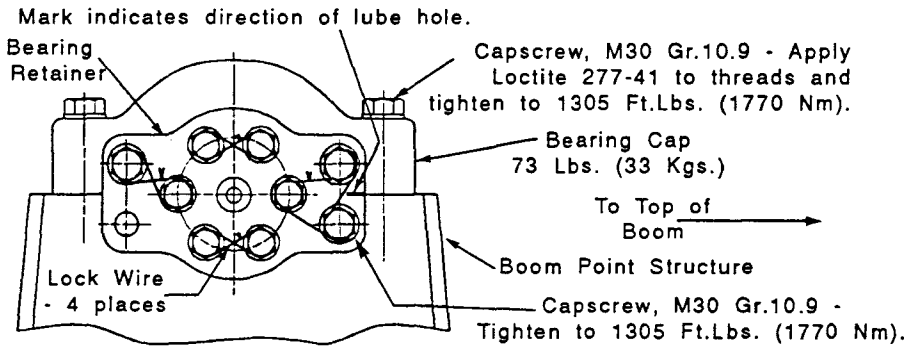
**301-M ROTATING (SWING) MACHINERY
INSTALLATION**

4. Remove the retainer, install the shims, the retainer, and the 8 capscrews, and tighten the capscrews to 382 Ft.Lbs. (518 Nm).
5. Install a new face seal on the upper end of the spacer, and a new O-Ring seal on the lower end of the spacer. Insert 1.0 Inch lifting eyes into the 3 tapped holes provided in the end of the spacer. Spray the seals with Molylube 1200 AR (P/N 170025-1).
6. Place the shaft in the vertical position, with the *bottom end up*. Carefully lower the pipe spacer assembly onto the shaft, with the end fitting into the circular slots in the bearing housing. Use caution not to damage the seals.
7. Install the lower bearing spacer on the shaft. Heat and install the lower bearing.
8. Pack both bearings with MPG lube. Install the rotating shaft assembly into the rotating frame.
9. Install the lower pinion spacer, the lower bearing retainer, and the rotating pinion.

NOTE: There must be a gap of .02 to .20 inch between the lower bearing retainer boss and the lower bearing outer race. If no gap exists, check that all parts are correctly assembled.



NOTE: Both sheave assemblies are symmetrical about the CL Boom.



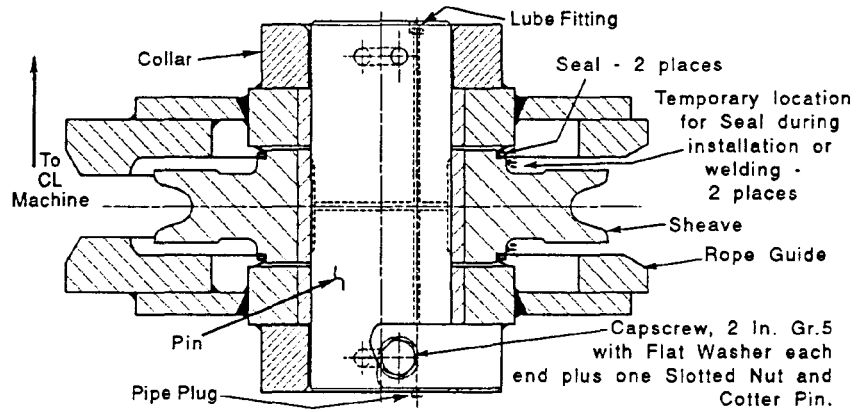
BOOM POINT SHEAVE ASSEMBLY - Section View

RIGHT OR LEFT CROWD GEARCASE REMOVAL

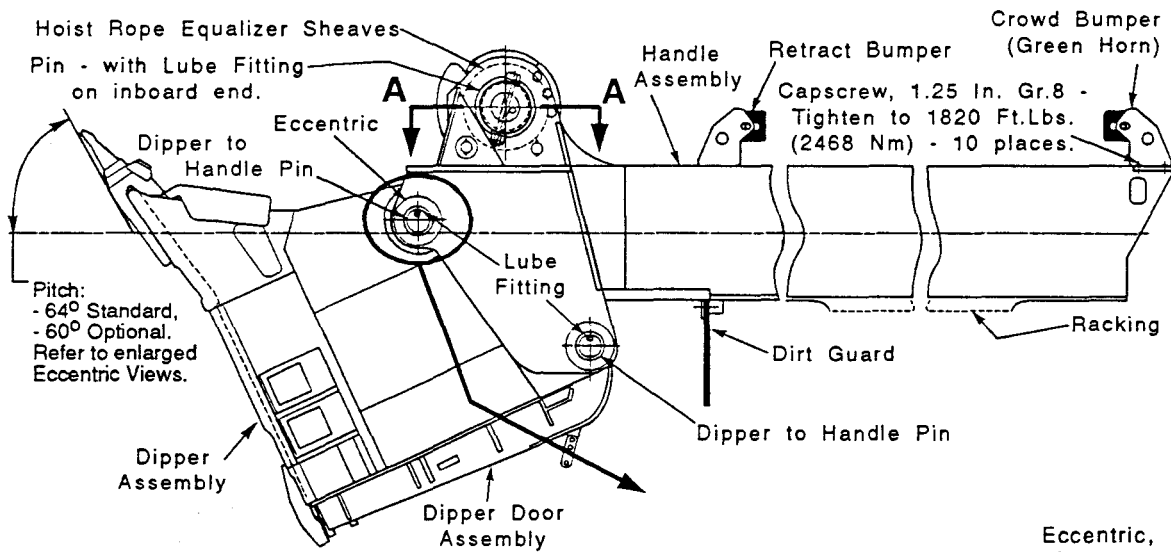
1. Park the machine on a level work area with ample room for a crane.
2. Set all brakes and shut down the machine.
3. Remove the crowd gear guard. If the left hand gear case is to be removed, isolate, disconnect and remove the crowd limit before removing the guard.
4. Remove the boom walkway over the crowd gear case and the motor coupling guard.
5. Remove the motor coupling housing and grids. Store in a clean area.
6. Note the position of the gear case and match mark with the mounting bracket if none can be found.
7. Attach a sling to the lifting eye provided and take the weight of the gear case.
8. Remove the 24 - .75 In. capscrews which secure the gear case to the boom. *Note that the lower front 4 capscrews are installed with the head toward the center of the boom.*
9. Move the case toward the center of the boom until the intermediate pinion clears the mounting bracket bore, then hoist it clear of the boom.
10. Install the gear case in the reverse order of removal.
 - Check coupling alignment and fill with L.T.G. It may be necessary to release the crowd brake to align the grid slots.
 - Fill the gear case with HGL. Check for leaks after one (1) hour of operation. Refer to Section 3 of this manual for the lube requirements and oil cooler maintenance.
 - Be sure all guards are in place.

The crowd gear case module includes 2 reductions, a right angle spiral bevel 1st reduction and planetary reduction. To minimize downtime, it is recommended that the gearcase be replaced as a complete unit if a problem should develop within the case.

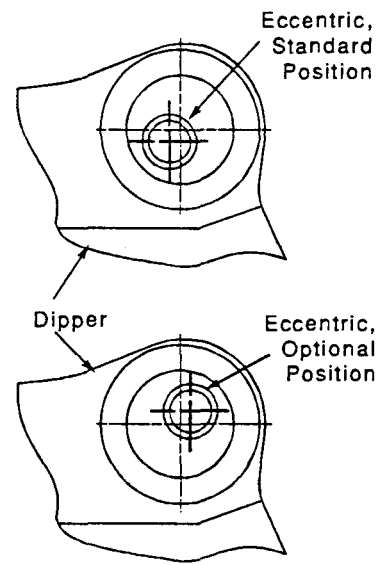
If the case is to be disassembled, it should be taken to the maintenance shop for repairs.



SECTION A-A



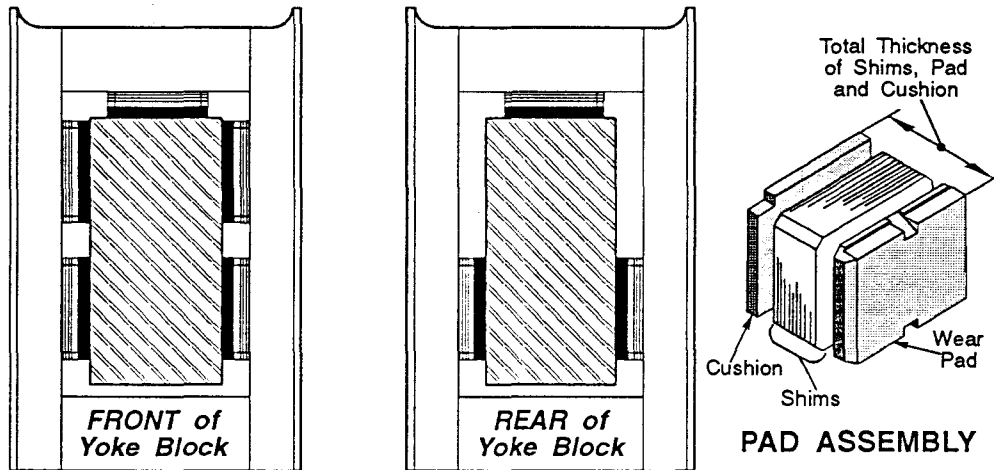
Pitch:
 - 64° Standard,
 - 60° Optional.
 Refer to enlarged
 Eccentric Views.



Eccentric Wgt.:
 580 Lbs. (263 Kgs.)

- d. Install the pad assemblies and retainers. Tighten the capscrews to specification and lockwire in place.
- e. Slowly crowd and retract the handle. Check for tight spots and correct as required.

During field erection (or immediately after a new set of pads and shims are installed), determine the thickness of the top and side pad assemblies. Record this measurement in the chart below. This will insure that the correct pad assembly thickness is used.

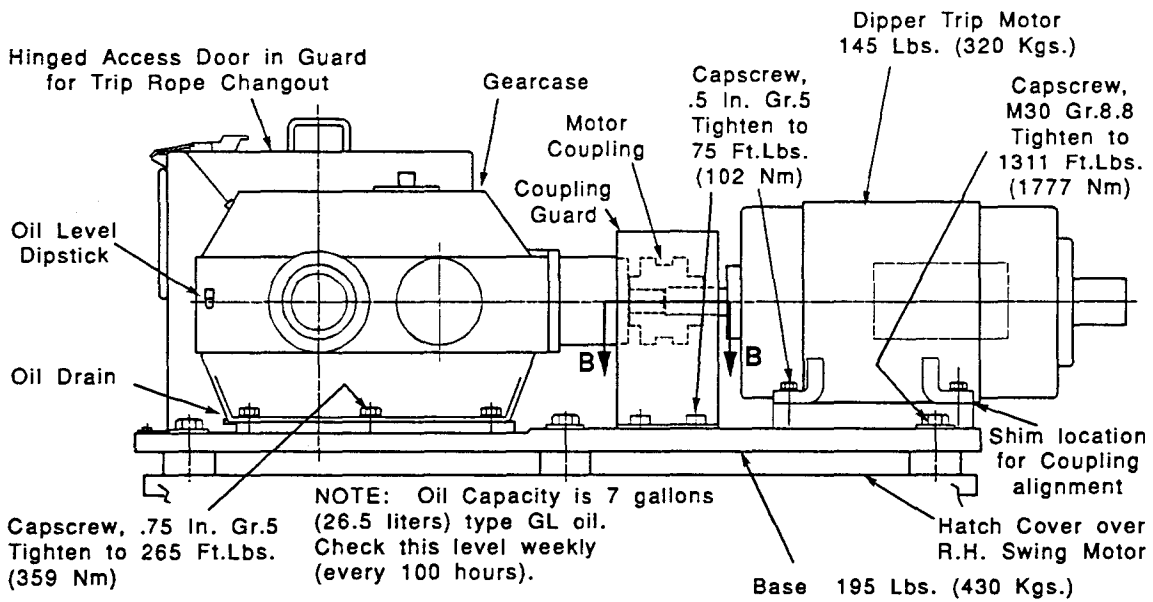
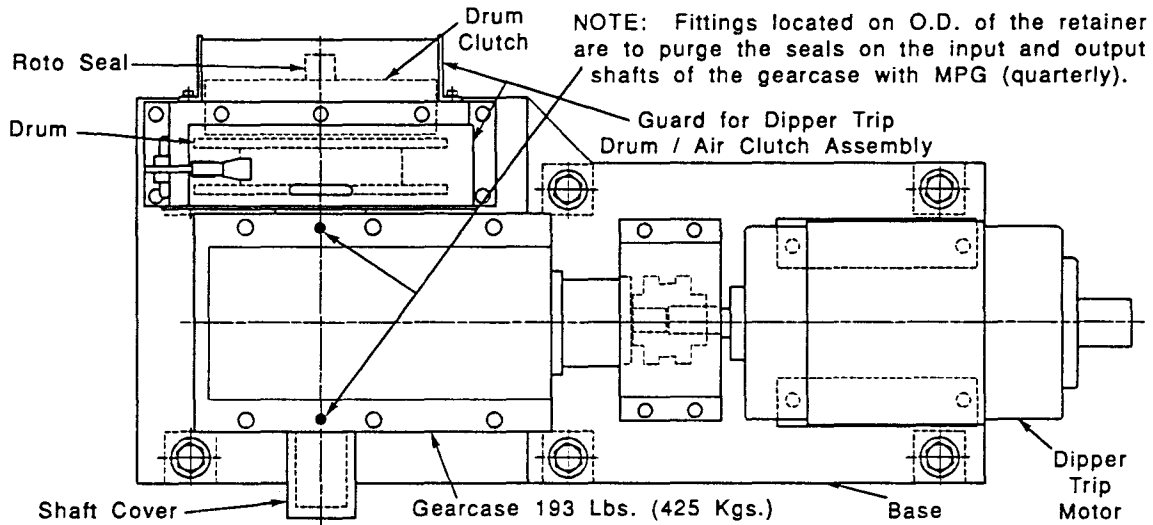


<i>SIDE PAD ASSEMBLY THICKNESS:</i>	
<i>TOP PAD ASSEMBLY THICKNESS:</i>	
<i>HANDLE WIDTH, MAXIMUM:</i>	
<i>END OF HANDLE TO MAXIMUM WIDTH:</i>	
<i>HANDLE HEIGHT, MAXIMUM:</i>	
<i>END OF HANDLE TO MAXIMUM HEIGHT:</i>	

NOTES:

- The nominal stack height for the top pad assembly is 4.03 inches.
- The nominal stack height for the side pad assembly is 4.34 inches.

(These dimensions will vary due to manufacturing tolerances. Record the actual stack heights in the space provided.)



DIPPER TRIP MACHINERY
 [2600 Lbs. 1179 Kgs.]

Normally, air flows to the clutch through the low pressure regulator, the quick release valve and the solenoid valve. When the door is opened (tripped), air flows through the high pressure regulator, the energized solenoid valve, and to the clutch. The quick release valve prevents possible damage to the low pressure regulator when the solenoid valve is energized.



CAUTION: The clutch will be damaged if the air pressure exceeds 120 PSI (827 kPa).

NOTES: (Dipper Trip Drum Clutch)

1. The fit of the drum to the clutch adapter shaft is .002-.007 (0.05-0.18mm) *LOOSE*.
2. Use Loctite RC/680 (or equivalent) between the drum and the adapter shaft at assembly.
3. the Fit of clutch adapter shaft to the gearcase output shaft is .0005-.0025 (0.013-0.064mm) *INTERFERENCE*.
4. Use Loctite RC/680 (or equivalent) between the adapter shaft and the output shaft at assembly.
5. the Key must not extend beyond the end of the shaft.
6. the Retaining ring inside the clutch adapter shaft is the axial stop for end of gearcase output shaft. Push clutch assembly onto the output shaft until it touches the retaining ring.
7. the Splines on the clutch adapter shaft for torque assembly contact may be lightly coated with Molycote M8800 (or equivalent). *LUBE MUST NOT CONTAMINATE FRICTION LINING SURFACES!*
8. Snap ring grooves inside the adapter shaft are furnished to use with a puller for removal of the gearcase output shaft. MARION will supply information on the puller arrangement upon request.
9. Tighten both set screws (No.1 and No.2) and loosen 1 turn. Re-tighten set screw No.1 then set screw No.2.

HOIST ROPE REPLACEMENT

1. Park the machine with the dipper front on the ground. Allow room in front of the dipper to pull the hoist ropes approximately 150 ft. Slacken the ropes until they lay on the boom.
2. Attach a sling to each of the ropes at the equalizer sheaves. Attach the other end of the slings to a vehicle parked ahead of the dipper.
3. Remove the rope retainer pins, removable rope guides and equalizer sheaves.

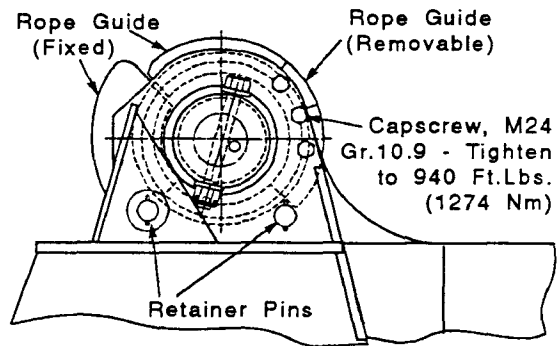


CAUTION: Be sure the hoist rope loops are loose in the equalizer sheaves. Unexpected movement by the sheaves and ropes when the pins are removed could cause injury.



CAUTION: Insure that there is phone or radio communications between all personnel involved with rope removal and installation.

4. Place the motion limits in the *BYPASS* position. The selector switch is on the right hand console in the operators cab. Slowly rotate the hoist drum (take up the slack with a vehicle at the front of the machine.) until the inside ropes are completely unspooled and the inside anchor (ropes "B" and "C") is on top of the drum.

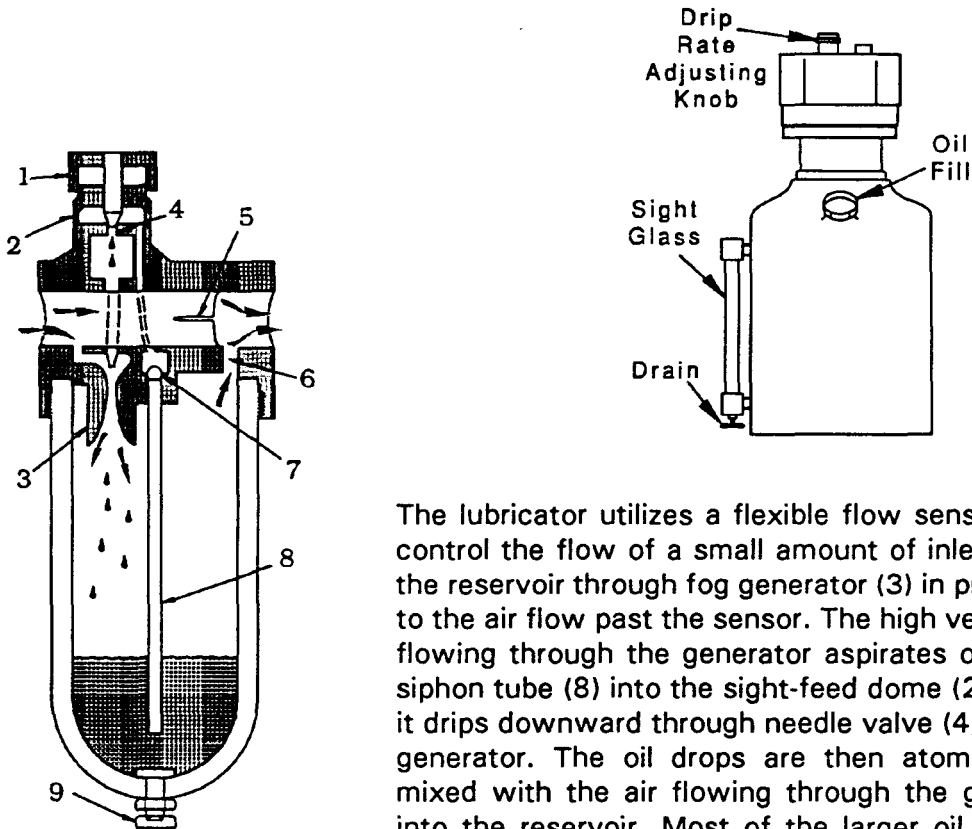


**DIPPER HANDLE EQUALIZER SHEAVE
- Hoist Rope Reeving**

5. Mark the rope anchors and rope ends. Attach a winch rope to each of the hoist ropes, remove the ferrule retaining screw and pull the ferrule out of their sockets.
 6. Continue to un-spool the hoist rope, by rotating the drum, paying out the winch, and taking up the slack until the drum rotates 180° to place the second anchor (ropes "A" and "D") on top of the drum. Attach the hoist rope ends to the winch ropes - remove the retainer screw and pull the ferrules out of their sockets.
-
-
-
-

AIR LINE LUBRICATORS

These devices inject a finely divided "fog" of oil into a flowing stream of compressed air to automatically provide internal lubrication for the operating components in the air system. Oil feed density is controlled by the drip rate adjusting knob (1) on top of the unit that is integral with a sight feed dome. Counterclockwise (CCW) rotation of the knob increases oil flow (density), and clockwise (CW) decreases it.



The lubricator utilizes a flexible flow sensor (5) to control the flow of a small amount of inlet air into the reservoir through fog generator (3) in proportion to the air flow past the sensor. The high velocity air flowing through the generator aspirates oil up the siphon tube (8) into the sight-feed dome (2), where it drips downward through needle valve (4) into the generator. The oil drops are then atomized and mixed with the air flowing through the generator into the reservoir. Most of the larger oil particles return to the reservoir. The finer particles ("fog") remain airborne and are carried through passage (6) into the downstream system. Only a small portion of the drops visible in the sight-feed dome are delivered downstream to the operating components. Check ball (7) keeps the siphon tube full during periods of no air flow.

The lubricator used in the air system has a 2 quart (1.9 liter) capacity metal bowl with a manual drain cock (9) and a sight glass. It cannot be filled under pressure. To add PO lube to the bowl, exhaust the air pressure from the circuit and then remove the oil fill plug from the bowl. Add oil to the prescribed level indicated on the sight glass. Replace the fill plug.

Adjust the oil flow rate to satisfy the lubrication requirements of the operating components in the air system downstream. The bowl reservoir can be removed and cleaned with a mild soapy water solution.

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SECTION I

GENERAL INFORMATION

1-1. This manual pertains to all Series 20 through 80/88A Single Stage and all Series 100 through 900/990A Two Stage Stationary Air Compressors. This Section provides general information about, and explains the operation of these Series of Compressors. Section II contains Installation Instructions and Section III covers Operation of the Compressors. Section IV is devoted to Preventive Maintenance.

1-2. DESCRIPTION

1-3. Series 20, 40, and 60/66A Compressors. These Series are Single Stage, air cooled. The two low pressure cylinders divide the work load. Each cylinder head is equipped with one suction and one discharge, disc or plate type valve. Pistons and connecting rods are made of aluminum alloy. Steel backed babitt lined insert type bearings are used at the connecting rod-crankshaft journal. The counter weighted crankshaft is statically balanced and is supported at each end by a tapered roller bearing. The combination flywheel fan is used as the drive pulley and cooling fan, and is balanced. The blades of the flywheel supply cooling air to the compressor.

1-4. Series 80/88A Compressors. The Series 80/88A are three cylinder, Single Stage Compressors. Three cylinders divide the work of compression. Each cylinder head is equipped with one suction and one discharge, disc or plate type valve. Pistons and connecting rods are aluminum alloy. Steel backed babitt lined insert type bearings are used at the connecting rod-crankshaft journal. The counter weighted crankshaft is statically balanced and is supported at each end by a tapered roller bearing. The combination flywheel fan is used as a drive pulley and cooling fan, and is balanced. The blades of the flywheel supply cooling air to the compressor.

1-5. Series 100 Through 600/660A Compressors. These are Two-Stage air cooled Compressors. Two cylinders, one high pressure, and one low pressure, divide the work of compression. Each cylinder head is equipped with one suction and one discharge disc or plate type valve. A finned tube type intercooler provides efficient air cooling between the low and high stages of compression. Low pressure pistons and connecting rods are aluminum alloy while the high pressure pistons are cast iron or heavy wall aluminum. Steel backed babitt lined insert type bearings are used at the connecting rod-crankshaft journal. The counter-weighted crankshaft is statically balanced and is supported at each end by a tapered roller bearing.

The combination flywheel is used as a drive pulley and cooling fan, and is balanced. The flywheel blades supply cooling air to the intercooler and compressor.

1-6. Series 700/770A, 800/880A, and 900/990A Compressor. These are Two Stage, Air Cooled Compressors. Three cylinders, two low pressure and one high pressure, divide the work of compression. Each cylinder head is equipped with one suction and one discharge disc or plate type valve.

A finned tube type radial intercooler provides efficient air cooling between the low and high stages of compression.

Pistons and connecting rods are aluminum alloy. Steel backed babitt lined insert type bearings are used at the connecting rod-crankshaft journal.

The counterweighted crankshaft is statically balanced and is supported at each end by a tapered roller bearing. The combination flywheel fan is used as a drive pulley and cooling fan, and is balanced. The blades of the flywheel, and a fan attached to the flywheel, supply cooling air to the intercooler and compressor.

NOTE

When changing the rotation of 80/88A, 700/770A, 800/880A, and 900/990A Series units it will require installation of the correct fan and/or flywheel to insure proper cooling of the compressor. All other models use the standard flywheel for either rotation.

1-7. AIR FLOW

1-8. SINGLE STAGE COMPRESSORS. (See Figure 1-1.)

1-9. All cylinder(s) draw air in through the air filter, compress and discharge it through a manifold directly into the receiver.

1-10. TWO STAGE COMPRESSORS. (See Figures 1-2., 1-3.)

1-11. The low pressure cylinder(s) draws air in through the air filter, compresses and discharges it into the intercooler. The low pressure compressed air is cooled as it passes through the intercooler. From the intercooler the cooled, low pressure air passes into the high pressure cylinder. Here it is further compressed and sent on to the air receiver for storage.

1-12. OIL FLOW (See Figures 1-1., 1-2., 1-3.)

tance should be the same at all three points. If any of the three measurements varies, there is a misalignment which must be corrected before the compressor is run.

NOTE

In some cases combination groove drive pulleys are used.

When these pulleys are used it is necessary to measure the pulley/flywheel alignment as follows:

- 1) Single Belt Drive: Measure from the straight edge to the center of the groove in both the flywheel and motor pulley.
- 2) Two Belt Drive: Measure from the straight edge to the center of the center rib or land between the two pulley/flywheel grooves.
- 3) Three Belt Drive: Measure from the straight edge to the center of the center groove in both the flywheel and motor pulley.

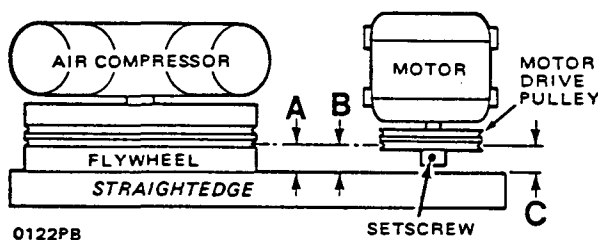


Figure 2-5. Typical Pulley Alignment

2-13. Correcting Pulley Misalignment. Correct pulley misalignment by loosening the setscrew in the motor drive pulley. Move the pulley toward or away from the motor, as necessary, for correct alignment. Tighten the setscrew. Recheck alignment. Adjust as required to obtain correct alignment.

2-14. Drive Belt Adjustment. Proper drive belt tension should equal one inch deflection with a ten pound load at midspan. (See Figure 2-4). If belt is too loose or too tight, proceed as follows:

- a. Loosen the motor mounting hardware.
- b. Move motor toward or away from the compressor until the proper tension is obtained.
- c. Tighten the motor mounting hardware.
- d. Recheck pulley alignment and realign, if necessary.

2-15. Drive Belt Replacement. (See Figure 2-6.) Loosen the motor mounting hardware and move the motor slightly toward the compressor. Remove the old drive belts and install a new matched set. Adjust the drive belts as indicated in Paragraph 2-14.

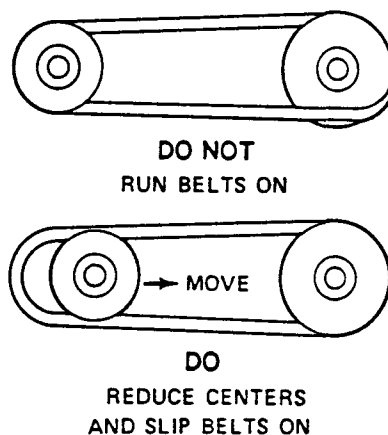


Figure 2-6. Drive Belt Replacement

2-16. PIPING, SUPPORTS, AND SAFETY VALVES (See Figure 2-2.)

2-17. Discharge Piping and Supports for Bedplate Mountings. The discharge piping connecting the compressor to the air receiver must be supported to keep pipe weight off the compressor and the receiver. The piping should be connected as directly as possible with a minimum number of bends. A flexible connection should be installed shortly downstream of the compressor discharge to prevent transfer of vibration through the piping. (Refer to Chart 1 for discharge piping size.)

WARNING

A SHUTOFF VALVE SHOULD NEVER BE INSTALLED IN THE DISCHARGE LINE BETWEEN THE COMPRESSOR AND RECEIVER. IN THE EVENT THAT A SHUTOFF VALVE MUST BE INSTALLED IN THIS LOCATION, IT IS IMPERATIVE THAT A SAFETY VALVE (WITH ADEQUATE FLOW CAPACITY AND CORRECT PRESSURE SETTING) BE PLACED IN THE LINE BETWEEN THE SHUTOFF VALVE AND THE COMPRESSOR. NEVER USE REDUCERS IN DISCHARGE PIPING. (REFER TO NOTES FIGURE 2-2.)

2-18. Air Intake Piping. When room conditions require the compressor air intake to be located outside the building the air cleaner must be weather protected. Do not locate the air filter near steam exhaust heads or other heat source or fan outlets

COMPLAINT	PROBABLE CAUSE	CORRECTIVE ACTION
7. Compressor vibrates.	1. Mounting bolts loose.	1. Tighten.
	2. Compressor not properly mounted.	2. Level compressor.
	3. Pulley & Flywheel misaligned.	3. Realign. See Maintenance Section.
	4. Belts Loose.	4. Tighten belts. See Maintenance Section.
8. Insufficient air pressure at point of use.	1. Leaks or restriction.	1. Check for leaks or restrictions in hose or piping. Repair.
	2. Restricted air intake.	2. Clean or replace air filter element.
	3. Slipping belts.	3. Tighten belts. See Maintenance Section.
	4. Service hose or pipe too small.	4. Replace with larger hose or pipe.
	5. Excessive air requirement.	5. Limit air requirement to compressor capacity.
	6. Faulty air gage.	6. Replace gage.
9. Excessive belt wear.	1. Pulleys out of alignment.	1. Realign drive pulley with compressor flywheel.
	2. Belts too tight.	2. Adjust tension. See Maintenance Section.
	3. Belts too loose.	3. Adjust tension. See Maintenance Section.
	4. Pulley or flywheel wobble.	4. Check for worn crankshaft, keyway or pulley bore, resulting from running with loose pulley.
	5. Damage in belt groove of pulley or flywheel.	5. Replace drive pulley or compressor flywheel.
10. Excessive discharge air temperature.	1. Dirty cooling surfaces.	1. Clean cooling surfaces of cylinder(s), intercooler and aftercooler.
	2. No water flow through aftercooler.	2. Restore water flow through aftercooler.
	3. Poor ventilation.	3. Improve ventilation or relocate compressor.
	4. Restricted air intake.	4. Clean or replace air filter element.
11. Compressor continues to build up pressure after unloading pressure is reached.	1. Severe air leak in unloader line, and/or pilot valve.	1. Check all fittings and lines and replace those which leak.
	2. Restriction in unloader lines.	2. Correct cause of restriction.
	3. Worn or damaged unloaders.	3. Repair unloaders as required.

About once a year, or after 7500 operating hours, purge the bearings by pumping enough lube through the bearing while running so that new grease appears at the shaft or bottom plug hole. **IMPORTANT!** — As lube seeps out along the shaft, wipe it away. Finally, after 15 or 20 minutes of operation, thoroughly clean off the shaft. New grease usually appears first at the bottom hole, but it may be seen first at the shaft. **DO NOT FORGET THE DRAIN PLUG.**

Whenever possible, about once every 2 years, disassemble the bearings and remove ALL the old lube by thoroughly cleaning with light oil or petroleum solvent. Each time the bottom plug is removed, push a clean wire into the hole to insure that the lube is not hard and plugging the hole.

When repacking bearings with fresh grease, the housings or grease reservoirs should be filled from 1/2 to 2/3 full. An excessive amount of grease in the bearing will cause excessive bearing temperatures. See table X below.

**TABLE X
BEARING LUBRICATION DATA**

<i>Minimum amount of grease (reservoir 1/2 full) and maximum amount of grease (reservoir 2/3 full) at each bearing.</i>				
Frame Size	Grease			
	(inches ³)	(centimeters ³)	(ounces)	(grams)
802	3.5-4.5	57-74	1.75-2.25	50-64
803	4-5.5	66-90	2-2.75	50-78
804	5-7	82-115	2.5-3.5	71-99
806	6.5-9	107-147	3.25-4.5	92-128
808	8.5-11.5	139-188	4.25-5.75	120-163
810	13-17.5	213-287	6.5-8.75	184-248
812	17-23	279-377	8.5-11.5	241-326
814	20-27	328-442	10-13.5	284-383
816	24-32	393-524	12-16	340-454
818	24-33	393-541	12-16.5	340-468
820	29-38	475-623	14.5-19	411-539
822	34-45	557-737	17-22.5	482-638
824	42-51	688-836	21-25.5	595-723
828	67-78	1098-1278	33.5-39	950-1106

6.3 REFERENCE PUBLICATIONS

For Detailed Electrical Information
Refer to the
ELECTRICAL INSTRUCTION MANUAL.

For Information on the
MAIN COLLECTOR RINGS and the
AUXILIARY COLLECTOR RINGS
Refer to Section 4 of this manual.

Marion provides (under separate cover) a **PARTS BOOK** from the electrical manufacturers in addition to the information supplied in this section and the above sources.

7.2 SEALS

Oil and grease seals are critical to machine availability. Careless storage, handling, removal and installation can contribute to reduced service life of machine components and higher cost of operation.

Seals come in all sizes, shapes and materials. Wherever possible, Marion has specified the use of the most common solid molded element type seals for use on Marion machines.

All types of oil and grease seals have a limited shelf life. Store seals in a cool, dry location protected from direct sunlight. Keep in sealed containers or packaging until ready to use. Seals keep lubricant clean and contained in their respective housings, bearings or passageways. Always handle seals carefully to prevent exposure to nicks, bends or pinching. Do not wash them in solvents as some solvents may destroy properties of the seal.

SEAL INSTALLATION

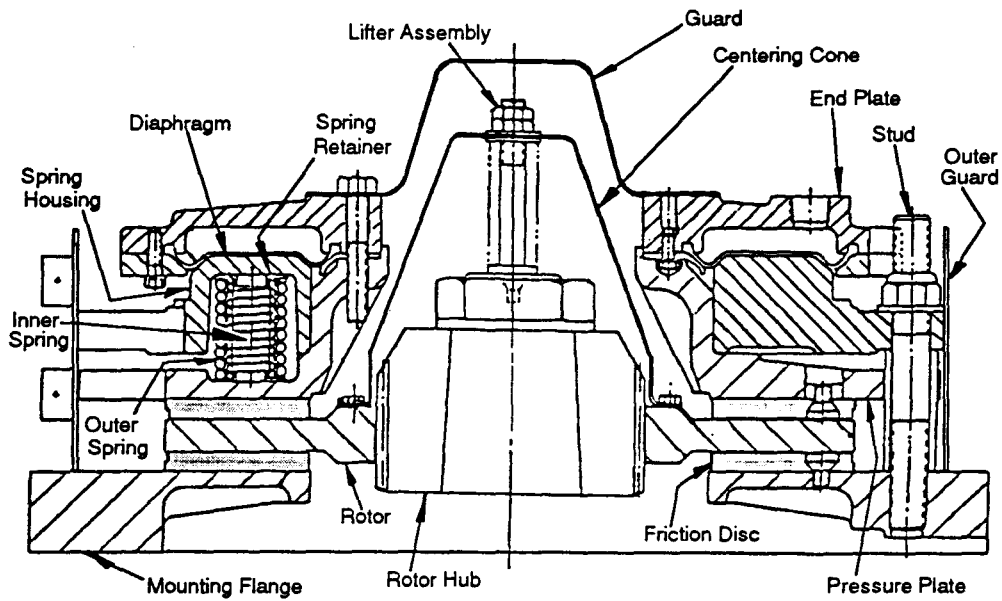
Solid molded seals are installed at time of manufacture with interference fit between seal and bore. This method of installation creates an oil tight fit. When partial disassembly of a machine component involves removal of solid molded seal before reassembly inspect it carefully for cuts, nicks or cracking. Replace with a split seal if complete disassembly is inconvenient or with a new solid molded seal. Split seals, especially those made with interference fit at butt, also install with compression at the joint. Split seals used as substitutes for solid molded seals should be replaced at next major component overhaul.



CAUTION: Do not cut a solid seal and reuse for a split seal.

Check shaft for scratches, burrs or surface roughness that may cut or score the lip of seal. Be aware of sharp threads key-ways or splines over which the seal must travel. Protect seal lip by covering these interferences with tape.

Inspect the bore area for surface roughness, dirt or burrs. Remove and clean as required. The bore and shaft need .0625 in. (1.588 mm) chamfer to accommodate a leak free installation. If shaft or bore do not have chamfer, carefully provide one by trimming inside flange of seal.



SWING BRAKE
Single Rotor with Lifter

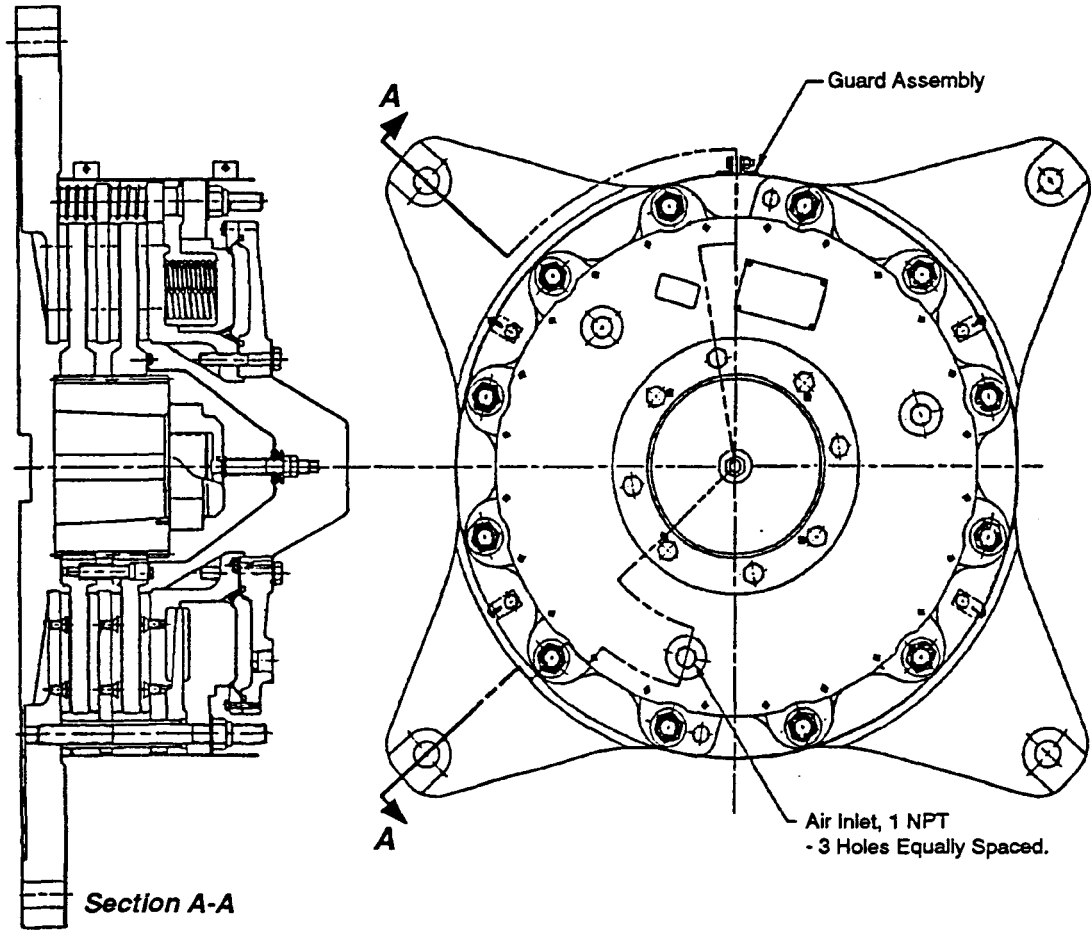
Two Swing brakes are use on this mining shovel. The brake is a single-rotor assembly, with one mounted on top of each swing motor. This is the same assembly used for the crowd, except it has a rotor lifter assembly that is required when mounting the brake on a vertical shaft.

For installation and maintenance refer to the end of this section.

REVISE SAMMIE AS

2213

INSTALLATION and ADJUSTMENT of the DISC CENTERING DEVICE
(Used in *DISC BRAKE ASSEMBLIES* MOUNTED on HORIZONTAL 822 and 824 FRAME MOTORS)



bkdiec_a.wpg

NOTE: The Wear Spacers are loose.
Collect and store with the Locknuts.



**CAUTION: LOCTITE #277
MAY IRRITATE
SENSITIVE SKIN.**

Refer to the product label for proper safety precautions.

Remove the hex head screws and lockwashers securing the disc centering cone to the rotor. Remove the rotor centering cone.

Loosen and remove the shoulder screws which secure the rotors together. Remove the first rotor. See Figure 8.

Remove the springs and wear spacers from the counterbores in the second rotor. Remove the reaction plate.

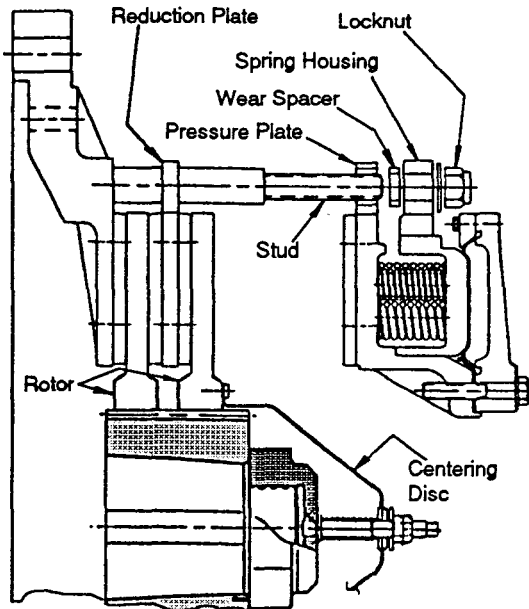


Figure 7.

bkdisc_7.wpg

Inspect the brake components for wear or damage. Replace as required.

Assembly of the rotors and reaction plate is the opposite of disassembly.

If the dimension in Figure 4 was less than 4.60" and new friction discs were not installed, the wear spacer is installed under the head of the shoulder screws. When new friction discs are installed the wear spacer is installed under the spring. See Figure 8.

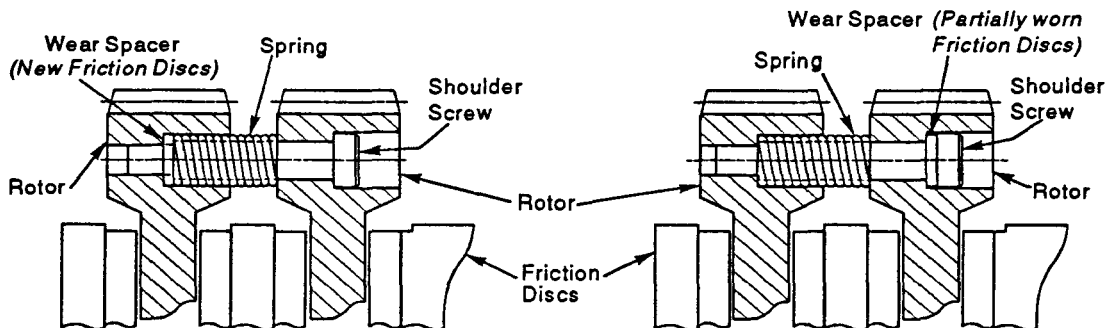


Figure 8.

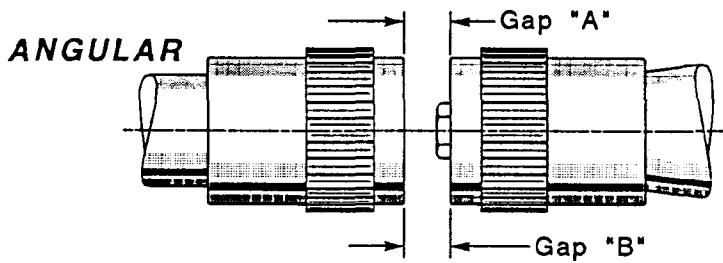
bkdisc_8.wpg

Insert the spring into the counterbores of the rotor.

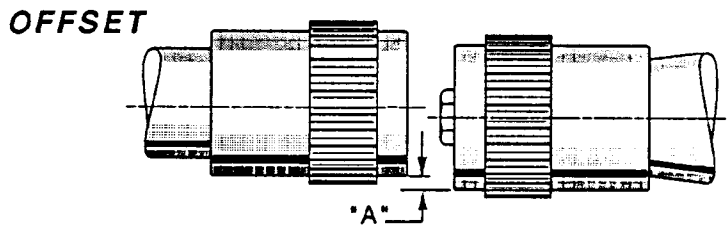
Noting the orientation of the large counterbores in the second rotor, align the rotor and lower it onto the reaction plate. Place the wear spacers in the counterbores.

COUPLING DATA

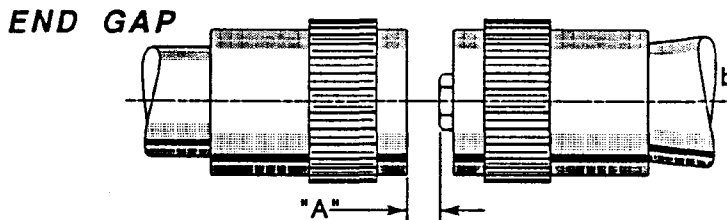
Function	CROWD	SWING	PROPEL	DIPPER TRIP
Motor Frame	812	814	814	CD327ATY
Marion Part No.	601529-8	333180-6	601250-7	294985-7
Vendor Part No.	1120T10	1120T10	1120T10	1070T10
End Gap	.250(6.35mm)	.250(6.35mm)	.250(6.35mm)	.13(3.3mm)
Alignment Limits				
Offset	.012(.305mm)	.012(.305mm)	.012(.305mm)	.010(.25mm)
Angular	.012(.305mm)	.012(.305mm)	.012(.305mm)	.010(.25mm)
Cover Bolt				
Torque - lb -in	650(75NM)	650(75NM)	650(75NM)	200(25NM)
No. of Bolts	4	4	4	4
Grease Wt.- lbs.	1.60(.73kg)	1.60(.73kg)	1.60(.73kg)	.25(.11kg)



The ANGULAR alignment is the difference between Gap "A" and Gap "B".



The amount of offset between 2 shafts.



The minimum gap between the shaft ends. Push the motor shaft toward the pinion shaft to remove end-play.



7.9 REPAIR WELDING PROCEDURES

When weld repair is required, it is extremely important it be done correctly because weld repairs can cause damage to an entire structure if performed incorrectly. Since several difficult to control variables can ruin a weld repair such as impurities in raw materials, defective welding equipment and state of normal wear it is recommended that you request a factory weld procedure.

The Weld Engineering Department at Marion issues repair procedures when a request is received from a customer. It is always better to see the repair problem, however, this is not always possible. Therefore, information received must be accurate. For example, its important to know the exact size of the defect, its exact location, available welding equipment, and whether the repair will be done on the machine or in a building. Machine information, serial number, part name and identification should also be sent to the service department. Pictures and sketches are also helpful to develop a good repair procedure.

Weld repair jobs should not be rushed. The worn or fractured area must be evaluated carefully to determine how the repair should be accomplished. It is good practice to listen to experienced welders and ask for their input if available.

A ten-step outline to follow when developing any weld repair procedure:

1. Clean the worn or fractured part or area to be repaired.
2. Analyze and inspect the fractured or worn component for proper reporting.
3. Determine the type of material you will be repairing or rebuilding.
4. Prepare the part to be repaired or rebuilt.
5. Determine the electrode and process to be used.
6. Preheat before welding if required.
7. Weld by using good welding techniques.
8. Post heat if required.
9. Slow cool.
10. Inspect the repair.

Each step of a welding procedure must be followed. Years of experience in the manufacture of mining equipment have proven major failures have occurred due to inadequate field repair of certain structures. Each step is explained in detail on the following pages.

STEP 8 -- Postheating.

The best practice is to thermally stress relieve a part that is highly stressed or requires machining. This is not always possible since parts of mining equipment are large and too complicated to stress relieve. Many times electric resistant heaters can be used for preheating and postheating of the weld area.

Weld repairs in alloy steels where it is not possible to stress relieve, but must be used as welded because of the size and configuration of the part, the preheat and interpass temperature should be held for one hour after welding. The objective is to permit the weld to transform from Austenite to a softer microconstituents rather than to martensite and thereby to minimize the possibility of cracking without undue sacrifice in mechanical properties. Postheating will also help in releasing entrapped hydrogen. Every precaution is important when making weld repairs.

STEP 9 -- Slow Cooling.

It is very important to keep any cool drafts away from parts which have been preheated, welded, and postheated. All parts should be covered by insulating blankets, returned to a furnace, covered with insulation or covered with sand for slow cooling. Cooling rates should be controlled so the temperature decreases about 50°F (10°C) per hour until reaching 150°F (66°C).

Many times welders will set a repair job on beams and will cover the top of part but forget about the area between the floor and the part. Unfortunately, the greatest draft occurs along the floor. This could cool the part unevenly and cracking could occur. Therefore, it is important to slow cool the whole part evenly.

Step 10 -- Inspection of Repair.

The last important step is to inspect the completed weld after it has cooled to the ambient temperature. Make sure there are no notches which could become a stress riser. Grind welds so they blend in with the parent material.

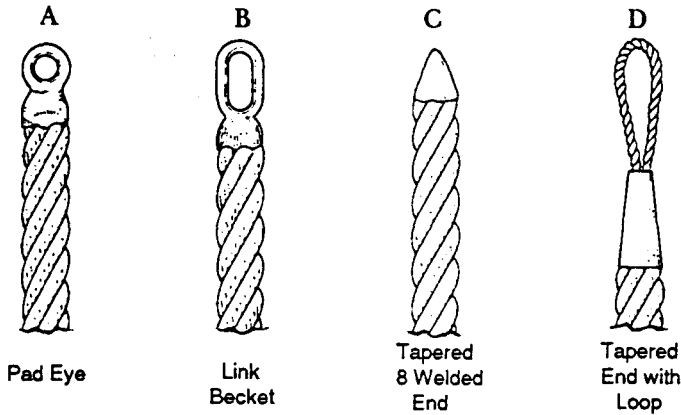
Non-destructively inspect the repaired welds with dye penetrant or magnetic particle inspection discussed earlier. If it is important to examine the whole weld, then a technician with ultrasonics or x-ray expertise should be contacted.

If any questionable weld should appear, it should be examined and repaired before the part is put back into service or it will not be long until the part will again have to be removed and repaired.

Make a final measurement of all important dimensions. This will show your success of staying within the dimension of tolerances. If the repair is successful, record the procedure for future reference.

END TERMINATIONS

The rope end must be fastened to the mechanism so that force and motion are transferred efficiently. End terminations thus become items of great importance for transferring these forces. Each basic type of termination has its own individual characteristic. Hence, one type will usually fit the needs of a given installation better than the others.



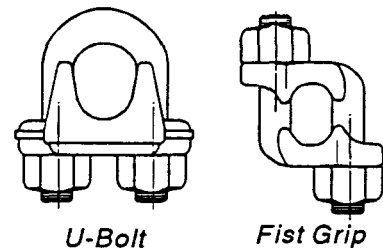
It should be noted that not all end terminations will develop the full strength of the wire rope used. To lessen the possibility of error, the wire rope industry has determined terminal efficiencies for various types of end terminations.

Beckets, or end preparations, are used on wire rope ends when another rope is needed to pull the operating rope into place. Four commonly used becketts are illustrated.

WIRE ROPE CLIPS

Wire rope clips are widely used for making end terminations. Clips are available in two basic designs; the *U-BOLT* and *FIST GRIP*. The efficiency of both types is the same.

When using *U-BOLT* clips, extreme care must be exercised to make certain that they are attached correctly, i.e.: the *U-BOLT* nut be applied so that the "U" section is in contact with the dead end of the rope. Also, the tightening and re-tightening of the nuts must be accomplished as required.



WIRE ROPE CLIPS

7. *Localized Conditions:*

Particular attention must be paid to wear at the equalizing sheaves. During normal operations this wear is not visible. Excessive vibration, or whip can cause abrasion and/or fatigue. Drum cross-over and flange point areas must be carefully evaluated. All end fittings, including splices, should be examined for worn or broken wires, loose or damaged strands, cracked fittings, worn or distorted thimbles and tucks of strands.

8. *Heat Damage:*

After a fire, or the presence of elevated temperatures, there may be metal discoloration, or an apparent loss of internal lubrication; fiber core ropes are particularly vulnerable. Under these circumstances the rope should be replaced.

9. *Protruding Core:*

If, for any cause, the rope core protrudes from an opening between the strands, the rope is unfit for service and should be removed.

10. *Damaged End Attachments:*

Cracked, bent, or broken end fittings must be eliminated. The cause should be sought out and corrected. In the case of bent hooks, the throat openings—measured at the narrowest point—should not exceed 15% over normal nor should twisting be greater than 10°.

11. *Peening:*

Continuous pounding is one of the causing of peening. The rope strikes against an object such as some structural part of the machine, or it beats against a roller, or it hits itself. Often, this can be avoided by placing protectors between the rope and the object it is striking. Another common cause of peening is continuous working—under high loads—over a sheave or drum. Where peening action cannot be controlled, it is necessary to have more frequent inspections and to be ready for earlier rope replacement.

12. *Scrubbing:*

Scrubbing refers to the displacement of wires and strands as a result of rubbing against itself or another object. This, in turn, causes wear and displacement of wires and strands along one side of the rope. Corrective measures should be taken as soon as this condition is observed.

8.2 INSPECTION SCHEDULE

ANNUAL CALENDAR OF INSPECTION INTERVALS

Operating Hours Inspection Interval							
	Hoist/ Swing Cases Oil Change	Hoist/ Propel Cases Oil Change	Crowd, Hoist, Swing Brakes	Propel Brakes	Drive Machinery Bolt Torque	Electrical Lower, Upper Frame	Drive Motors
250 500 750 1000 1250			X	X	X	X	X
1500 1750 2000 2250 2500	X		X	X	X	X	
2750 3000 3250 3500 3750			X	X	X	X	X
4000 4250 4500 4750 5000	X	X	X	X	X	X	X

NOTE:

This program schedule is based on the shovel operating 5000 hours per year.

Reference Hours	Approximate Weeks
5000	50
2500	26
1000	10
500	4
250	2

● FRONT END COMPONENTS ●

1. Boom:
 - a. Structural damage?
 - b. Bolts?
 - c. Lubrication?
 - d. Walkway damage?
 - e. Foot pins condition?
 - f. Condition of lube and air piping?
 - g. Condition of dipper trip mechanism and rope?

2. Point Sheaves:
 - a. Rope grooves?
 - b. Cracks?
 - c. Bearings?
 - d. Lubrication?

3. Boom Support Ropes:
 - a. Condition of socket connections?
 - b. Broken strands?
 - c. Corrosion?
 - d. Lubrication?

4. Crowd machinery:
 - a. Structural cracks or damage?
 - b. Lubrication?
 - c. Lube piping?
 - d. Clearance of yoke block wear pads?
 - e. Brake operation?
 - f. Brake linings?
 - g. Shipper shaft pinions?
 - h. Crowd gearing?
 - i. Bolts?

5. Handle assembly:
 - a. Structural cracks or damage?
 - b. Worn racking?
 - c. Lubrication?
 - d. Bail sheaves.
 - e. Bail sheave pins.
 - f. Bail sheave lubrication?

Section **9**

Air Conditioner

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9.8 REFRIGERATION SYSTEM

Each air conditioning unit has a single refrigeration system which consists of the following main components, all contained within the unit: (A.) A semi-hermetic compressor, (B.) An induced draft air cooled condenser coil with AC fan assembly and (C.) A cooling assembly consisting of an evaporator coil and AC motor fan assembly.

Piping between these components comprises both flexible and copper lines sized to ensure the refrigerant pressure drop is acceptable when the unit is operating at maximum load, and to ensure refrigerant velocities are sufficiently high to allow return of compressor lubricating oil to the pump at minimum load.

A. COMPRESSOR

The compressor raises the pressure of the refrigerant gas from its suction (evaporator) pressure to a pressure at which the condensing process can be achieved. The compressor conforms with modern practice and has suction and discharge valves pressure actuated instead of being mechanically actuated.

The compressor incorporates a force feed, positive displacement oil pump attached to, and driven by, the compressor crankshaft. Lubrication oil is distributed under pressure to main and big end bearings.

The compressor is fitted with suction and discharge service valves of the packed and sealed type which can be utilized for the isolation of the compressor from the remainder of the system. They also incorporate connection points for gauges or refrigerant charging.

The compressor assembly is mounted via a subframe to the base of the frame. Flexible hoses are provided as a means of making vibration free connections between the compressor service valves and the suction and discharge lines.

B. AIR COOLED CONDENSER

The condenser coil is fed with high pressure, superheated refrigerant discharge gas from the compressor and comprises a brass frame coil with rows of copper tubes and extended surface heat exchange fins.

Liquid refrigerant drains from the condenser coil into a receiver, through a strainer drier and sight glass to the thermostatic expansion (TX) valve.

Ambient air is drawn through the condensing coil by a multi blade, axial flow fan which is direct coupled to an AC motor. Air is drawn through the coil and discharged out the base and side of the unit. In addition, this air also provides some cooling for both the compressor and condenser fan motors.

The unit nameplate identifies the type of refrigerant (R134A) and the approximate mass of refrigerant required.

There are two recognized methods of adding refrigerant, as follows:

1. Liquid Charging

Charging with liquid refrigerant is much faster than vapor charging, and hence is almost always used. Liquid charging can only be used to insert the approximate amount of refrigerant into the system. After inserting say 1 lb. (1/2 kg) less than the required amount of refrigerant by liquid charging, the system should be vapor charged until the correct quantity of refrigerant has been inserted. It is recommended that liquid charging be done through a large, separate filter-drier to prevent contaminants entering the system.

Liquid charging on a unit of this type is carried out through the compressor discharge (H.P.) valve. It is one of the valves on either side of the top of the compressor.

A deep vacuum should be drawn on the system. Weigh the refrigerant drum, and attach the charging line from the refrigerant drum to the valve. The approximate weight of refrigerant required is known, (see data plate) so the refrigerant can be checked frequently.

Open the cylinder liquid valve and move the compressor discharge valve two turns from the back seat. The vacuum in the system will cause liquid to flow through the charging connection until the system pressure is equalized with the pressure in the refrigerant cylinder, or until the approximate quantity of refrigerant has been entered. Back seat the discharge valve. Allow 15 minutes for the refrigerant to disperse into the system. Charging must then be continued by vapor charging.

2. Vapor Charging

Vapor charging is normally used when only small amounts of refrigerant are to be added to a system, possibly up to 2-3 lbs. (1 kg) and it can be more precisely controlled than liquid charging. Vapor charging is usually accomplished by means of a gauge manifold into the compressor suction (L.P.) valve.

Back seat both valves and connect the gauge manifold to both compressor suction and discharge valves, with the common connection to the refrigerant cylinder. Move both the compressor service valves 1 1/2 turns in from the back seat. Open the refrigerant modes and open the suction connection on the gauge manifold. Modulate the rate of charging with the gauge manifold valve.

TROUBLE ANALYSIS CHART NOTES

A. Clogged Strainer or Filter:

Occasionally the strainer or filter in the liquid line may become clogged with foreign material left in the system during assembly. When this happens, the liquid line leaving the strainer will feel cooler than the liquid entering. If it is badly clogged, some sweat or frost may appear at the strainer. Bubbles in sight glass usually accompany this fault.

B. Thermal Expansion Valve Leaks:

A leaky expansion valve may allow the evaporator to fill with liquid which will be "slugged" into the suction line and into the compressor when the system starts. "Liquid slugging" within the compressor is detrimental to valves, gaskets, etc., and should be avoided.

C. Thermal Expansion Valve Stuck in Open Position:

If the expansion valve is stuck in an open position there will be an excessive amount of sweating on the suction line and compressor crankcase due to the large amount of liquid being passed into the suction line. Expansion valve should be checked for loss of charge or faulty thermal bulb contact with the suction line.

D. Power Element:

The power element of an expansion valve consists of the thermal bulb, capillary tube and the bellow or diaphragm which actuates the valve pin. If this power element is defective or has lost its charge, the valve will either maintain an almost closed position or may close completely. To test for a defective power element, the thermal bulb should be removed from the suction line and warmed by holding it tightly in the hand. The valve will open if the power element is not defective. If the power element is defective, the valve will remain closed.

E. Thermal Expansion Valve Improperly Adjusted:

If the expansion valve is adjusted for too low a superheat, too much liquid will be passed to the evaporator. The suction line will be abnormally cold and liquid may "slug" back to the compressor. If the expansion valve is adjusted to too high a superheat, too little liquid line will be passed to the evaporator and the suction line will be abnormally warm. Superheat should always be adjusted carefully using thermometer and suction gauge.

PHYSICAL DATA

Boiling Point	-26.2°C (-15.2°F) at 736 mm Hg.
Vapor Pressure	96 psia at 25 deg C (77 deg F)
Vapor Density	3.60 (Air = 1.0) at 25 deg C (77 deg F)
% Volatiles	100 WT %
Water Solubility	0.15 WT % at 25°C (77°F) and 14.7 psia
Odor	Slight ethereal
Form	Liquefied gas
Color	Clear, colorless
Density	1.21 g/cc at 25 deg C (77 deg F) - Liquid

HAZARDOUS REACTIVITY

Instability	Material is stable. However, avoid open flames and high temperatures.
Incompatibility	Incompatible with alkali or alkaline earth metals- powdered Al, Zn, Be, etc.
Polymerization	Polymerization will not occur.
Decomposition	: Decomposition products are hazardous. "SUVA" Cold-MP can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrofluoric acid and possibly carbonyl fluoride.

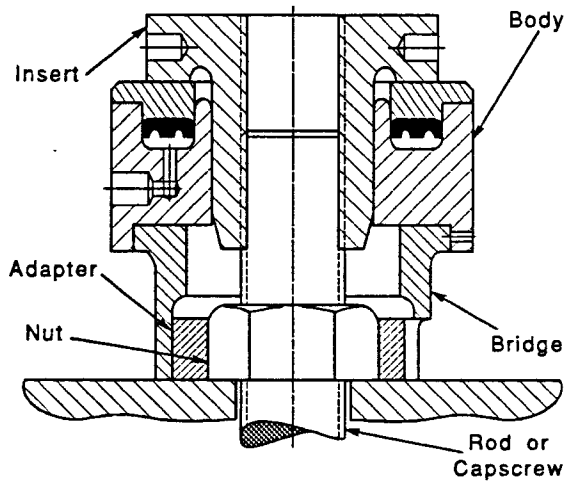
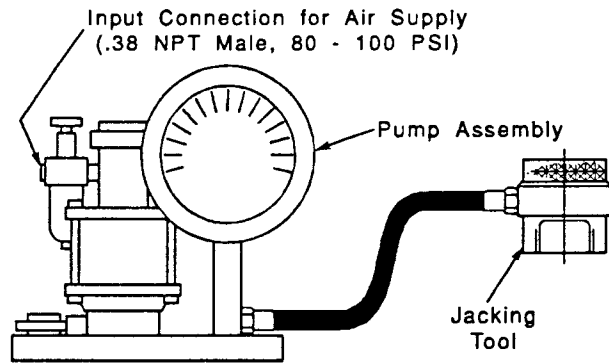
FIRE AND EXPLOSION DATA

Flash Point	Will not burn
Method	TOC
Flammable Limits in Air, % by Volume	LEL Not applicable UEL Not applicable
Autoignition	>750°C (>1,382°F)
	"SUVA" Cold-MP is not flammable at ambient temperatures and atmospheric pressure. However, "SUVA" Cold-MP has been shown in tests to be combustible at pressures as low as 5.5 psig at 177 deg C (351 deg F) when mixed with air at concentrations of generally more than 60 volume % air. At lower temperatures, higher pressures are required for combustibility. Experimental data have also been reported which indicate combustibility of HFC-134a in the presence of certain concentrations of chlorine.
Fire and Explosion Hazards	Cylinders may rupture under fire conditions. Decomposition may occur.
Extinguishing Media	As appropriate for combustibles in area.
Special Fire Fighting Instructions	Cool cylinders with water spray. Self-contained breathing apparatus (SCBA) may be required if cylinders rupture or release under fire conditions.

(continued)

HYDRAULIC TENSIONER

tnr1 all.wpg



tnr2 all.wpg

The Bolt Tensioner includes an air powered hydraulic pump and a jacking tool with inserts for 1.5, 1.75, 2.25 and 3.00 inch diameter bolts. Proper tensioning prevents premature failure or the bolted connection. Check the Bolt/Rod connections monthly.

HYDRAULIC PUMP PRESSURES FOR CLAMP LOADS

Reference Group	Nut Size	Residual Clamp Load (Lbs.)	Hyd. Pump Gauge Pressure (PSI)
<i>Lower Frame to Crawler</i>	3.00	300,000 (1)	15,000
	3.00	425,000 (2)	21,200
<i>Hoist Machinery</i>	2.25	165,000 (1)	13,700
	2.25	236,000 (2)	21,900
	1.75	95,000 (1)	15,400
	1.75	136,000 (2)	21,900
<i>Rotating Gear to Lower Frame</i>	1.50	70,000 (1)	10,300
	1.50	100,000 (2)	14,800
<i>Ballast Box and Wing</i>	1.50	70,000 (1)	10,300
	1.50	100,000 (2)	14,800

NOTE:

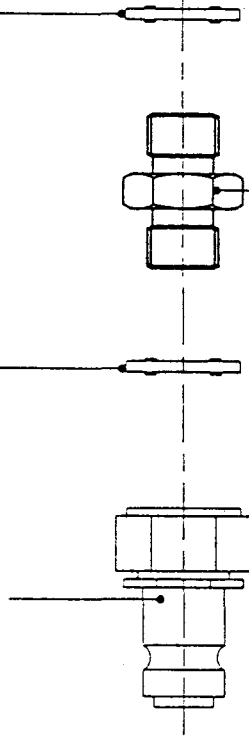
- (1) PRELOAD
- (2) FINAL LOAD

- 1.1.8 The maximum extension of the tools is indicated by a "vee" groove machined into the piston outer surface appearing out of the load cell body.
- 1.1.9 Several types of hydraulic pump can be supplied. If only one or two small tools are to be used then a manually operated pump unit is normally suitable but in most instances when several tools are to be used simultaneously, an air operated pump unit is often more appropriate. Both manual and air operated pump units are available in various capacities / configurations.

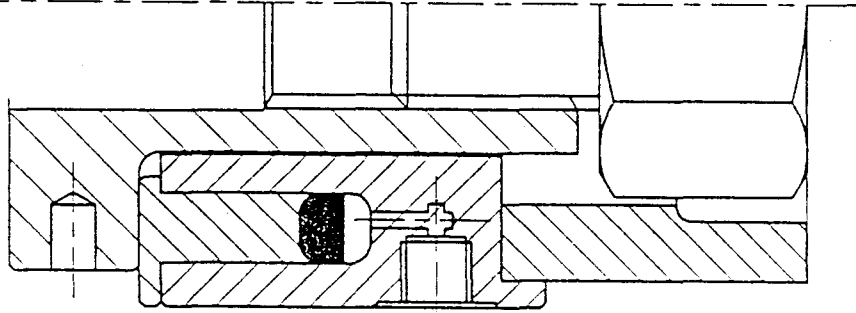
ALL MODIFICATIONS TO BE CARRIED OUT ON C.A.D. SYSTEM

DOVTY SEAL
DOVT.0001.1500

SNAP NIPPLE
CEJN.N116.1500



1/4" BSPx1/4" BSP ADAPTOR
ADAP.1M1M.1500



JACKING TOOL

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HTD
A DIVISION OF IAN P.L.C.

DRAWN DATE
M/W 31/10/91

CHECKED DATE
0 10 20 30 40

ITEM DESCRIPTION

DATE SHEET OF

LIMITS UNLESS STATED

TITLE

BREAKDOWN OF STANDARD 21750 PSI
(1500 BAR) HYDRAULIC CONNECTIONS

HTD LIMITED, A Division of IAN p.l.c.

HEAT TREATMENT

REMARKS

ISSUE No.

DRG. No.



3. OPERATING PROCEDURE

Note! Read Section 4 - Maintenance, prior to commencement

3.3 TENSIONING PROCEDURE

4.1 INSPECTION PERIODS

C. COOLING ASSEMBLY

The air cooling portion of the unit comprises a direct expansion evaporator coil using rows of finned copper tubes. A thermostatic expansion valve feeds liquid to the coil through a distributor system to the individual circuits in the coil. In addition, under part load, the suction pressure in the evaporator is maintained by Hot Gas injection into the evaporator.

The evaporator fan assembly comprises an AC two speed motor on which is mounted a forward curved fan rotor. This wheel rotates within a steel scroll. It will deliver air in either direction of rotation BUT reverse direction will only result in approximate 30% of normal.

IMPORTANT NOTE: Any service or repairs to the Refrigeration System should be carried out by a qualified refrigeration mechanic who has been specifically trained to work on this type of equipment.

TROUBLE ANALYSIS

When a fault is suspected the system should be fully evaluated to determine the cause. If necessary reference can be made to the Trouble Analysis Chart included in Section 10 of this manual. If the fault and subsequent analysis necessitates removal of components from the unit proceed as follows:

Removal of Components

The following items cover the removal and replacement of some major components which, following diagnosis may be required to be carried out: (A.) Unit from cabin, (B.) Compressor assembly, (C.) Refrigerant Drier, (D.) High/Low pressure switch, (E.) Supply air fan assembly (F.) Condenser fan assembly.

A. Removing Unit

Removal of the unit must be carried out using an overhead crane, and either wire rope slings or a suitable lifting frame. The unit weighs approximately 900 lbs. (400 kilograms) and a crane suitable for lifting this mass must be utilized.

1. Open the remote circuit breakers. Have a qualified electrician disconnect the incoming power supply wires, and connection to pilot control box.
2. The drain connection must then be removed.
3. On the roof of the cabin the retaining nuts must be removed taking care to retain the spring, flat and sealing washers used.

The refrigerant cylinder must remain upright with refrigerant withdrawn only through the vapor valve to ensure vapor only reaching the compressor. The vaporizing of the liquid refrigerant in the cylinder will chill the liquid remaining and reduce the cylinder pressure. To maintain cylinder pressure and expedite charging, warm the cylinder by placing it in warm water or by using a warming heat lamp.



WARNING: DO NOT APPLY HEAT WITH A TORCH!

To determine if sufficient charge has been introduced, close the refrigerant cylinder valve and observe the sight glass, which should not contain any bubbles or gas. When a clean sight glass is first evident this indicates that the critical charge has been entered into the system. Slow charging should continue for one or two minutes after the clear sight glass first appears. This will allow a small "reserve" of refrigerant to be maintained in the system. Normally, the system should be under a normally loaded condition.

3. To determine when properly charged:

The most common method of determining the proper system charge is by means of the sight glass in the liquid line. This is visible through the condenser fan access panel or condenser fan grille and must be checked with the unit operating in either high or low cool mode. Since a solid head of liquid refrigerant is essential for proper expansion valve control, the system can be considered properly charged when a clear stream of liquid refrigerant is visible when the unit is operating. Bubbles or flashing usually indicates a shortage of refrigerant.

NOTE: If there is only vapor, and no liquid in the sight glass, it will also appear to be clear.

It should be noted that the sight glass may show bubbles or "flash" gas even when the system is fully charged. A restriction in the liquid line ahead of the sight glass may cause sufficient pressure drop to cause flashing of the refrigerant. If the expansion valve feed is erratic or surging the, increased flow when the expansion valve is wide open can create sufficient pressure drop to create flashing at the condenser coil outlet. Rapid fluctuations in condensing pressure can also be a source of flashing. In this case, the liquid may be at a temperature higher than the saturated temperature equivalent of the condensing pressure and flashing will occur.

Systems have a different charge requirement under different operating conditions. A system operating with a clear sight glass under summer conditions will require a different refrigerant charge for proper operation under low ambient conditions.

While the sight glass can be a valuable aid in determining the proper charge, the system performance must be carefully analyzed before placing full reliance on it as a positive indicator of the system charge.

F. Thermal Expansion Valve Too Large:

If a replacement thermal expansion valve has been improperly selected, and its capacity is too great for the system, the valve will not maintain a consistently level suction pressure. The thermal bulb will attempt to control the flow of liquid at its superheat settings, but the oversized valve port will pass liquid too rapidly. The presence of liquid near the thermal bulb will close the valve and the pressure in the evaporator will drop until the valve opens to pass another "slug" of liquid. This "hunting" will cause a suction pressure variation noticeable on the suction pressure gauge.

G. Thermal Expansion Valve Too Small:

If the replacement thermal expansion valve is too small, it cannot pass a sufficient amount of liquid to satisfy the evaporator. Under conditions of heavy load, the superheat will be excessive and the system will lose capacity. Under conditions of light load, the system may function properly. Too small expansion valves usually result in abnormally low suction pressure.

NOTE: Items (F) and (G) should not occur and we strongly recommend that the Factory be contacted if this problem is suspected.

H. Thermal Expansion Valve is Obstructed:

Unless the expansion valve is properly protected by a strainer or filter, foreign matter may obstruct the valve port. If the obstruction is small, the resulting operation will be much the same as though the valve were undersized as described in (G). If the obstruction holds the valve open during shutdown, the operation will be as described in (B) and (C). An obstructed expansion valve is usually indicated by a partly warm evaporator.

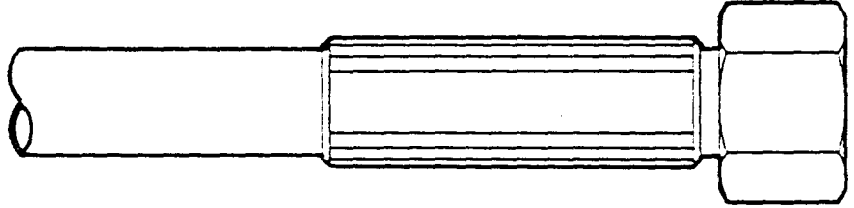
I. Shortage of Refrigerant:

There should always be sufficient liquid in the receiver to completely submerge the inlet to the liquid line pipe. If there is a shortage of refrigerant, the liquid level will fall below the inlet to the liquid line. Frequently there will be a hissing or whistle at the expansion valve. The coil and suction line will be relatively warm while the suction pressure will be low due to little or no liquid being supplied to the evaporator if the shortage is severe.

HTD
A Division of T&N plc.

FLEXIBLE HYDRAULIC HOSE ASSEMBLY

PART No.
HHSS.4500.1500



HOSE TYPE	4 PLY
INSIDE DIA	1/5" / 5.0mm
OUTSIDE DIA	29/64" / 11.2mm
WORKING PRESSURE	1500 BAR / 21750 PSI
MIN.BURST PRESSURE	4500 BAR / 65250 PSI
TEST PRESSURE	50% ABOVE WORKING PRESSURE
MIN.BENDING RADIUS	6"/150mm
INNER CORE	DERIN [®]
REINFORCEMENT	4 LAYERS OF SPECIALLY TREATED HIGH TENSILE STEEL WIRE
OUTER COVER	PA
WORKING TEMPERATURE	-22°F TO 176°F / -30°C TO +80°C
COLOUR	BLUE
WEIGHT	0.260 Kg/m
OUTER PVC COVER	CLEAR
FITTINGS	1/4" BSP FEMALE SWIVEL PART No. ECSW.4005.1500

3.3. Tensioning Procedure

- 3.3.1. Ensure that all designated procedures have been carried out satisfactorily, and that the tools, harness and pump unit are correctly assembled.
- 3.3.2. Ensure that "tommy" bars are available.
- 3.3.3. Ensure that the calculated working pressure, maximum system pressure (see Technical Data) and maximum piston extension are known to all operating personnel.
- 3.3.4. Close the oil pressure release valve (G) on the pump unit (Rotate clockwise).
- 3.3.5. VERY SLOWLY open the pump unit air ON/OFF valve (F) (Rotate anti-clockwise). As this is done, the pump will begin to operate. After a short time the pressure gauge (B) will begin to register pressure. CONSTANTLY monitor the piston extension; the piston may extend before any pressure is registered on the gauge. CONSTANTLY monitor the oil pressure. If EITHER operating oil pressure OR maximum piston extension is reached then stop the pump IMMEDIATELY by closing the air ON/OFF valve (F). (Rotate clockwise).

NOTE! Even if a "stall" pressure has been set during commissioning, for extra safety CONTINUE to manually monitor the oil pressure on the gauge.

- 3.3.6. While the tools are held at pressure, insert the "tommy" bar through the tightening slot in the bridge of one of the tools and into the mating hole in the nut (or nut rotating disc) which is furthest to the right. Rotate the nut clockwise until it seats down onto the joint face. When seated, tap the "tommy" bar with a hammer sharply, a few times, to ensure a firm contact. Repeat this procedure on all tools.
- 3.3.7. VERY SLOWLY open the oil pressure release valve (G) on the pump unit; the oil pressure registered on the gauge will fall to zero.

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