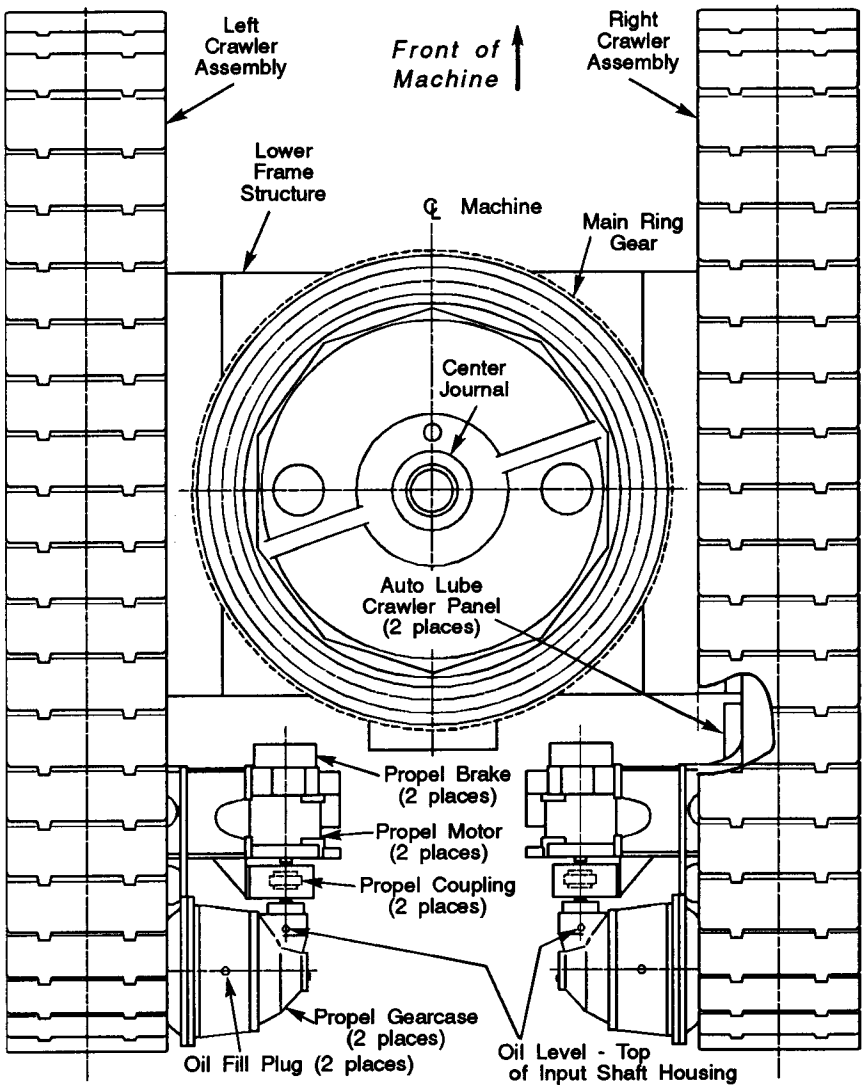
BUCYRUS®

Technical Manual



301-M LOWER FRAME and CRAWLER ASSEMBLY
(Plan View)

ROLLER CIRCLE SEGMENT REMOVAL

1. Place the machine on a level work area.

2. Rotate the rotating frame so that the segment to be removed is located at the side of the rotating frame.

3. Shut down the machine and set the brakes.

4. Remove the 4 splice bars (2 inner and 2 outer) from the ends of the segment.

5. Replace the through capscrews in the end rollers. Replace the nuts on the ends of the capscrews after the splice bars are off the segment.

6. Carefully lift the roller segment (approx. 1300 Lbs.) up off the lower rail and move it away from the machine.

NOTE: This segment removal provides access to the upper and lower roller rails for rod and bolt tightening and/or replacement. The entire roller circle can also be replaced by systematically removing a segment, replacing the rollers, reassembling the segment into circle, rotating machine to next segment, and so on until the entire roller circle is installed.

7. Reassembly is the reverse of disassembly.

   a. Refer to "Roller Circle Adjustment Procedure" above.

   b. Tighten the roller capscrews as specified in the procedure after the roller circle assembly is situated correctly.

   c. Refer to "Roller Replacement" above for lubrication and matching of adjacent roller diameters.

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.

LOAD and IDLER ROLLERS

The Load and Rear Idler Rollers are located at the bottom of each crawler side frame. The load rollers and rear idler distribute the machine weight on the crawler belt.

Each of the load rollers and rear idler roller turn on a fixed shaft secured in the crawler side frame by a lock collar and pin. Each roller is fitted with a bronze bushing.

Thrust washers are located between the rollers and inner frame bosses to retain lubrication and prevent the entry of dirt.

ROLLER REMOVAL or REPLACEMENT

To remove a roller from the crawler side frame:

1. After a pit has been prepared, position a handling fixture under the roller for support when the shaft is removed.

2. Propel the machine forward to a position where the roller to be removed is directly over the hole. Separate the belt by removing the lock bolts. Lower each end of the belt into the pit exposing the roller for removal.

3. Disconnect the autolube line from the end of the roller shaft. Plug the line to prevent dirt entry.

4. Remove the shaft retaining bolt.

5. Drive or pull the shaft out of the crawler frame, being careful to support the roller on a handling fixture, jack or cribbing. Remove the thrust washers as they come free.

The same procedure can also be used to remove the rear idler roller.

9. Reassembly is the reverse of disassembly:

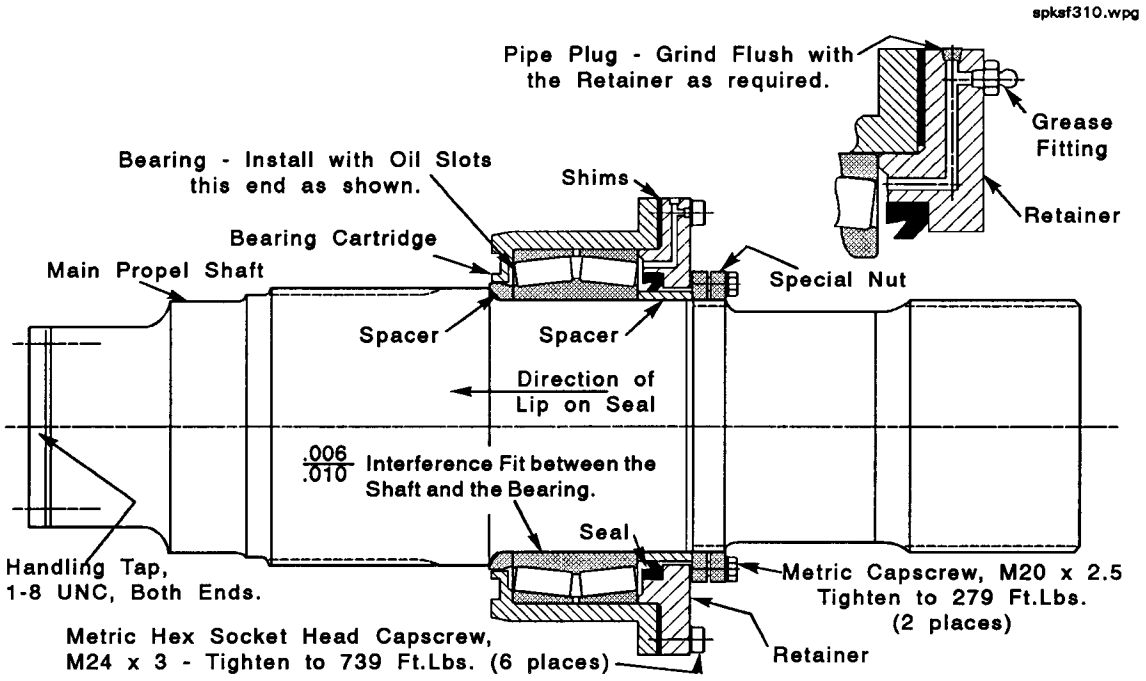
   a. The double tapered bearing may be heated for assembly to the shaft. Use a dry heat source and do not permit the temperature of bearing to exceed 300° F (149° C). Allow the bearing to cool to ambient temperature before assembling any other parts to it.

   b. Install the bearing retainer and new seal without shims. Shim the gap at the retainer/cartridge as indicated in the accompanying sketch.

   c. Fill the bearing cavity with MPG lube at assembly.

   d. Spray the lip seal area with Molylube 1200 AR (P/N 170025-1) or an equivalent at assembly.

10. Assemble the main propel shaft into the sprocket and crawler.



MAIN PROPEL SHAFT - *Section View*

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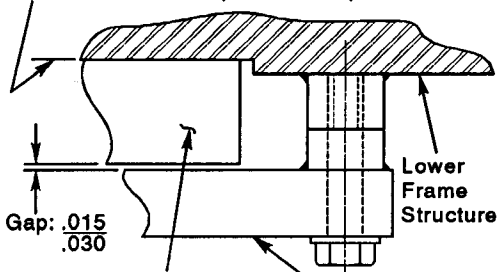
NOTE: Hold the flange of the center journal against the bottom register of the lower frame structure until the temperatures equalize.



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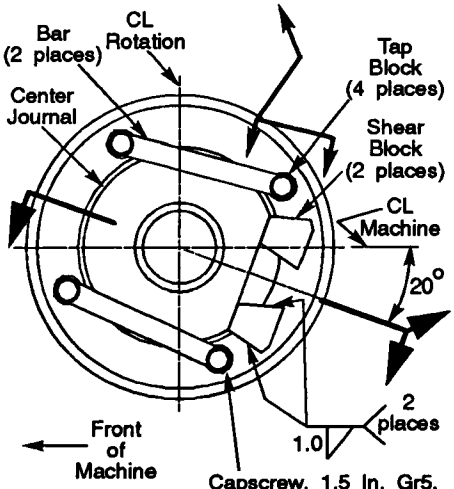
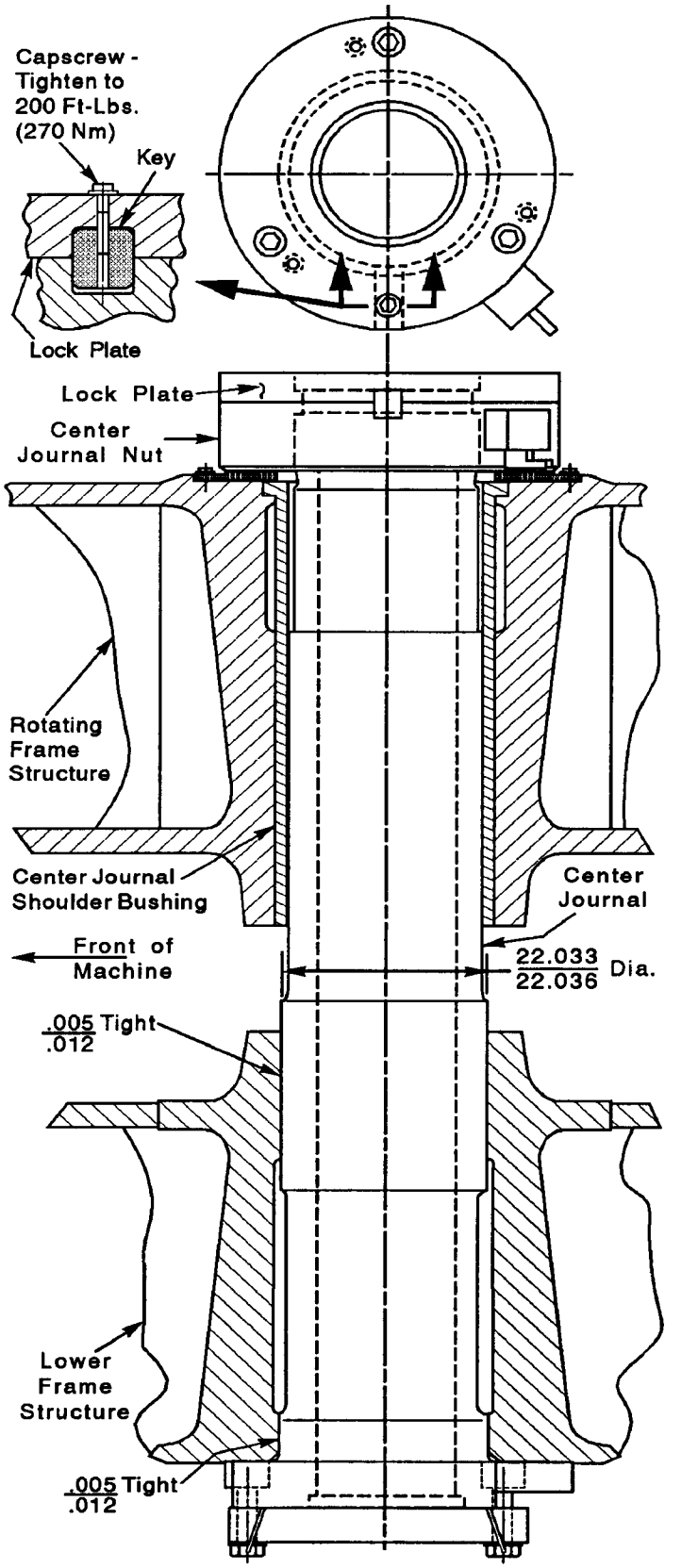


Capscrew, 1.5 In. Gr5, and Flat Washer - Tighten to 2000 Ft.Lbs., wire lock in place, after the Center Journal is resting against the Lower Frame.



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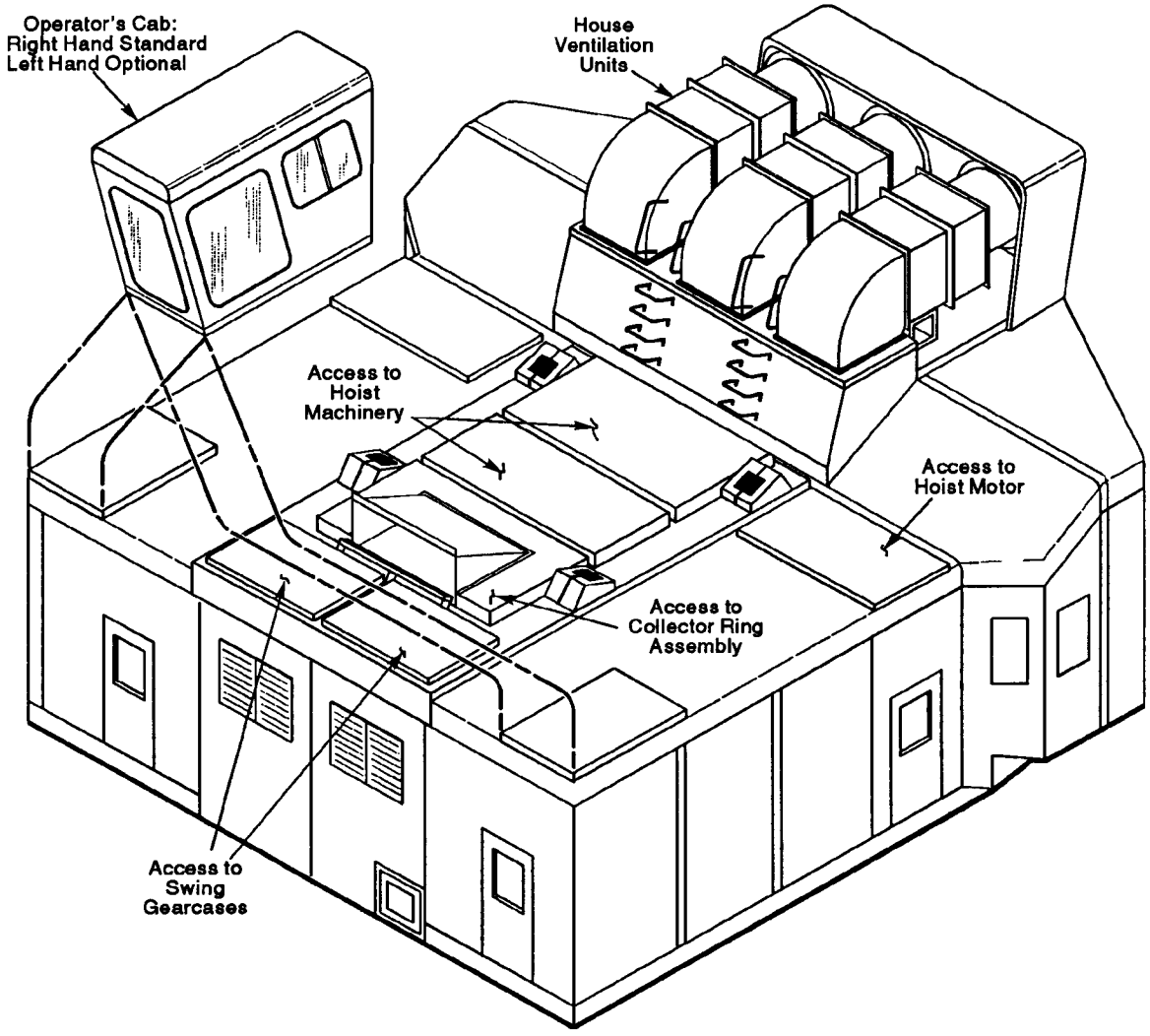
CENTER JOURNAL INSTALLATION

4.4.2



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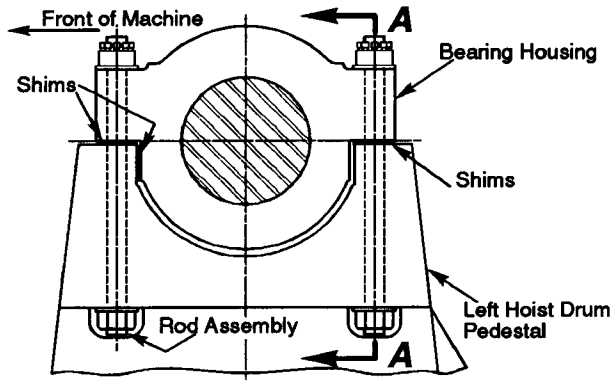
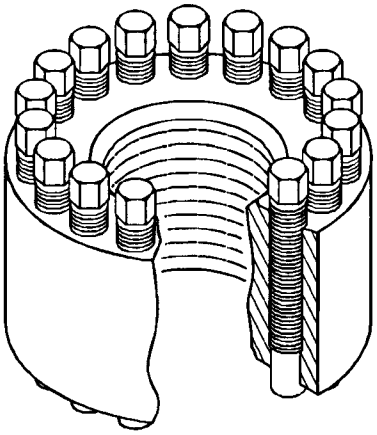
301-M MACHINERY HOUSE

HOIST DRUM BEARING HOUSINGS

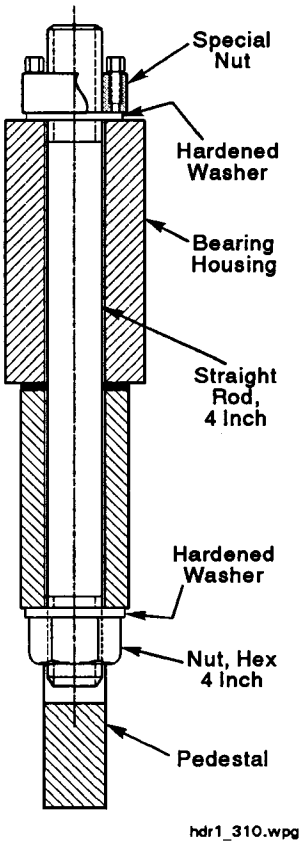
Each *Hoist Drum Bearing Housing* is secured to the hoist pedestals with 4.0 inch diameter rods. Special nuts are used to tension the rods to 642,000 Lbs.



HOIST DRUM BEARING HOUSING
(Viewed from the left side of the machine)



SPECIAL ROD NUT



Section A-A
(4 places)

Rod Installation

1. Install the lower washer and nut as the rod is lowered into place. Use Loctite 271 (or equivalent) on the threads.

2. Install the hardened washer and special nut. Tighten the nut as much as possible by hand.

3. Using a small wrench, tighten the jack screws in the sequence noted in Figure No.1.

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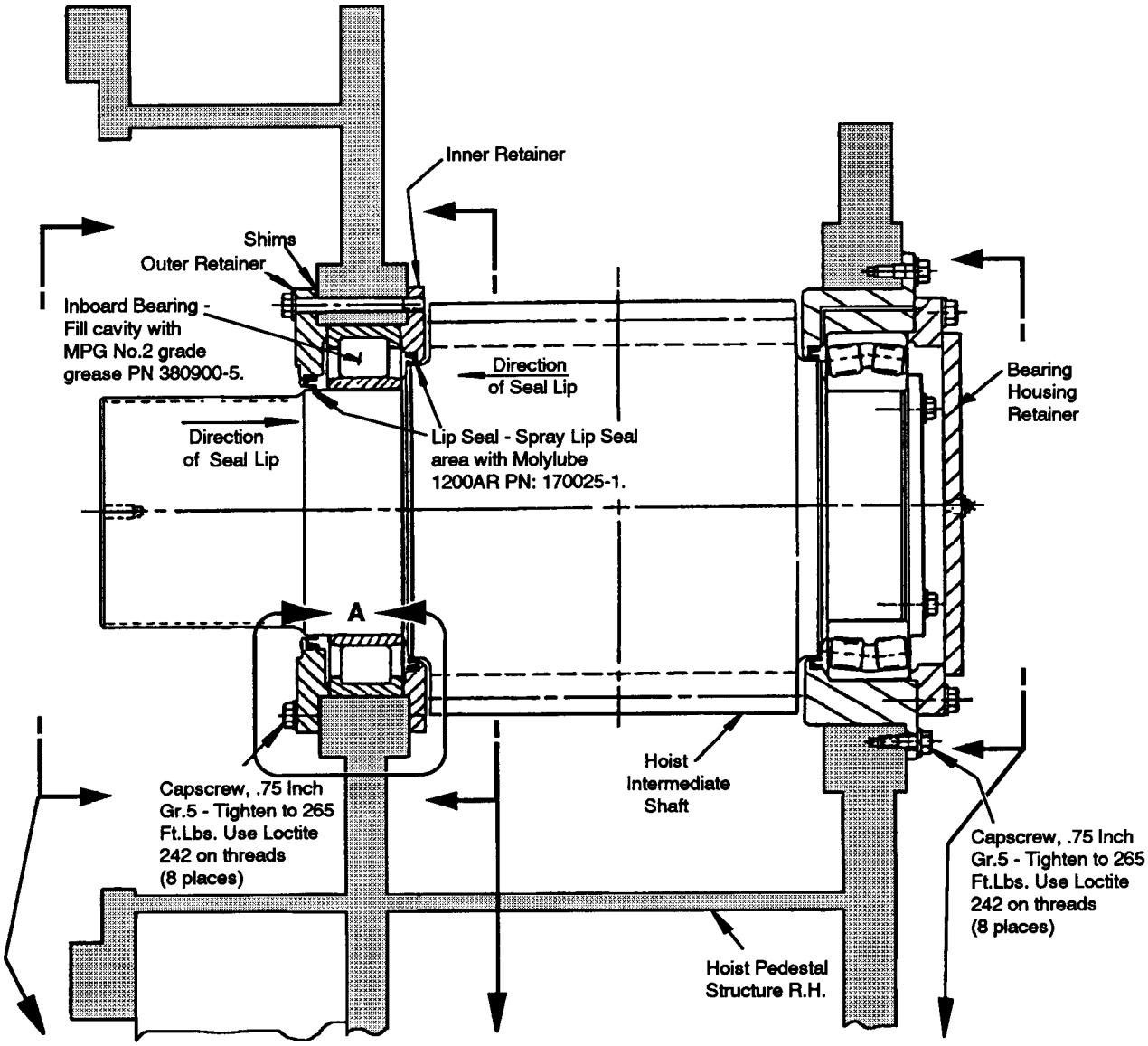

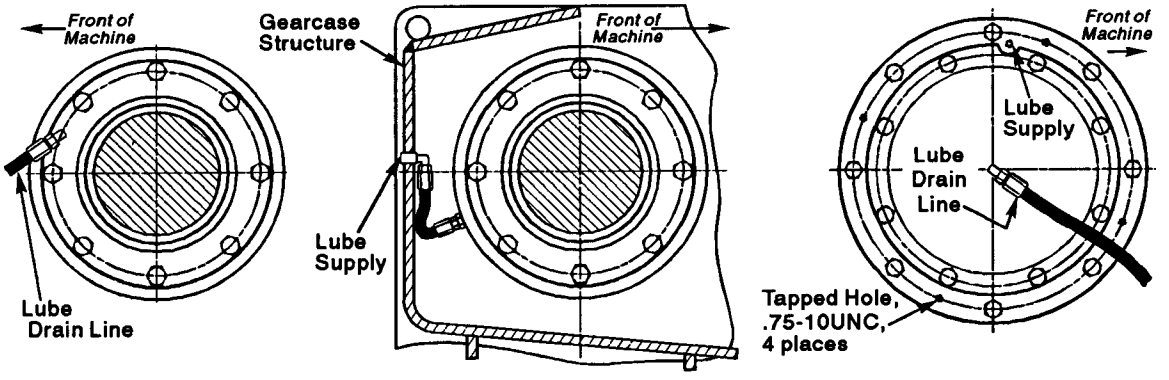

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INTERMEDIATE HOIST SHAFT - *Section View*

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.

CAUTION: Do not mix bearing parts.

6. Note the position of the lube hole in the side of the shaft and mark its direction on the end of the shaft.

7. Set the sheave (with its casting risers up) over the shaft and install the remaining bearing cone, grease retainer, sleeve and bearing retainer. Mark the bearing retainer to indicate the lube hole location.

8. Install 3 - M24 capscrews (No.'s 2,3 and 6 in the view) and tighten to 500 Ft.-Lbs. (919 Nm) while rotating or oscillating the sheave.

9. Loosen the capscrews and re-tighten to 165 Ft.-Lbs.(224 Nm) while rotating or oscillating the sheave.

10. Measure the gap between the shaft end and the bearing retainer. Adjust the shim thickness to this gap dimension.

11. Install the shims, bearing retainer and all 6 - M24 capscrews with hardened washers. Tighten to 940 Ft.Lbs (1274 Nm) in the sequence indicated. Lockwire 4 of the capscrews in pairs. (1 & 3, 2 & 4).

BOOM POINT SHEAVE INSTALLATION

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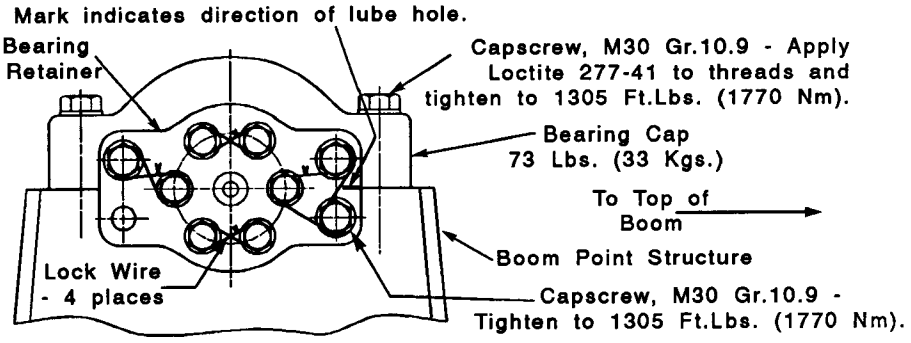
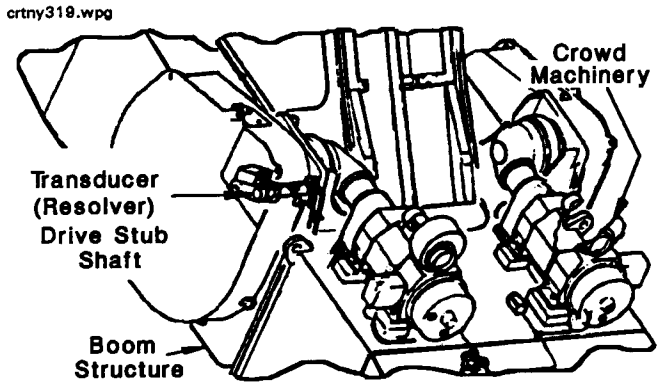


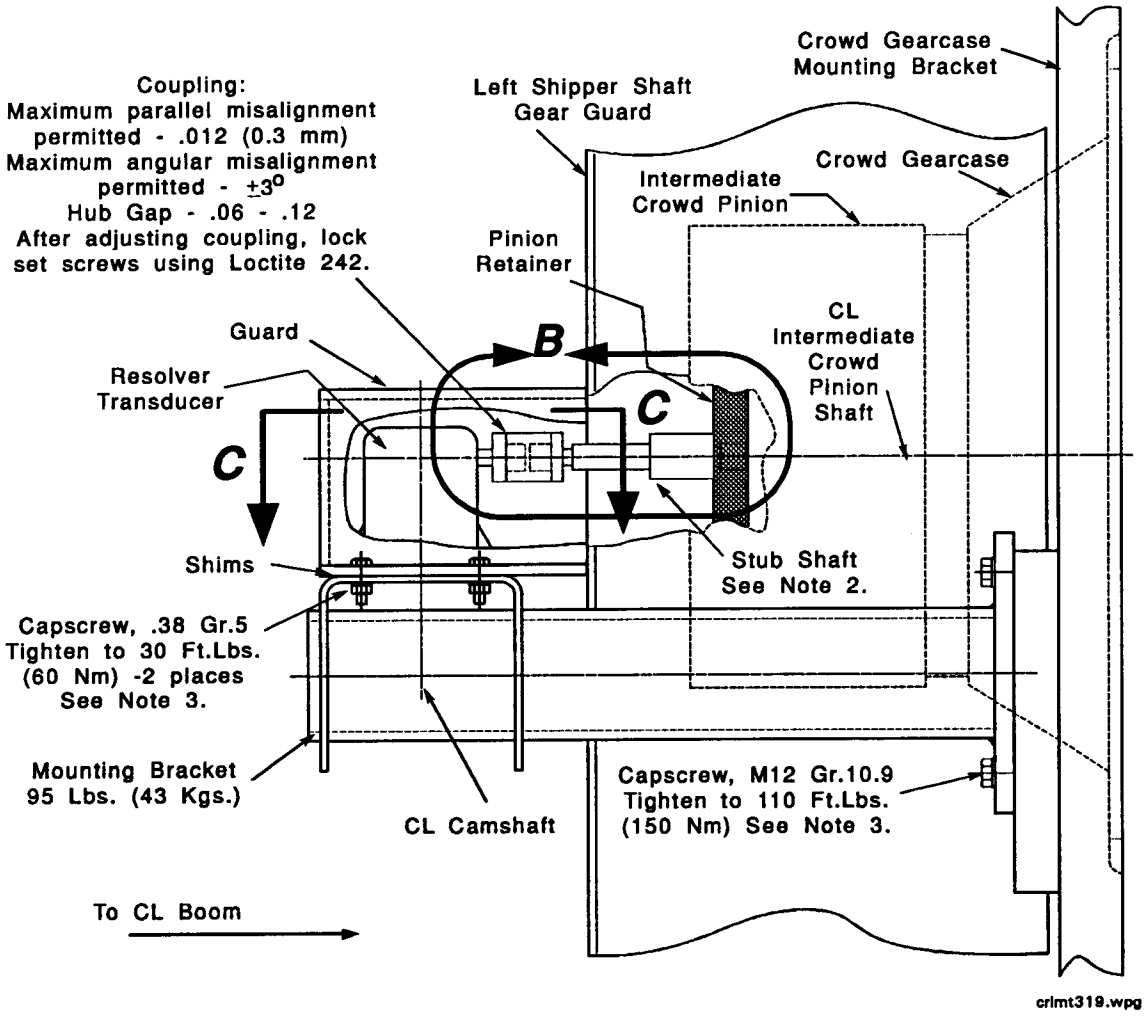
1. Set the sheave assembly (5825 Lbs., 2642 Kgs.) in place on the boom. Rotate the bearing retainer to align the bolt holes and to orient the lube hole toward the top of the boom.

2. Install the 2 bearing caps and the 3 - M30 capscrews which secure the bearing retainer to the boom and bearing cap. Tighten all 7 - M30 capscrews to pull the mating parts in place.

3. Remove the 4 - M30 capscrews from the bearing caps, apply Loctite 277-41 to the threads, re-install the capscrews and tighten to 1305 Ft.Lbs. (1770 Nm).

4. Tighten the 3 - M30 capscrews securing the bearing retainer to 1305 Ft.Lbs. (1770 Nm) and lockwire in place.





CROWD / RETRACT LIMIT SWITCH ASSEMBLY

The *Yoke Block Assembly* contains 8 wear pad assemblies which guide the dipper handle through the yoke block. Each wear pad assembly is composed of a nylatron wear pad, shims and a urethane cushion. To assist in removal, each wear shoe has a M12 X 1.75 tapped hole on its front and rear surface. It is very important that the same total thickness of PAD/SHIMS/CUSHION be used in the 6 side pad assemblies and the same thickness in the 2 top pad assemblies. Therefore, *ALL PADS and SHIMS SHOULD BE CHANGED IN SETS.*

Determine the correct pad assembly thickness required with the following procedure:

1. Park the machine in a level work area.

2. Check the handle width and depth along the length of the handle. Starting at 76 inches (1930 mm) ahead of the last rack tooth on the dipper end, to 45 inches (1143 mm) behind the last rack tooth on the green horn end of the handle. Record the maximum dimensions found along with their location.

DANGER: Adjusting shims requires working around live machinery. USE MAN BASKETS AND SAFETY BELTS WHILE WORKING IN THIS AREA.

3. Top wear pad adjustment:

   a. Hoist the dipper until the handle is horizontal. Adjust the hoist rope lengths as required to place the handle squarely within the yoke block.

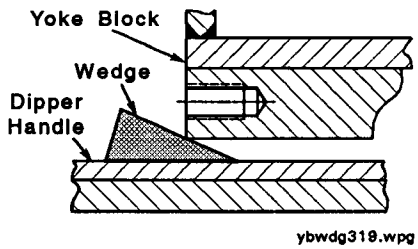
   b. Crowd in or out to place the deepest section at the center of the yoke block. Set all brakes and remove the pad retainers. Drive a wedge between the handle and the front of the yoke block. Pull out the wear pad assemblies and thoroughly clean all parts.

   c. Lift the front of the yoke block until the gap "A" (refer to page 4.10.12), between the handle and yoke block structures, is the same front and rear.

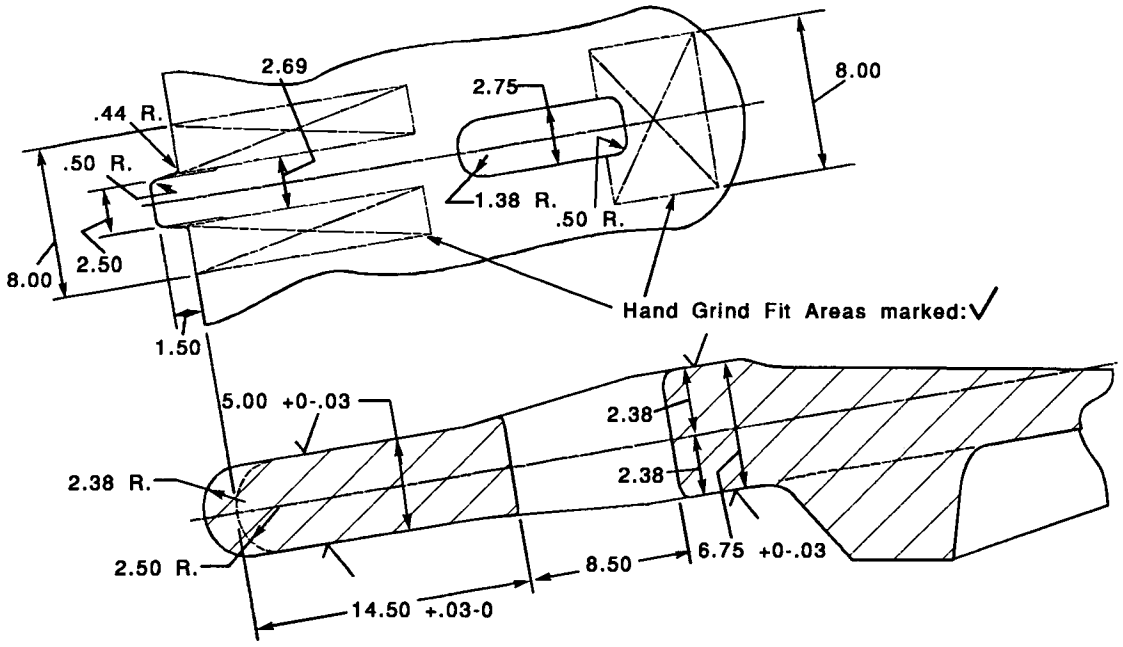
   d. Measure the gap at the front and rear. Subtract .18 (4.6 mm) from the smaller dimension. The remainder is the pad assembly thickness required. Record this dimension.

   e. Make the front and rear pad assemblies the same height by adjusting the shims as required and install.

   f. Remove the wedges and install the retainers. Tighten the capscrews to specification and lockwire in place.

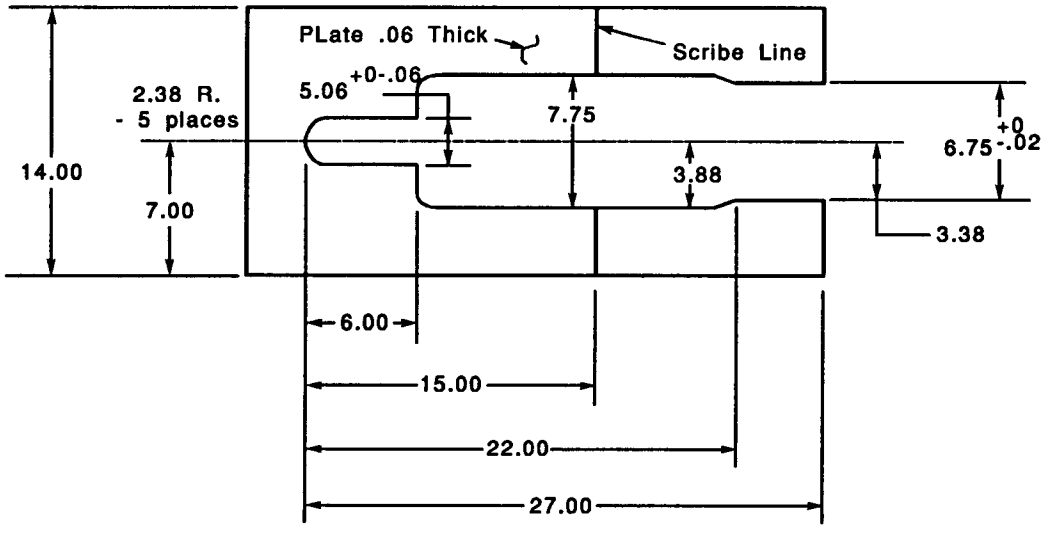


Section G-G
WEDGE INSTALLATION
(from Pg. 4.10.11)

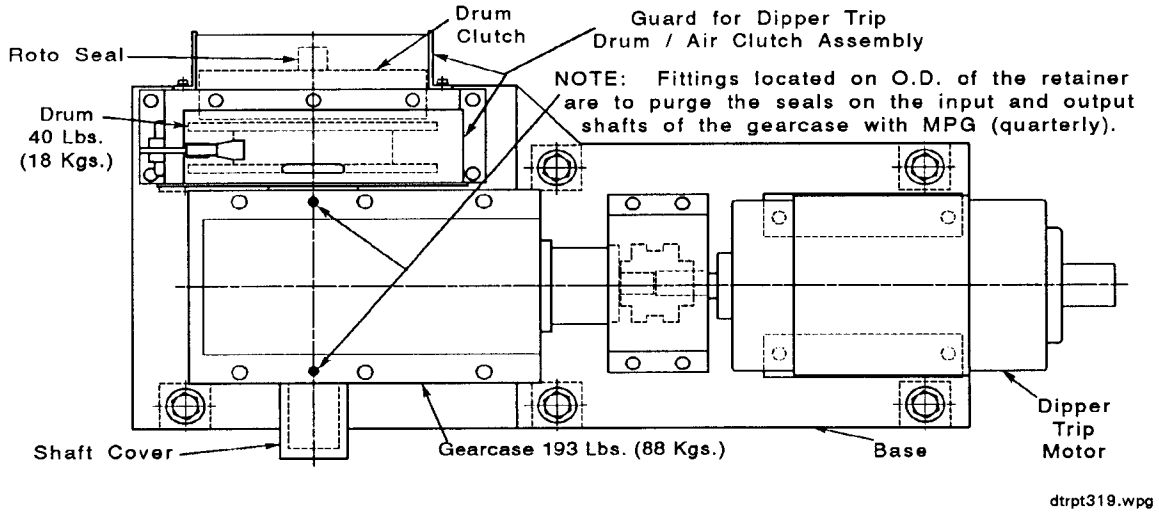


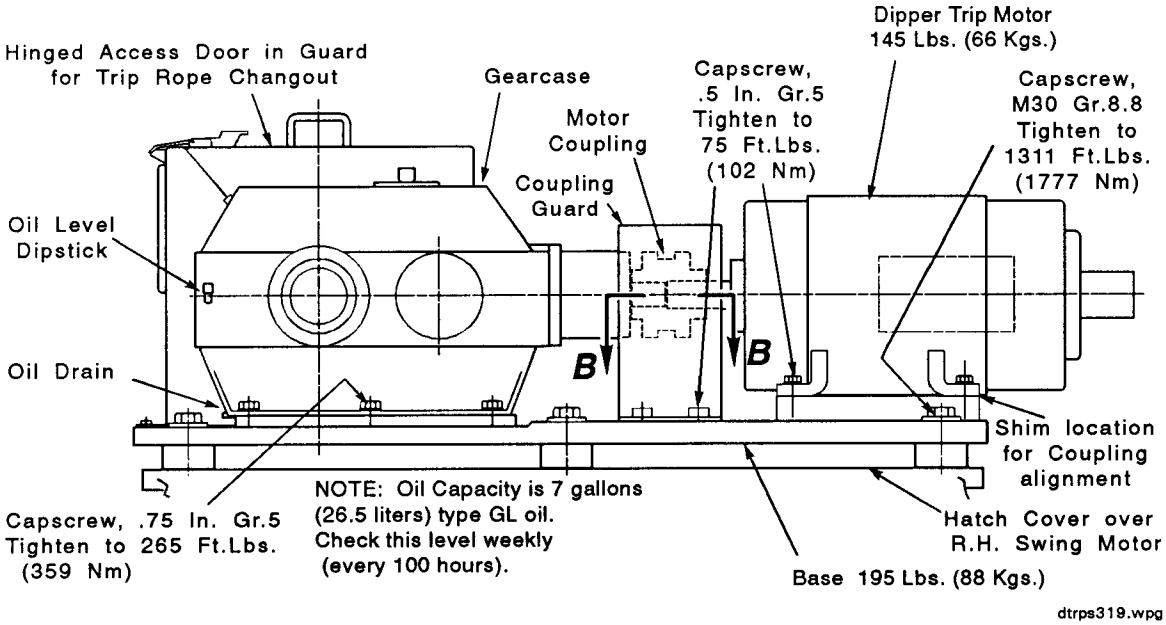
TOOTH BASE DETAIL *(9 Places)*

NOTE: When replacing tooth adapters, check the mounting surfaces for wear. Stock weld and grind to the dimensions shown. It is very important to keep the leading edge of the base perpendicular to the CL of the wedge/C-clamp slot and the key tab centered. A tooth gauge will assist with establishing the mounting surfaces. Refer to Section 14 - *AMSCO INSTRUCTIONS*, in this manual, for welding.



Detail - **GAUGE for TOOTH BASE**





DIPPER TRIP MACHINERY

[Approx. 2600 Lbs., 1179 Kgs.]

DRUM/AIR CLUTCH ASSEMBLY REMOVAL from the GEARCASE

Remove the dipper trip clutch from the gearcase with the dipper trip machinery removed from the machine and in a properly equipped shop. Refer to assembly removal procedure.

1. Disconnect 2 hose lines from the rotating union seal and torque assembly.

2. Disassemble the rotating union seal with its adapter from the end of the clutch adapter shaft.

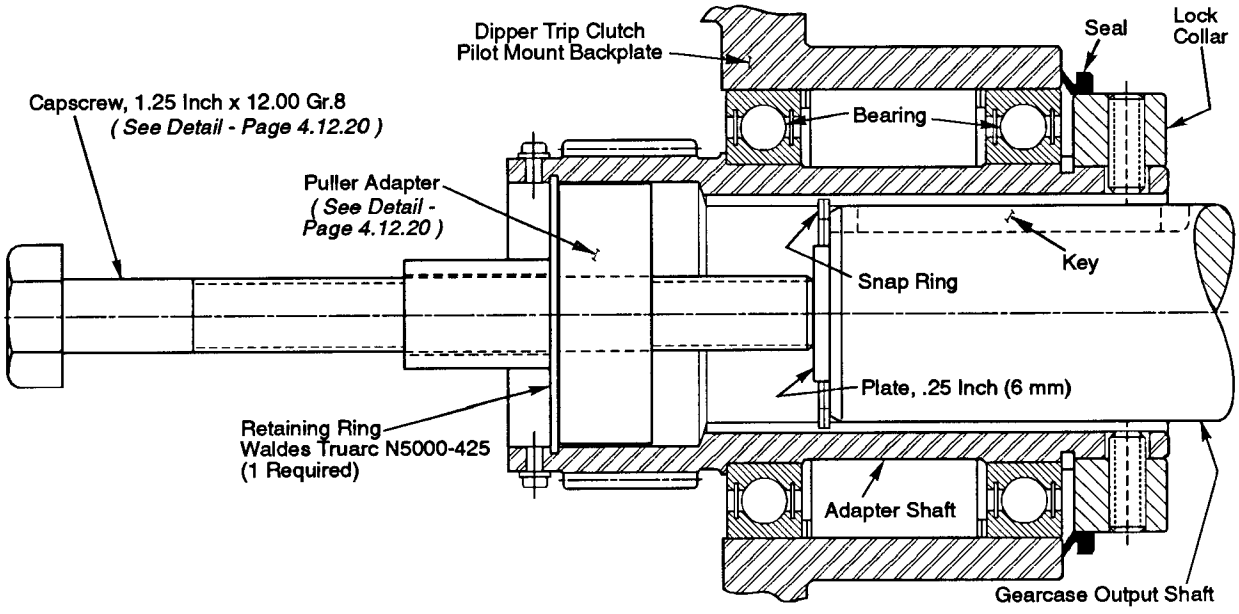
3. Loosen 2 set screws in the lock collar so they are off the key and gearcase output shaft.

4. Install a puller assembly onto the clutch for removal. Refer to the following figure. Insert the small plate, puller adapter and capscrew into the clutch cavity. Install the retaining ring to secure the puller adapter.

NOTES:

- Apply a maximum torque of 1820 Ft.Lbs. (2468 Nm) to the capscrew to remove the clutch from the gearcase shaft.

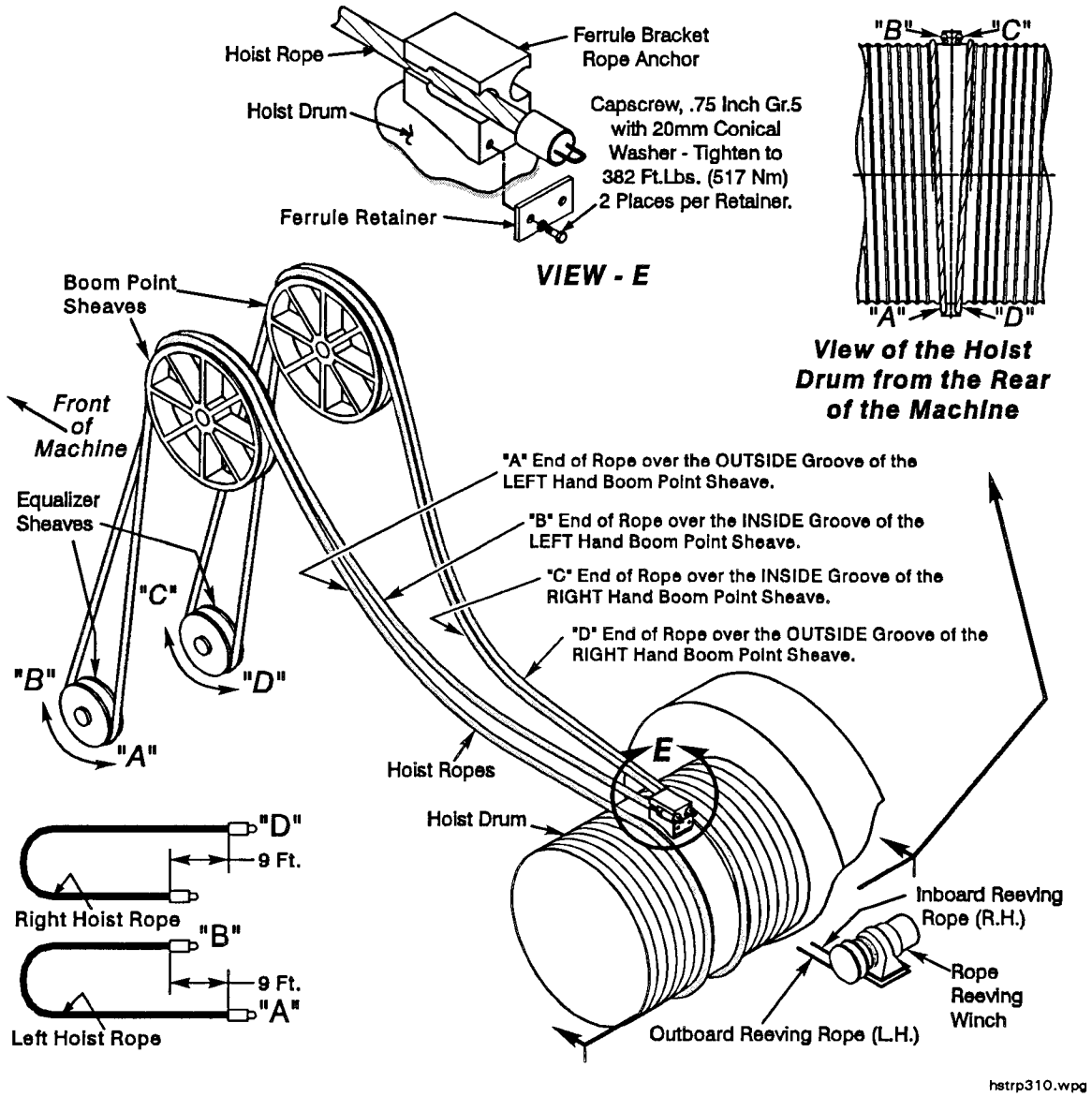
- Additional jacks may be used between the clutch drum and the gearcase. However, *USE CAUTION NO TO DAMAGE THE GEARCASE.*



PULLER INSTALLATION for DIPPER TRIP GEARCASE dtplr301.wpg

5. Pull the drum/clutch assembly off the gearcase output shaft.

NOTE: The fit is .0005-.0025 Inch (.013-.064 mm) tight (interference). Retaining compound used between parts insure the fit. Contact the Marion Service Department for consultation on removal.



HOIST ROPE INSTALLATION

INSTALLATION NOTES:

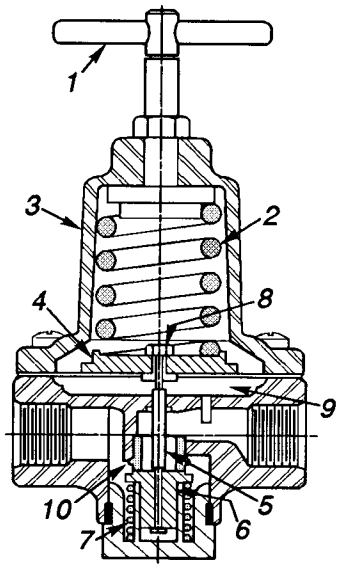
1. Route the inboard (RH) winch rope over the boom point sheave and attach it to the RH hoist rope ends "C" & "D". Route the outboard (LH) winch rope over the boom point sheave and attach it to the LH hoist rope ends "A" and "B".
2. Pull all 4 ends of the hoist ropes over the boom point sheaves simultaneously. Use spacer bars at the connections between the winch ropes and hoist rope ends to maintain spacing between the hoist ropes as they pass over the boom point sheaves.
3. The hoist rope ends "A" & "D" are reeved from the front of the equalizer sheave over the point sheave outside groove to the drum sockets marked "A" and "D".
4. The hoist rope ends "B" and C" are reeved from the back side of the equalizer sheaves over the point sheave inside grooves to the drum socket marked "B" and "C".

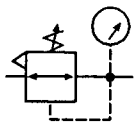
PRESSURE REGULATORS

These regulators are used in compressed air systems to maintain a nearly constant downstream (outlet) pressure despite changes in the upstream (inlet) pressure and in the downstream flow requirements. These units are of the relieving, diaphragm type and are each fitted with a gauge that indicates outlet air pressure.

Outlet pressure is controlled by an adjusting screw (1) on top of the regulator that is fitted with a T-handle. Clockwise (CW) rotation *increases* outlet pressure, and counterclockwise (CCW) *decreases* it.

When the adjustment (1) is rotated fully counterclockwise, no force is applied to the regulating spring (2), and the valve (6) is held closed by the valve spring (7). Clockwise rotation of the adjustment (1) compresses the regulating spring (2) which applies a downward force on top of the diaphragm (4). The diaphragm and valve pin (5) move downward, forcing valve (6) off its seat (10) which allows air to flow through the regulator to the downstream system.





Graphic Symbol

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Outlet pressure increases in the downstream system and sensing chamber (9) and applies an upward force on bottom of diaphragm (4). The diaphragm, valve pin (5), and valve (6) move upward, compressing the regulator spring (2). Upward movement stops when the forces below the diaphragm balance the forces above the diaphragm. When there is no downstream flow demand, the balance of forces occurs with the valve (6) closed. When there is downstream flow demand, the balance of forces occurs when the valve opens sufficiently to compensate for demand, thus maintaining the desired outlet pressure.

These air pressure regulators require no maintenance. If a unit leaks air excessively or malfunctions, replace it.

	Weight (Lbs.)
Swing Gear Case	6,548
• • Swing Motor with Blower & Brake	6,170
• • • Swing Brake	600
• • Main Rotating Shaft	3,630
• • Main Rotating Pinion	640
Gantry Assembly	33,338
• • Front Leg with Platform	28,048
• • Back Leg	4,745
Left Wing Module	38,440
• • Left Wing Structure	8,980
Right Wing Module	51,400
• • Right Wing Structure	8,520
Ballast Box with Ballast	763,130
• • Ballast Box	156,000
• • Ballast Box Module	67,130
House Filter/Fan Unit	3,000
Operator's Cab	8,160
• • Air Conditioner	705
Dipper Trip Assembly	2,610
• • Motor	316
• • Gear Case	880
Boom Assembly	232,300
• • Boom Structure	125,060
• • Boom Point Sheave	5,850
• • Yoke Block	41,500
• • Shipper Shaft	2,954
• • Shipper Shaft Gear	2,438
• • Shipper Shaft Pinion	1,168
• • Shipper Shaft Gear Guard	732
• • Crowd Gear Case	3,130
• • • Crowd Motor with Brake	3,900
• • • Crowd Brake	480
• • Walkways & Platforms	9,800
Dipper Handle with Snubber	104,190
• • Snubber	4,750
Dipper Front Assembly (54 Yd3)	74,800
• • Dipper Tooth Assembly	849
• • Dipper Door Assembly	27,224
• • • Latch Bar	938
• • • Latch Lever	536
Hoist Rope	3,768
Boom Support Rope	1,795

OPERATOR'S SEAT ADJUSTMENT

The operator's seat was selected to give operators of all sizes the ability to position and adjust the seat to their preferred arrangement. Since the operator must sit for extended periods of time, it will be worthwhile to adjust the seat to his most comfortable position.

A. *WEIGHT COMPENSATOR* - knob adjusts support coils tension to suit weight of occupant. Use knob to dial weight of operator (in Metric/English) on visual indicator next to it.

B. *HEIGHT* - vertically adjustable a total of 2.36 inches (60mm) to three levels 1.18 inches (30mm) apart. Grasp the seat on each side and lift it to the desired level. Raising the seat above the third and highest level will permit it to return to the lowest level.

C. *FOR AND AFT* - adjustable through a range of 6.25 inches (159mm). Lift the lever bar at the front of the seat and move the seat front or rear as desired, releasing the lever at the desired location.

D. *BACKREST TILT* - angle of the backrest is adjustable from vertical to 15° back from vertical by using the adjustment knob on the left side.

E. *LUMBAR CONTOUR* - knob adjusts contour of lumbar support in backrest.

F. *LUMBAR HEIGHT* - knob adjusts height of lumbar support in backrest.

G. *SEAT CUSHION* - the angle of inclination adjustable using this knob within a range of 4°.

H. *ARMREST HEIGHT* - the inclination of the covered portion of the armrest can be altered with the adjuster indicated through an arc of 20°. Each armrest has its own adjustment. The armrest each side can be raised up out of the way if desired by grasping the front of it and lifting. Each armrest can be lowered to the level of the seat cushion by pushing on it at the rear of the covered portion, tilting it up as far as it can go, and then pushing the whole armrest down.

I. *TELEPHONE HEADSET* - stored in a bracket mounted on the rear side of the right console support for easy access.

K. *JOYSTICK POSITIONS* - each controller can be adjusted from a vertical position to a forward slanted position. Push or pull on the joystick module to move it from one detented position to the other.

L. *SEAT SWIVEL* - can be rotated either way 10° off its forward position. Lift the lock lever, swivel the seat, release the lever, and continue swiveling the seat into the detent position. The consoles support will probably restrict this movement. It is not necessary to swivel the seat for the operator to gain admittance. Some seats may not have this swivel adjustment.

AUTOLUBE - One of the lube systems has been shut down. Check the autolube control panel for further troubleshooting.

LADDER DOWN - Stairway is not fully up. Raise the stairway.

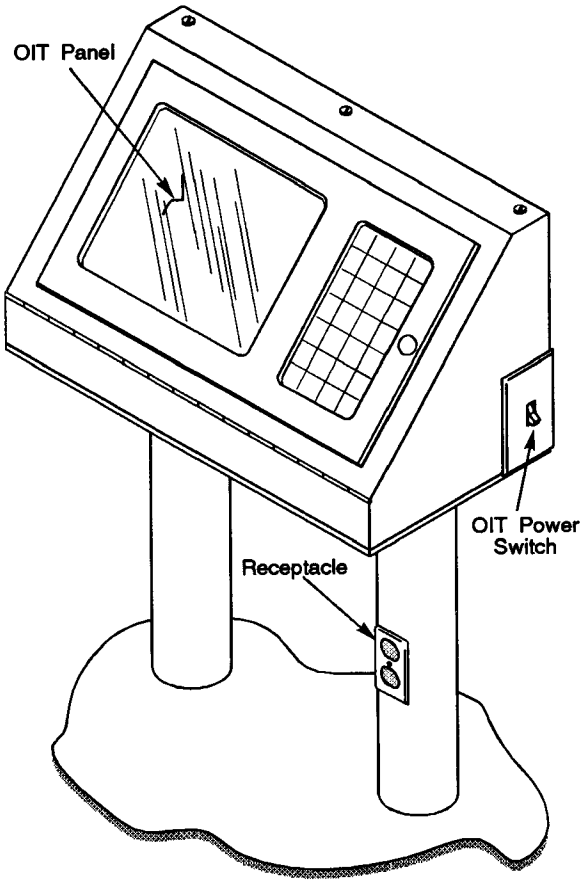
OPERATOR INTERFACE TERMINAL

Located in the top portion of the *OIT STAND* is the *OPERATOR INTERFACE TERMINAL* (OIT). This *CRT* display screen and its accompanying keys permit operator access to the on-board control, monitoring, and diagnostic computer.

This computer:

- Contains an annunciator system that monitors selected machine functions and components, and alerts the operator to any detected faults with audible and visual alarms.

NOTE:
Annunciation of faults are integrated into this program. Refer to manual *2198 - ELECTRICAL SERVICE MANUAL* for more information.



OPERATOR INTERFACE TERMINAL (OIT) Cabinet

- Can display an event log listing the last 100 events experienced.
- Is equipped with a date and time clock.

VISUAL INSPECTION ROUTINE

The following check lists can be used to help with the inspection.

Dipper and Handle Structure:
- ✓ Teeth and door
- ✓ Ropes and sheaves
- ✓ Trip mechanism

Lower Frame Structure:
- ✓ Roller circle, gear, and rails
- ✓ Crawler side frame, left and right
- ✓ Shoes, pins, and belt tension
- ✓ Idlers and rollers
- ✓ Sprocket and propel machinery

Boom Structure:
- ✓ Point structure and sheaves
- ✓ Boom support and hoist ropes
- ✓ Crowd machinery left and right
- ✓ Yoke block and handle structure
- ✓ Handle alignment and racking
- ✓ Boom foot structure and pins

Rotating Frame, Machinery Deck and House Structure:
- ✓ Swing machinery, left and right
- ✓ Hoist machinery
- ✓ Hoist drum and ropes
- ✓ Compressed air system
- ✓ Autolube system
- ✓ House ventilation system
- ✓ Stairways, walkways, and ladders
- ✓ Electrical equipment

Gantry Structure:
- ✓ Various pins
- ✓ Boom support ropes

Cab and Operator Controls:
- ✓ Hoist, crowd, swing, propel, and steer controls
- ✓ Brake controls
- ✓ Annunciator lights
- ✓ Air conditioning/heater
- ✓ Window wiper/defroster

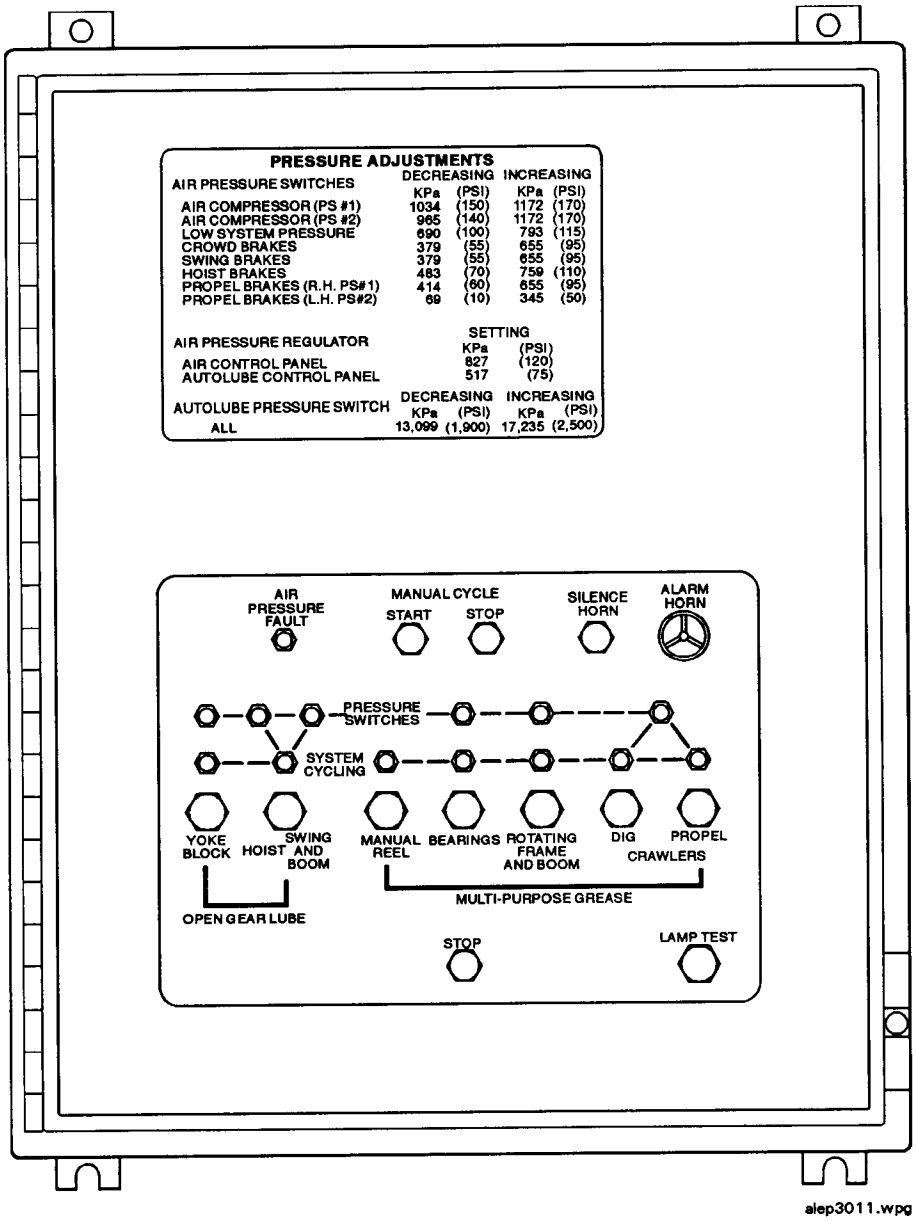
NOTE: If any problems are found after going through the above check lists, notify maintenance at once so that correction can be made.

Move the *AIR COMPRESSOR* selector switch to its *OFF* position.

If it is humid or cool, turn the *ANTI-CONDENSATION HEATER* switch to *AUTO.*

The machine is now shutdown to a point where inspection, maintenance, etc. can be performed. Turn off all lights not needed.

DANGER: HIGH VOLTAGE. Incoming electric power is "on" to the transformers, disconnects, electrical cabinets, and collector rings. NEVER PERFORM MAINTENANCE OR REPAIRS IN THESE AREAS WITHOUT DISCONNECTING THE POWER SUPPLY (TRAIL CABLE) FROM THE MACHINE. Failure to do so could result in personal injury or death.



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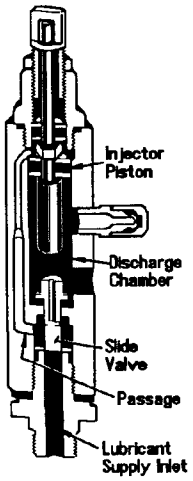
AUTOLUBE ELECTRIC CONTROL PANEL

LUBRICANT INJECTOR SL-1



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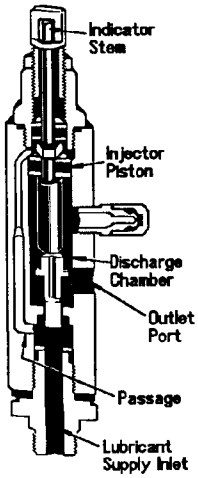
STAGE 1: The injector piston is in its normal or reset position. The discharge chamber is filled with lubricant from the previous cycle. Under the pressure of incoming lubricant, the slide valve is about to open the passage leading to the piston.



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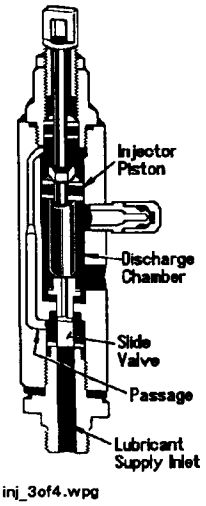
STAGE 2: When the slide valve uncovers the passage, lubricant is admitted to the top of the piston, forcing the piston down. The piston forces lubricant from the discharge chamber through the outlet port to the bearing.



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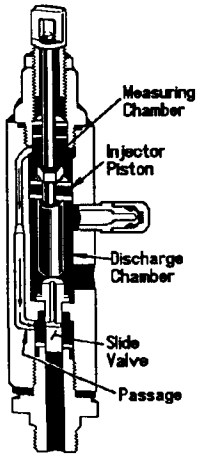
STAGE 3: As the piston completes its stroke, it pushes the slide valve past the passage, cutting off further admission of lubricant to the passage. The piston and slide valve remain in this position until lubricant pressure in the supply line is vented (relieved) at the pump.



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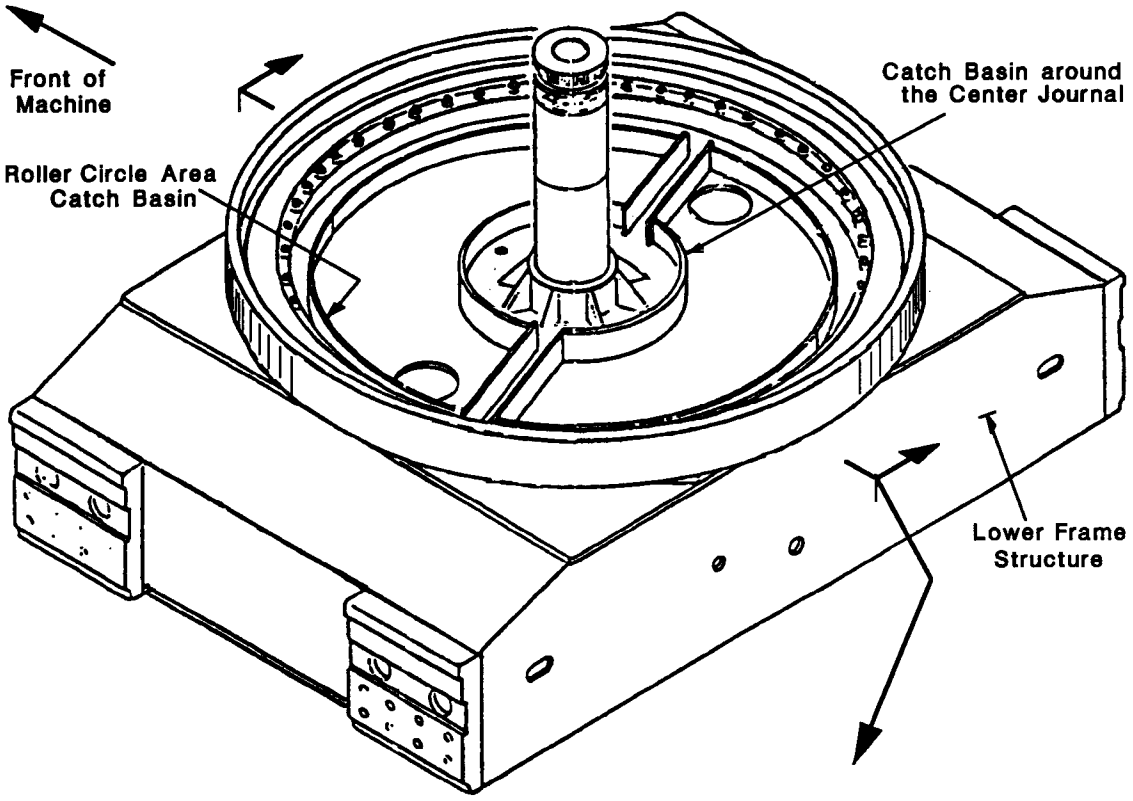
STAGE 4: After the pressure is relieved, the compressed spring moves the slide valve to the closed position. This opens the port from the measuring chamber and permits the lubricant to be transferred from the top of the piston to the discharge chamber.

NOTE: The injectors may be mounted singly, or may be grouped in a manifold at one location.



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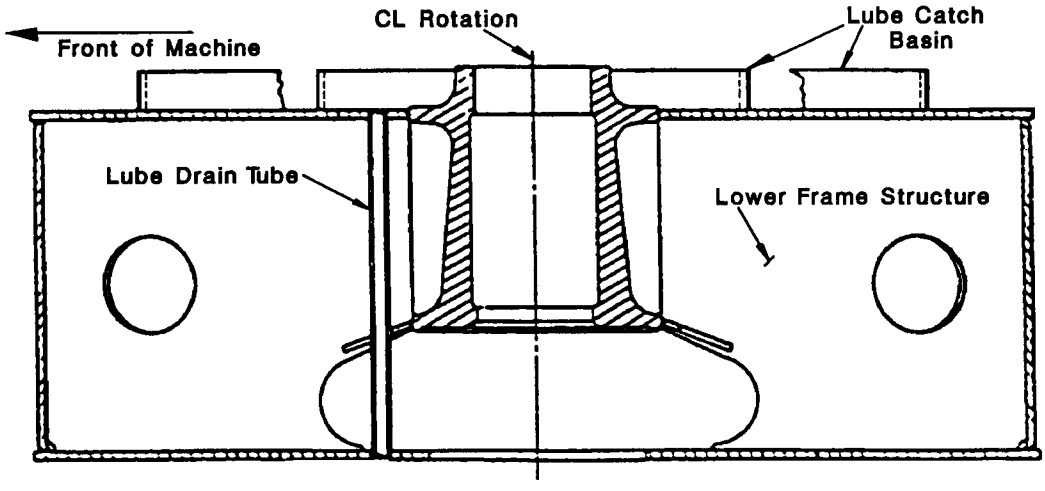

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301-M LUBE DRAINAGE SYSTEM on the LOWER FRAME

3.8 OIL COOLING SYSTEM - HOIST and CROWD GEARCASE

GEARCASE OIL COOLERS

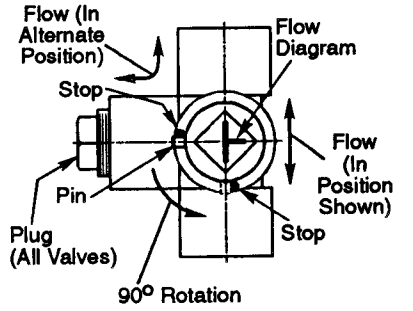
The Hoist and Crowd gearcases are fitted with oil coolers. The oil cooler/pump assembly for the hoist gearcase is located on the machinery deck behind the hoist gearcase. Each crowd gearcase has a separate oil cooler/pump assembly. These units are located on the house roof.

The cooling system is turned on when the RTD temperature sensor in each gearcase or the thermostat located at the bottom of each gearcase senses that the oil temperature has reached 140°F (60°C). If the system fails to circulate oil after 6 seconds, the failure will be announced in the operator's cab with a pulsating buzzer and a light. If the alarm does sound, *DO NOT OPERATE THE MACHINE UNTIL THE PROBLEM HAS BEEN CORRECTED.*

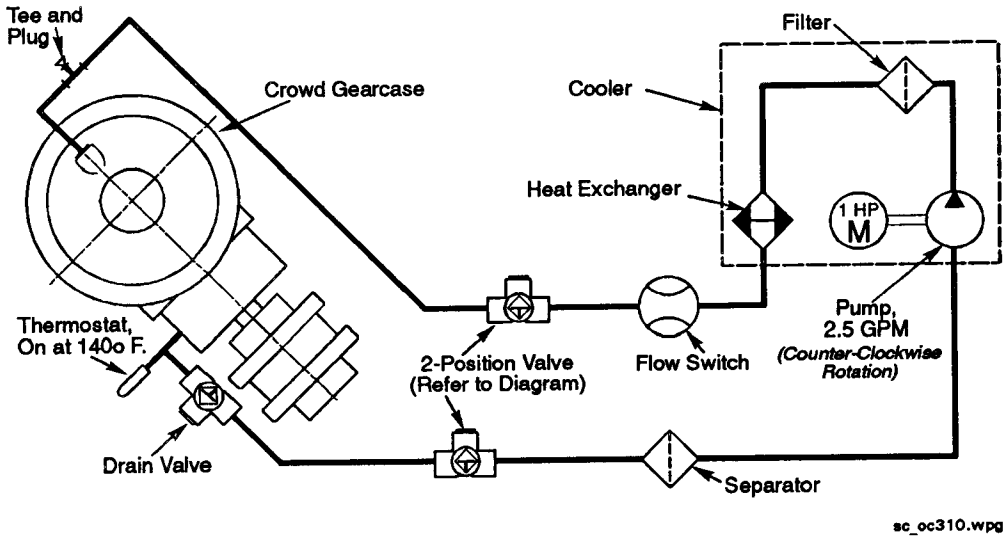
When filling the system with oil, add the oil at the gearcase. Run the cooler/pump to purge the lines of air and oil as required to obtain the proper level in the gearcase.

NOTE: Before filling the system, check that all the 2-position valves are open and the vent port is plugged.

CAUTION: **FAILURE TO PURGE THE SYSTEM OF AIR COULD RESULT IN SEVERE DAMAGE TO THE GEARCASE.**



2-POSITION VALVE



Schematic - CROWD COOLER PIPING

Section 4

Mechanical Adjustments

4.1 LOWER FRAME & CRAWLER ASSEMBLY

LOWER FRAME ASSEMBLY

The *LOWER FRAME* assembly consists of the crawler belts, crawler side frames (bolt-on), lower frame structure, propel motors and planetary gearcases, center journal, roller circle, ring gear, lower roller circle rails.

The Lower Frame is the primary support structure for the machine. The two bolt-on crawler side frames each have a propel motor and planetary gearcase. This assembly provides the operator complete independent control of each crawler.

Both the Lower Frame and crawler structures should be inspected during each maintenance period for areas of distress. If cracks are found in any of the structural welds or plates these should be repaired during the next scheduled maintenance period.

Each propel motor is equipped with a spring set, air released disc brake. These brakes require no adjustment. Inspect friction disc wear by removing the assembly cover and observe remaining amount of friction material on the disc. When wear reaches the change notch, replacement is required. Since these are holding brakes, wear rate will be slow. For brake maintenance, see Section 7 - *ENGINEERING DATA* in this manual.

RUN-IN PROCEDURE for the ROLLER CIRCLE

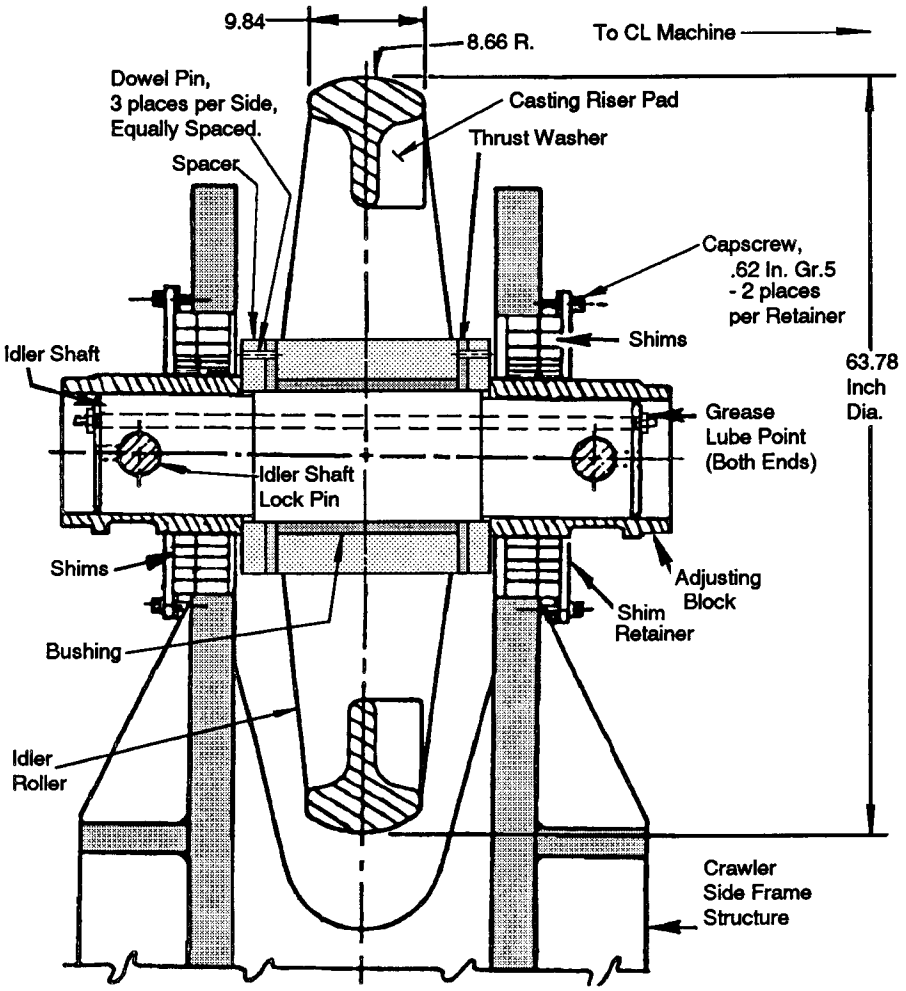
For the first few days after installing a new roller circle or new rollers, rotate the machine 360° every four hours. Check the torque of the roller capscrews at the end of this period and adjust as required.

It is normal practice to rotate the upper frame one full revolution (360°) at the start of each shift to relocate the rollers 180° so they wear evenly.

ROLLER CIRCLE - ROLLER REPLACEMENT

NOTE: Replace a broken or flat roller immediately.

1. Place the machine on a level work area.
2. Rotate the rotating frame so that the roller to be replaced is located at the side of the rotating frame.
3. Shut down the machine and set the brakes.
4. Remove the capscrews from the roller to be replaced.
5. Lift the roller with bushing and thrust washer from the cage.
6. Remove the thrust washer as soon as it clears the inner cage.
7. Place the roller on some cribbing at ground level. Remove the spacer and bushing.
8. Inspect the parts and replace as needed.
9. Reassembly is the reverse of disassembly:
    a. The diameter of the new roller must be within ±.001 inch (±.03 mm) of adjacent rollers. Measure the diameter of its adjacent rollers and grind the new roller(s) to match.
    b. Coat the nylatron bushing, thrust washer and bore of the roller with a winter grade of MPG.
    c. With the roller seated against the thrust rail, the gap between the thrust washer and roller is to be .13 to .37 inches (3 to 9 mm). Refer to "Roller Circle Adjustment Procedure" above.
    d. Tighten the capscrews to 210 ft.lbs. (285 Nm) per the adjustment procedure in Item 5.



FRONT IDLER ASSEMBLY - *Section View* crfid310.wpg

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.

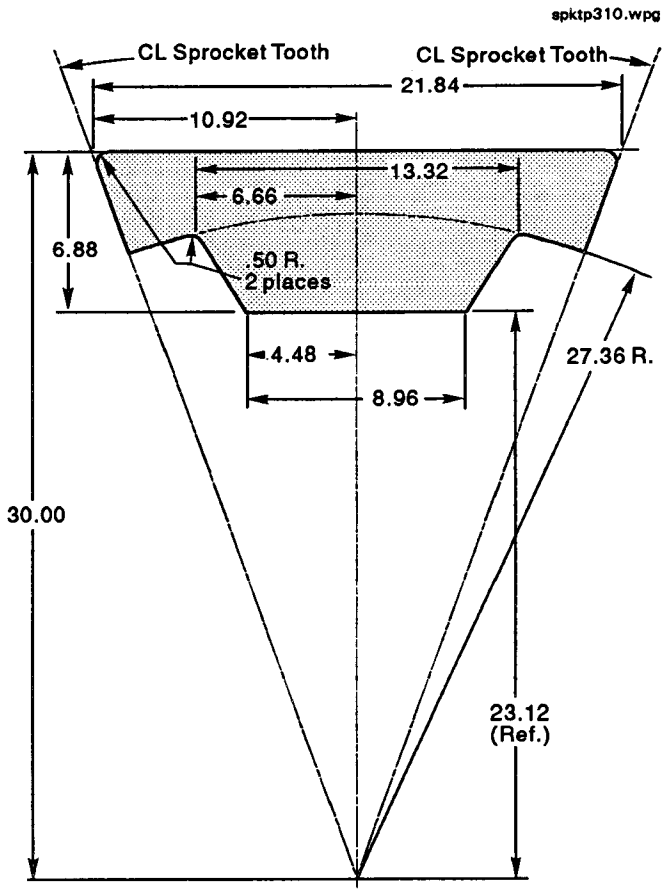
6. Separate the crawler belt behind the top of the idler and lay shoes out on the ground.

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.

TEMPLATE for REBUILDING the CRAWLER DRIVE SPROCKET



MAIN PROPEL SHAFT - DISASSEMBLY

1. Remove 2 locking capscrews from the bearing nut, and unscrew the bearing nut from the shaft using the special wrench provided with the machine.
2. Lift the lip seal from the back face of the bearing cartridge, if it is still there.
3. Remove 6 hex socket head capscrews holding the retainer to the cartridge.
4. Remove the retainer and spacer from the shaft.
5. Pull the cartridge from the bearing.
6. Use a bearing puller to remove the bearing from the shaft.
7. Remove the remaining spacer from the shaft.
8. Inspect all parts and replace as required.

4.4 CENTER JOURNAL

The center journal connects the rotating and lower frames at the center of rotation. This keeps the frames in concentric alignment and transfers machine digging reactions to the lower frame.

The center journal fits into a heavy housing in the lower frame. A restraining bracket bolts to the lower frame across the bottom flange on the center journal to keep it in place. Two shear blocks fit against the bottom flange on the journal and are welded to the lower frame structure, to prevent center journal rotation in the Lower Frame.

MAINTENANCE

The center journal nut adjustment is periodical to compensate for thrust washer, roller circle and rail wear. If the upper roller circle rails are lifting off the rollers .500 inch (12.5 mm) during operation, tighten the center journal nut. Refer to the *CENTER JOURNAL NUT ADJUSTMENT* procedure.

During the daily/visual inspection, check lube flow to the bushing and thrust washer.

Inspect the journal to lower frame fit every 500 hours. If the bore wear at the top of the lower frame bearing becomes loose the bore must be stocked and re-bored to a .005 to .012 inch interference fit.

Check for evidence of movement between the journal flange and shear blocks. If movement is found, locate and correct the problem, then remove and reinstall the shear blocks.

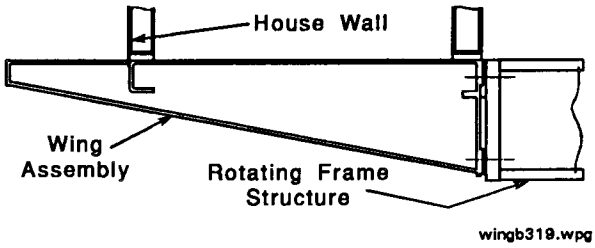
Check the running clearance between the center journal and bushing in the rotating frame. When the total clearance exceeds .44 inch (11 mm), replace the bushing.

The thrust washer under the journal nut must be replaced when the wear surface is worn flush with the bolting flange. Check for wear when adjusting the journal nut.

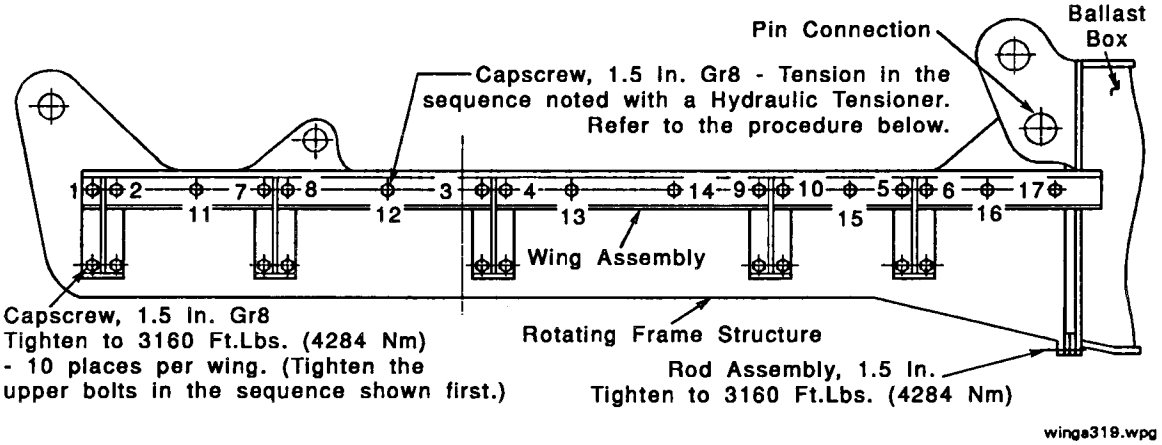
NOTES:

1. Check for broken or loose bolts monthly (420 hrs.).

2. Check the structure for cracking monthly (420 hrs.).



Section B-B



Section A-A
WING BOLT TIGHTENING

PROCEDURE for USE of the HYDRAULIC TENSIONER:

1. All capscrew threads should be clean and the fit of the nuts on the capscrews should be very free.

2. For hydraulic pump pressures, refer to Section 7 - ENGINEERING DATA in this manual. During all tensioning operations, observe the operation of the tensioner to be sure that the maximum stoke is not exceeded.

3. Tension the top row of capscrews (17 per wing structure) in 3 steps:

   3.1 Tension the capscrew to 70,000 Lbs., reference 1700 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.

   3.2 Tension the No.1 capscrew to 100,000 Lbs., reference 2400 Ft.Lbs. and tighten the nut down.

   3.3 Before moving on the next capscrew, relax the tensioner, wait one minute and then bring the tensioner back to 100,000 Lbs. Turn the nut down, if necessary.

   Repeat the procedure in steps 3.2 and 3.3 for each capscrew in the sequence shown.

   3.4 After all the capscrews are tensioned per steps 3.2 and 3.3, repeat step 3.2 for the first 2 bolts. If additional turning down of the nut is possible when the tensioner is brought up to 100,000 Lbs., continue step 3.2 on subsequent capscrews until the nut cannot be turned down at this tensioning load.

B. Tightening capscrews #36 and #37 is a continuation of the pre-tightening procedure:

Step 4 - Tighten the jack screws to 82.5 Ft.Lbs. per the sequence in Figure 2.

Step 5 - Tighten the jack screws to 75 Ft.Lbs. per the sequence in Figure 2. Repeat steps #4 and #5 as required to obtain the 75 Ft.Lbs. value on all jack screws.

NOTE: For nut removal, refer to page 4.6.7.

Pedestal Capscrews:

1. Tension the 18 capscrews to 165,000 Lbs., ref. 6190 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.

2 A. Tension the No. 1 capscrew to 236,000 Lbs., ref. 8850 Ft-lbs. Turn the nut down.
B. 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 capscrews in the sequence shown.

3. After all the capscrews are tensioned per step 2, repeat Step 2A for the No. 1 and No. 2 capscrews. If additional turning of the nut is possible when the tensioner is brought up to load, continue Step 2A and 2C on subsequent capscrews until there is no more take-up or rotation of the nut.

INTERMEDIATE HOIST SHAFT SHIMMING PROCEDURES

Procedure for Shimming Gap "A":

1. After the bearing has been installed on the shaft, assemble the internal bearing retainer to the end of the shaft. Tighten the capscrews to 37 Ft-lbs. (50 NM) for gap measurement.

2. Measure the distance from the outer face of the retainer to the end of the shaft with a depth micrometer through the 3.25 dia. (6 mm) holes in the retainer. Average these measurements.

3. Remove the retainer from the end of the shaft and measure its thickness at the same 3 holes with a micrometer and again average these measurements.

4. The difference between the average measurements from steps 2 and 3 is the measured gap dimension.

5. Prepare a shim pack that is from 0 to .003 inch (0.08 mm) *less than* the measured gap dim from Step 4.

6. Assemble the internal bearing retainer and shim pack to the end of the shaft. Tighten the 6 capscrews to 265 Ft-lbs. (360 NM).

Procedure for Shimming Gap "B":

1. Install the outside bearing retainer to the bearing housing and tighten capscrews to 37 ft-lbs. (50 NM) for gap measurement.

2. Measure the gap between the retainer and the housing at a minimum of 3 places equally spaced around the O.D. of the retainer.

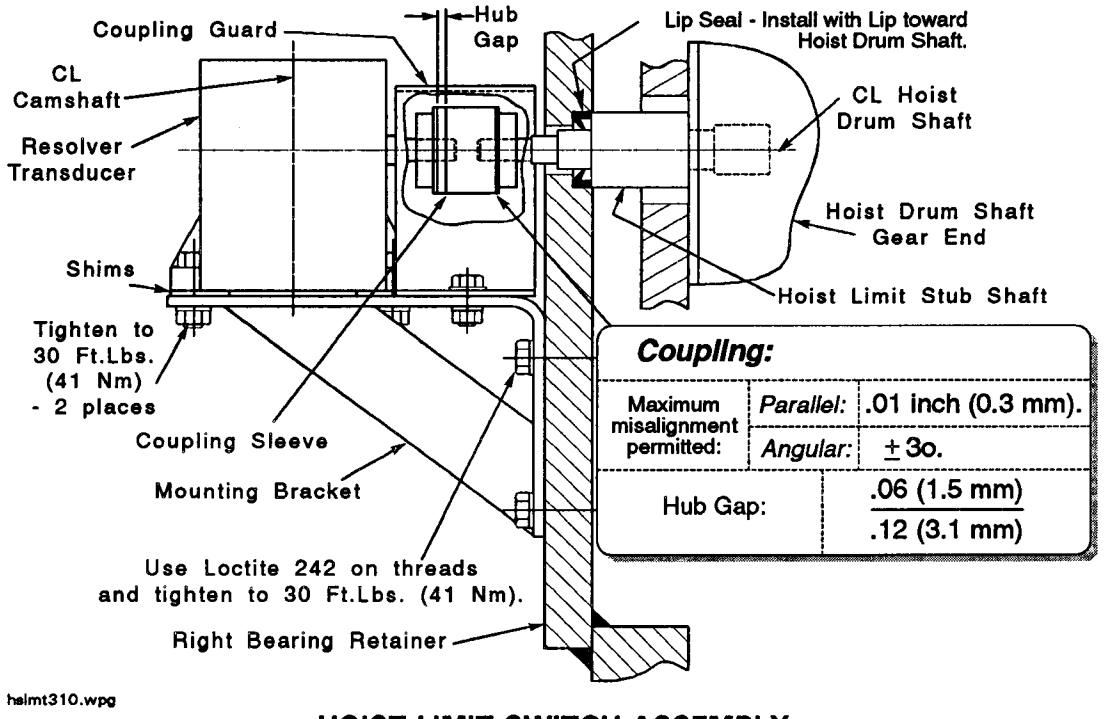
3. Average these measurements to determine the nominal gap dimension.

4. Prepare a shim pack that is 0 to .003 inch (0.08 mm) *less than* the nominal gap dimension from Step 3.

5. Remove the outside bearing retainer and reassemble it with the shim pack in place to the bearing housing. Tighten the capscrews to 265 Ft-lbs. (360 NM).

NOTES:

- After adjusting the coupling hub gap, lock the set screws using Loctite 242.
- The resolver gearcase assembly has a gear ratio of 5 to 1.



HOIST LIMIT SWITCH ASSEMBLY
(Viewed from the Front of the Machine)

HOIST LIMIT RESOLVER ALIGNMENT

1. Align the coupling with the sleeve removed.
2. Add shims under the resolver (limit switch) mounting pads to obtain proper alignment.
3. Remove the resolver & install the coupling sleeve.

Indexing is not required. When the resolver is disconnected or replaced & after changing the hoist ropes, it must be recalibrated. Calibration is done from the operator's cab. Refer to Section 2 - *OPERATION*, in this manual, for the procedure.

MAIN ROTATING SHAFT - *DISASSEMBLY*

1. Use a bearing puller to remove the bottom spherical bearing from the shaft. Remove the bearing spacer from the shaft.

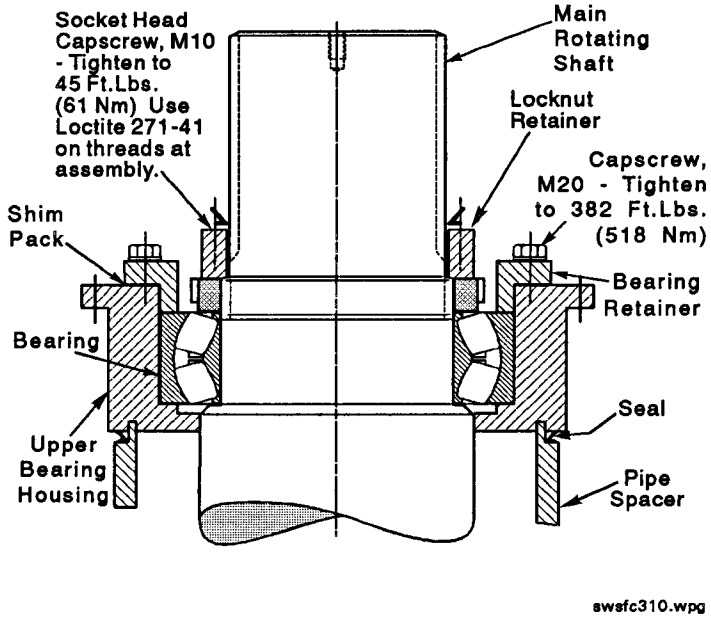
2. Position the shaft assembly vertically, with the bottom end up. Attach lifting eyes to the 3 tapped (1-8UNC) holes in the spacer. Carefully pull the spacer out of the circular slots in the upper bearing housing and away from the shaft assembly.

3. Remove the upper bearing retainer and shims from the shaft assembly.

4. Pull the bearing housing toward the bottom end of the shaft to remove.

5. Remove the seal from the bearing locknut retainer. Remove the locknut retainer assembly from the locknut.

NOTE: The hex socket head capscrews were assembled with loctite epoxy on the threads.



MAIN ROTATING SHAFT
UPPER BEARING ASSEMBLY

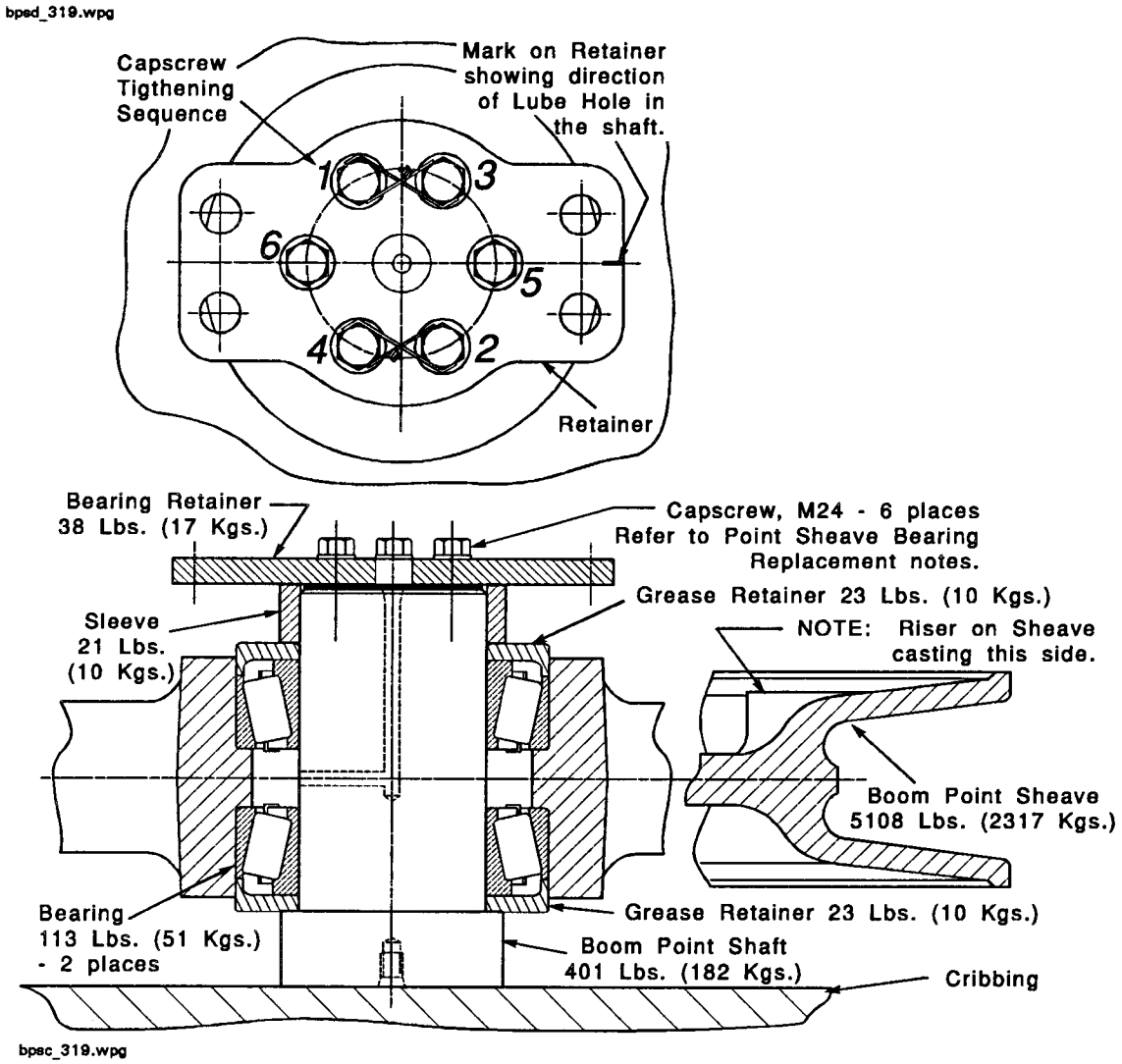
6. Unscrew the locknut from the shaft. Use a bearing puller to remove the top bearing from the shaft.

MAIN ROTATING SHAFT - *ASSEMBLY*

1. Warm the bearings to 194°F (90°C) using a dry heat source. Assemble the upper bearing onto the shaft and immediately assemble the locknut and tighten. After the bearing cools, retighten the locknut and install the key onto the retainer.

2. Install the bearing housing from the opposite end of the shaft. Install the 8 - M20 capscrews and tighten to 30 Ft.Lbs. (40 Nm).

3. Measure the gap between the bearing retainer and the housing at 3 places equally spaced. Average the measurements and subtract .003/.006 to obtain the required shim thickness.



BOOM POINT SHEAVE ASSEMBLY - *Section View*

POINT SHEAVE BEARING REPLACEMENT

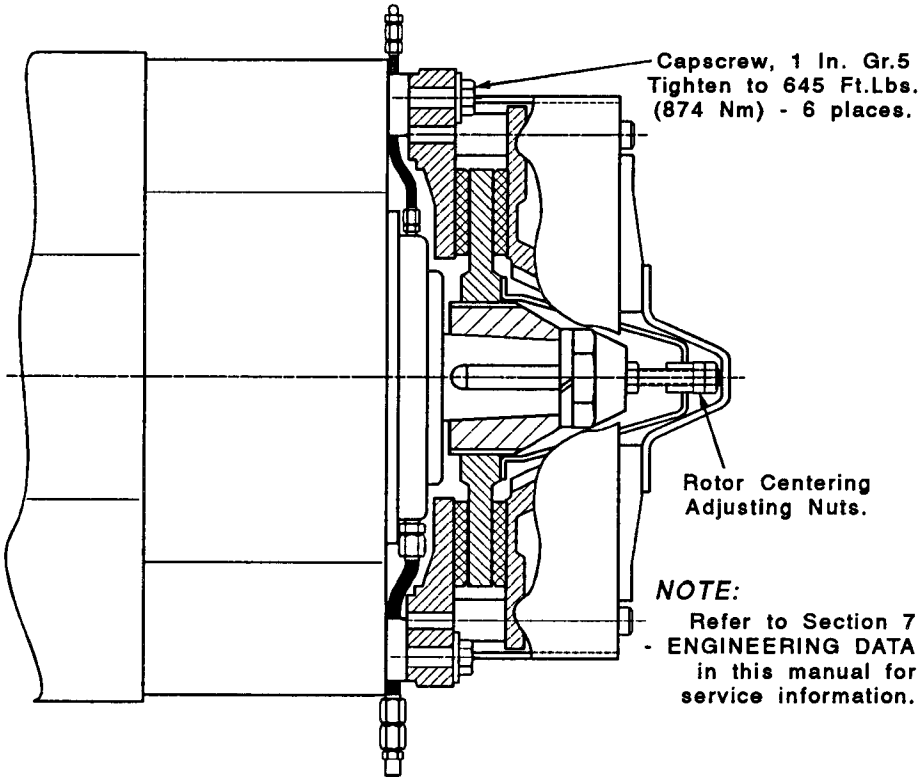
1. Set the sheave assembly on cribbing with the shaft vertical and the bearing retainer on top.

2. Remove the bearing retainer, shims, sleeve and grease retainer.

3. Lift the sheave off the shaft and remove the bearings.

4. Clean and inspect all parts. Replace the bearings and any damaged parts. Pack the bearings with MPG.

5. Install the new bearing cups in the sheave and the grease retainer with bearing cone on the shaft.



CROWD MOTOR BRAKE INSTALLATION

CROWD LIMIT

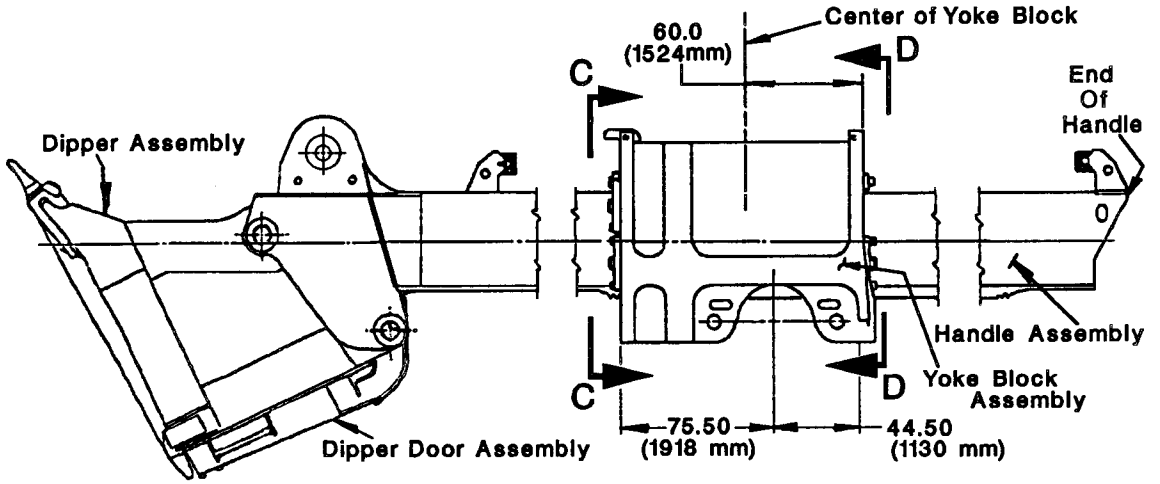
1. Align the coupling with the sleeve removed.

2. Add shims under the resolver (limit switch) mounting pads to obtain proper alignment.

3. Remove the resolver and install the coupling sleeve.

Indexing is not required. When the resolver is disconnected or replaced and after removing the dipper handle, it must be recalibrated. Calibration is done from the operator's cab. Refer to Section 2 - *OPERATION,* in this manual for the procedure. Also refer to the figures on the following pages.

YOKE BLOCK ASSEMBLY



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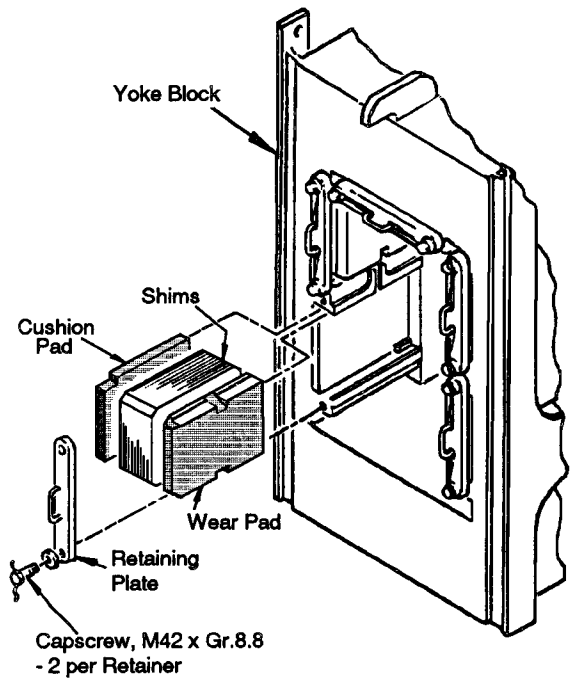
YOKE BLOCK WEAR PAD ADJUSTMENT



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WEAR PAD and SHIM INSTALLATION *(Typical)*

NOTE: Install the necessary shims at the wear pads per the initial set-up instructions, Notes 2A & 3A. Save the remaining shims to compensate for wear.

Shim Requirements - TOP:

A. Initial set-up: Due to handle dimension variations and uneven wear, install the shims required to give .18 (4 mm) clearance where handle fits tightest to yoke block.

B. Re-shim when maximum clearance reaches .50 (12.7 mm).

Shim Requirements - SIDES:

A. Initial set-up: Install shims required to give .09 (2.3 mm) clearance per side, or .18 (4.6 mm) total, where handle fits tightest with yoke block. Maintain equal shim packs on both sides of handle.

B. Re-shim when maximum clearance reaches .25 (6.4 mm) per side or .50 (12.7 mm) total.

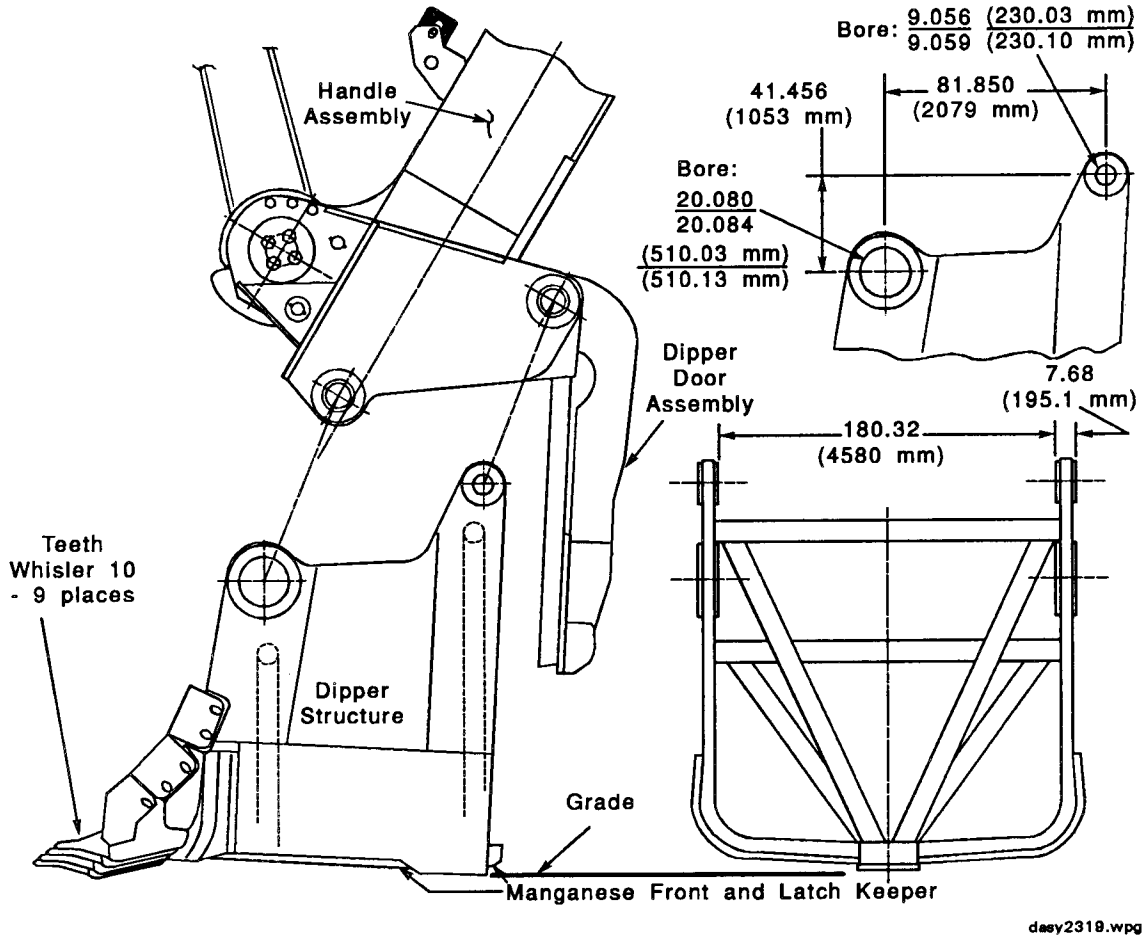
5. Slowly lift the handle, with the dipper door still attached, away from the dipper, using the crowd and hoist motions.

6. Reassembly is the reverse of disassembly:

   a. Coat all pins and bores with MPG lube.

   b. If a new dipper is installed, use the eccentric inserts from the old dipper, if needed.

   c. Adjust the snubbers and latch bar engagement.



DIPPER ASSEMBLY DIMENSIONS

4.12 DIPPER TRIP MACHINERY

The dipper trip machinery is a small winch that is mounted on the left hand swing motor hatch. Used to operate the latch on the dipper door, the trip machinery is connected to the latch levers via a trip rope. The machinery consists of a D.C. drive motor coupled to a gearcase. Mounted on the gearcase output shaft is a trip rope drum and drum clutch.

When the machine is in operation, the trip rope is constantly tensioned to prevent slack as the dipper is lowered or retracted. This feature requires that the trip motor be energized to provide a slight amount of torque. To open the dipper door, the operator presses a button on the left hand controller. The motor develops full torque, which reels in the trip rope and operates the trip lever.

The drum clutch is a torque limiter. It normally operates at low air pressure, 3.5 PSI (24 kPa), providing only enough torque to rotate the drum. If the dipper is suddenly crowded out, the clutch will slip until the trip machinery can speed up to match the speed of the crowd. When the dipper door is opened, the clutch torque is automatically increased with the increase in trip motor torque.

DIPPER TRIP MACHINERY REMOVAL

1. Deactivate the trip system by shutting down the machine drive and closing off the air supply to the clutch.

2. Pull the trip rope off the drum and disconnect it from the drum. Secure the rope to the roof handrails.

3. Disconnect the air supply line at the rotating union seal on the trip clutch.

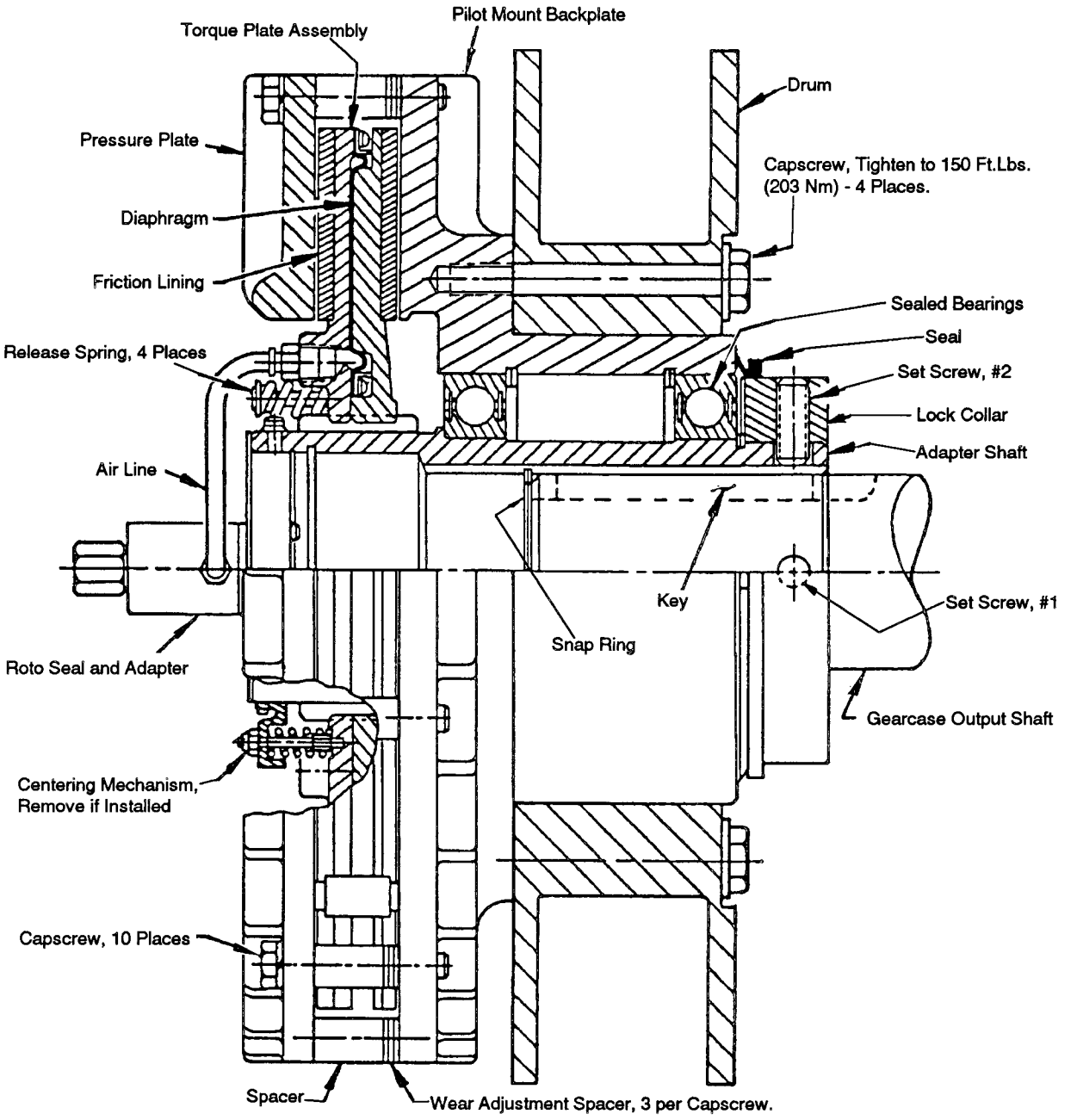
4. Have a qualified electrician remove the wiring at the motor junction box and lay the cable out of harm's way.

5. Remove the 6 capscrews holding the base on the roof.

6. Attach the dipper trip assembly to a crane.

7. Lift the assembly clear of the machine and set it on cribbing.

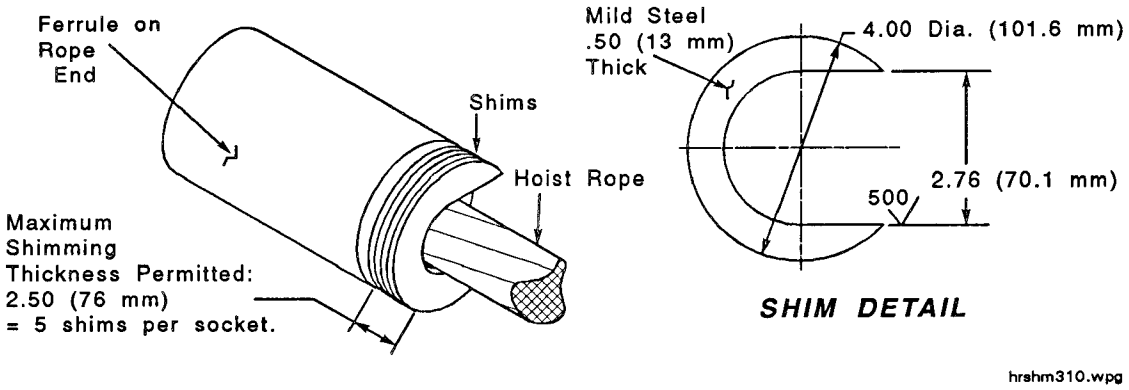
Reassembly is the reverse of disassembly.



DIPPER TRIP DRUM-CLUTCH ASSEMBLY - *Section View*

WARNING! NO AIR PRESSURE SHOULD BE APPLIED TO THE TORQUE ASSEMBLY UNTIL IT HAS BEEN PROPERLY BOLTED BETWEEN THE PRESSURE PLATES.

CAUTION! Air pressure to the clutch should never exceed 120 PSI (827 kPa).



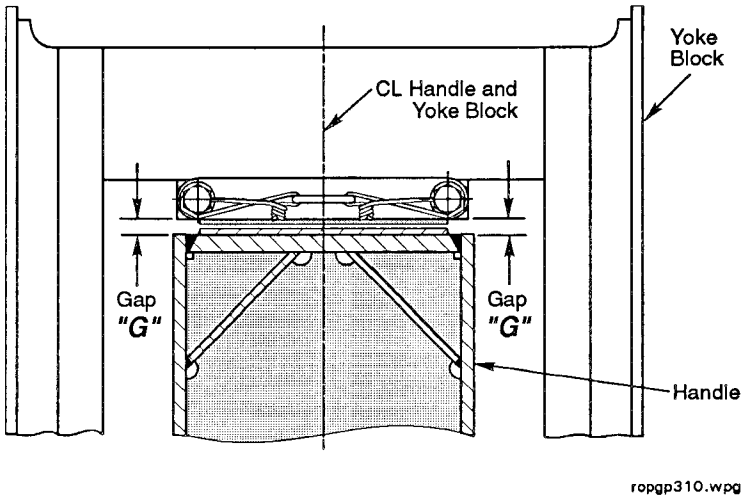
ADJUSTING the LENGTH OF HOIST ROPE with SHIMS

g. Add shims as required to shorten the ropes on the side of the machine with the largest gap "G". Recheck the gaps after adding shims.

h. Reset the motion limits. Refer to section 7 of this manual for the procedure.

k. Recheck the gap "G" after several hours of operation.

NOTE: Observe the dipper handle during operation. Unequal rope lengths will be indicated by polished streaks along the sides of the handle. As an example, if the polished areas are at the top-right side and bottom-left side, then the *right* hand hoist rope must be shorted.



GAP BETWEEN the YOKE BLOCK and the DIPPER HANDLE
(Viewed from the Rear of the Yoke Block)

GENERAL PROCEDURES FOR WELDING AUSTENITIC MANGANESE STEEL

Preparation:

1. The areas to be welded must be clean. Remove scale and other foreign matter by grinding.

2. Select proper weld groove design. In double U or V grooves a 3/16" root opening is recommended.

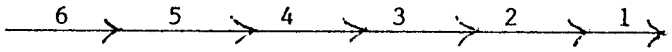
3. To tackweld castings together use Amsco Nicro Mang electrodes (5/32" or 3/16" diameter).

4. Tackwelding should not be done on the same side as where the first root pass will be.

5. Weld run-off blocks at each end of the weld grooves. This will allow the weld beads to end on the blocks instead of in the joint or groove.

6. The root pass should penetrate as much as possible into the weld joint.

7. Use the step back technique



to weld the root pass.

Preheating and Temperature Control:

1. Do not preheat manganese steel. In extremely cold weather, take the chill out of the castings.

2. Avoid excessive heat buildup in localized areas. For safety, do not continue welding in area when the temperature of the base metal is above 600°F. Use a Tempilstick to determine temperature. Weld in different areas (skip welding) to avoid local overheating.

Preparation and Welding of Cracks

In welding a fractured manganese steel part, the end, or ends, of the crack should be located and a hole burned through if possible to prevent further cracking as in Figure 4.

Then torch cut or grind a single "V" the full depth of the crack. The "V" should be no wider than necessary for the welder to manipulate the electrode. A "U" shaped groove may also be used. (Figure 5.)

Internal cracks, that is those with two ends in the base metal, should be prepared by burning through at each end and cutting or burning a groove or "V" the depth of the crack between the holes. (Figure 6.)

Using Amsco Nicro Mang, fill in the "V" or "U" groove to full height and reinforce it on top and bottom. Start at the edge of the hole and run the weld beads along the groove. When working on internal cracks (Figure 6), it is a good idea to peen the deposit after each rod is applied to minimize the possibility of cracking caused by contraction of the weld metal.

When the crack is completely welded, weld the hole or holes which were made to prepare the crack for welding. Use Nicro Mang to build up any worn areas around the crack.

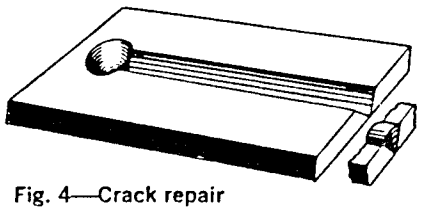


Fig. 4—Crack repair using a "V" groove.

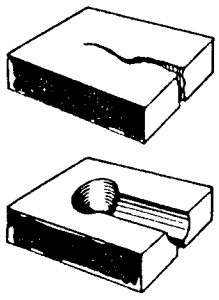


Fig. 5—Crack repair using a "U" groove.

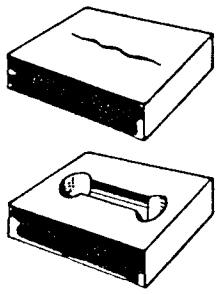


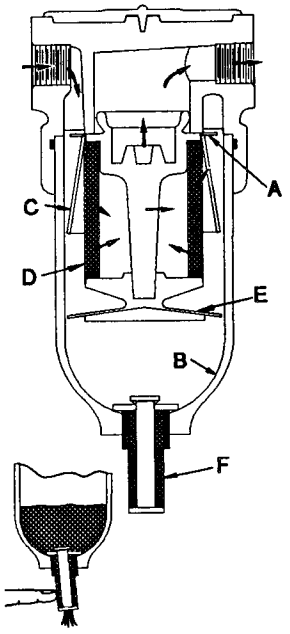
Fig. 6—Internal crack repair.

AIR LINE FILTERS

These filters are placed at strategic points in the air distribution system. They are designed to remove moisture, solid contaminants, pipe scale, rust, pipe dope, etc., which may plug small orifices or cause excessive wear and premature failure of pneumatic components. Each filter has a metal bowl with a sight gauge and is equipped with a manually activated drain that requires only finger tip touch to control. Each filter comes with a 40 micron plastic filter element that can be removed, cleaned, and reused.

First Stage Filtration: Air enters at inlet port and flows through deflector plate (A) which causes a swirling action. Liquids and coarse particles are forced to the bowl interior wall (B) by the centrifugal action of the swirling air. They then carry down the bowl wall by the force of gravity. Shroud (C) assures that the proper swirling action occurs and that
the air does not pass directly through the filter element (D) until the large particles and liquids are removed. The baffle (E) separates the lower portion of the bowl into a "quiet zone" where the removed liquid and particles collect, unaffected by the swirling air, and are therefore not re-entrained into the flowing air.

Second Stage Filtration: After liquids and large particles are removed in the first stage of filtration, the air flows through element (D) where smaller particles are filtered out and retained. The filtered air then passes downstream.

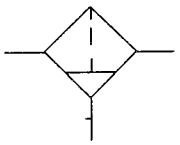


fltr_air.wpg

Collected liquids and particles in the "quiet zone" should be drained before their level reaches a height where they would be re-entrained in the flowing air. This can be accomplished by using the manual drain (F) which is actuated by pushing it to the side from any direction. It requires only a fingertip touch to drain the condensate, even in hard to reach places.

Element removal is accomplished by unscrewing the threaded bowl and then the baffle (E). Wash the element and bowl in mild soapy water and reinstall them. Check the unit for unwanted air leads around seals, gaskets, or O-rings. Replacement kits are available for these filter units. Refer to the Parts Book.

CAUTION: Do not use acetone, benzene, carbon tetrachloride, ethylene di-chloride, gasoline, toluene, or any other solvents to clean plastic components. These solvents will melt the plastic and are fire hazards.

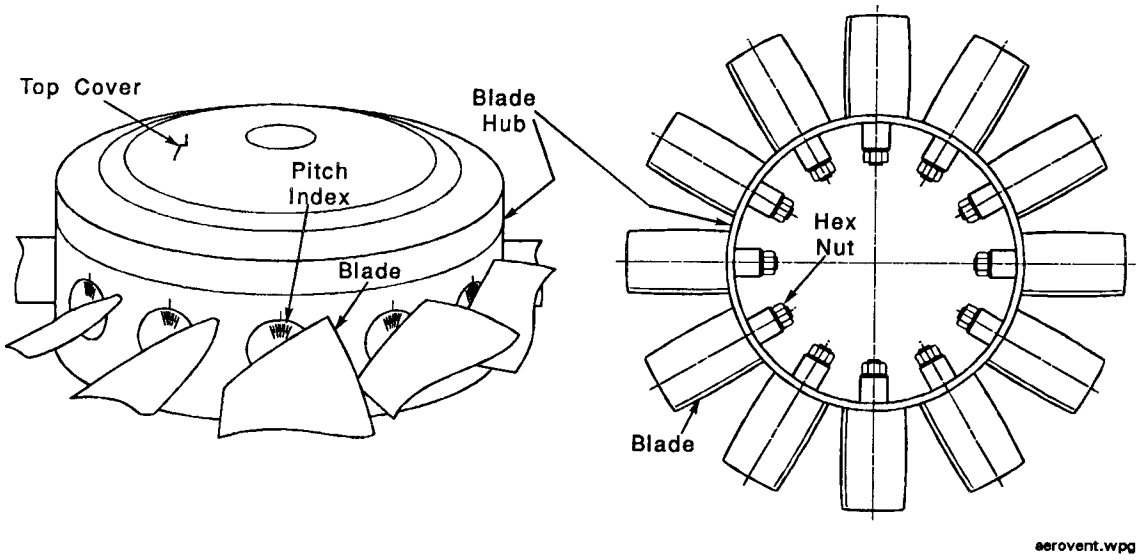


sym_afilt.wpg

Graphic Symbol

AIR FILTER FAN BLADE PITCH

The fan blade pitch is preset at the factory, however, it may not provide maximum air flow due to site conditions. Check the motor operating amperes versus the rated amperes. If the operating amperes are not 80% to 95% of the motor nameplate amperes, adjust the blades in 2 degree increments until the operating amperes are within the proper range.



DESCRIPTION OF LUBRICATION

Series 200, 300, 4000 & 5000 Models - Lubrication is provided by a positive displacement oil pump that circulates oil through the crankshaft to the main bearings and crankpin bearings, up through the connecting rod(s) to the wrist pin bearing(s), piston pin(s), and piston(s). Series 300 and 5000 models are equipped with a 10 micron spin-on oil filter. This feature is available optionally on most 200 and 4000 series compressors.

Series X, A & 100 Models - Lubrication is provided by a dipper, which is an integral part of the connecting rod, dipping into the oil with each stroke of the piston and casting the oil and all moving parts.

DESCRIPTION OF CONTROLS

Continuous Run (Load - Unload) - Receiver or plant air system pressure is controlled within limits by holding the suction valve open when a preset maximum pressure is reached and allowing the suction valve to function when the receiver or system pressure drops to a preset minimum pressure. The compressor runs continuously at constant speed.

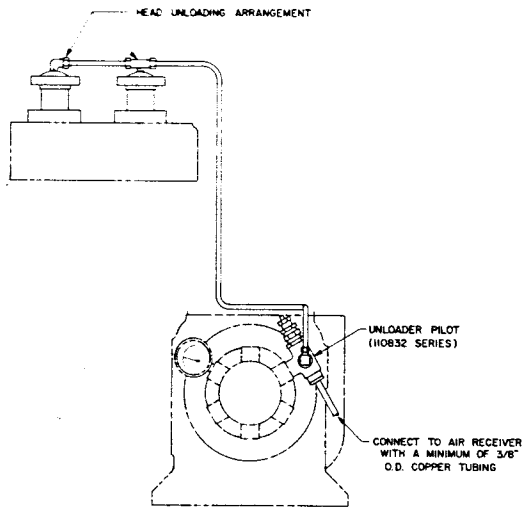
Stop-Start - Receiver or plant air system pressure is controlled within limits by automatically stopping and starting the compressor as the air pressure reaches a maximum preset pressure and then drops to a minimum preset pressure. This system should only be used when demand for air is low and the motor is not required to stop and start more than approximately six (6) to ten (10) times an hour, see your authorized Quincy distributor for your particular application.

Dual Control - This control system is a combination of the Continuous Run and Stop-Start systems. Either one can be selected manually by opening or closing a shutoff valve (see fig. 4-7) or with a Hand-Off-Automatic (HOA) switch connected to the starter. Other systems are available for selecting the mode of control and should be discussed with your Quincy distributor.

Automatic Alternation (Duplex Compressors) - Primary compressor X starts and runs to satisfy the air demand. When the air demand is satisfied and the pressure in the system reaches the cut-out pressure of the primary compressor X, it shuts off. The next time air is required, compressor Y starts up first and becomes the primary compressor.

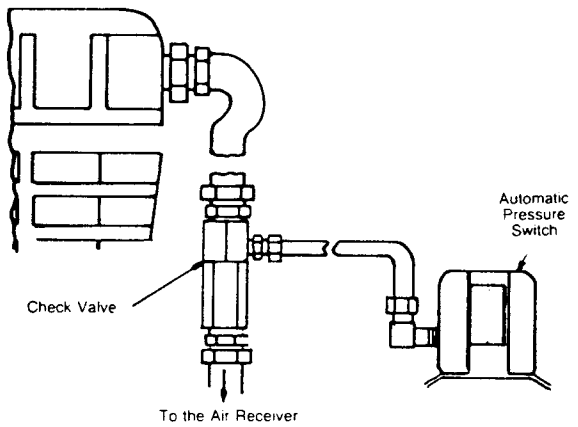
If primary compressor X can not satisfy the air demand, standby compressor Y will automatically start and assist compressor X until the demand is satisfied and the pressure in the system reaches the cut-out pressure of the primary compressor X. At the cut-out pressure both the primary compressor X and standby compressor Y shut down. The next time air is required, compressor Y becomes the primary compressor and starts first, if it can not satisfy the demand compressor X automatically starts up and assists. The cut-in and cut-out pressure of the primary compressor are normally set 10 psig higher than the standby compressor.

Automatic alternation systems, other than what has been explained, may be required as a result of the accessory equipment harnessed to the electrical system. These systems are special and the factory should be consulted regarding optional alternation systems.



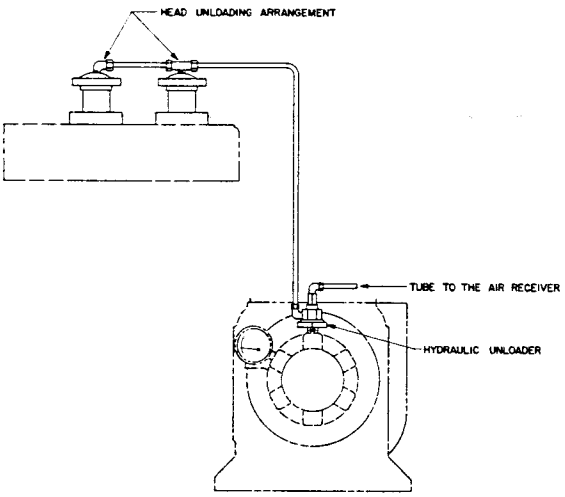
TUBING HOOKUP FOR UNLOADER PILOT

Figure 4-3



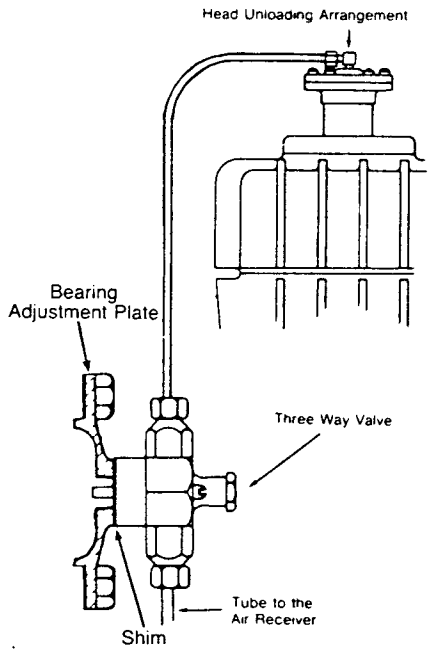
TUBING HOOKUP FOR COMPRESSORS USING DISCHARGE LINE CHECK VALVE AND PRESSURE SWITCH

Figure 4-4



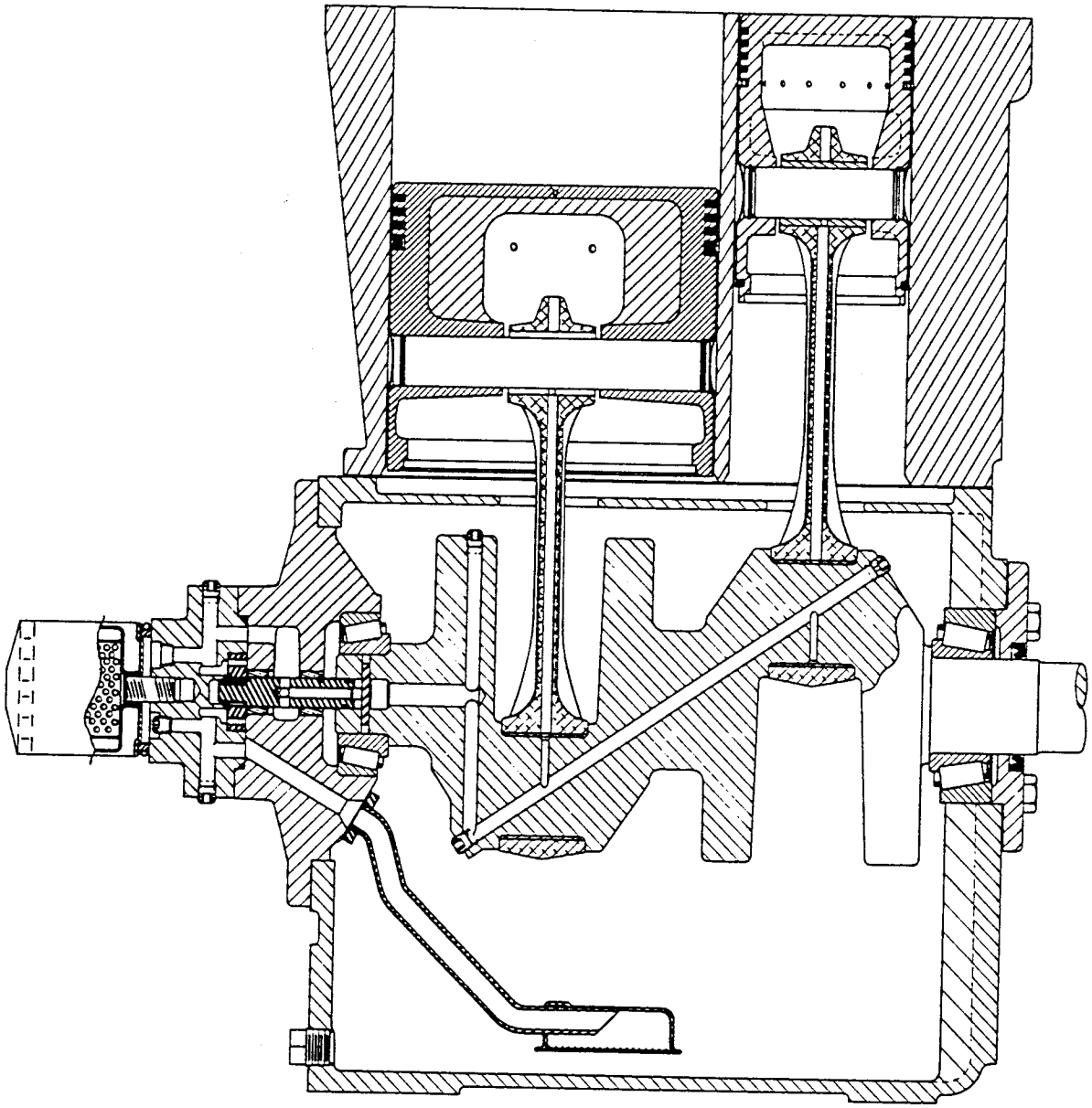
TUBING HOOKUP FOR HYDRAULIC UNLOADER

Figure 4-5



TUBING HOOKUP FOR MECHANICALLY ACTUATED CENTRIFUGAL VALVE AS USED ON THE MODEL 106 AND 108

Figure 4-6



TYPICAL CROSS SECTION
Figure 8-1

TROUBLE	PROBABLE CAUSE
Failure to start (continued).	•Pressure switch mis-adjusted or inoperable. •Loose or broken wire. •Motor defective. •Compressor seized.
Motor stalls.	•Motor overloaded. See "Excessive current draw" in this section.

Next, question other witnesses and determine what they may know, getting every detail. Then make a quick visual inspection of the equipment for obvious things, such as flash-over, smoke, or other evidence of overheating or broken components.

After listening to witnesses and making the first inspection, stop and consider *ALL* the facts before proceeding. Valuable time is lost by going off quickly in the wrong direction. So, carefully examine the problem logically, using knowledge of the system. Consider all the data collected. Do not make hasty decisions on what to use or what information to discard. Give special value to obvious facts, easily confirmed (such as a stopped generator) and reserve opinion on contradictory facts.

Barring the obvious, you gain a direction from all this and knowledge of the system. For example, if no motion operates, look into circuits common to all motions - D.C. exciter or A.C. circuits. Likewise, if one motion is normal in one direction, but not in the other, check the components for the separate directions. A few minutes spent analyzing saves time spent in a false misled direction later.

Once a founded suspicion exists as to which set of components or circuits is faulty, select a starting point for tests that meets the following:

- You know the approximate value expected for the test conditions, whether at stall, no-load, hoist, lower, etc.
- No false indications exist, you've avoided points where a reading is effected by a short circuit.
- This point is the logical suspected circuit.
- It also allows for checking as many circuits as possible at one time.

With the proper instrument, measure circuit values at a selected point and compare them to the expected values. If the measurement is correct, apparently all system parts leading to this point are correct, so trouble exists further down the line. With an incorrect reading, trouble probably lies further back toward the start of the system.

Based on the first test, proceed toward the system start or end, and seek an expected reading. The trouble, of course, lies between the points where the correct and incorrect readings occur. In other words, the faulty stage has correct input but incorrect output. Be positive the correct stage is located, rather than a false lead. Where possible, make tests under 2 different conditions to confirm conclusions (i.e., stall and no-load).

Once the faulty stage is located, determine the actual part that failed. Often an ohmmeter helps, but it may offer erroneous indications. If a semi-conductor, magnetic amplifier, or other complex device is suspected, replace it rather than try to prove it bad by testing.

Section 7

Engineering Data

The design of Marion machines follows standards established by industry practices and procedures, material specifications and design/manufacturing disciplines developed by Marion. This section supplements the manual with additional information on maintenance practices and procedures. Some of this information may not apply to your specific machine.

7.1 BUSHINGS

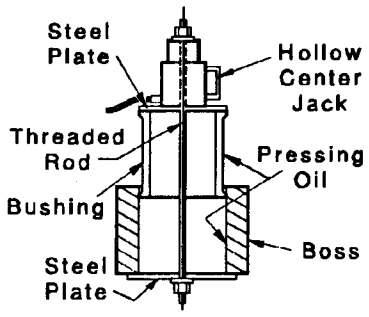
There are several types of bushings used on Marion machines. Two most common are the bronze sleeve bushing and the flange bushing. The sleeve type mounts in a machined bearing boss opening with a light press fit. A flange bushing rests in an opening and is held in place with a minimum of 4 dowels. Dowel material is softer than bushing materials to prevent scoring of shafting over the life of the bushing.

Bushing service life depends on several factors. Various environmental conditions, lubricant types & maintenance practices will result in various replacement frequencies. Table 1 gives specification tolerances for the full range of shaft diameters. When running clearance exceeds the value of these tolerances by a factor of 3, *REPLACE THE BUSHING*.

Bushing replacement requires disassembly of machinery shafting and gearing. Removal of bushings may require the use of an air chisel to slit the bushing for removal. Use extreme care to avoid cutting or scoring the bearing boss. Once the bushing is removed *CLEAN* bearing boss thoroughly of metal burrs and debris, grease, and dirt.

A clean new bushing can be easily installed in a bore if it is cooled in a bath of dry ice and alcohol. This will shrink the outside diameter of the bushing allowing it to drop or slide freely into the bearing boss bore.

An alternate method installs the bushing using a long threaded rod, steel plates and a hollow center jack. Assemble items as shown. Lightly coat bushing O.D's and boss I.D. with high quality anti-scoring, extreme pressure, pressing oil. Then *PULL* the bushing into place.



bushinst.wpg

BUSHING INSTALLATION

7.4 BRAKES

The 301-M Mining Shovel uses spring-set, air-released brakes on the Hoist, Swing, Crowd and Propel motions.

In the event of a power failure or loss of air pressure, the brakes will automatically set to stop the machinery motion. Pressure switches located near each brake control valve monitors air pressure at the brake. The brakes cannot be released for operation until the air pressure reaches the operating pressure.

The brakes used include:

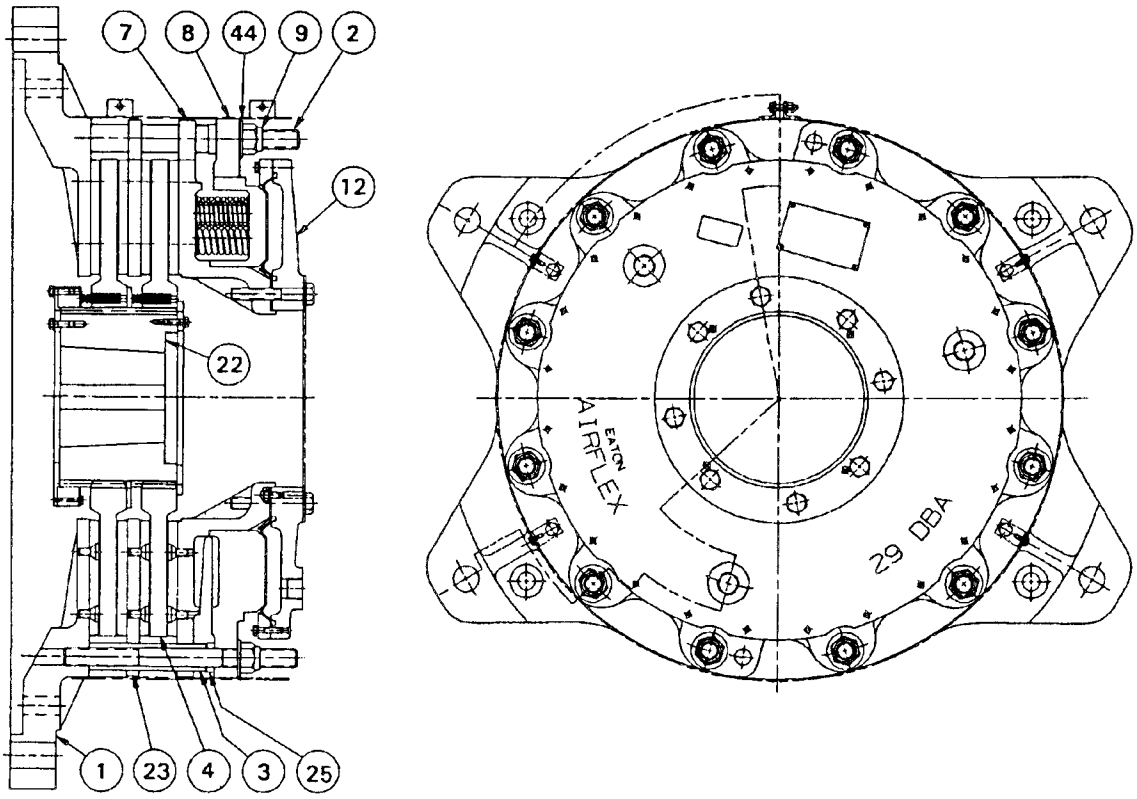
		Hoist	Swing	Crowd	Propel
Quantity:		1	2	2	2
Motor Frame Size:		824	814	812	814
Rotors per Brake:		2	1	1	1
Weight of Brake:		1475 Lbs. (670 Kg)	600 Lbs. (272 Kg)	480 Lbs. (218 Kg)	600 Lbs. (272 Kg)
Mounting Screws -	*Qty:*	4	6	6	6
	Size:	1.5 inch	.75 inch	1.0 inch	1.0 inch
	Torque:	1950 Ft.-Lbs. (2644 Nm)	265 Ft.-Lbs. (360 Nm)	645 Ft.-Lbs. (875 Nm)	645 Ft.-Lbs. (875 Nm)

IMPORTANT:

To reduce noise and rapid friction disc wear, the new double rotor motor brakes used on the 822 and 824 horizontal shaft motors may be equipped with a motor centering device.

Before performing any maintenance, determine if this device is on the brake by removing the end guard. Check the rotor hub, if fitted with a centering cone adjusting nuts. The rotors will have the centering device. Refer to 7.4.13 for maintenance information.

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



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Item	Description	Item	Description	Item	Description
1	Mounting Flange	7	Pressure Plate	22	Rotor Hub
2	Stud	8	Spring Housing	23	Reaction Plate
3	Clamp Tube	9	Locknut	25	Wear Spacer
4	Rotor	12	End Plate	44	Flat Washer

10. Lubricate the gear teeth with a LIGHT coat of Molub-Alloy OG Heavy grease, or equivalent.

WARNING: EXCESSIVE GREASE APPLICATION ON THE DRIVING GEAR MAY RESULT IN CONTAMINATION OF THE FRICTION MATERIAL. GREASE ON THE DISCS OF THE FRICTION DISCS WILL SIGNIFICANTLY REDUCE THE TORQUE CAPACITY OF THE BRAKE AND DECREASE ITS ABILITY TO HOLD THE MACHINERY IN A SAFE POSITION.

11. Noting the position and orientation from which it was removed, slide the first disc onto the gear. Insert the springs into the spring pockets in the disc and slide the disc toward the motor.

12. Noting the orientation from which it was removed, slide the reaction plate over the clamp tubes, and against the disc.

13. Install the required number of spacer plates (97) onto the gear and against the disc. The number of spacer plates (97) installed at the location described here should be equal to the number of spacer plates (95) that remain installed in Step No.9.

14. Slide the second disc onto the gear and install the springs into the spring pockets.

15. Install the remaining spacer plates (95, 97) onto the gear. On 824 Frame motor applications, also install the spacer plate (102) onto the gear.

16. Attach the end plate to the gear using two 3/8-16NC2 x 1.75" screws, evenly spaced. Draw the end plate toward the gear to compress the springs using the 2 screws until they bottom in the tapped holes of the gear. Do not tighten the screws after they have bottomed in the holes.

WARNING: EXCESSIVE TIGHTENING OF THESE FASTENERS MAY DAMAGE THE THREADED HOLES IN THE GEAR.

17. Install two hex head screws (99) and lockwashers (100) in the remaining two holes in the end plate. Tighten these two screws one turn at a time, in an alternating sequence, until the end plate contacts the end of the gear.

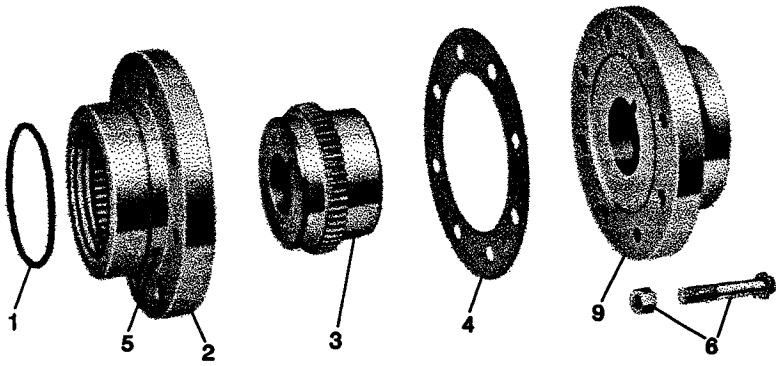
18. Remove the two 3/8-16NC2 x 1.75" screws, replacing them with hex head screws (99) and lockwashers (100). Tighten all four screws to 44 Ft.Lbs., dry.

19. Lubricate the threads on the ends of the studs with 30 wt. oil or "Never-Seez".

20. Hoist the pressure plate, spring housing and end plate assembly into position, and slide the assembly over the clamp tubes, placing the required number of wear spacers (125) onto the studs between the pressure plate and spring housing. See Table 1.

7.7 GEAR COUPLING

INSTALLATION



Part Numbers:

1. Seal Ring
2. G Flanged Sleeve
3. G Flex Hub
(Specify bore and keyway)
4. Gasket
5. Lube Plug
6. Fasteners
9. Rigid Hub

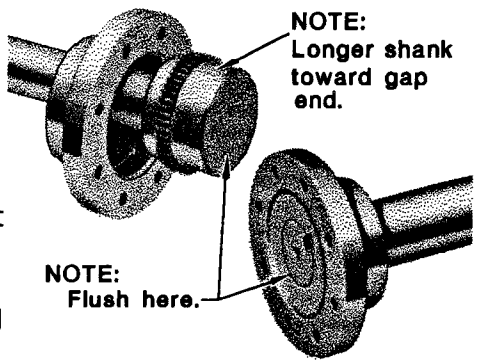
cplg_gr1.wpg

1. Clean all parts. Heat hubs in an oven or use suitable dry heat. DO NOT rest gear teeth on container bottom or apply a flame directly to gear teeth. DO NOT heat hubs over 275°F. (135°C.) for mounting. Refer to motor shaft installation for hubs mounted on drive motors.

   Pack sleeve teeth with grease and lightly coat seals with grease *BEFORE* assembly. *DO NOT DAMAGE THE SEALS.*

   Use a dial indicator to align dynamically balanced couplings and assembly parts with mating match marks aligned. Mount the indicator on one hub and take readings for the *OFFSET* check on the O.D. of the other hub. The difference between the minimum and maximum readings *DIVIDED* by two should not exceed the values in the table. For *ANGULAR* check, take readings on either face of other hub. The difference between the minimum and maximum readings should not exceed the values in the table.

cplg_gr2.wpg



Mount flanged sleeve, seal and hubs

2. Mount the flanged sleeves, seal and hubs. Place the flanged sleeves *WITH* the seal rings on the shafts before mounting the hubs.

CAUTION: DO NOT DAMAGE THE SEALS. Mount the hubs on their respective shafts, as shown, so that each hub is flush with its shaft end. Position the equipment in approximate alignment with the approximate gap specified in the table.

STEP 4 -- Preparation of the Defect or Worn Part.

Proper preparation is half the job, therefore, it is important to evaluate each part on its own merit. Some points to consider are as follows:

1. How large is the crack or defect?

2. Is the crack completely through the thickness?

3. Will distortion be a factor?

4. Can two welders weld opposite each other in order to control distortion or must all the repair be done from one side?

5. Will the welder be able to withstand the preheat if required?

6. Can the welder get into a position to do a good job?

7. Does the cost of repairing the part compare favorably to buying a new part?

These points are important factors when evaluating how the defect should be prepared for welding. A welder can repair most defects, add modifications or repair worn parts as long as good equipment is available to him such as the correct clothing, head gear, exhaust systems or respirators and platforms for the job. If the welder is kept comfortable and given the required equipment and consideration, a quality job can be expected.

Methods of metal removal to be considered are:

1. Air carbon arc gouging.

2. Grinding.

3. Machining.

4. Oxyfuel burning.

Before any weld repair is started, a survey should be made of the area and all safety considerations satisfied such as fuel tanks, oil lines, electrical cables and toxic materials.

A decision should be made whether the part will be repaired on the machine or disassembled and repaired in a shop or on the mine floor.

7.10 WIRE ROPE

STORAGE

Wire rope stock reels placed in a warehouse may be kept on hand for a considerable length of time. This is particularly true of some slow-moving special ropes that may not be disposed of completely for several years. Consequently, wire rope should be stored in a fairly well ventilated, comparatively dry building or shed.

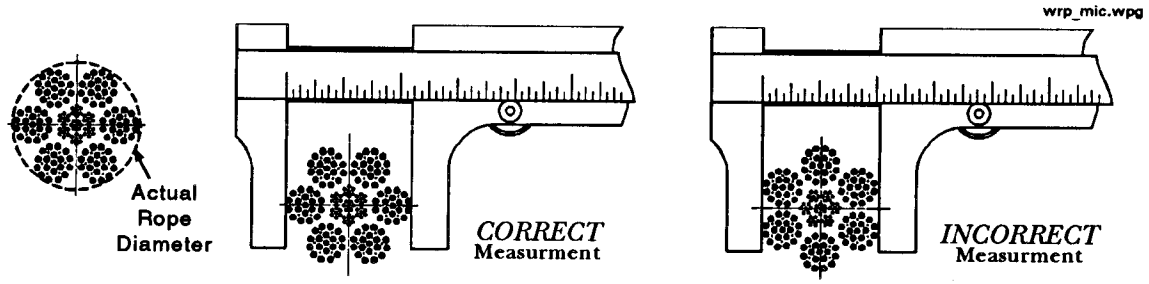
Do not store rope on the bare ground or expose it to the elements. Excessive atmospheric vapors will condense moisture on the rope causing rust. If exposed to the direct sun or stored next to a boiler or in similar conditions, the original lubrication will dry out to some extent.

Do not store in a dusty or chemically laden atmosphere as this may coat the surface of the rope or even deteriorate the fiber core. If it should ever be necessary to store rope outside, the reel should be set on blocks, off the ground, and covered with a waterproof covering.

CHECKING THE DIAMETER

It is most important to check the diameter of the delivered rope *BEFORE* installation. This is to make certain that the rope diameter meets the specified requirements for the given machine or equipment. With an *UNDERSIZE* diameter tope, stresses will be higher than designed for and the probability of breaking the rope will be increased; an *OVERSIZE* diameter rope will wear out prematurely. This happens because of abuse to the rope caused by pinching in the grooves of the sheave and drum.

In checking, however, the actual rope diameter must be measured. And this is defined as the diameter of the circumscribing circle, i.e., its largest cross-sectional dimension. To insure accuracy this measurement should be made with a wire rope caliper using the *CORRECT* method. For measuring ropes with an odd number of outer strands, special techniques must be employed.



3. *Reduction in rope diameter*:

Any marked reduction rope diameter indicates degradation. Such reduction may be attributed to:

- Excessive external abrasion.
- Internal or external corrosion.
- Loosening or tightening of rope lay.
- Inner wire breakage.
- Rope stretch.
- Ironing or milking of strands.

In the past, whether or not a rope was allowed to remain in service depended to a great extent on the rope's diameter at the time of inspection. Currently this practice has undergone significant modification.

Previously, a decrease int eh rope's diameter was compared with published standards of minimum diameters. The amount of change in diameter is, of course, useful in assessing a rope's condition. But, comparing this figure with a fixed set of values can be misleading. These long-accepted minimums are not, in themselves, of any serious significance since they do not take into account such factors as:

1) Variations in compressibility between IWRC and Fiber Core.

2) Differences in the amount of reduction in diameter from abrasive wear, or from core compression, or a combination of both.

3) The actual original diameter of the rope rather than its nominal value.

As a matter of fact, all ropes will show a significant reduction in diameter when a load is applied. Therefore, a rope manufactured close to its nominal size may, when it is subjected to loading, be reduced to a smaller diameter that stipulated in the minimum diameter table. Yet, under these circumstances, the rope would be declared unsafe although it may, in actuality, be safe.

As an example of the possible error at the other extreme, we can take the case of a rope manufactured near the upper limits of allowable size. If the diameter has reached a reduction to nominal or slightly below that, the tables would show this rope to be safe. But it should, perhaps, be removed.

Today, evaluations of the rope diameter are first predicated on a comparison of the original diameter—when new and subjected to a known load—with the current reading under like circumstances. Periodically, throughout the life of the rope, the actual diameter should be recorded when the rope is under equivalent loading and in the same operation section. This procedure, if followed carefully, reveals a common rope characteristic: after an initial reduction, the diameter soon stabilizes. Later, there will be a continuous, albeit small, decrease in diameter throughout its life.

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

SHOVEL NO: **DATE:**

INSPECTION SCHEDULE	SERVICE HOURS 250 500 1000	REMARKS
6. GENERAL COMMENTS / WORK DONE:		

[Chart #3]

301-M MINING SHOVEL
PROJECTED MAINTENANCE SCHEDULE

DESCRIPTION	QTY/ MACH.	OPERATING HOURS X 1000									
		10	20	30	40	50	60	70	80	90	100
Rotating Gearcase Assy.											
Swing Motor			R		X		X		X		X
Motor Blower		R	X	X	R	R	X	X	R	R	X
Motor Coupling	2		R		X		X		X		X
Brake Gear Hub	2		R		R		R		R		R
Brake Assembly	2		R		X		X		X		X
Gearcase	2			R			X			X	
Boom Support											
Boom Support Rope	4					R					R
Bushing (Support Rope)	8					R					R
Bushing (Equalizer)	2					R					R
Hoist Motor Assembly											
Hoist Motor	1		R		X		X		X		X
Motor Blower	1	R	X	X	R	R	X	X	R	R	X
Motor Cplg. (Mtr. Half)	1		R		X		X		X		X
Motor Cplg. (Case Half)	1		R		X		X		X		X
Brake Gear Hub	1		R		R		R		R		R
Brake Assembly	1		R		X		X		X		X
Hoist Gearcase Assembly											
Hoist Gearcase	1			R			X			X	
Seal (Face)	1			R			R			R	
Bearing (Inboard)	1			R			R			R	
Seal (Inboard Brg.)	1			R			R			R	
Seal (Inboard Brg.)	1			R			R			R	
Bearing (Outboard)	1			R			R			R	
Inter. Pinion Shaft	1			R			R			R	
Hoist Drum Shaft											
Lagging	1				R				X		
Bearing	2				R				R		
Gear	1				R				X		
Hoist Rope	2	Replace at 1000 Hour Intervals									

X = Exchange for Rebuild R = Replace W = Weld Repair

9.2 CONTROL SETTINGS AND DATA

The following settings apply to automatic controls incorporated in the SIGMA M7 units supplied in this instance.

Applicable to Refrigeration Equipment

Dual Pressure Switch (HLPS)

Low Pressure

a. Cut-Out 15 psig (105 kPa)
b. Cut-In 30 psig (210 kPa)

High Pressure

a. Cut-Out 265 psig (1825 kPa)
b. Cut-In Manual reset

Capacity Control Regulator (HGB)

a. Opens at 28 psig (195 kPa)

NOTE: Ensure that all switches are set using accurate gauges.

Thermostatic Expansion Valve

1. Factory set at: 10-12°F (6-7°C) Superheat
2. Compressor Oil Charge*
   a. 3.6 pints or 0.45 gals (1.7 Liters)
3. Total Refrigerant Charge of R134A*
   a. Approximately 10 lbs. (4.5 kg) but charging must be to a full sight glass, ideally under load with the capacity control regulator isolated or adjusted so that no bypass occurs.

NOTE: Refer to attachments at the end of this section for specifications.

9.7 ELECTRICAL SYSTEM

The air conditioning control and power system has been designed to operate when supplied with power from a 3 phase supply. This supply should be regulated and free from spikes and harmonics.

Whenever working on the air conditioning unit the system should be isolated by opening all circuit breakers.

CONTROL EQUIPMENT

Accessible from within the cabin:

Air conditioning Main Selector Switch (MCS)

This switch selects the mode operation for the air conditioning system in the cab. This is located on the pilot control box, accessible from within the cabin. Four positions are provided:

"OFF" - This position provides isolation to all control equipment and motors. The unit will not run in this position.

"COOL" - In this position power is provided to either the low or high evaporator fan winding, condenser fan, fresh air fan and compressor. Unit may continue to cool with capacity control through the hot gas bypass valve (HGBP) and the compressor will cycle with the return air thermostat.

"HEAT" - In this position power is provided to either the low or high evaporator fan winding and fresh air fan. The heating elements are cycled by the return air thermostat.

"VENT" - In this position power is provided only to the evaporator fan winding and fresh air fan.

Fan speed Switch (FSS)

"LOW FAN:" - Power is supplied to the low speed evaporator fan windings and pressurizer motor.

"HIGH FAN" - Power is supplied to the high speed evaporator fan windings and pressurizer motor.

Thermostat - for regulation of dry bulb temperature.

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.

J. Overcharge of Refrigerant:

An overcharge of refrigerant will cause high head pressure. Liquid will back up in the condenser and decrease the amount of surface available for condensing and as a result, the head pressure will rise. In extreme cases, it may rise to a point where the thermal overload elements in the compressor motor or the high pressure cutout will stop the compressor. This may result in "short cycling", (compressor cycles too frequently).

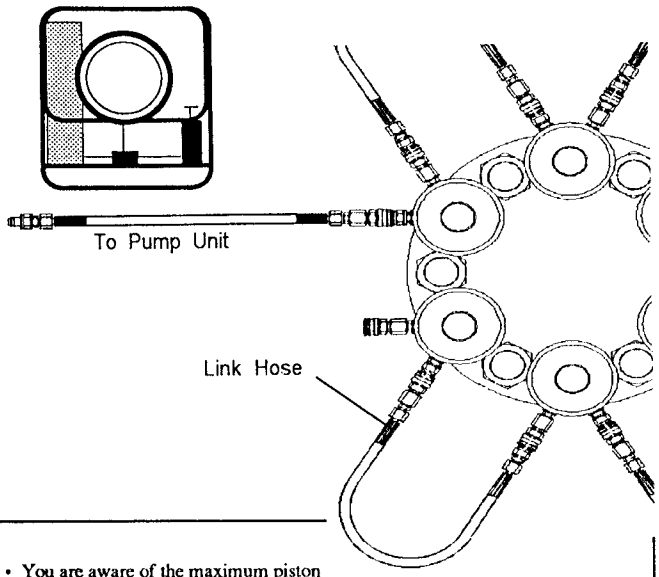
K. Air in System:

If air or other non-condensible gases are present in the system, they will tend to move toward and collect at the condenser. The head pressure will rise to a point above the pressure corresponding to the temperature at which the vapor is condensing. In extreme cases, the pressure may rise to a point where either the high pressure cut-out or the thermal overload elements in the compressor motor may stop the compressor.

L. Broken Valves in Compressor:

Broken or leaky discharge valves in a compressor are generally indicated by the suction pressure rising rapidly as soon as the machine is stopped. If the suction pressure rises faster than 13 kPa per minute, it is an indication that the compressor discharge valves are not holding. Before the compressor is opened however, it should be determined that the pressure rise is not due to other causes such as a leaky expansion valve or residual refrigerant in the evaporator.

NOTE
This operator procedure assumes a 50% bolt/tool ratio.
For detailed information on tensioning sequences contact **Raymond.**



Step 6

Continue until all of the tensioners are connected together with link hoses. The last tensioner in the system will have an unconnected female coupling, which is correct, and can be left unconnected.

*** Never pressurize an unconnected male connector**

TENSIONING PROCEDURE

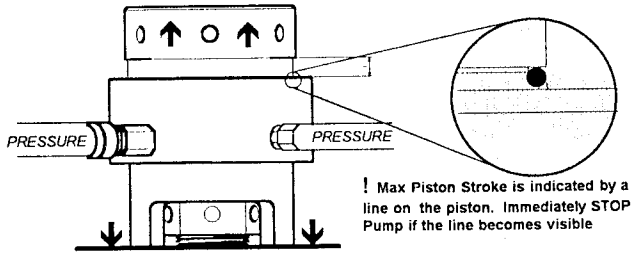
The tensioning system is now ready to apply a bolt load to the joint. Before applying pressure to the system make sure you understand the following points:-

- You are aware of the correct operation of the Pump Unit. (See Raymond Air Pump User's Guide)
- You are aware of the maximum working pressure of the tensioners. (See Technical label specification on tensioners).
- You are aware of the maximum piston movement of the tensioners. (See Technical label specification on tensioners).
- You are aware of the required working pressure that must be applied to the tensioners. (For guidance in calculating working pressures and bolt loads, see Raymond technical paper "Load Transfer and Working Pressures").
- It is recommended the next procedures are read and understood prior to starting the tensioning.

Step 7

During pressurization procedure, continually monitor both piston stroke and pressure. Never exceed either. If the maximum piston stroke is reached before the working pressure is attained, go to Step 9.

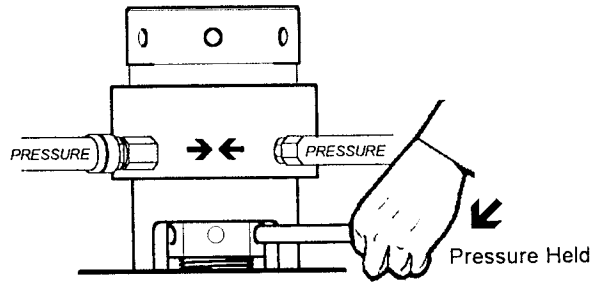
Close stop valve on pump unit, then pressurize the system to the required pressure. When the required pressure is reached, stop the pump (hold pressure). At this stage the bolts will be initially loaded, with the load being held by the tensioners.



! Max Piston Stroke is indicated by a red line on the piston. Immediately STOP the Pump if the line becomes visible

Step 8

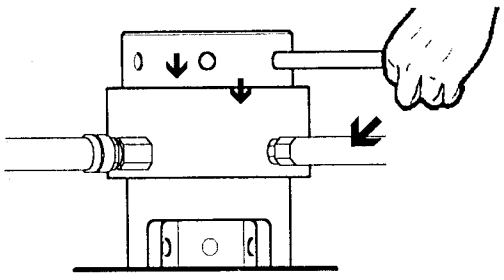
Check the pump gauge to ensure that pressure is steady. When you are satisfied the pressure is stable, approach the tensioners and, with the tommy bar, rotate the hexagon nuts, (through the bridge access windows), back down toward the joint face. Seat the hexagon nuts firmly against the joint, by use of a mallet and Tommy bar (If the hexagon nuts are not seated firmly, the tensioning procedure will take much longer to complete). It is not important in which order the nuts are tightened but to be sure of not missing one, it is recommended that they be tightened in sequence.



Pressure Held

Step 9

Slowly release the return to tank valve on the pump. The load is now transferred from the tensioners to the nuts. Use a Tommy bar in the thread insert to return the pistons to their fully closed position (Note: If the desired pressure has not yet been reached, continue from Step 6). Disconnect all of the hydraulic link hoses and reposition the tensioners onto the final 50% of bolts to be tensioned, and continue from Step 4.



Pressure Released

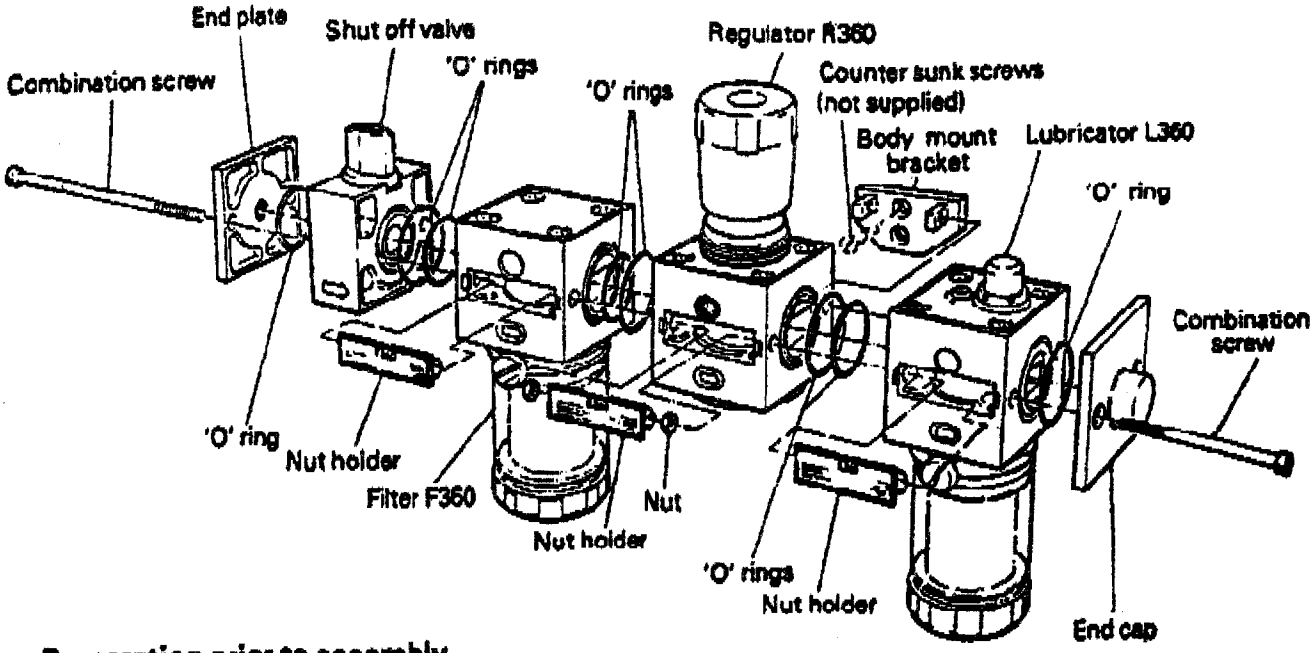
Assembly instructions for 360 Series combination units

BI006441

Parts required for combination units

a) Unit assemblies required. e.g. F360 etc.
b) End plate kit. e.g. IK360A
c) Combination screw kit. e.g. CS360E

Note. Assemblies are complete with nut holders and 'O' ring seals.



Preparation prior to assembly

a) Ensure all sealing faces are clean.
b) Lightly grease 'O' ring grooves.
c) Insert 'O' rings in groove.

Assembly. For example 3 piece F.R.L.

a) Insert screws through end plate and filter body with nut holders fitted (without nuts) ensure that face sealing 'O' rings are in position.
b) Insert nut holder (with nuts) into regulator body.
c) Loosely assemble filter to regulator ensuring all flow arrows are in same direction.
d) Use same procedure to fit lubricator.
e) Finally tighten all screws.

Note. When body mount bracket is required first fix to wall, then insert into body and retain with combination screws.

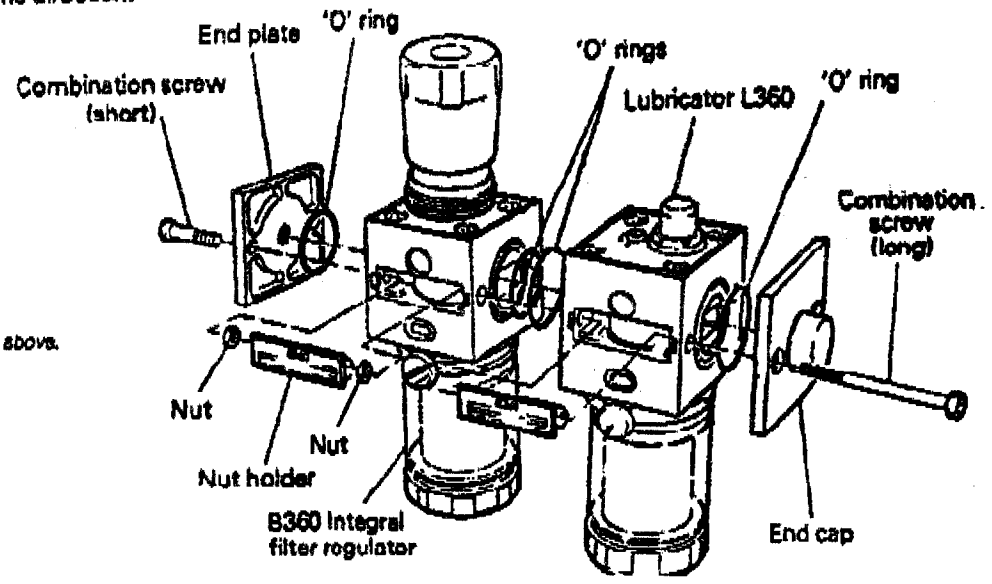
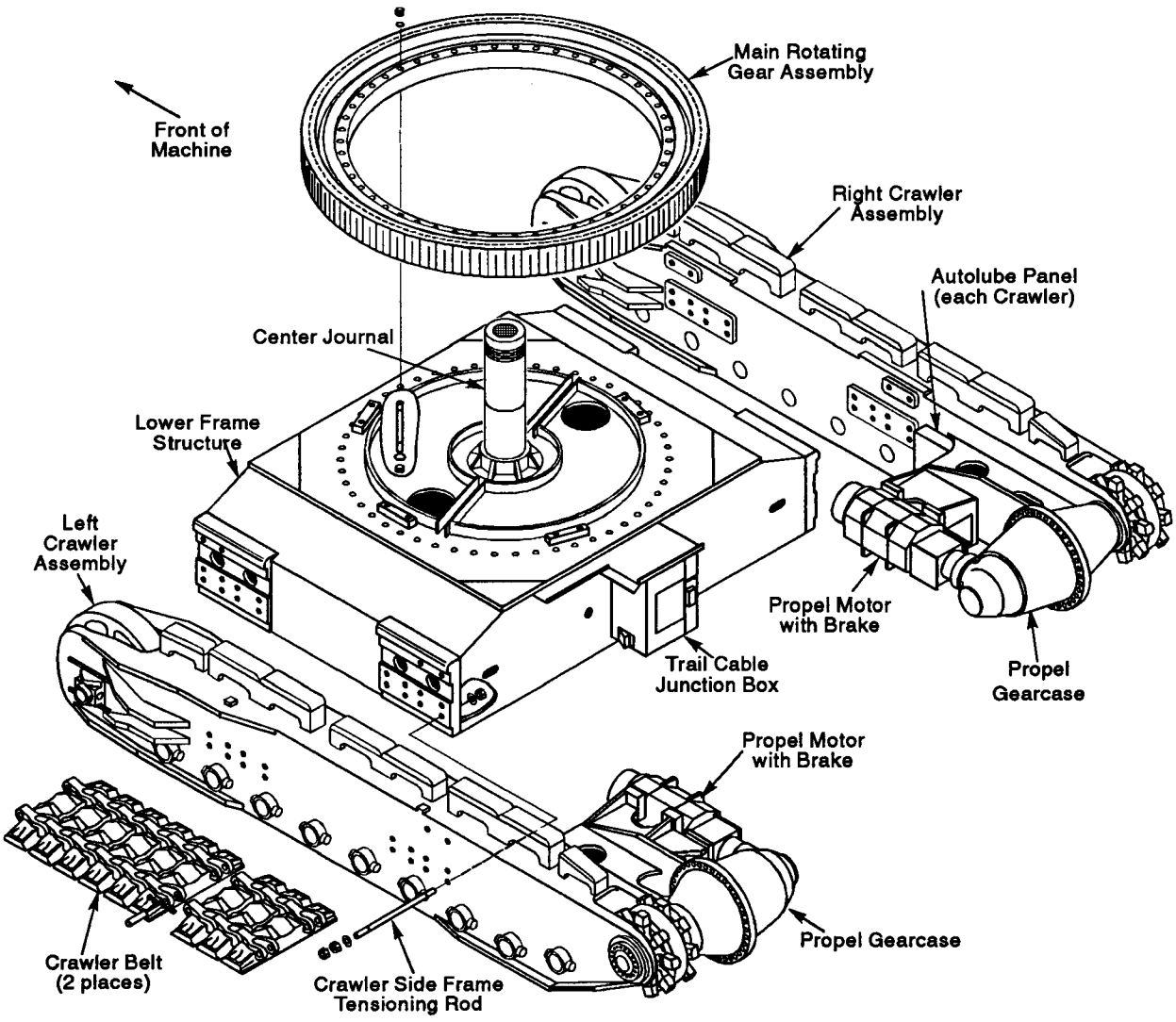
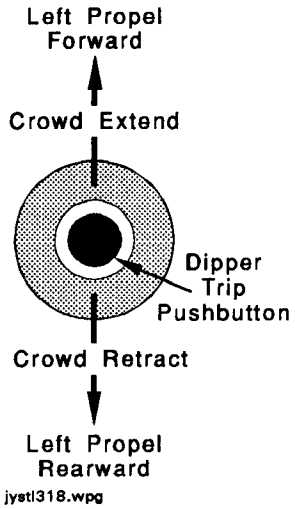


Illustration of 2 piece BL unit. For assembly instructions see above.



301-M LOWER FRAME and CRAWLER ASSEMBLIES

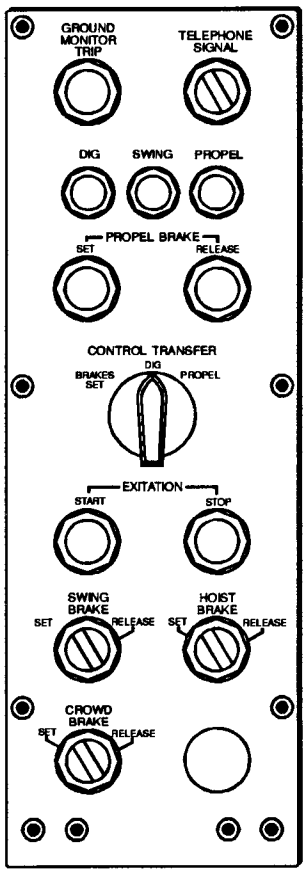
LEFT CONTROLLER and CONTROLS



LEFT JOYSTICK

When the machine drive is in the *DIG* mode, the joystick on the left side of the operator's seat controls the crowd machinery - to move the dipper handle through the yoke block, either *IN* (crowd retract) or *OUT* (crowd extend). Dipper handle motion follows controller motion - that is - *toward* the operator crowds the handle in and *away* from the operator crowds out. If the machine drive is in the *PROPEL* mode, then this joystick controls the propel machinery on the *left crawler* to cause the crawler belt travel either forward or rearward, again in the same direction as the controller motion. The button on top of the crowd controller activates the dipper trip to open the dipper door.

NOTE: Both the crowd and left propel drives are speed controlled. This means that the further the joystick lever is moved from its neutral position, either direction, the faster the drive will go. Refer to "Machine Operation" in this section for more detail.



LEFT CONTROL CONSOLE

The controls on the left console are:

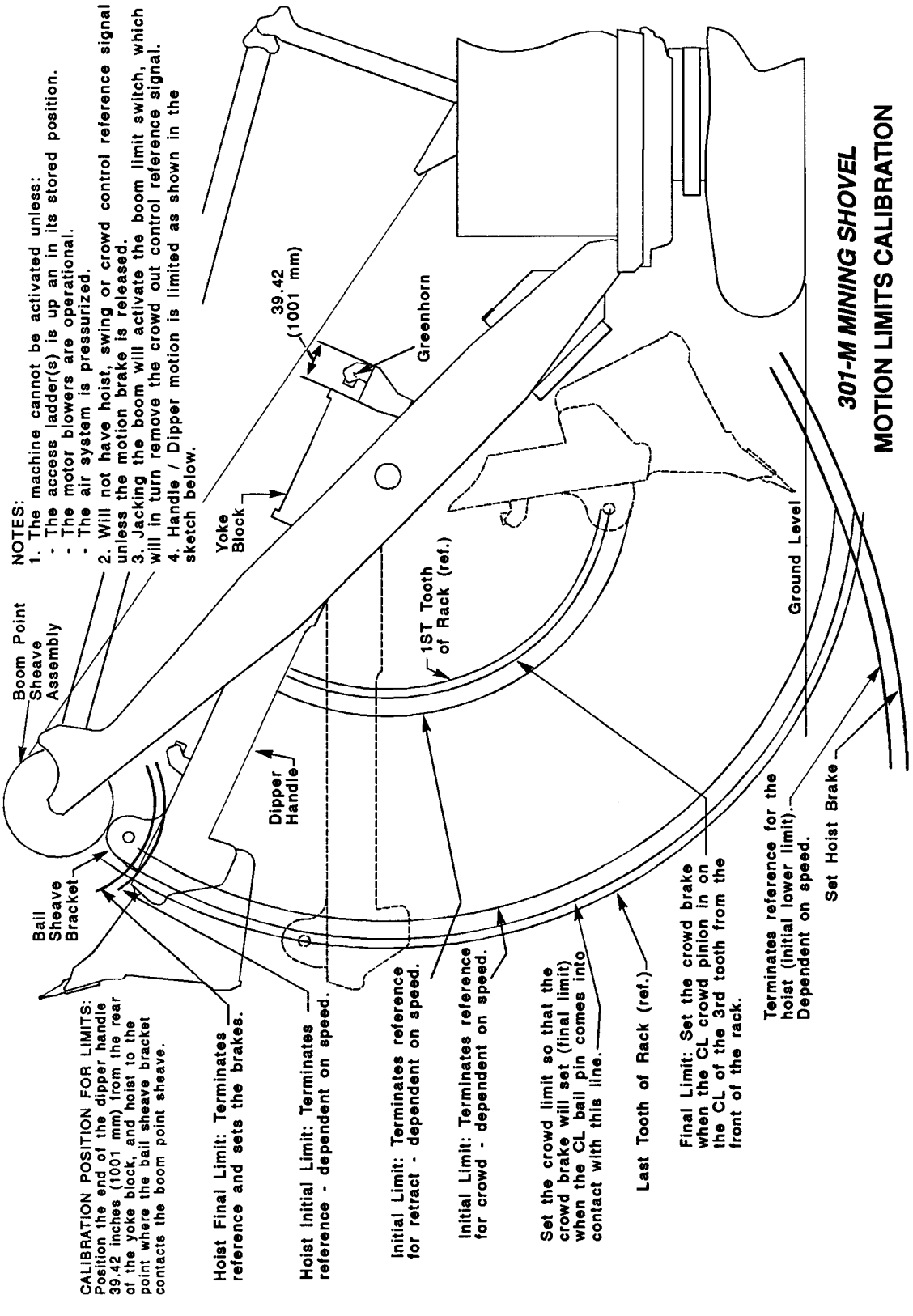
GROUND MONITOR - By customer.

TELEPHONE SIGNAL - a black pushbutton that, when pressed, activates the telephone signals in the machinery house and lower frame.

DIG, SWING, PROPEL - a row of three green lights that indicate machine operating modes.

PROPEL BRAKES - two illuminated pushbuttons side by side that *SET* or *RELEASE* the two propel brakes. These are activated only when the control is in the PROPEL mode.

- *SET* - pressing this pushbutton sets the propel brakes when in the propel mode. Its red light being on indicates the brakes are set.
- *RELEASE* - pressing this pushbutton releases the propel brakes when in the propel mode. Its green light being on indicates the brakes are released.


NOTES:
1. The machine cannot be activated unless:
- The access ladder(s) is up an in its stored position.
- The motor blowers are operational.
- The air system is pressurized.
2. Will not have hoist, swing or crowd control reference signal unless the motion brake is released.
3. Jacking the boom will activate the boom limit switch, which will in turn remove the crowd out control reference signal.
4. Handle / Dipper motion is limited as shown in the sketch below.
Boom Point Sheave Assembly
Yoke Block
39.42 (1001 mm)
Greenhorn
1ST Tooth of Rack (ref.)
Ground Level
Dipper Handle
Bail Sheave Bracket
CALIBRATION POSITION FOR LIMITS: Position the end of the dipper handle 39.42 inches (1001 mm) from the rear of the yoke block, and hoist to the point where the bail sheave bracket contacts the boom point sheave.
Hoist Final Limit: Terminates reference and sets the brakes.
Hoist Initial Limit: Terminates reference - dependent on speed.
Initial Limit: Terminates reference for retract - dependent on speed.
Initial Limit: Terminates reference for crowd - dependent on speed.
Set the crowd limit so that the crowd brake will set (final limit) when the CL bail pin comes into contact with this line.
Last Tooth of Rack (ref.)
Final Limit: Set the crowd brake when the CL crowd pinion in on the CL of the 3rd tooth from the front of the rack.
Terminates reference for the hoist (initial lower limit). Dependent on speed.
Set Hoist Brake
301-M MINING SHOVEL
MOTION LIMITS CALIBRATION
molmt319.wpg

To return to the face for the next dig cycle, move the right joystick forward and toward the face simultaneously. This will lower the dipper to the toe of the bank as it swings. Be careful not to hit the crawlers with the dipper.

CAUTION: Stop the swing motion completely before beginning to dig in the bank. DO NOT use the dipper to stop the swing motion.

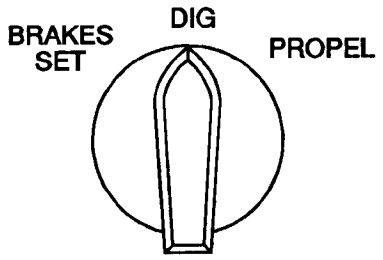
The machine control must be in the *DIG* mode, L.E. energized, and the hoist, swing, and crowd brakes released.

HOIST/SWING/R. PROPEL controller or joystick, at the operator's right, controls the raising or lowering of the dipper and the swinging of the machine to the left or the right.

HOIST MOTION - From the spring centered, or "neutral", position, forward movement of the joystick lever results in the hoist machinery raising the dipper. Rearward lever movement results in it lowering the dipper.

The forward/rearward movement of the joystick controls the speed of the hoisting or lowering motion in proportion to the amount the lever is moved away from neutral.

CONTROL TRANSFER



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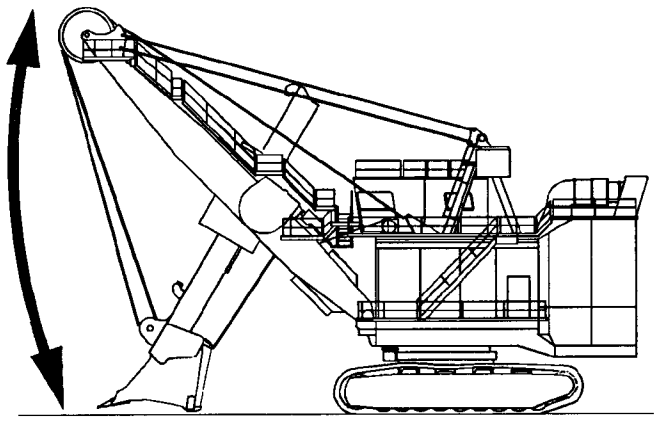


HOIST MOTION

SWING MOTION - Left or right lever movement of the joystick from neutral position causes the upper machinery works to rotate left or right respectively on the lower structure.

The left/right movement of the joystick lever controls the torque output of the swing drive in the proportion to the amount the lever is moved away from neutral.

NOTE: The swing drive is operational in either *DIG* or *PROPEL* mode.

TABLE OF CONTENTS

The safety valve should prevent pressure in the weakest component from exceeding 110% of the maximum allowable working pressure during maximum flow conditions but must not be set higher than the maximum working pressure of the weakest link. Failure to properly size, set and install pressure relief valves can be fatal.

Pressure Vessels - Air receiver tanks and other pressure containing vessels such as, but not limited to, pulsation bottles, heat exchangers, moisture separators and traps, shall be in accordance with ASME Boiler and Pressure Vessel Code Section VIII.

⚠WARNING

ASME coded pressure vessels must not be modified, welded, repaired, reworked or subjected to operating conditions outside the nameplate ratings. Such actions will negate code status, affect insurance status and may cause severe personal injury, death and property damage.

⚠WARNING

High voltage may cause severe personal injury or death. Disconnect all power supplies before opening the electrical enclosure or servicing.

Electrical - Before installation, the electrical supply should be checked for adequate wire size and transformer capacity. During installation a suitably fused or circuit breaker disconnect switch and motor starter should be provided. Where a 3 phase motor is used to drive a compressor any unreasonable voltage unbalanced between the legs must be reduced and any low voltage corrected to prevent excessive current draw. The installation, electric motor, wiring and all electrical controls must be in accordance with NFPA 70-1984 National Electric Code, National Electric Safety Code, state and local codes. All electrical work should be performed by a qualified electrician. Failure to abide by the national, state and local codes may result in physical harm and/or property damage.

1. Moisture and oil buildup at the pressure switch diaphragm which will affect the cut-in pressure of the pressure switch allowing the pressure in the receiver to drop lower than desired.

2. Rupturing of the diaphragm which prevents the pressure switch from functioning.

3. Burned contact points.

4. A plugged air passage to the pressure switch preventing the switch from functioning.

5. A loose electrical connection.

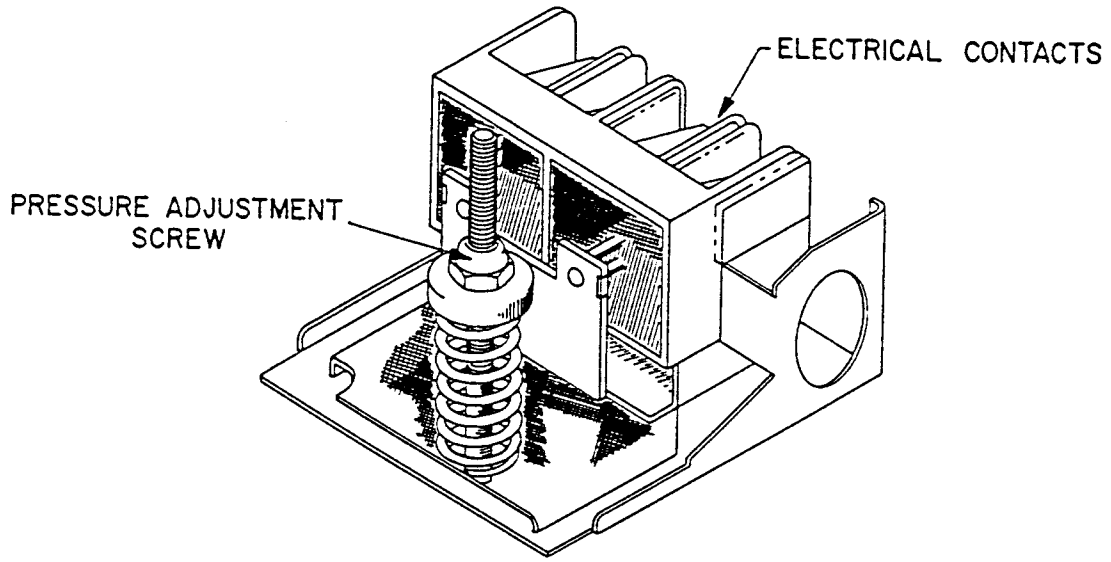


FIGURE 4-10

Air Distribution Lines - The air distribution lines should be sized so the pressure drop at any point in the system does not exceed 10% of the air receiver pressure. Generally the discharge piping from the receiver should be the same size as the compressor discharge connection.

All piping should either be sloped to the receiver or a drop leg or moisture trap to insure a collection point where the moisture can easily be removed.

All service line outlets should be installed at the top of the headers. This will prevent moisture from entering the tool or device using the air. See Figure 4-11.

Shutoff valves protected by safety valves in the system, should be installed at all service line outlets to eliminate leakage when the tools are not in use.

Install auxiliary air receivers near heavy loads or at the far end of a long system. This will insure sufficient pressure if the use is intermittent or a sudden large demand is placed on the system.

SECTION IX
MAINTENANCE CHART
(Hours/Days Whichever Occurs First)

BI006441

CHECK	8 HOURS DAILY	40 HRS WEEKLY	160 HRS MONTHLY	500 HRS OR 3 MTHS	1000 HRS OR 6 MTHS	2000 HRS 12 MTHS
1. Check oil level. Maintain between high and low level marks on bayonet gauge. CAUTION: Do not overfill!	X					
2. Drain moisture accumulation from the air receiver.	X					
3. Drain drop legs and traps in air distribution system.	X					
4. Give compressor an overall visual inspection and be sure safety guards are in place.	X					
5. Check oil pressure, hot. Maintain 18 to 20 psig. For receiver pressures above 200 psig maintain a minimum oil pressure of 25 psig.	X					
6. Check for any unusual noise or vibration.	X					
7. Check for oil leaks.	X					
8. Operate the safety valves to be certain they are functioning.		X				
9. Clean the cooling surfaces of the intercooler, aftercooler and compressor.		X				
10. Replace or clean air intake filter. Check more more often if dirty conditions exist.		X				
11. Check the air distribution system for air leaks.		X				
12. Inspect oil for contamination and change if necessary. Check more often under humid or dirty conditions.			X			
13. Check belt tension.			X			
14. Check pulley and pulley clamp screws or set screws for tightness.			X			
15. Inspect filters in Unloader Pilot Hydraulic Unloader, and Three Way Valve.			X			
16. Change oil and oil filter.				X		
17. Inspect compressor valves (including check valves) for leakage and or carbon build-up.					X	
18. Inspect pressure switch diaphram and contacts. Also contact points in motor starter.						X
19. Lubricate electric motor or engine.	See manufacturers recommendations					X

CAUTION - Follow all safety precautions noted in Section VII.

COMMUTATORS

Commutators should be inspected frequently by an electrician to assure detection of surface faults in the early stages. Burned bars, high and low bars, high mica or flat spots, become serious at an accelerating rate. When not detected and corrected early, repairs often require a long shutdown.

A good commutator surface is highly polished. It shows a chocolate brown color. If the commutator is only slightly blackened due to arcing, the best cleaning procedure is the use of a piece of canvas wrapped around a wooden block. The canvas cleans the surface and does not scratch the copper. When excessive arcing takes place over a long time, a burned and blackened commutator results. In these severe cases, use a very fine sandpaper (2/0 or 3/0).

DANGER: NEVER USE EMERY CLOTH OR EMERY PAPER. Emery conducts electricity. Serious injury to personnel and equipment results.

Shape a wooden block to the commutator contour. Fold sandpaper around block and hold against commutator while motor or generator runs at no-load. Use a slow lateral movement of the block to avoid diagonal scratches. Undue amounts of sandpapering destroys the needed polished surface and results in increased brush wear. Use sandpaper as little as possible. In most cases, polishing with canvas (see above) removes the blackening. One main objection to using sandpaper is that it rarely leaves bars properly grounded. On an unslotted commutator particularly with high mica, sandpaper tends to flatten the center of the bars.

Should the commutator become rough or pitted to a point where canvas and sandpaper cleaning does not remove bad spots, use a hand stone as needed. Sandpapering removes some slight spots, but not large flat ones. The effect merely broadens out the spots so they no longer show due to the flexibility of sandpaper. The stone smoothes much better, presenting a smooth contact surface and is easily held firmly in place. Sanding or stoning destroys perfect brush contact, so after polishing, bring the unit to rest and remove carbon and copper dust with dry compressed air.

Although hand stone grinding restores a true cylindrical surface, it does not remove extreme bad spots or out-of-round. A good commutator is within .0005 (.0127 mm) to .001 (.02 mm) out-of-round when checked with a dial indicator. Out-of-round is not caused by severe arcing and poor commutation, although it may cause these problems. Often out-of-round is caused by commutator changing shape due to heat and age. In extreme cases, remove the armature and turn or grind in a lathe. After grinding, undercut the mica on the commutator. Some large commutators may be ground in the frame using the proper equipment. This avoids time loss in removal. Commutator speed while grinding is important to prevent commutator damage. After grinding, bring unit to rest and removal *ALL* carbon and copper dust with dry compressed air. Run-in brushes for a short period under very light load. This allows brushes to seat before applying heavier loads.

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.

CORD GASKET SEALING

Use the following procedure to seal bolted joints:

1. Clean flanges of all dirt, rust and scale.

2. Use a cord gasket material .12 inch wide (part no. 469229-2) on machined joints and .25 inch wide (part no. 469230-6) on non-machined joints.

3. To apply the seal, peel the protective strip off the adhesive and install the adhesive edge against 1 surface of the joint. Place 2 cord gaskets around the joint to be sealed - 1 inboard of the bolt holes and 1 outboard. Keep the seal approximately 1/2 its width away from the edge of the bolt holes. (see the figure on this page)

4. Complete the seal of a continuous flange by crossing the ends near a bolt hole. Cross 1 end over the other end and cut the cord. For a discontinuous flange, see the end joints in the figure.

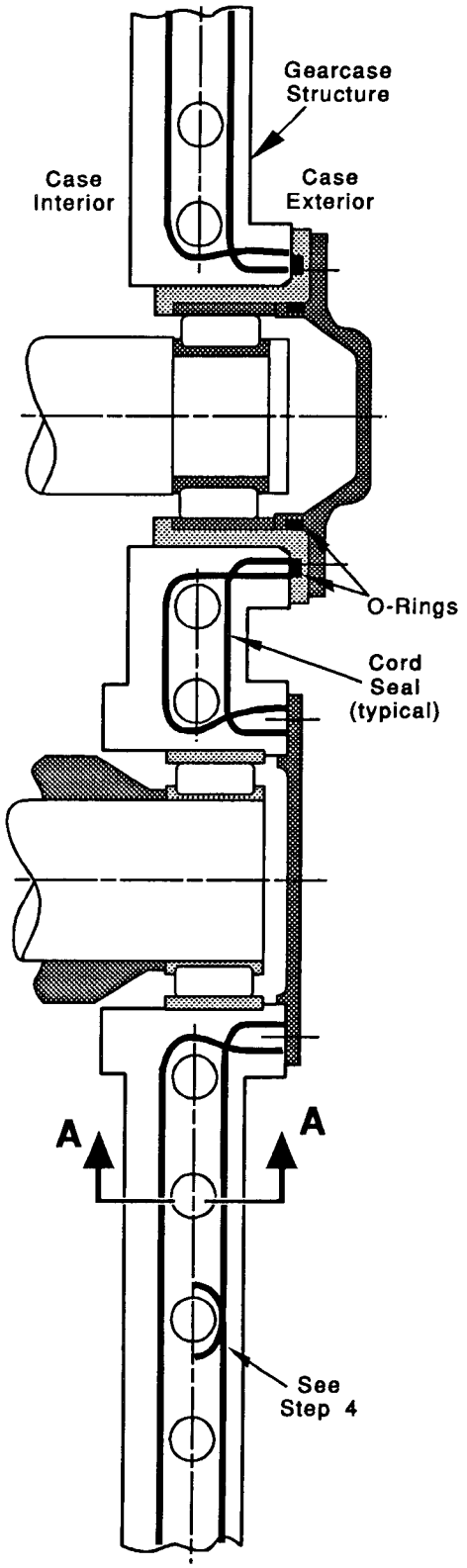
5. When tapped holes are <u>THROUGH HOLES</u> into the interior of a gear case, apply sealant (part no. 134562-1) thoroughly to both the male and female threads of the fasteners prior to assembly.

6. Assemble the joint and tighten the bolts, in a sequence, in 2 steps as follows:

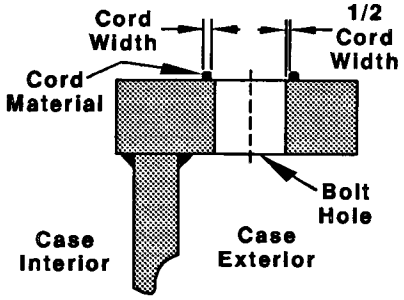
   - Tighten ALL the bolts to approximately 50% of their maximum torque (per spec.).

   - Tighten ALL the bolts to 100% or their maximum torque.

sealing1.wpg



sealing2.wpg



Section A-A
(Cord Seal Location)

SWING / CROWD BRAKE - CENTERING the DISC

After the swing brake has been assembled to the swing motor, the rotor disc must be centered between the friction discs so it will not rub when released during operation. Check this running clearance once per operating week and readjust it when required.

1. Remove the outer shield and lifter guard from the brake unit.

NOTE: Only two capscrews hold the lifter guard to the end plate. Do Not remove the other 4 capscrews from the end plate during this procedure.

2. Remove the top hex jam nut from the centering plug extending through the lifter housing.

3. Release the brake, using the manual override on the air control valve. *MAKE SURE THE MACHINE CANNOT ROTATE!*

DANGER: STAY CLEAR OF THE SPRING LOADED BRAKE ASSEMBLY WHEN ACTUATING IT FOR TEST.

4. Hold the bottom jam nut on the centering plug with a wrench and turn the centering plug to obtain equal running clearance between the rotor disc and the two friction discs.

5. When the running clearance is equal on each side of the rotor disc, install the top hex jam nut to the centering plug and tighten.

6. Reinstall the outer shield and lifter guard.

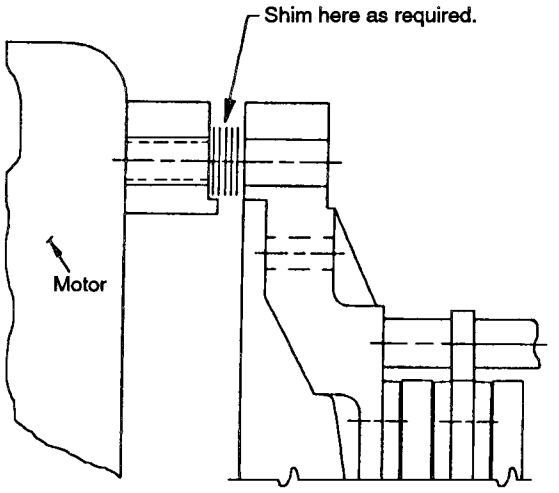
DANGER: BE SURE TO RESET THE MANUAL OVERRIDE ON THE AIR CONTROL VALVE TO NORMAL OPERATING MODE AFTER CENTERING THE DISCS ON THE SWING OR CROWD BRAKES. Failure to do so could result in major machine damage and possibly personal injury or death.

11. Install two hex head screws (99) and lockwashers (100) in the remaining two holes in the end plate. Tighten these two screws one turn at a time, in an alternating sequence, until the end plate contacts the end of the hub.

12. Remove the two 3/8-16NC2 x 1.75 screws, replacing them with hex head screws (99) and lockwashers (100). Tighten all four screws to 44 Ft.Lbs., dry.

13. Measure the gap between the mounting flange friction surface and the face of the first rotor. This gap should measure approximately .060".

14. If necessary, shim the mounting flange by installing an equal number of shims (101) at each of the four mounting points, to adjust the gap to .060 ±.010".



efx_6828.wpg

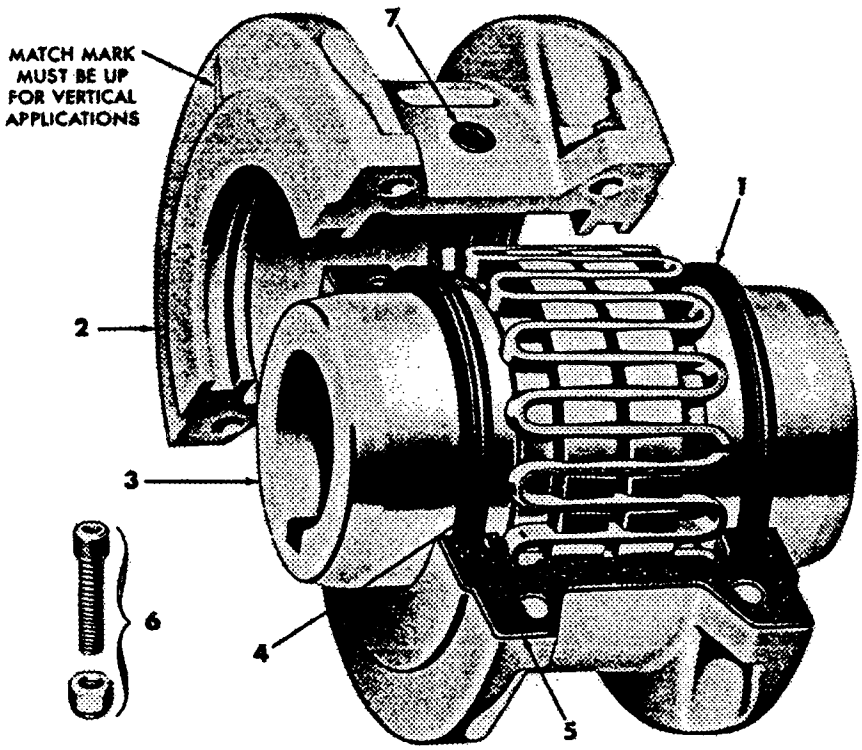
NOTE: The shimming procedure described is for preliminary set-up only. The operation of the brakes should be monitored during initial start-up to check for proper alignment. Due to various influences including gearing, couplings, or alignment of the motor to the pinion, the motor shaft may drift away or oscillate from the centered position, forcing the brakes discs against the friction material. If the discs tend to favor one side (mounting flange or pressure plate), or remain in constant contact with the friction material, shim adjustment may be necessary. The discs should rotate freely, with no contact to the friction material while the brake is fully disengaged.

WARNING: FAILURE TO SHIM THE BRAKE PROPERLY MAY CAUSE PREMATURE WEAR OF THE BRAKE COMPONENTS. Excessive heat may be generated from improper shimming, resulting in damage to the brake and possible loss of torque.

15. Tighten the 1.5-6NC Grade 8 mounting fasteners to 800 Ft.Lbs., dry.

16. Lubricate the exposed threads on the ends of the studs with 30 wt. oil or "Never-Seez".

7.6 GRID COUPLINGS



Part Numbers

1.Seal (T10)
2.Cover (T10)
3.Hub (Specify bore and keyway)
4.Grid
5.Gasket (T10)
6.Fasteners(T10)
7.Lube Plug

cplgard1.wpg

INTRODUCTION

These instructions apply to Tapered Grid Couplings. They are designed to operate in either the horizontal or vertical position without modification. However, for vertical applications, the match mark shown above, must be up. The performance and life of the couplings depend largely upon how you install and service them. Carefully follow these instructions for optimum performance and trouble free service.

PARTS IDENTIFICATION

All coupling parts have identifying part numbers as shown above. When ordering parts, always *SPECIFY SIZE and TYPE* shown in the coupling data table in this section.

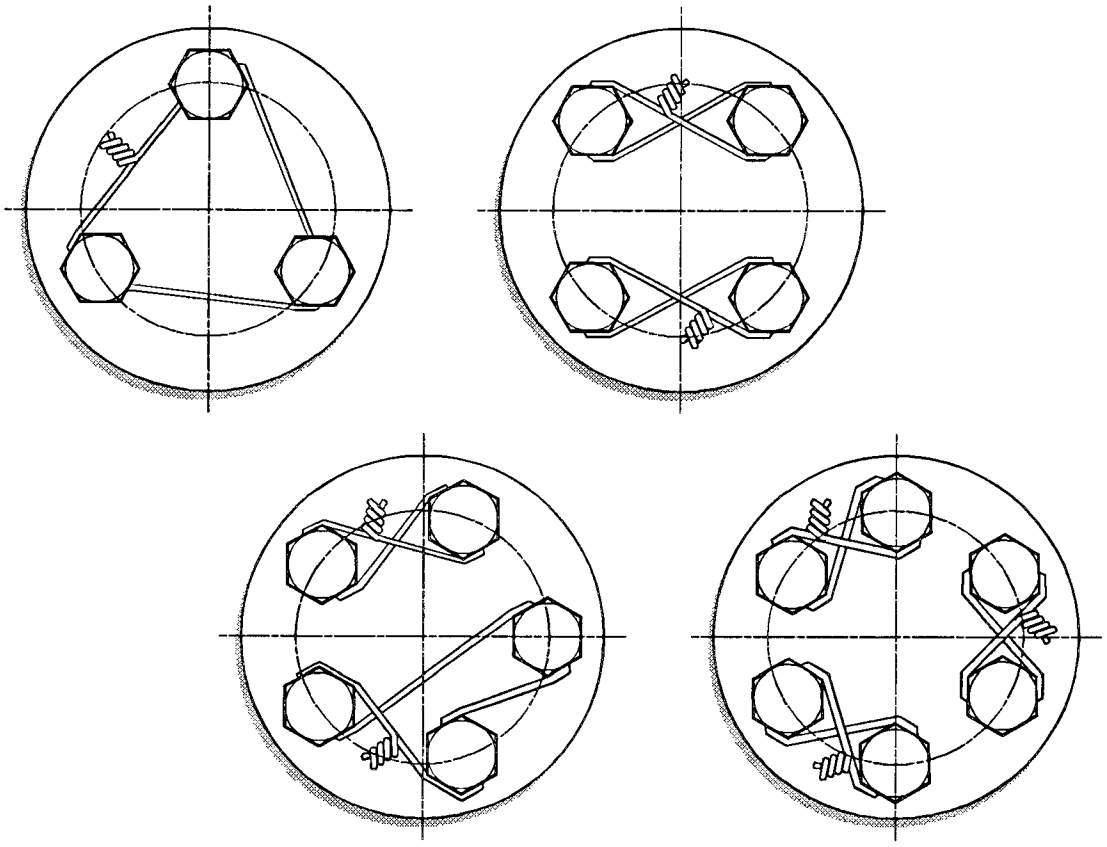
LUBE FITTINGS

Cover halves have 1/8 NPT lube holes. Use a standard grease gun and lube fitting.

WIRE LOCKING CAP SCREWS

Wire locking of cap screws is used when maximum lock assurance is required when periodic visual inspection is not possible.

The illustrations below show the recommended wire locking methods for various right hand thread cap screw patterns. For patterns not shown, wire lock the screws "in pairs". For odd numbered patterns, wire lock the screws in pairs except the remaining 3 capscrews wire lock together.



wirelock.wpg

PATTERNS for WIRELOCKING CAPSCREWS

Use 14 gauge soft annealed lockwire. Thread the wire through the capscrew head so that tightening stress on the wire will exert a tightening torque on the direction of cap screw thread. (The illustrations show lock wire threading for right hand threaded capscrews. Reverse the lock wire patterns shown for left hand capscrews.)

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.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown. If a greater number of clips are used than shown in the table, the amount of rope turn-back should be increased proportionately. *THE ABOVE IS BASED ON THE USE OF CLIPS ON A NEW ROPE.*

IMPORTANT: Failure to make a termination in accordance with aforementioned instructions, or failure to periodically check and re-tighten to the recommended torque, will cause a reduction in efficiency rating.

The correct spacing and number of clips is shown below.

WIRE ROPE CLIP SPACING

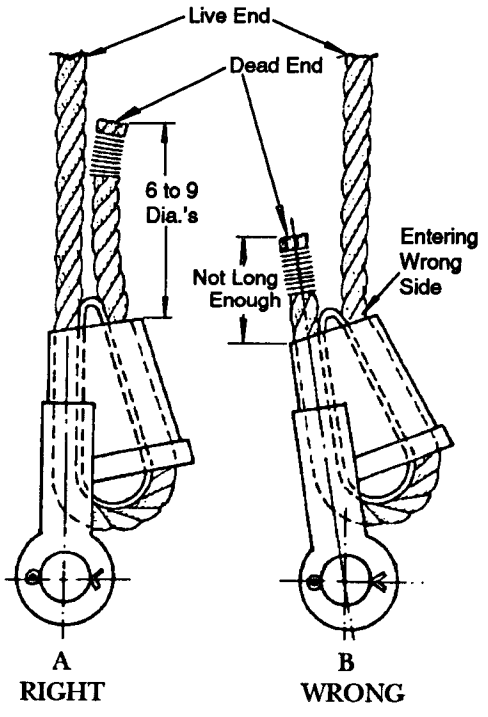
Rope Diameter (inch)	Rope Diameter (mm)	Clips	Space (inches)	Space (mm)
5/8	15	3	4	101
3/4	19	4	4-1/2	114
1	25	4	6	152
1-1/4	31	5	7-1/2	190
1-1/2	38	6	9	228
2	50	8	12	304
2-1/2	63	8	15	381
3	76	9	18	457

WEDGE SOCKETS

One of the more popular end attachments for wire rope is the *wedge socket.* for field, or on the job attachment, it is easily installed and quickly dismantled. The procedure is simple:

1. Inspect the wedge and socket; all rough edges or burrs, that might damage the rope, should be removed.

2. If the end of the rope is welded, the welded end should be cut off. This will allow the distortions of the rope strands, caused by the sharp bend around the wedge, to adjust themselves at the end of the line. IF the weld is not cut off, the distortions will be forced up the working line. This may result in the development of high strands and wavy rope.



wrpeckts.wpg

WEDGE SOCKET

Section 8

Preventive Maintenance

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SHOVEL NO.: DATE:

INSPECTION SCHEDULE	SERVICE HOURS 250	500	1000	REMARKS
3. SWING MACHINERY:				
a) Swing Gearcases - check oil level, clean breather, check for loose bolts and leaks. Take oil sample.	X			
b) Swing Motors - check hold down bolts and ensure no loose covers.	X			
c) Swing Brakes - remove guards and measure linings. Replace and adjust as required.	X			
4. GANTRY ASSEMBLY:				
a) A-Frame Compression Member Structure - check for cracks. Indicate location of cracks in comments section of service sheet.		X		
b) A-Frame Tension Member Structure - check for cracks. Indicate location of cracks in comments section of service sheet.		X		
c) check all pins and retainers; check lube to all pins; check walkway; check for pendant rope damage		X		
5. AIR SYSTEM:				
a) Auxiliary Air - check the following:	X			
- check compressors for correct operation (including safety valves). Cut-in 125 psi (870 kPa) and Cut-out 150 psi (1050 kPa)				
- check belts and guards				
- check air receiver, drain water, remove inspection cover and check for rust				
- check air lines, lubricators (refill) and water traps (drain)				
- check correct operation of pressure switches				
- check operation of air receiver auto water dump valve				

• GANTRY STRUCTURE •

1. Structural cracks?
2. Connecting pins?
3. Bushings?
4. Lubrication?
5. Ladders and walkway damage?

• LUBRICATION SYSTEMS •

1. Are all grease tanks filled with correct grease?
2. Grease pump operation?
3. Injector operation?
4. Grease line damage?
5. Do all systems cycle properly?

• AIR COMPRESSOR •

1. Air compressor operating properly?
2. Compressor and motor mounting bolts?
3. Crankcase oil level?
4. High and low operating pressures to specification?
5. Air filters?
6. Guards in position and secure?
7. Air leaks?
8. Air line damage?
9. Drain water from reservoir?
10. Tanner deicer filled?

Section 9

Air Conditioner

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9.5 MAINTENANCE PROCEDURES

Although the systems are of heavy duty, industrial design, they still need maintenance and service. They will not run indefinitely and our warranty is conditional upon these services being carried out.

Service Schedule

TWO-Week Service:

1. Before shutting down the power, and with the unit running and all covers closed, check the refrigerant sight glass for "flashing" or bubbles in the liquid line. Should this be evident, see Chapter 8 - The Refrigeration System, Item C.2, and fix. Turn the unit off, isolate and lock out the remote supply.

2. Open the condenser cover and using a small mirror check compressor oil level. Add oil as detailed in Chapter 8 if necessary.

3. Check the condenser coil visually for clogging, i.e. dust, grass or insects. Clean if necessary by reverse blowing with compressed air or low pressure water. Clean out any foreign material from the floor of the condensing section.

4. The evaporator return air filter should be cleaned by tapping against a firm surface allowing any dust to fall from the "air on" side. It should then be washed in warm soapy water.

5. The air conditioning unit should be function tested and the correct operation of the system should be confirmed.

NOTE: This service is most important during initial start up as it will catch most problems before they escalate.

6. Check for leaks and repair as required.

7. Check for tightness of bolts, nuts, etc., and tighten as required. Do not over-tighten.

8. Check structural members and case for integrity, repair as required.

9. Check cab for seals, structural integrity and repair as required.

10. Clean out or replace the pressurizer filter.

NOTE: It is typically the operators responsibility to determine the frequency in which the filters must be cleaned as frequency depends on site conditions.

11. Check wire terminations for tightness and any signs of malfunction. This is *VERY* important as loose connections will cause overloads, which will result in contactor and/or motor failure.

6. Crack open the line valve next to the condenser coil to allow the refrigerant to purge air out of the new drier through the finger tight flare connection and the down steam line valve.

7. Tighten all flare connections and fully open both valves. Leak test all joints and connections.

8. Close the cover.

9. Test run unit and recharge if necessary.

D. High/Low Pressure Switch (HLPS)

1. Close the liquid line valve after the sight glass.

2. Run the unit on cooling to pump all refrigerant into the condenser.

3. Switch off cooling to stop the compressor and front seat compressor suction discharge valves.

4. Isolate the unit by opening the remote circuit breakers.

5. Remove the condenser cover.

6. Disconnect the pressure switch electrically, taking careful note of the terminal numbers.

7. Working quickly to avoid contamination, disconnect the refrigerant connections from the pressure switch. The refrigerant in the compressor will be released.

8. Reconnect the refrigerant connections to the new switch finger tight and crack open the compressor suction access valve. Use the compressor suction and discharge valves to purge air from the lines and from the compressor. Back seat the valves, tighten the connections and refit the cap nuts to the discharge valve.

9. With the compressor suction valve back seated check the operation and settings of the low pressure side of the controller with manifold gauges, by bleeding gas in and out of the controller from a R134a refrigerant gas cylinder connected to the manifold gauges.

10. Relieve the suction valve 1 1/2 turns from the back seat.

11. Close the remote circuit breaker and test run the unit. Check the high pressure setting by opening the covers and/or covering the condenser coil.

	Possible Cause	Symptoms	Recommended Action
		Compressor Loses Oil	
1.	Insufficient oil Charge.	Oil level gradually drops.	Add oil and fix leak.
2.	Traps in hot gas and suction lines.	Oil level gradually drops.	Repitch lines and provide lift.
3.	Clogged strainers or valves.	Oil level gradually drops.	Clean or repair and replace.
4.	Loose expansion Valve bulb.	Excessively cold suction.	Provide good contact between bulb and suction line.
5.	Liquid slugging back to compressor.	Excessively cold suction.	Re-adjust super heat setting or check thermal bulb contact.
6.	Short cycling.	Too frequent starting and stopping of compressor.	See Trouble Analysis Note (B)
7.	Shortage of refrigerant.	Low suction pressure.	Repair leak and charge.
		Compressor is Noisy	
1.	Lack of oil.	Low oil level	Add oil.
2.	Excess oil in oil crankcase.	High oil level.	Drain off excess to required level. Ensure crankcase heater operational.
3.	Broken compressor valve strip.	Compressor knocks. Suction pressure is abnormally high.	Overhaul compressor.
4.	Worn or scored bearings in compressor.	Compressor knocks.	Overhaul or replace compressor.