

Figure 3. Pressure Feed to Vanes in Intra-Vane Cartridge.

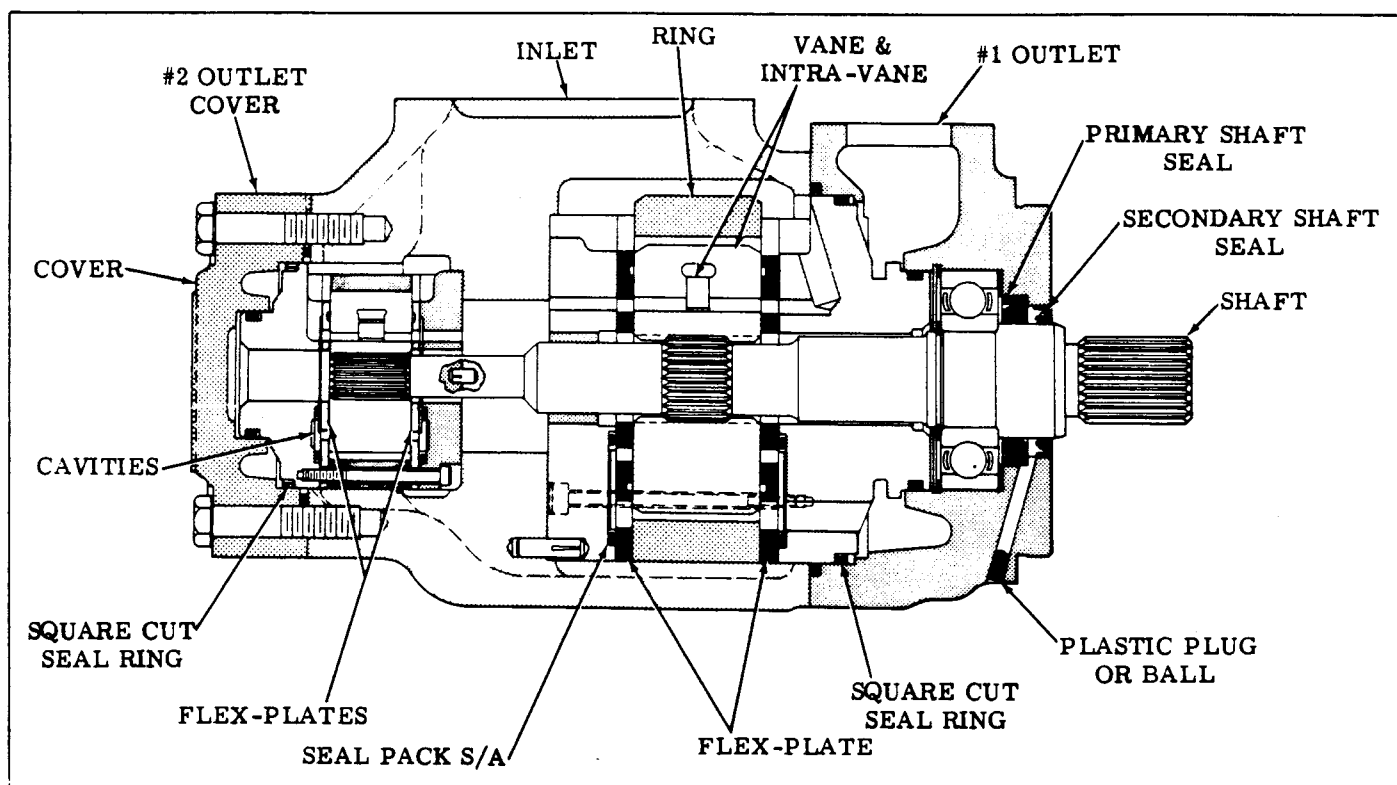


Figure 4. Flex Side Plate Operation

The flex side plates also provide passages for feeding under vane pressure to the space between the vane and insert.

The bronze faces of the flex side plates ride next to the rotor and provide excellent wear and cold start characteristics.

The inlet and outlet support plates hold the flex side plates in position and contain passages which allow fluid to pass from the inlet to the pumping cartridge and from the cartridge to the outlet port.

#### E. Shaft End Outlet Body #1

Two outlet body configurations and two shaft seal arrangements are available in this pump series.

When a single shaft seal is used, a steel ball is pressed into the body.

#### SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

##### A. Mounting and Drive Connections

High performance vane pumps are designed for foot or flange mounting.

1. Direct Drive: A pilot on the pump mounting flange assures correct mounting and shaft alignment, provided the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening all flange mounting screws to prevent misalignment.

If gaskets are used between flanges, they should be installed carefully so as to lie flat and should not be the type that will take a set. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

Proper coupling alignment is essential to prolong pump life.

##### CAUTION

Pump shafts are designed to be installed in couplings with a slip fit or very light press. Pounding the coupling on the shaft can ruin the bearings. Shaft tolerances are shown on the pump installation drawings.

2. Indirect Drive: Indirect drive is not recommended for these pumps.

## B. Shaft Rotation

### NOTE

Pumps are normally assembled for right hand (clockwise) rotation as viewed from the shaft end. A pump made for left hand rotation is identified by an "L" in the model code. (See Table 1)

### NOTE

If it is desired to reverse the direction of drive rotation, it is necessary to disassemble the pump and reverse the location of the cartridge inlet and the outlet support plates. Use rotational arrows on inlet plate for proper screwholes. (See Section VI)

### CAUTION

Never drive a pump in the wrong direction of rotation. Scoring may result, necessitating extensive repairs.

## C. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wirebrushing, and pickling.
2. To minimize flow resistance and the possibility of leakage, use only as many fittings and connections as necessary for proper installation.
3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

## D. Overload Protection

Relief valves must be installed in the system as close to the pump outlets as possible. The relief valves limit pressure in each system to a prescribed maximum and protects components from excessive pressure. Each relief valve pressure setting depends on the work requirements of the circuit being fed.

## E. Port Positions

Port positions are shown in Figure 8.

## F. Start-Up

Whenever it is possible to do so, fill the pump ports with system hydraulic fluid. This will make it easier for the pump to prime when it is first started.

Self Priming: With a minimum drive speed of 600 RPM, a pump should prime immediately. Failure to prime within a short length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to loosen a fitting on the outlet side of the pump to purge entrapped air.

No Load Starting: These pumps are designed to start up with no load on the pressure ports. They should never be started against a load or a closed center valve.

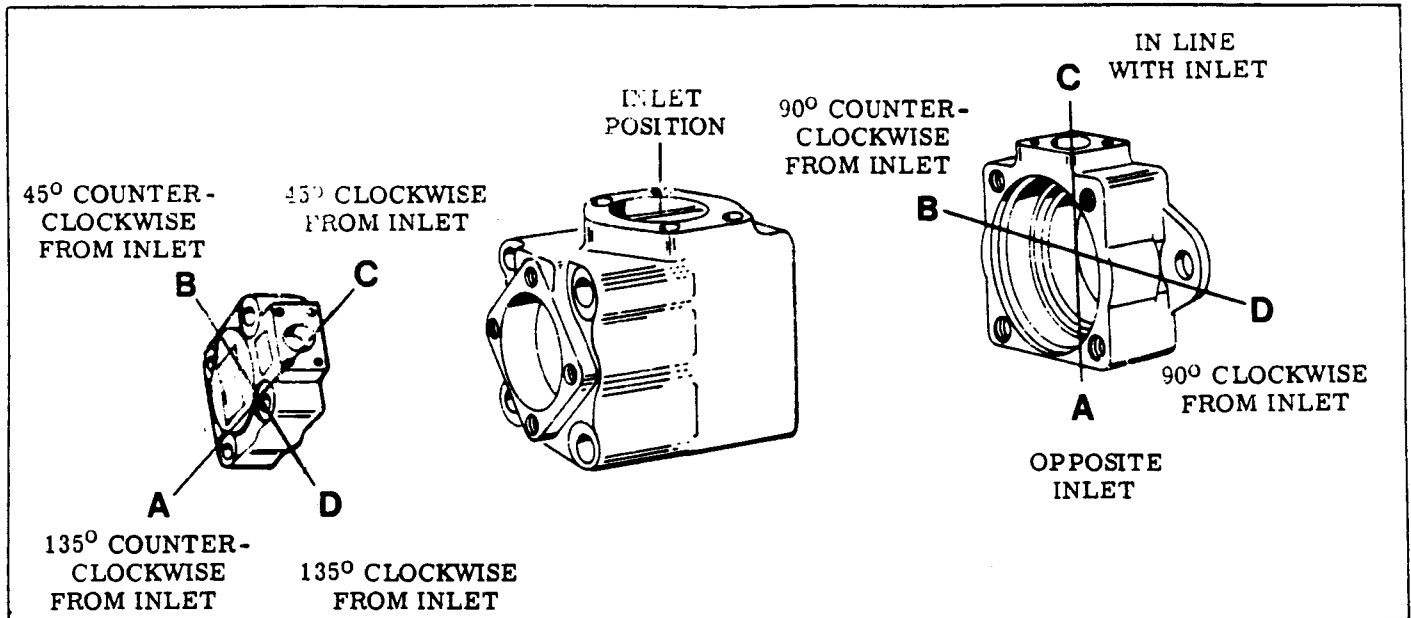


Figure 8. Port Positions

## SECTION V - SERVICE, INSPECTION, & MAINTENANCE

### A. Service Tools

Two special tools are required to service these pumps. A driver should be used to assure installation of the primary shaft seal without damage, and a "bullet" (or plastic tape) should be placed over the end of the shaft, to avoid damaging the seal lip, when the shaft is installed. Installation of the secondary seal does not require a driver.

The driver can be made from tubular stock as shown in Figure 9. The tool applies a uniform pressure to the recessed area of the seal, rather than to the lip of the seal. The inside diameter of the tool will not interfere with the garter spring located around the lip of the seal.

### B. Inspection

Periodic inspection of the fluid condition and tube or piping connections can save time consuming break downs and unnecessary parts replacement. The following should be checked regularly.

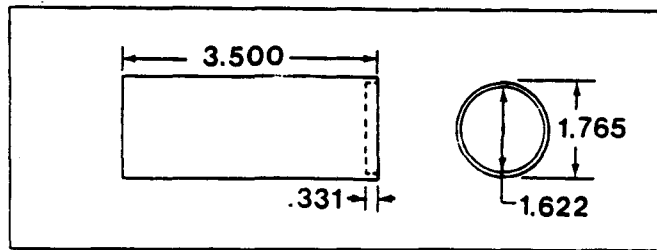


Figure 9. Primary Shaft Seal Driver.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.
2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be thoroughly drained and the reservoir cleaned before new fluid is added.
3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.
4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak. See Table 3.
5. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

#### C. Adding Fluid to the System

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

#### D. Adjustments

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

## E. Lubrication

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft coupling should be as specified by their manufacturers.

TABLE 3 - TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Refer to section VI.D. for the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING.	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary, flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gage to correctly adjust the relief valve.
	LOSS OF FLOW FROM PUMP	Worn pump parts. Broken inlet or pressure line
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign the coupled shafts.

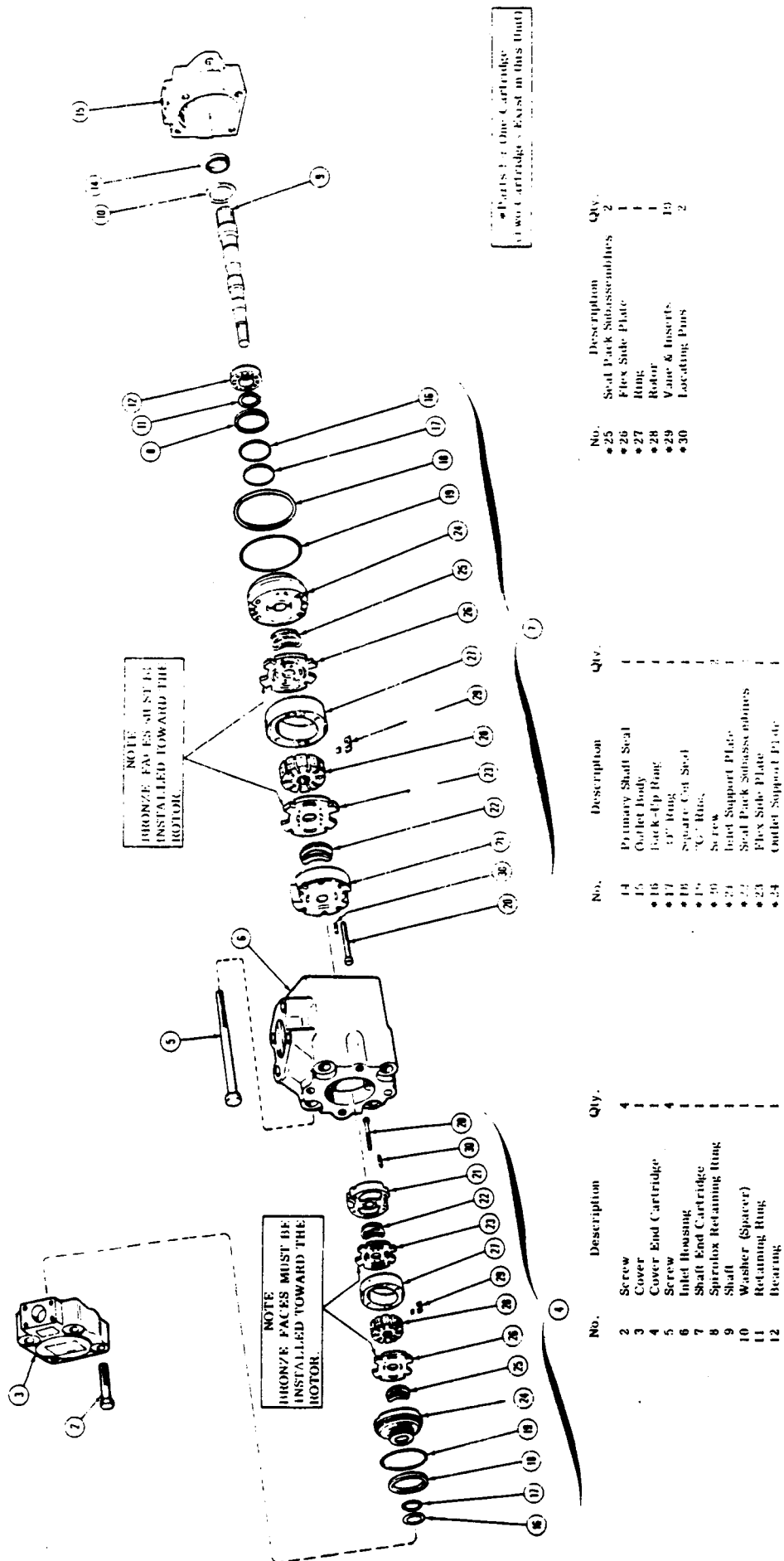


Figure 10. EXPLODED VIEW OF TYPICAL PUMP.

## F. Troubleshooting

Table 3 lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually due to the failure of other parts of the system. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

## SECTION VI - OVERHAUL

### A. General

During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly. Figure 10 is an exploded view which shows the proper relationship of parts for disassembly and assembly. Refer to Figure 1 and Figure 10 for the correct assembled relationship of the parts.

### WARNING

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure. Plug all removed units and cap all lines to prevent the entry of dirt into the system.

### B. Disassembly

1. Basic Pump: Remove the foot mounting and shaft key (1) if used. Support the pump on blocks or clamp the body in a vise. If a vise is used, use protective jaws to avoid damage to outlet body (15) and its machined surfaces. Mark the pump inlet, outlet and cover for correct reassembly. Remove the four cover screws (2) and lift cover (3) from the pump. This will expose the cover end cartridge (4). Discard square cut seal (18) and o-ring (19).
2. Pull or pry cover cartridge (4) from the inlet housing. Set aside for disassembly during step B8.
3. Remove four screws (5) from the inlet housing (6). Separate inlet housing (6) and outlet body (15). This exposes shaft end cartridge (7). Discard square cut seal (18) and o-ring (19). Refer to Figure 10.



4. Rotate shaft to loosen cartridge (7), then remove the cartridge from outlet body (15). Set aside for disassembly during step B8.
5. Remove spirollox ring (8). Slide shaft (9) and bearing (12) from outlet body (15).
6. If bearing (12) is defective, remove retaining ring (11) and press bearing from the shaft with an arbor press. (Apply force to inner race of bearing).

NOTE

In the following step, secondary shaft seal (13) is used on double shaft seal models only and will not exist on standard units.

7. Remove spacer (10) from the outlet body, then drive shaft seal (13) and (14) from the outlet body (15). Be careful not to damage the bore areas where the seals were located.
8. Disassemble the two cartridge kits one at a time. Follow the procedure noted in this step. Keep the parts separated from each other during inspection, repair, and assembly.
  - a. Remove o-ring (17), back-up ring (16) and square sealing ring (18) from the outlet support plate.
  - b. Scribe a line across the outer surface of the cartridge kit. The scribe marking will provide a reference for parts during assembly.
  - c. Place the cartridge on a flat surface (outlet support plate down) and remove the two socket head screws (20).

CAUTION

DO NOT slide flex plates across the ring and rotor. Burrs on the ring or rotor can cause deep scratches in the soft bronze surface.

- d. Slide inlet support plate (21) and seal pack subassemblies (22) off the cartridge. DO NOT allow the flex side plate (23) to slide with the support plate.
- e. Move flex side plate (23) off center just enough to lift up and away without sliding.
- f. Place a small clean piece of wood over the exposed ring and rotor. Reverse the position of the cartridge.

- g. Slide outlet support plate (24) and seal pack subassemblies (25) off flex side plate (26). DO NOT permit flex side plate (26) to move across the ring and rotor.
- h. Move flex side plate (26) off center just enough to lift up and away without sliding.
- i. Lift ring (27) away from the rotor (28) and vanes (29). Locate the arrow stamped into the rotor periphery. Remove the vanes and inserts in order, starting at the arrow. Keep them in order for inspection.

#### NOTE

Do not remove cartridge locating pins (30) from the inlet support plate unless they are damaged. The pins are of a drive-loc type and can be difficult to remove.

### C. Inspection and Repair

**Cleaning:** All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination.

Discard the shaft seal(s), o-rings, back-up ring, and seal pack subassemblies. Use a new seal kit for reassembly. Wash the metal parts, blow them dry with air, and place on a clean surface for inspection.

1. Check the cartridge wear surfaces for pickup, scoring, and excessive wear. Slight heat discoloration of the flex side plate bronze surface is normal. Score marks deeper than 0.001 inch and scratches deeper than 0.002 inch indicate a new part is needed. Slight scoring and/or scratches can be removed with an oiled Arkansas stone.

#### CAUTION

DO NOT use a dry stone on the bronze surface or scratches will result.

2. Inspect both sides of each vane (29) and insert in order. If pickup, heavy wear, or scoring is found inspect the appropriate rotor (28) slot. Replace scored parts.
3. Inspect ring (27) for vane chatter marks, wear and/or scratches. Replace if scoring is evident.

### CAUTION

Replacement ring width must be identical to the ring being replaced or reduced life and/or output flow will result. The minimum ring to rotor clearance limits are .0015 on Shaft End and .0012 on Cover End.

### NOTE

All cartridge kit parts must be free of burrs. Stone the mating surfaces of each part with an oiled Arkansas stone prior to assembly.

4. Vane to rotor wear can be checked by inserting the vane in the rotor slot and checking for excessive play. Replace rotor (28) and vanes (29) if wear is evident.
5. Rotate bearing (12) while applying pressure to check for wear, looseness and pitted or cracked races.
6. Inspect the seal and bushing mating surfaces on shaft (9) for scoring or wear. Replace the shaft if wear exceeds 0.005 diametrical change, or if marks cannot be removed by light polishing. If wear is found in the bushing area, a new bushing will be required.

### D. Assembly

#### NOTE

Coat all parts except seals and back-up rings with clean hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold the o-rings in place during assembly.

### IMPORTANT

During handling and shipping of precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges of new cartridge kit should be stoned prior to installation.

### NOTE

To reverse direction of a new cartridge kit, simply reverse location of the inlet and outlet support plates, and realign the cartridge with a "V" block or fixture made from two pieces of hardwood nailed together.

1. Cartridge: The direction of rotation is viewed from the shaft end; right hand rotation is clockwise; left hand counterclockwise.

NOTE

Assemble shaft end cartridge (7) in the direction of rotation noted by model code. Assemble cover end cartridge (4) in reverse of the shaft end cartridge.

NOTE

If locating pins (30) were removed from inlet support plate (21), install new pins with locking flutes located within the inlet support plate. Drive the new pins into the support plate, with a soft tip hammer.

- a. Place the inlet and outlet support plates on a flat surface. Install seal pack subassemblies (22 and 25) into cavities with seal retainer surface up. (O-rings facing downward into the cavities).
- b. Place flex side plates (23 and 26) over each of the support plates with bronze wear surface facing up. Align scribe marks to make sure the correct flex side plate is used with the correct support plate. (Bronze wear surface must face rotor when assembled).

NOTE

Flex side plates develop a wear pattern with the rotor and vanes and should not be interchanged.

- c. For right hand rotation units, set the rotor on a flat wooden board with the arrow pointing right. (For left hand rotation, the arrow should point left). Assemble the vanes and inserts into the rotor in reverse order. Make sure the sharp chamfer edge of each vane leads in the direction of rotation. All vanes must move freely in the rotor slots with no evidence of bind.
- d. Assemble the ring (27) over rotor (28) and vanes (29) with arrow pointing in the same direction as the rotor. Lubricate the top surface of the rotor and vanes liberally with system fluid.
- e. Locate the scribe mark on ring (27), outlet support plate (24), and flex side plate (26). Hold the outlet support plate and flex side plate together and assemble over the ring and rotor with the scribe marks in-line.

- f. Hold the cartridge together to prevent movement and turn the assembly over so the outlet support plate rests on a flat surface, and the wooden board is up. Remove the wooden board.
- g. Lubricate the exposed surface of the rotor and vanes with system fluid. Locate the scribe mark on inlet support plate (21) and flex side plate (23). Hold the inlet support plate and flex side plate together and assemble over the exposed ring, rotor and vanes. Make sure the scribe marks are in line.

NOTE

The cast-in arrows located next to the socket head screws, indicate cartridge direction of rotation.

- h. Thread two socket head screws (20) into the cartridge until snug (hand tight).

NOTE

The O.D. of all component parts of the cartridge kit must be in-line with each other or the cartridge will bind during assembly. Align the cartridge as follows:

- i. Build a "V" block from hardwood or if a metal "V" block is available, use that. Place the cartridge into the "V" block on its side. Loosen socket head screws (20) enough to allow each section of the cartridge to come into alignment within the "V" block. Torque tighten socket head screws (20) as noted in Table 5. Recheck alignment after tightening.

CARTRIDGE SIZE	CARTRIDGE SCREW TORQUE
Cover End - 25	50 lb. in.
Shaft End - 35	100 lb. in.

Table 5. Cartridge Screw Torque Requirements.

- j. Check rotor (28) for bind by inserting the index finger through the shaft opening of inlet support plate (21). Hold the cartridge kit in a horizontal shaft position and lift the rotor with the finger. The rotor should move freely back and forth within the cartridge. If the rotor binds, open the kit, clean and stone all possible areas of bind, then reassemble using the aforementioned procedure. The rotor MUST move freely within the cartridge when assembled.

NOTE

Repeat step D1 for the other cartridge kit.

2. Basic Pump: Clamp outlet body (15) in a vise or place on 2 x 4 wood blocks to facilitate assembly.

- a. Lubricate shaft seal (14) with petroleum jelly and place in position within outlet body (15), garter spring up.
- b. Use the seal installation tool shown in Figure 9 to prevent damage to the seal. Press seal (14) into the body until it bottoms out against the shoulder.

NOTE

If shaft bearing (12) was defective, install a new bearing as follows:

- c. Press shaft (9) into the new bearing with an arbor press while supporting the bearing inner race. Refer to Figure 10 for correct location of bearing on the shaft. Install a small retaining ring (11) behind the bearing on the shaft.
- d. Place the bearing spacer washer (10) over the shaft, against the front of the bearing. Use a "bullet" or plastic tape over the shaft end to prevent damage to the seal(s). Lubricate the "bullet" with petroleum jelly and carefully push the shaft through the seal(s) until the bearing and spacer are in location within the body. Install the large spirolox ring (8) into the outlet body retaining ring groove located just behind the bearing.
- e. Install square cut sealing ring (18) into outlet body (15).
- f. Install o-ring (17) and back-up ring (16) on the cartridge outlet support plate hub. Refer to Figure 10.
- g. Carefully install cartridge (7) over shaft (9) and into outlet body (15) with one of the chamfers on the ring in alignment with the outlet port.
- h. Lubricate and install the large inlet housing (6) to outlet body (15) o-ring (19) in place. (Locate in the o-ring groove of the outlet body).
- i. Install inlet housing (6) in position; move back and forth until the cartridge pins drop into the alignment holes located within the housing. Turn the inlet housing slightly until the alignment marks are in line and the large screw holes are aligned. Oil and install four screws (5) and torque tighten to 140-160 lb.ft.

- j. Turn pump shaft by hand to verify freedom of the cartridge.
- k. Install a square sealing ring (18) into the outlet cover (3).
- l. Install o-ring (17) and back-up ring (16) on the cover end cartridge outlet support plate hub. Refer to Figure 10.
- m. Carefully install cartridge (4) over shaft (9) and into the inlet housing. Turn cartridge slightly to bring into alignment the pin holes and cartridge alignment pins.
- n. Install outlet cover (3) to inlet housing (6) o-ring seal (19) over the cartridge and up against the inlet housing.
- o. Make sure square cut seal is in place within the cover. Orient the cover to agree with the alignment marks and gently slide the cover over the outlet cartridge. Be careful not to cut square cut seal (18) or pinch o-ring (19) during cover installation.
- p. Oil and install the cover inlet housing with four screws (2). Torque the screws to 65-75 lb.ft.
- q. Turn the pump shaft to verify freedom of the cartridges.

### SWING MOTOR MAINTENANCE:

Two Hydraulic motors mounted on the turntable head provide the power for the 360° continuous rotation on a shear-ball type turntable bearing. Swing system operating pressure for your loader can be found on the Specifications page in this manual.

The following small "manual" gives the service and maintenance information on the Swing Motor.

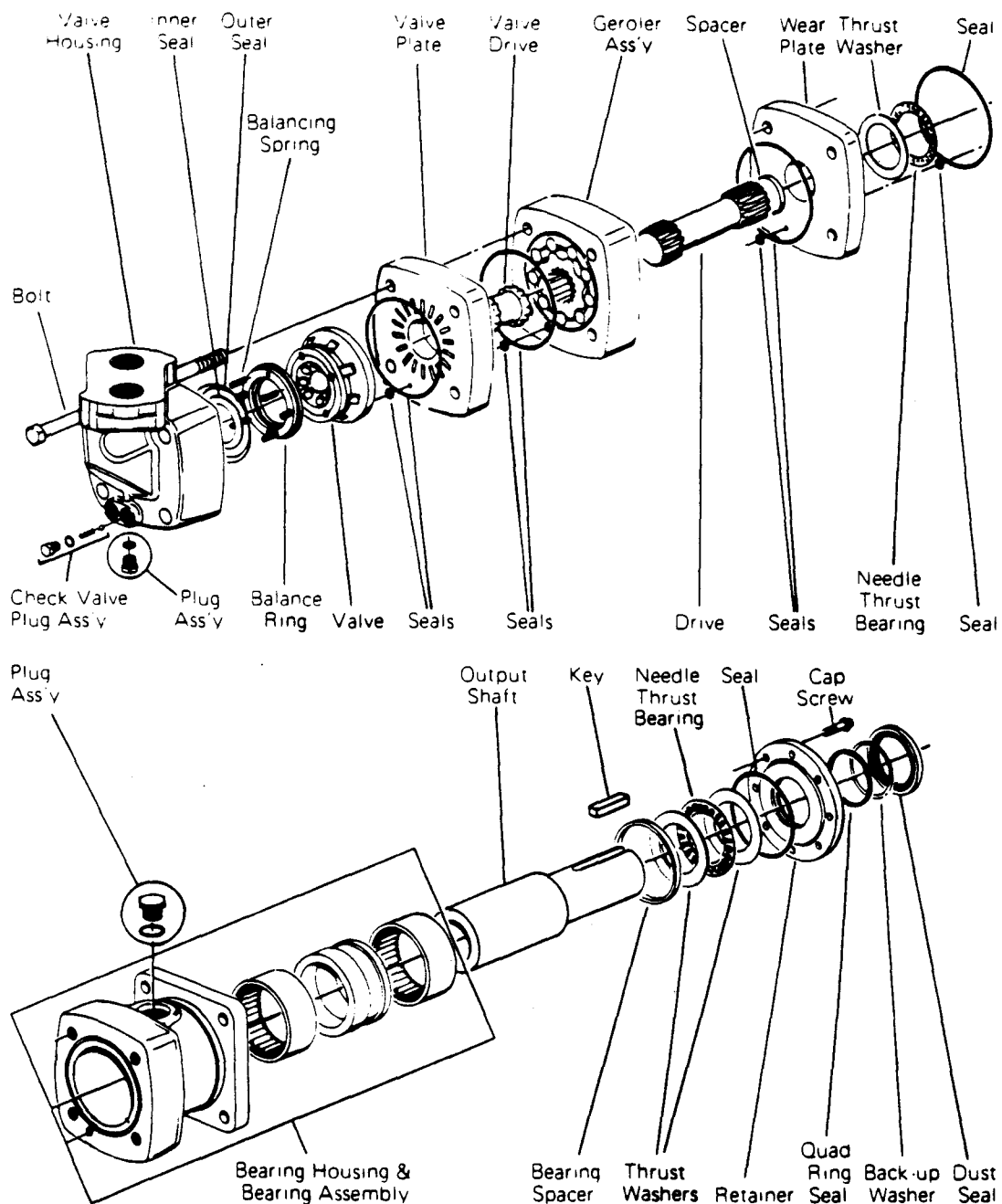


# **HYDRAULIC MOTOR**

**SERVICE INFORMATION**

**EFFECTIVE 11-2-89**

**3-72**



**Tools required for disassembly and reassembly are**

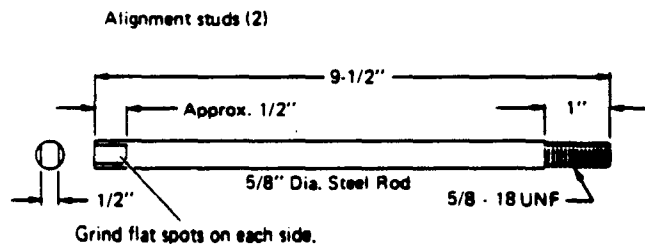
- Torque wrench (1200 in. lb. or 100 ft. lb. capacity)
- 1", 15/16", 1/2" and 5/16" sockets

- 12" - 16" breaker bar
- Small screwdriver (6" - 8" long, 1/4" blade)
- Plastic or rubber hammer

**The following tools are not necessary for disassembly and reassembly, but are extremely helpful.**

- Seal sleeve or bullet
- Alignment studs (2) if required\*

\* Motors with tie bolts and original studs not available.



# Disassembly

## Disassembly

Cleanliness is extremely important when repairing a hydraulic motor. Work in a clean area. Before disconnecting the lines, clean the port area of the motor thoroughly. Use a wire brush to remove foreign material and debris from the exterior joints of the motor. Check the shaft and keyway, remove all nicks, burrs, or sharp edges that might damage the shaft seals when installing the retainer over the shaft. Before starting the disassembly procedures, drain the oil from inside the motor.

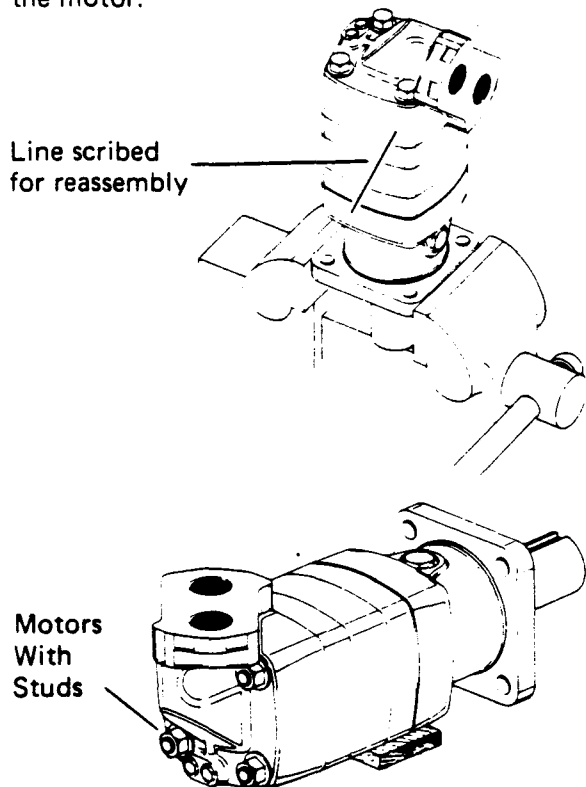


Figure 1

1 Place the motor in a vise with the output shaft down, or place the motor (earlier models with studs) on a smooth, clean, flat surface; use a piece of wood under the center section of the motor to raise the valve housing end of the motor off the surface of your work area, see Fig. 1, for these preparations.

**Note:** It may be helpful for reassembly to scribe a line across the length of the motor.

Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly and reassembly. Follow the clamping procedures explained throughout the manual.



Figure 2

2 Remove 4 bolts (or nuts and washers for earlier models) from motor. Remove studs (earlier models) per step 17.

3 Carefully lift the valve housing straight off. If this is done carefully, the springs and balance ring assembly will remain on the valve for easy removal.

4 Remove 2 check valve plug assemblies (plugs, springs, and steel balls) from valve housing.

5 Place valve housing on bench with open end up, then carefully remove 4-1/4" I.D. seal, and 3/8" I.D. seal.

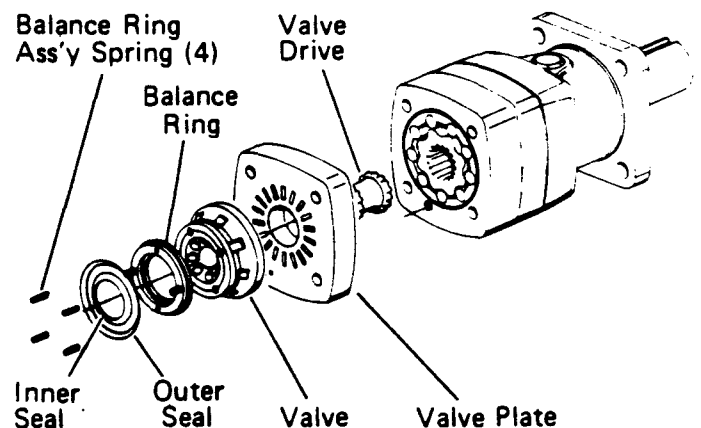


Figure 3

6 Remove 4 balance ring assembly springs.

7 Remove balance ring assembly.

8 Remove inner and outer seals from balance ring.

# Disassembly

- 9 Remove valve.
- 10 Remove valve plate.
- 11 Remove valve drive.

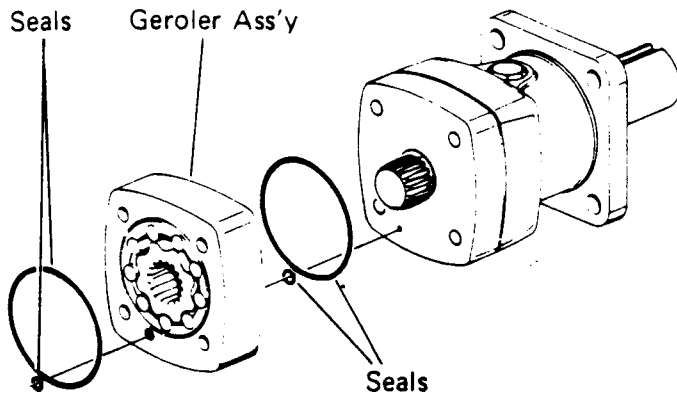


Figure 4

- 12 Remove Geroler. Retain rollers in Geroler assembly.
- 13 Remove 3/8" I.D. seals, and 4-1/4" I.D. seals from the Geroler, 2 seals on each side of the Geroler.

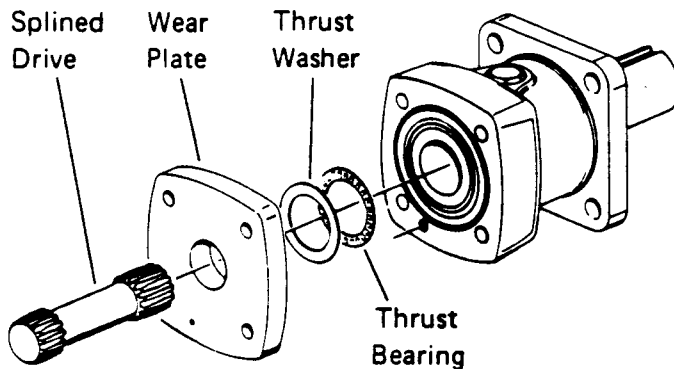


Figure 5

- 14 Remove splined drive from bearing housing.
- 15 Remove wear plate.
- 16 Remove thrust bearing and thrust washer from wear plate.

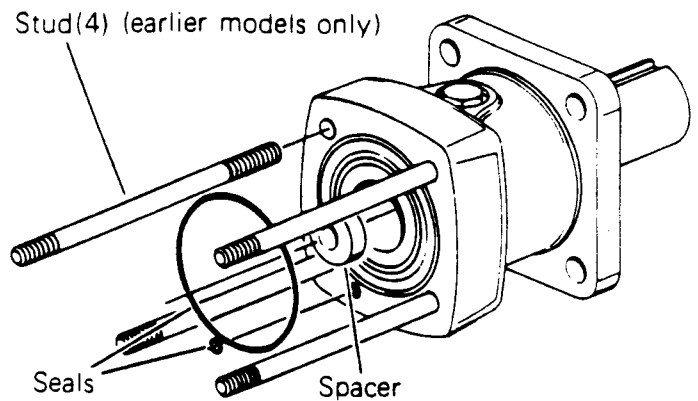


Figure 6

- 17 Use a stud remover or vise grips to remove studs (earlier models only) see Fig. 6.
- 18 Remove 3/8" I.D. seal, and 4-1/4" I.D. seal from bearing housing.

- 19 Remove spacer from inside output shaft.

**Note:** Some units have shafts with a raised area at bottom of splined cavity and do not use spacer.

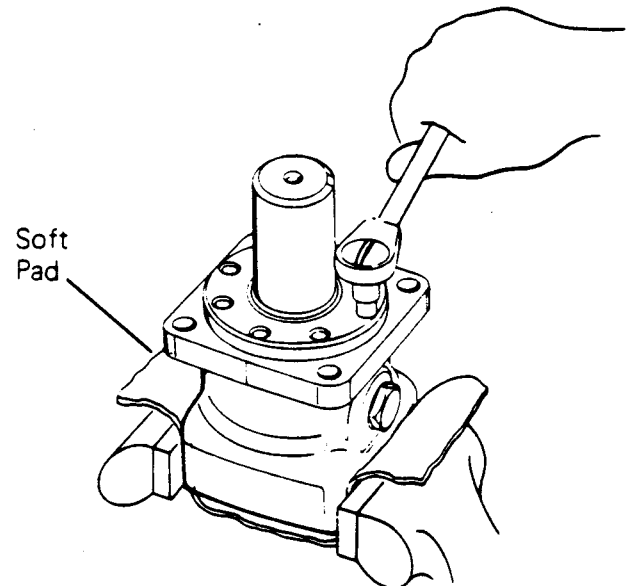


Figure 7

- 20 Place bearing housing in vise, as shown in Figure 7. Loosen 8 cap screws (5/16") in retainer.

# Disassembly

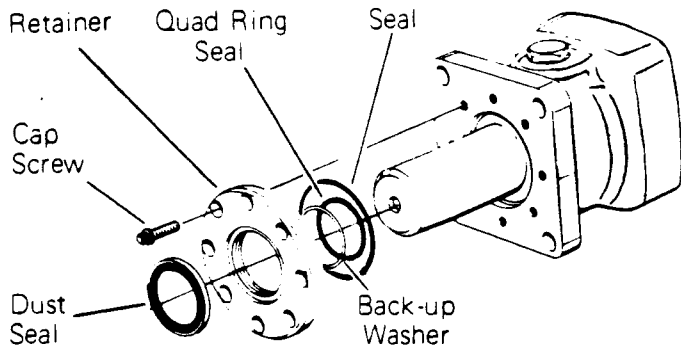


Figure 8

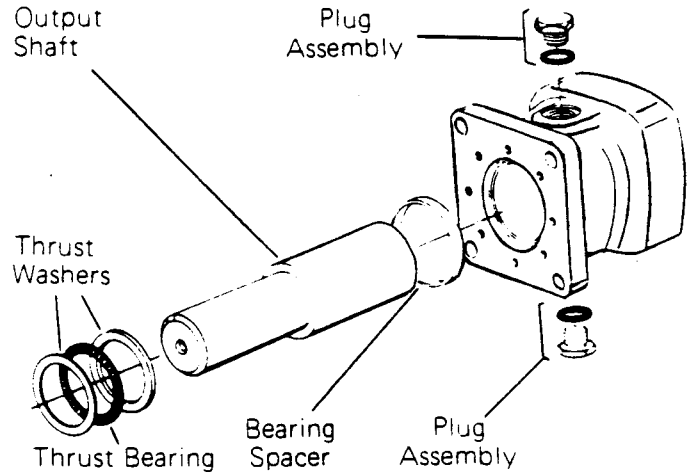


Figure 9

**21** Place bearing housing on a clean, flat surface. Remove 8 cap screws and retainer.

**22** Remove quad-ring seal, back-up washer, o-ring seal, and dust seal from retainer. Use a small screwdriver to remove the dust seal. Do not damage bore of retainer.

**23** Remove output shaft.

**24** Remove 2 thrust washers and thrust bearing from the output shaft.

**25** Remove bearing spacer.

**26** Remove 2 plug assemblies (1") from the bearing housing.

**Note:** The bearing housing and bearings inside the housing are not sold separately. These bearings are hydraulically pressed into the bearing housing.

# Reassembly

## Reassembly

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe with a cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use coarse grit or try to file these parts. Check around the keyway and chamfered area of the shaft for burrs nicks or sharp edges that can damage the seals when reassembling the retainer.

**Note:** Lubricate all seals with petroleum jelly such as Vaseline.

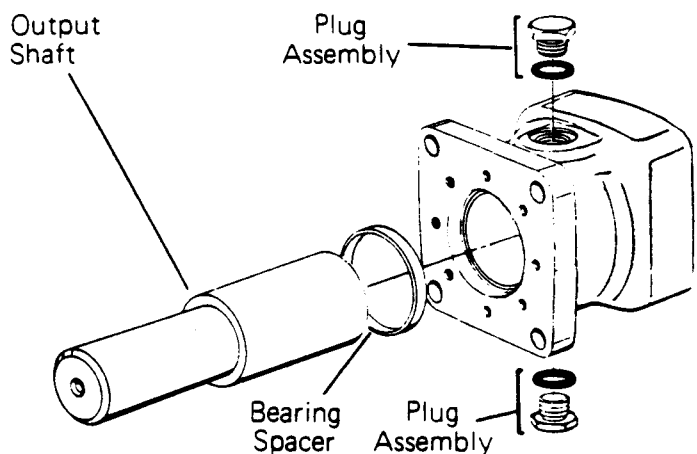


Figure 10

# Reassembly

1 Place bearing housing on a smooth, flat surface. Install 2 plug assemblies, see Figure 10. Tighten to 75 lb-ft.

2 Install bearing spacer in bearing housing.

3 Install output shaft. Rotate shaft while installing in bearing housing.

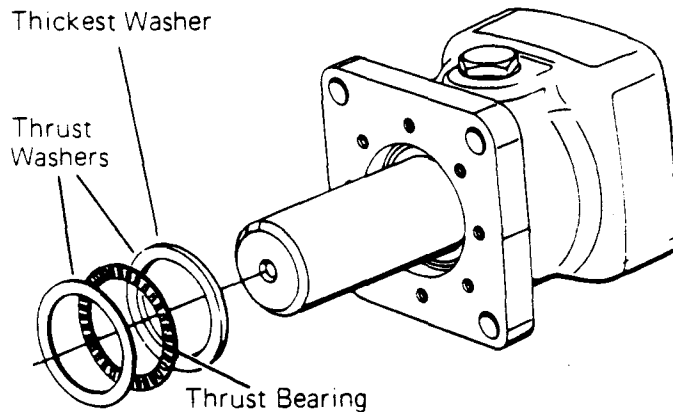
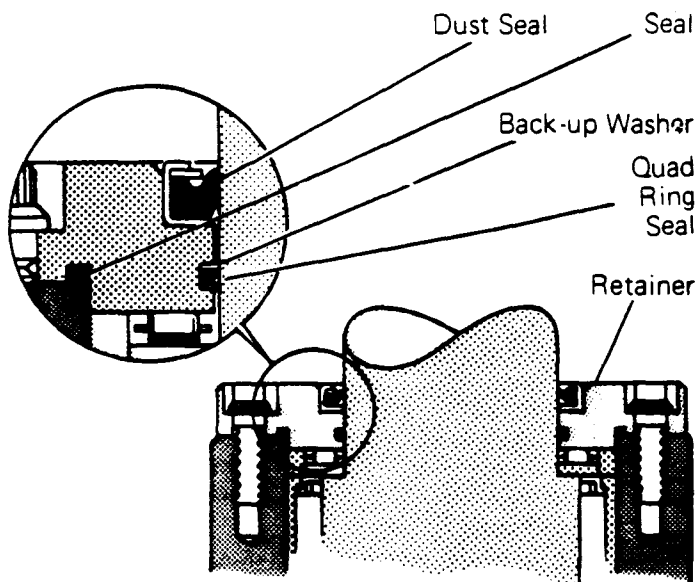


Figure 11

4 Install 2 thrust washers and thrust bearing. Install thrust bearing between the 2 thrust washers, thickest washer over shaft first, see Figure 11.



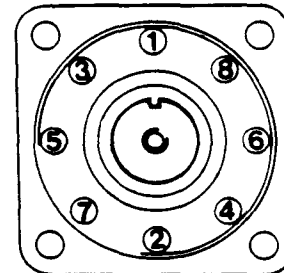
Seal Replacement

Figure 12

5 Use a small press, if available, to install dust seal in retainer. Metal side of dust seal must face toward retainer, as shown in Figure 12. If a press isn't available, use a plastic or rubber hammer to tap dust seal in place.

6 Install back-up washer, quad ring seal, and 3-1/2" I.D. seal in the retainer. Apply petroleum jelly to inside diameter of dust seal and quad ring seal.

7 Before installing retainer, place a protective sleeve or bullet, if available, over shaft. To prevent damage to seals, install retainer over shaft with a twisting motion. Do not cut or distort retainer seals. Damage to these seals will cause external leakage.



Torquing Sequence

Figure 13

8 Lubricate threads of 8 cap screws with a light film of oil. Install and finger tighten screws. Place unit in a vise, as shown in Figure 7. Tighten cap screws to 290 pound-inch of torque--in the sequence shown in Figure 13.

9 Install key (when used) in key slot of shaft.

10 Reposition motor in vise, clamp housing flange, as shown in Figure 1.

11 Pour a small amount of hydraulic oil inside output shaft.

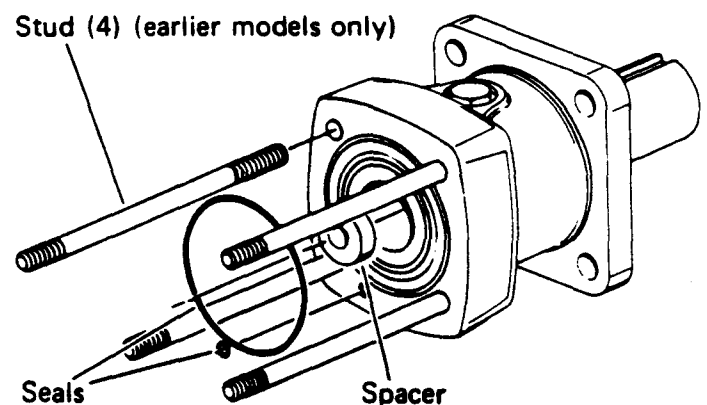


Figure 14

**Note:** Spacers are not used on units that have a raised area at bottom of splined cavity.

12 Install spacer in output shaft, guide spacer with a pencil.

# Reassembly

13 Apply petroleum jelly to 4-1/4" I.D. seal, and install in seal groove of the bearing housing see Fig. 14.

14 Apply petroleum jelly to 3/8" I.D. seal. Install seal in case drain groove of bearing housing.

15 Install 2 studs (earlier models), diagonally opposed, in bolt holes of bearing housing, see Fig. 15. If you replace studs with bolts, use 2 studs for alignment purposes when stacking parts.

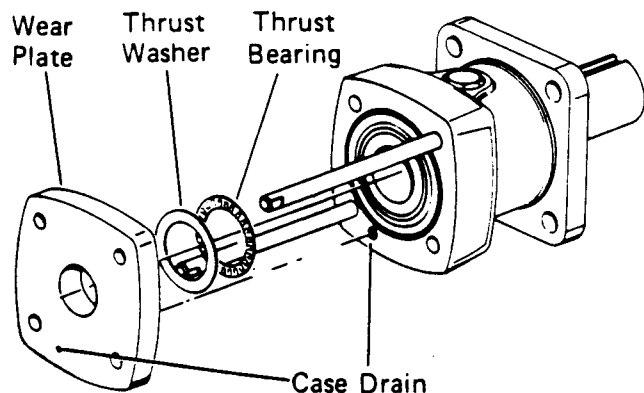


Figure 15

16 Install thrust washer and thrust bearing in wear plate—washer first, see Fig. 15. A light film of lubricant on the washer and bearing will help hold them in place.

17 Align case drain hole in wear plate with case drain hole in bearing housing. Install wear plate flush against bearing housing, see Fig. 15.

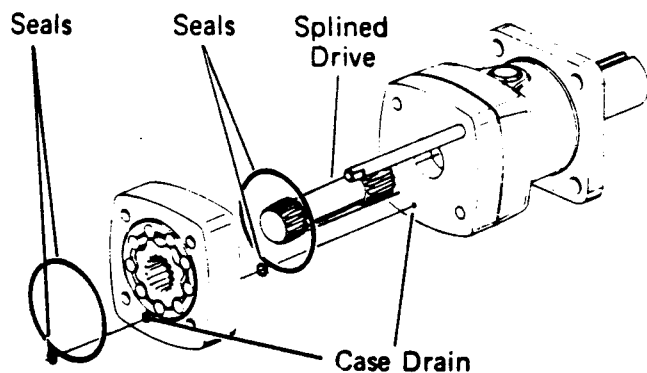


Figure 16

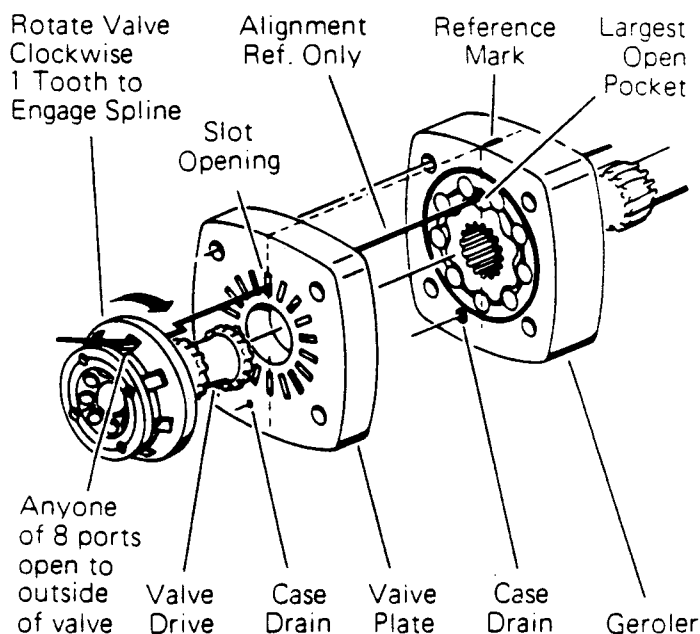
18 Install splined drive in output shaft. For 20 cubic inch displacement motor insert longer splined end of drive first, see Fig. 16.

19 Apply petroleum jelly on 2 seals 3/8" I.D. and 2 seals 4-1/4" I.D. Install them in the seal grooves of the Geroler, see Fig. 16, (one of each seal on both sides of the Geroler).

**Note:** Installation at this point involves 3 steps in the timing of the motor. Timing determines the direction of rotation of the output shaft.

The timing parts include . . .

- |                |                |
|----------------|----------------|
| 1. Geroler     | 3. Valve Plate |
| 2. Valve Drive | 4. Valve       |



Timing Alignment

Figure 17

**Timing Step # 1**—Locate the largest open pocket in the Geroler and mark it on the outside edge of the Geroler, See Fig. 17.

20 Align case drain hole in Geroler with case drain hole in wear plate. Install Geroler on wear plate, see Fig. 16. Be sure to retain rollers in Geroler assembly.

21 Install valve drive in Geroler.

22 Align case drain hole in valve plate with case drain hole in Geroler. Install valve plate flush against Geroler, see Fig. 17.

**Timing Step # 2**—Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler. See Fig. 17.

# Reassembly

23 Use the following procedure for installing the valve on the valve plate.

**Timing Step # 3**—Locate any one of the side openings of the valve that goes through to the face of the valve. Line up this side opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Rotate the valve clockwise until the spline teeth engage (1 spline tooth), see Fig. 17. This will provide the rotation shown when pressurized as shown, see Fig. 18.

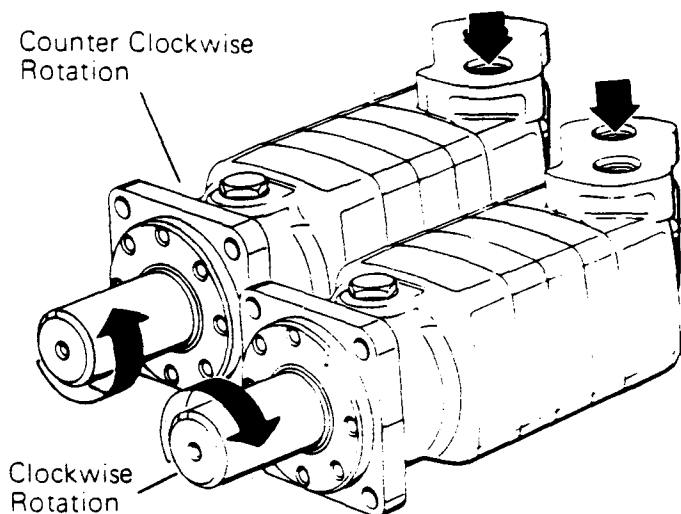


Figure 18

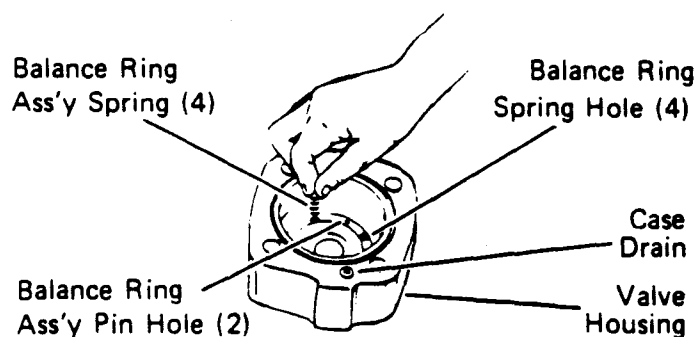


Figure 19

24 Apply grease to 4 balance ring assembly springs. Install springs in 4 holes located inside bore face of valve housing, see Fig. 19.

25 Apply a light film of petroleum jelly to 3/8" I.D. seal. Install seal in case drain groove of valve housing.

26 Apply a light film of petroleum jelly to 4-1/4" I.D. seal. Install seal in outside seal groove of the valve housing.

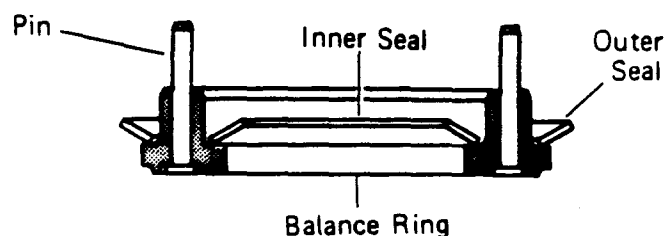


Figure 20

27 Apply petroleum jelly to inner and outer face seals. Install them on balance ring as shown in Fig. 20.

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

28 Align 2 pins in balancing ring assembly with 2 holes in valve housing as shown in Fig. 19. Install the balancing ring assembly in the valve housing.

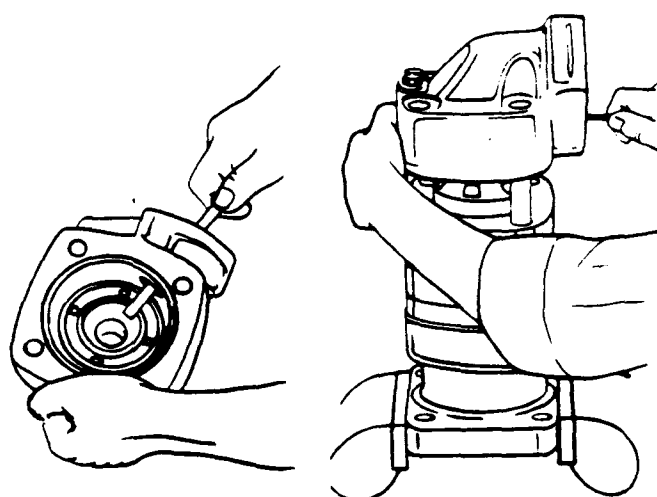


Figure 21

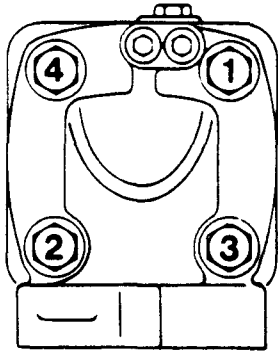
29 Insert a flat brass rod, or similar flat tool, through port of valve housing to hold balance ring assembly in position until you install valve housing. Align case drain hole in valve housing with case drain hole in valve plate. Install valve housing against valve plate, see Fig. 21. Remove brass rod as balance ring contacts the valve.

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

**Note:** After installing valve housing on valve plate, visually check between body parts of motor for unseated seals.



# Reassembly

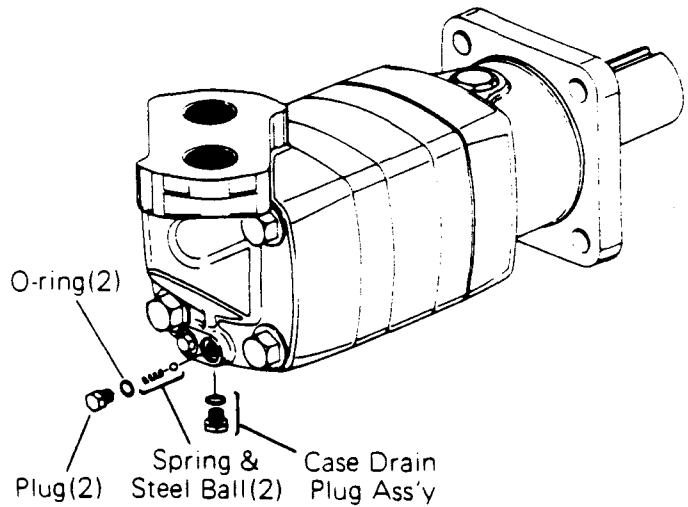


Bolt Torquing Sequence

**Figure 22**

**30** Install and finger tighten 2 bolts (or studs for earlier models) opposite alignment studs. Remove alignment studs and install remaining bolts (or studs, 4 washers, and 4 nuts for earlier models). Torque bolts (or nuts) to 95 - 110 pound-feet, in sequence, see Fig. 22.

**31** Install 2 check balls in valve housing, one ball in each hole. To seat check balls, (on new valve housings only), tap lightly on ball with a punch, using a plastic (or rubber) hammer.



**Figure 23**

**32** Install 2 springs in check valve holes, one spring in each hole. Install o-rings on plugs, then install plugs. Tighten to 85 lb-in.

**33** Install case drain plug assembly. Tighten to 320 lb-in.

# ELECTRICAL SYSTEM

ELECTRICAL  
SYSTEM

<u>CONTENTS</u>	<u>PAGE</u>
Description .....	4-1
Trouble-shooting .....	4-1
Service .....	4-2
Battery Information .....	4-3
Alternator Information .....	4-4, 4-5
Drive Belt Information .....	4-5

### DESCRIPTION:

This machine has a 12 volt electrical system with an alternator, negative ground, and 12 volt battery.

There are two basic circuits in the electrical system:

1. Charging circuit (alternator and battery)
2. Starting circuit (switch, solenoid, battery, and starter)

NOTE: Disconnect the battery ground cable before making any repairs to the electrical circuits.

In addition to the two basic circuits there is an accessories circuit which includes operating lights.

### TROUBLE-SHOOTING THE ELECTRICAL SYSTEM:

The following trouble-shooting chart is provided as an assistance in locating and correcting problems which are most common. Many of the recommended procedures must be done by authorized Barko Personnel only.

PROBLEM	CAUSE
Battery does not hold it charge.	1, 2, 3, 4, 5
Alternator will not charge.	1, 2, 5
Starter will not turn the engine.	2, 3, 4, 6, 7, 8

KEY TO CORRECT THE CAUSE
<ol style="list-style-type: none"><li>1. Alternator belt is loose or damaged.</li><li>2. Battery connections are dirty or loose.</li><li>3. Battery is damaged.</li><li>4. The ground connection is not making a good contact.</li><li>5. The alternator is damaged.</li><li>6. The engine is locked.</li><li>7. The starter has damage.</li><li>8. The wiring or the solenoid is damaged.</li></ol>

## ELECTRICAL SYSTEM SERVICE:

1. Check that the battery cables are clean and tight. Remove any acid or corrosion from the battery cables with a baking soda and water solution. Cover the terminals with grease to prevent corrosion.
2. Check the tension on the drive belt for the alternator. Refer to figure 1.
3. Check all wire connections for loose connections.
4. Check all wires for broken or open wires.

SEE THE ELECTRICAL SCHEMATIC IN THE PARTS MANUAL FOR THE COMPLETE ELECTRIC SYSTEM.

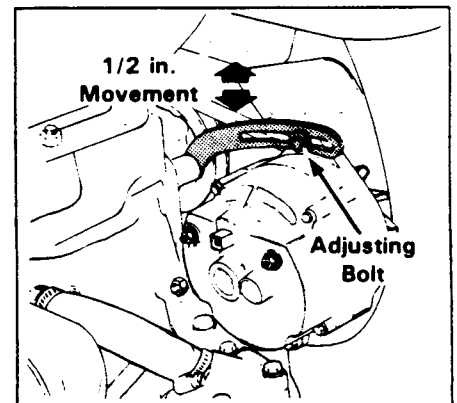
## USING AN EXTRA BATTERY:

If it is necessary to use an extra battery to start the engine, be careful. This is a two-person operation. There must be one person in the operator's seat and one person to connect and disconnect the battery cables.

1. Make sure the ignition is in the "OFF" position.

### **WARNING**

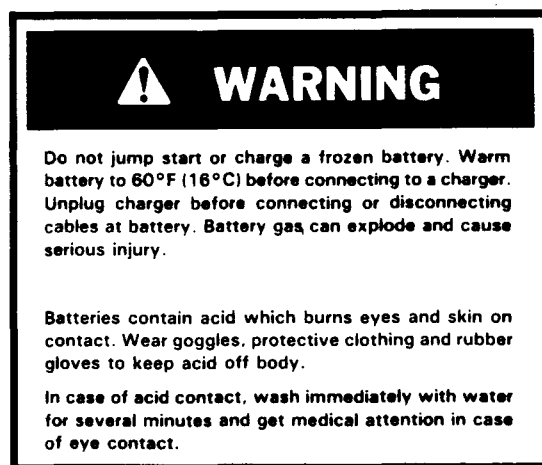
Lead-acid batteries produce flammable and explosive gases. Keep arcs, sparks, flames and lighted tobacco away from battery. When using an extra battery to "jump" start an engine, make connections as recommended in manual. When connecting extra battery for "jump" start, always make last connection (negative cable) to engine (never at battery). When removing "jump" start cables, always remove negative cable from engine first. Never charge frozen battery.



**Fig. 1** Adjusting Belt Tension

2. Be sure that the battery to be used is of the same voltage as the batteries in the machine.
3. Battery terminals have identification marks. The positive terminal is marked (+) and the negative terminal is marked (-).
4. Be sure the negative terminal (-) of the battery is connected to the engine.
5. Connect the end of the first cable to the positive terminal (+) of the extra battery. Connect the other end of the same cable to the positive terminal (+) of the loader battery.

6. Connect the end of the second cable to the negative terminal (-) of the extra battery. Connect the other end of the second cable to the engine. DO NOT connect directly to the negative terminal (-) of the loader battery. Connecting the cable directly to the negative terminal (-) of the loader battery can cause spark and destroy the battery and cause personal injury.
7. Keep the cables away from the fans and belts.
8. Start the engine.
9. After the engine starts, remove the cable connected to engine first.
10. Remove the cable from the loader battery positive terminal (+).



#### INSTALLING A NEW BATTERY:

1. Remove the battery cables. Remember the position of the positive (large) terminal and the negative (small) terminal so you can connect the cables correctly.
2. Remove the hold-down bar. Remove the battery from compartment.
3. Clean the terminal posts of the new battery and the cable connections with a wire brush.
4. Install the new battery in the compartment. Install the hold-down bar.

NOTE: Make sure that you do not touch the battery terminals with any metal.

5. Install and tighten the battery cables. Connect the ground cable last to prevent sparks.

## **WARNING**

Lead-acid batteries contain sulfuric acid which will damage eyes or skin on contact. Always wear goggles to avoid acid in eyes. If acid contacts eyes, wash immediately with much clean water and get medical attention. Wear rubber gloves and protective clothing to keep acid off skin. If acid contacts skin, wash off immediately with clean water.

### ALTERNATOR DAMAGE:

Damage to the alternator can occur if:

1. The battery connections are not connected correctly.
2. The wires from the alternator are grounded.

## **IMPORTANT**

Damage to alternator can occur if:

1. Engine is operated with battery cables disconnected.
2. Cables are connected when using a fast charger or when welding on the loader (Remove both cables from the battery.).
3. Extra battery cables (booster cables) are connected wrong.

## **IMPORTANT**

Never attempt to polarize the alternator. Damage to the rectifying parts of the unit can result.

### CHECKING THE CONDITION OF THE BATTERY AND CABLES:

1. Check the electrolyte level and add distilled water if necessary.
2. Check the battery for voltage and amperage.
3. Check the cables. Both must be clean and tight.

## DRIVE BELT FOR THE WATER PUMP AND ALTERNATOR:

To adjust the drive belt (Fig. 2)

1. Loosen the alternator adjusting bolt and mounting bolt.
2. Adjust tension of belt to have 1/2" movement at 10 pounds of pressure at center of the belt.
3. Tighten the alternator adjusting bolt and mounting bolt.

After a new drive belt has been installed, it will be necessary to adjust it after 8 hours of loader operation.

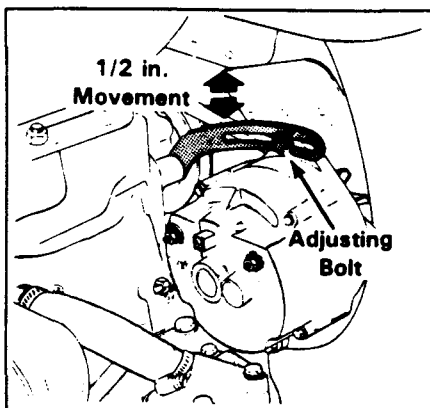
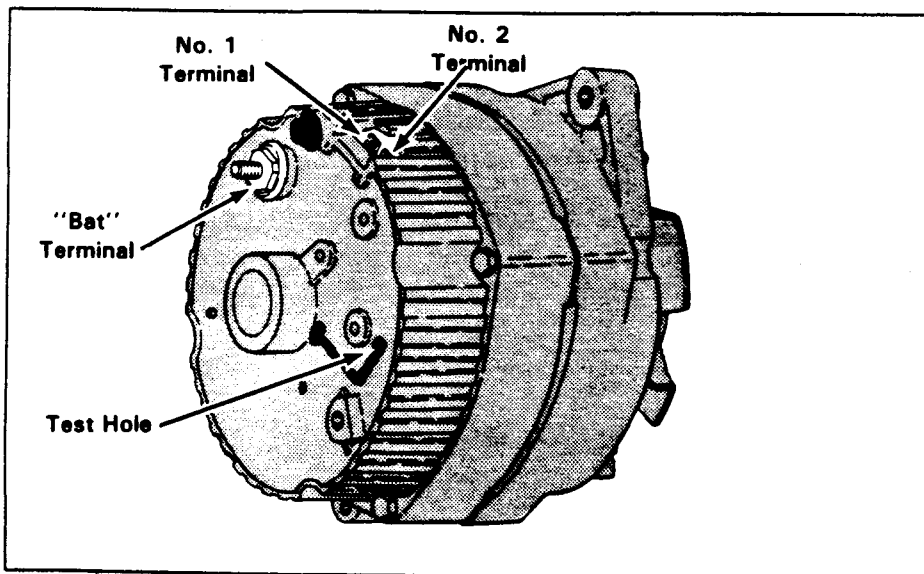


Fig. 2 Adjusting Belt Tension

## ALTERNATOR:

Checking the wiring:

1. Turn the starter switch on.
2. Connect a volt meter between the ground and:
  - a) the No. 1 alternator connector.
  - b) the No. 2 alternator connector.
  - c) the "BAT" connector.



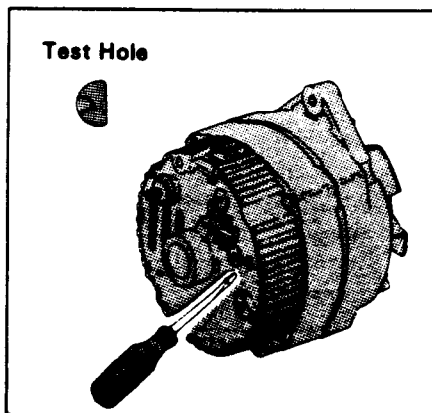
3. If any of these tests show zero voltage, repair the wiring.
4. Check the voltage again.

Checking the alternator output:

1. Disconnect the negative battery cable.
2. Remove the wire from the "BAT" connector on the alternator and fasten it to one connector of an ammeter. Fasten the other connector of the ammeter to the "BAT" connector of the alternator.
3. Connect the battery cable again.
4. Remove the hot wire from the electric solenoid on the fuel injection pump and turn the engine with the starter for approximately 30 seconds to cause a discharge of the battery.
5. Install the hot wire on the electrical solenoid and start the engine and run at full engine RPM.
6. The ammeter reading must be within 10 percent of the rated amperage marked on the alternator case.
7. If the reading is correct, the alternator is good. If the reading is more or less than 10 percent of rated amperage, check the regulator.

Checking the regulator:

1. Use steps 1 through 5 of "Checking Alternator Output."
2. Put a small screwdriver in the test hole (Fig. 4).
3. If the ammeter reading is within 10 percent of rated amperage (marked on the alternator case), the regulator may be damaged. If the ammeter reading is not within 10 percent of the rated amperage, check the diode trio, rectifier, stator, or rotor.



**Fig. 4** Checking the Regulator



## POWER PACKAGE MAINTENANCE

<u>CONTENTS</u>	<u>PAGE</u>
Engine Service - (separate Cummins Manual) .....	5-1
Pump Drive Maintenance .....	5-2
Disconnect Pump Maintenance .....	5-2
Air Cleaner Maintenance .....	5-3
Engine Mounting Instructions .....	5-4
Engine Control Cable Mounting .....	5-5, 5-6

POWER PACKAGE  
MAINTENANCE

## ENGINE SERVICE:

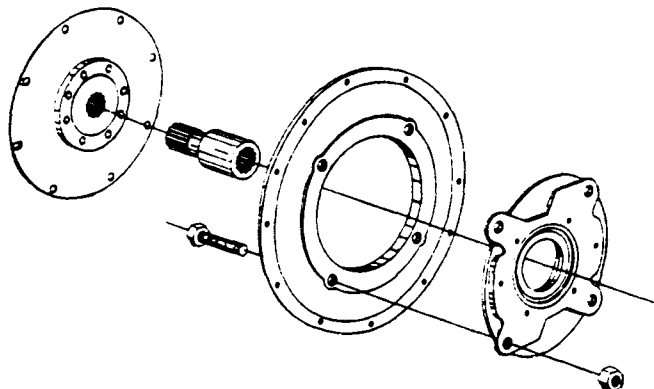
The standard source of power for the hydraulic system in the Barko 160A is a Cummins 4BT3.9, 92 HP Diesel Engine. It has it's own fuel source, a diesel oil reservoir, located near the hydraulic oil reservoir on the Platform. Also available is the Cummins 6BT5.9 Diesel Engine. Accessories include: a hour meter, a 12 volt starter motor, and a pump drive. Complete specifications, operating instructions, and maintenance and lubrication information will be found in the Cummins Engine Manual which accompanies this manual. Stationary Electric Barko Loaders utilize electric motors to drive the pumps instead of a diesel engine.

The Cummins Manual includes information on other sizes of Cummins Engines also. Use only the service information applicable to the engine in your loader.

Also you may need to refer to the Power Package illustration and parts list in the Mechanical Section of the Parts Manual.

## PUMP DRIVE MAINTENANCE:

The Pump Drive is mounted to the engine, and is virtually maintenance free. See the Service Schedule for lubricant and lubrication intervals.

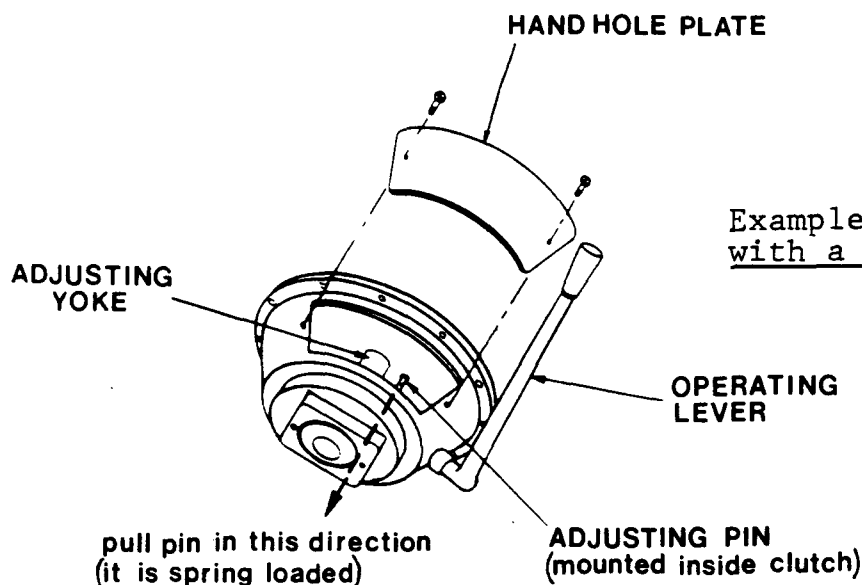


If a Disconnect Clutch (optional) is ordered on your machine, the following maintenance must be done.

### DISCONNECT CLUTCH: (optional)

#### CLUTCH ADJUSTMENT - IMPORTANT

If clutch does not pull, heats, or operating lever jumps out, adjustment is required. To adjust clutch, remove hand hole plate, turn clutch until adjusting lock pin can be reached. Pull adjusting pin out and turn adjusting yoke to right or clockwise until operating lever requires a distinct pressure to engage. A new clutch requires several adjustments until friction discs are worn in.

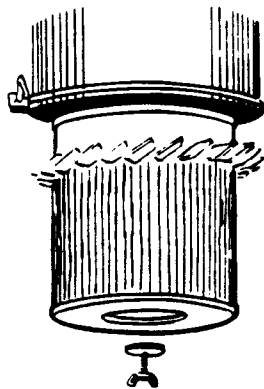


Example of a Pump Drive with a Disconnect Clutch

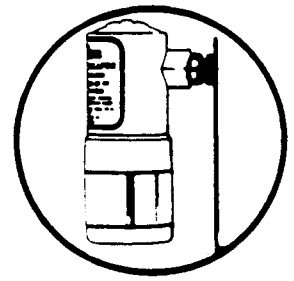
NOTE: For cold weather start-up instructions utilizing the Disconnect Clutch, see Preventive Maintenance section under Cold Weather Start-up.

## AIR CLEANER MAINTENANCE:

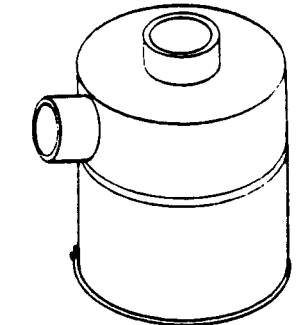
1. Measure the restriction of the air cleaner with a service gauge, or a water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake. Replace or clean the element only when the restriction has reached the maximum allowed by the engine or equipment manufacturer.
2. Empty the dust cup as required. Dust should not be allowed to build up closer than one inch from the baffle. On vacuator valve equipped models, dust cup service is cut to a minimum; a quick check to see that the vacuator valve is not inverted, damaged, or plugged is all that is necessary.



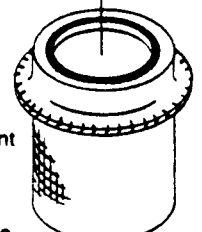
3. **Element Servicing**  
When restriction indicates that element servicing is required, loosen wing nut and remove primary element. Before installing new element, inspect the element and gasket for shipping or storage damage. Carefully install element and wing nut.  
For minimum vehicle downtime, replace dirty filter with a new or properly cleaned filter element. If element is to be serviced for immediate re-use, reinstall outer cover to protect induction system while cleaning element.
4. Reinstall the dust cup, making sure it seals 360° around the air cleaner body. Reset the restriction indicator to green.
5. Check all connections between the air cleaner and the engine to be certain they are tight and leak-free.



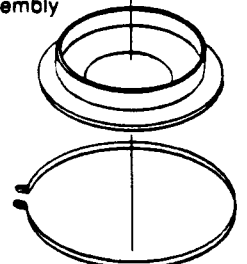
Body Assembly



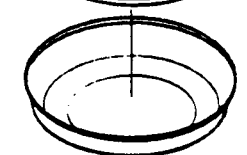
Element



Baffle Assembly



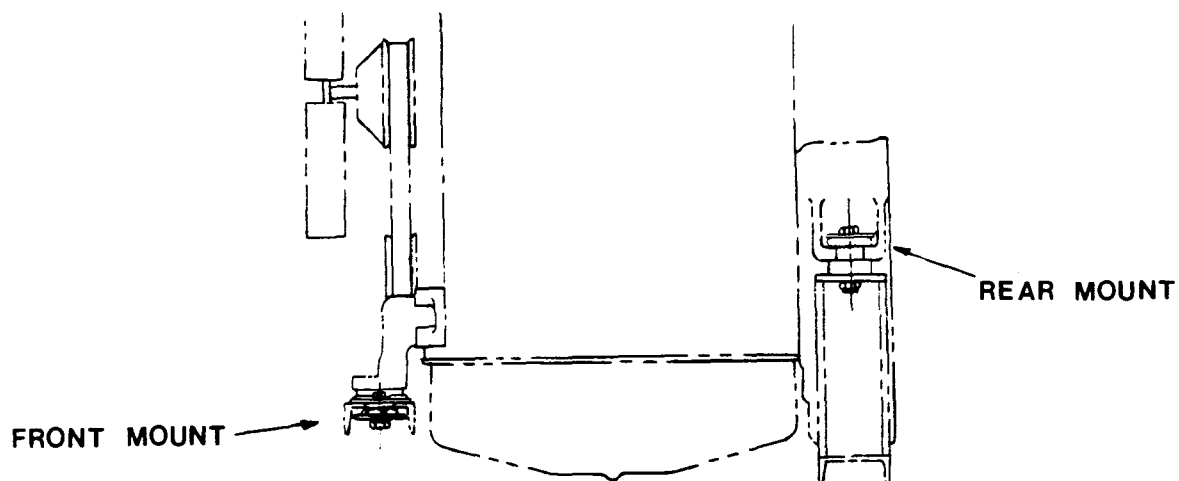
Dust Cup



Maximum engine protection against the ravages of dust is possible ONLY if the air cleaner is serviced at regular intervals. Over-servicing does not utilize the air cleaner features to the fullest. The procedure is simple - just follow these easy steps as shown.

## ENGINE MOUNTING INSTRUCTIONS:

There are two Rear Mounts on the engine, and one Front Mount. They can be disassembled as shown in the illustration below.

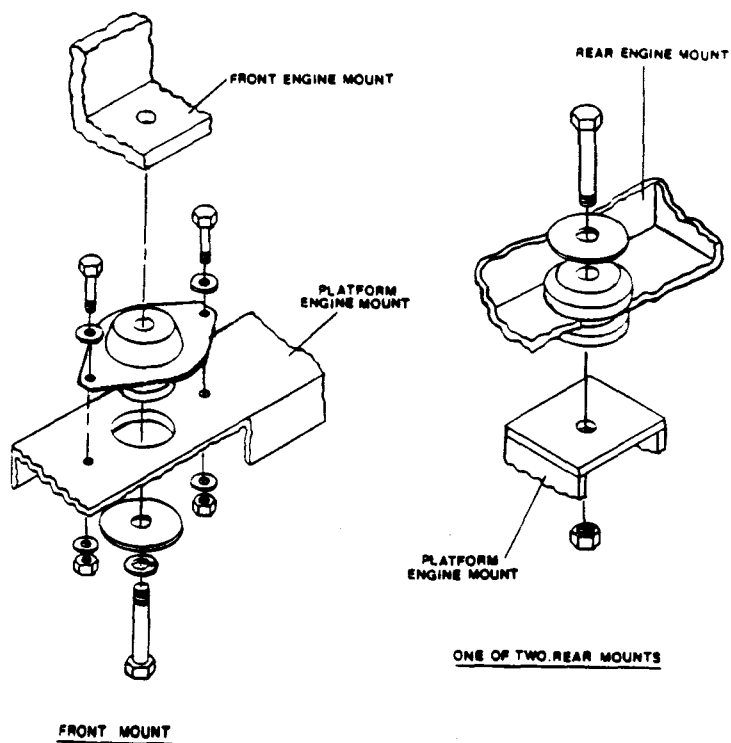


SIDE VIEW of ENGINE  
see detail

NOTE: On the Rear Mount, a rubber bushing and cap are used. Make sure the "bushing" half is on the bottom, and the "cap" is on the top, for proper installation.

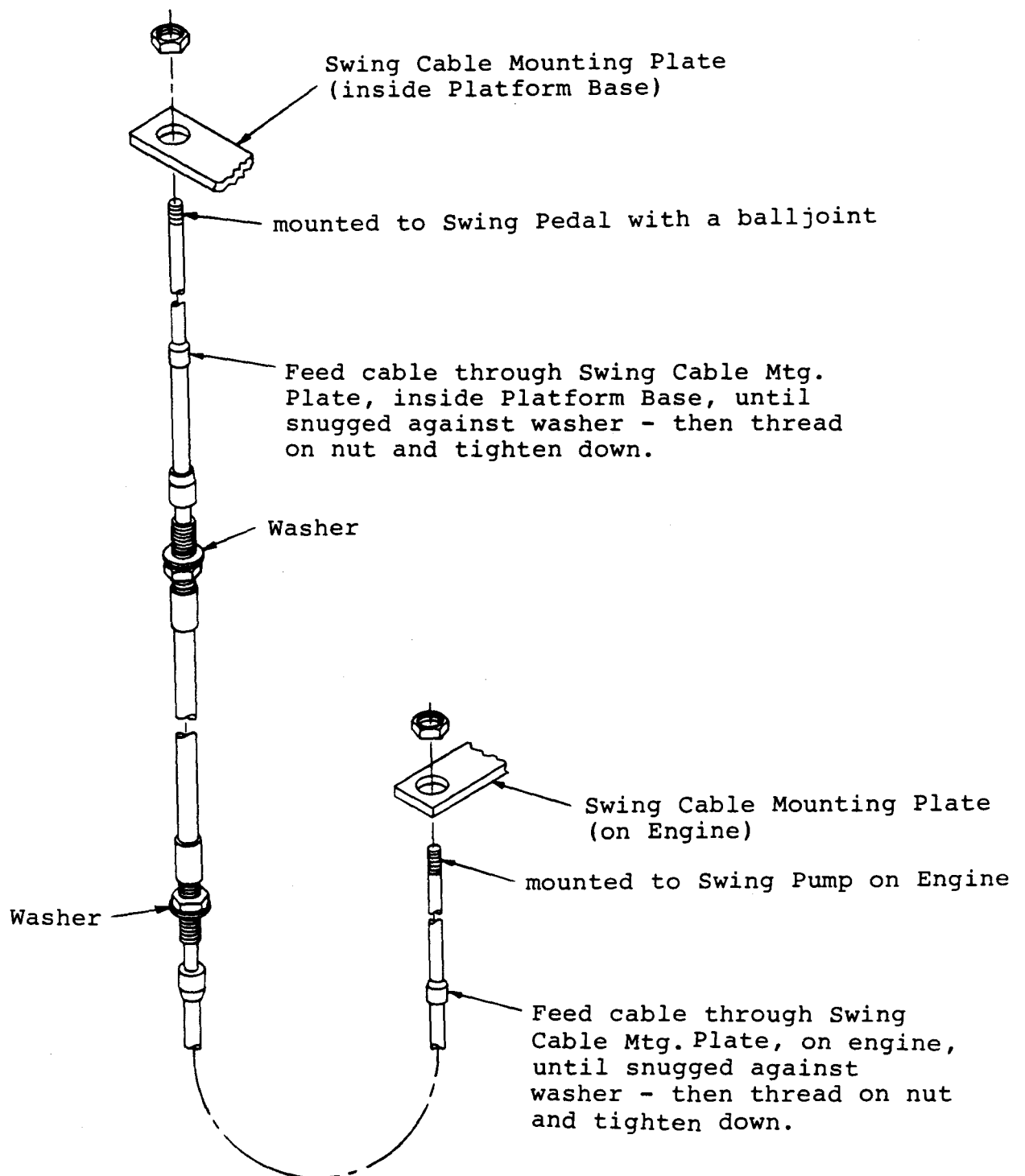
Use soapy water as a lubricant to install the rubber bushing and cap on the Rear Mounts.

DO NOT USE GREASE OR OIL!



DETAIL

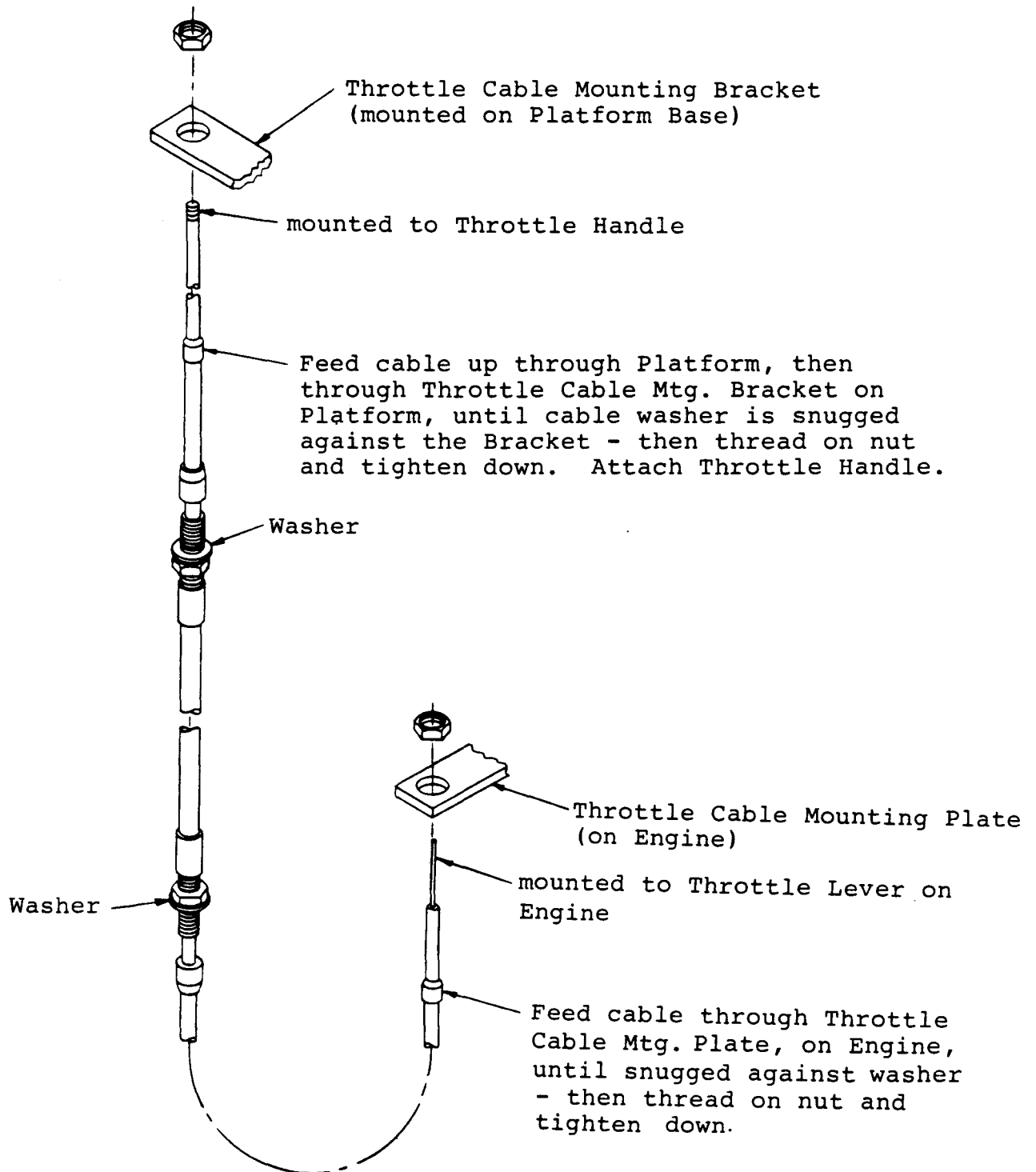
## SWING CABLE MOUNTING:



EFFECTIVE 5-17-88

REV. 0

## THROTTLE CABLE MOUNTING:



EFFECTIVE 5-17-88

REV. 0

# STRUCTURAL MAINTENANCE

## CONTENTS

## PAGE

Control Deck & Cab .....	6-1
Stabilizer Assembly .....	6-1
Turntable Bearing Maintenance .....	6-2
Torqueing Turntable Bolts .....	6-3
Grapple Installation .....	6-4
Grapple Lubrication .....	6-6
Grapple Bolt Torque Specifications .....	6-7

STRUCTURAL  
MAINTENANCE



## CONTROL DECK & CAB:

The "command post", so to speak, of your Barko loader is the control deck which is mounted atop the head and rotating turntable. The deck contains the operator's cab, the power source, and hydraulic oil reservoirs. In some models, there are 12-volt storage batteries and a diesel fuel reservoir. The operator's cab, which features a fold-away locking door, sliding window and tinted windshield, contains the instrument panel and control lever console. It includes an adjustable operator's seat. A complete description of the instrument panel, control lever console and other features of the cab appears in the Operator's Manual.

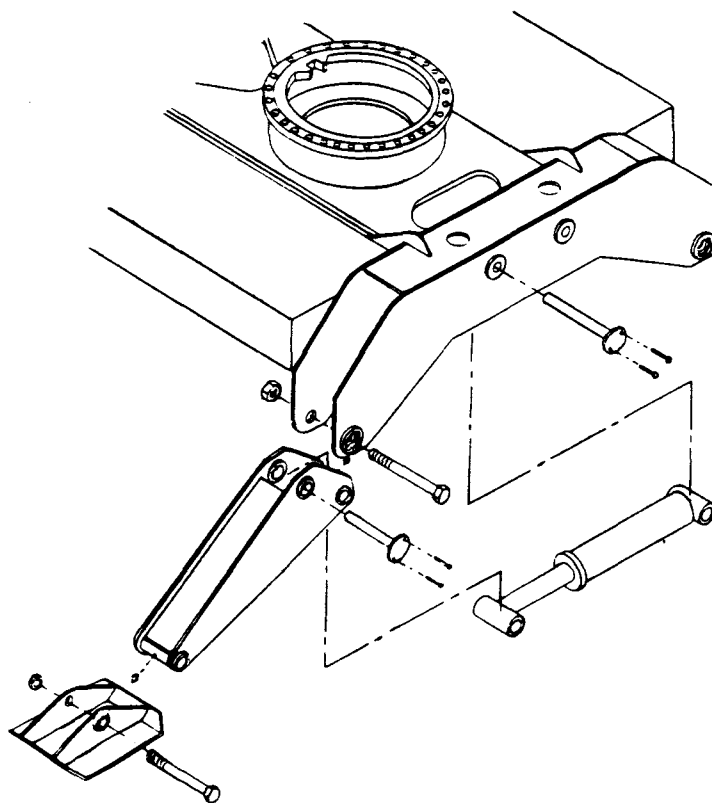
Also, the Parts Manual gives a description of, and location of cab components.

- Keep cab area & control deck free of dirt, debris, rags, tools, ice, and snow, etc.

## STABILIZER ASSEMBLY:

Stabilizers on models so equipped provide stability during operation and allow the operator to maintain the loader in a level position. Attached to the sub-frame, they are activated by control levers in the operator's cab.

See parts manual for complete parts breakdown.

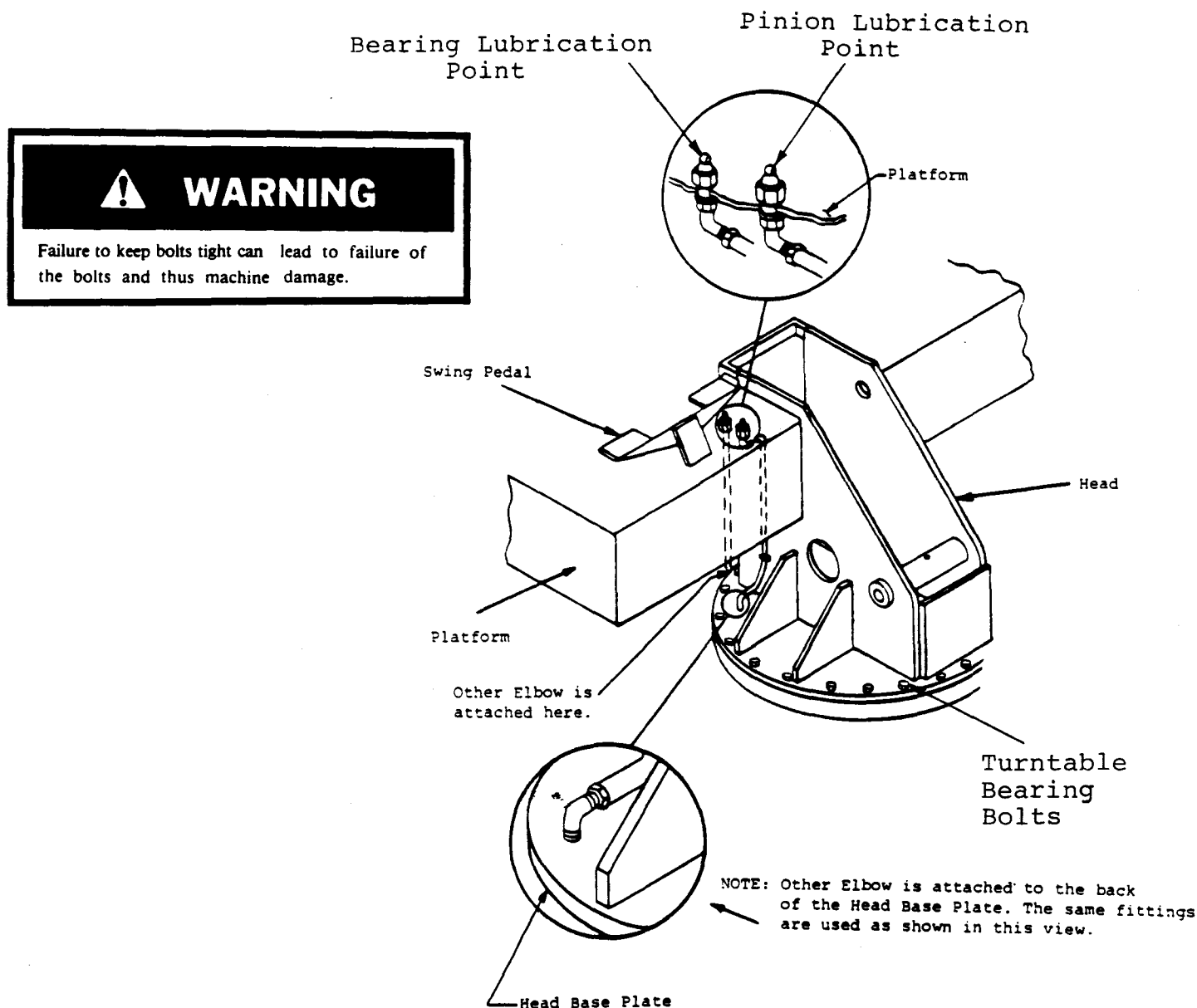


## TURNTABLE BEARING MAINTENANCE:

Periodic servicing must be performed on the loader's turntable bearings to ensure long bearing life. This servicing includes regular lubrication and torque checks on the bearing bolts. Turntable bearings must be greased daily. Type of grease used is listed on the general Lubrication Diagram.

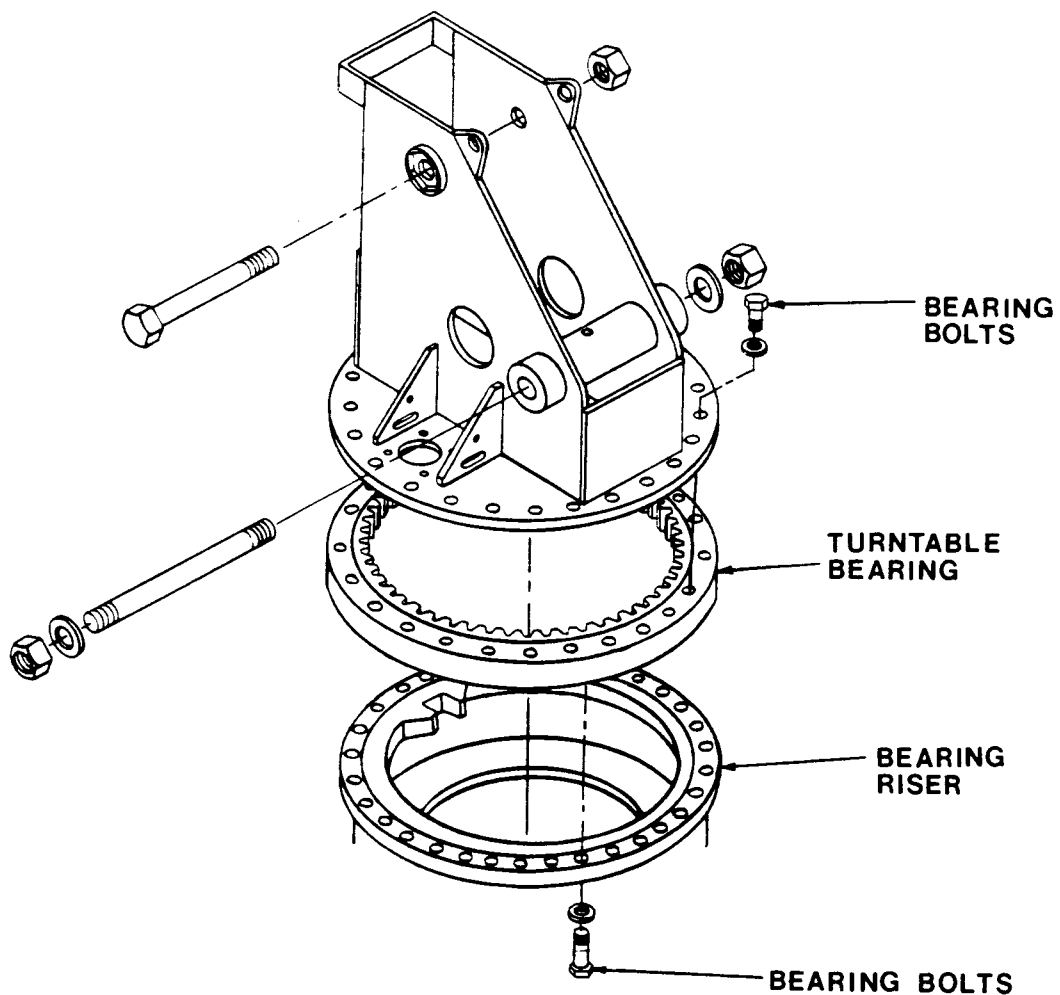
These lube points, (pinion & bearings) can be greased from the Platform (see illustration). High pressure grease guns are not recommended for the turntable bearing, as they may damage the seal. Use of hand grease gun is suggested.

For complete distribution of the grease throughout the bearings, it is necessary to have the machine rotating as the grease is being applied. Rotate at least two complete revolutions for each fitting. Three shots of grease per fitting will be sufficient, on a daily basis.



## TORQUE SPECIFICATIONS OF BEARING BOLTS

The turntable bearing bolts should be checked and retorqued, if necessary, every 100 hours, or every two weeks. Torque to 310 foot pounds of lubed torque (using anti-seize compound, part no. 514-00700).



## GRAPPLES:

Because Barko Hydraulics builds and sells a variety of grapples, we will use the Continuous Rotation model as an example here, since it is one of the most popular models. Other models will be mentioned separately later on.

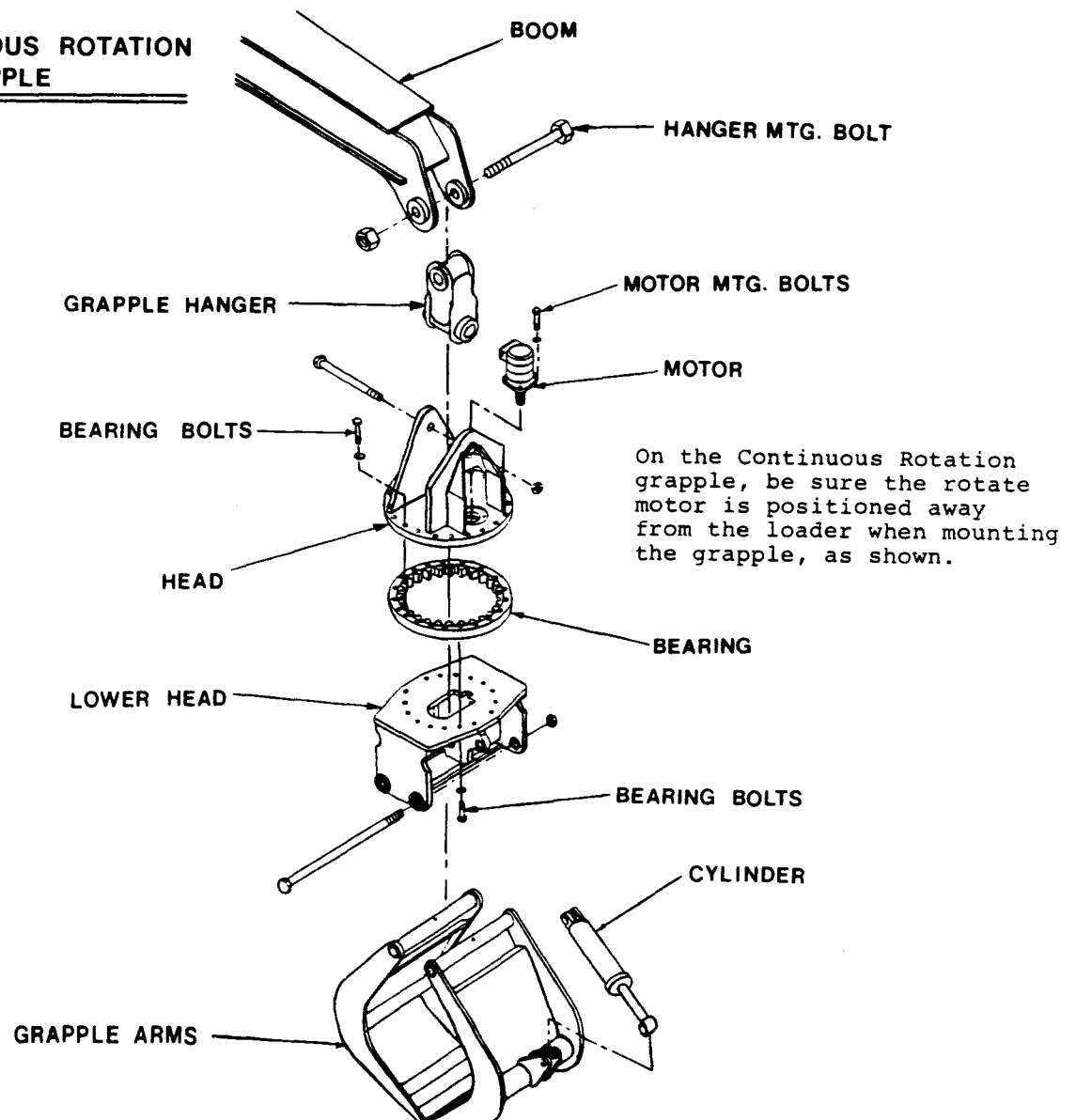
NOTE: The grapple hanger referenced below is installed on the grapple at the factory.

### GRAPPLE INSTALLATION

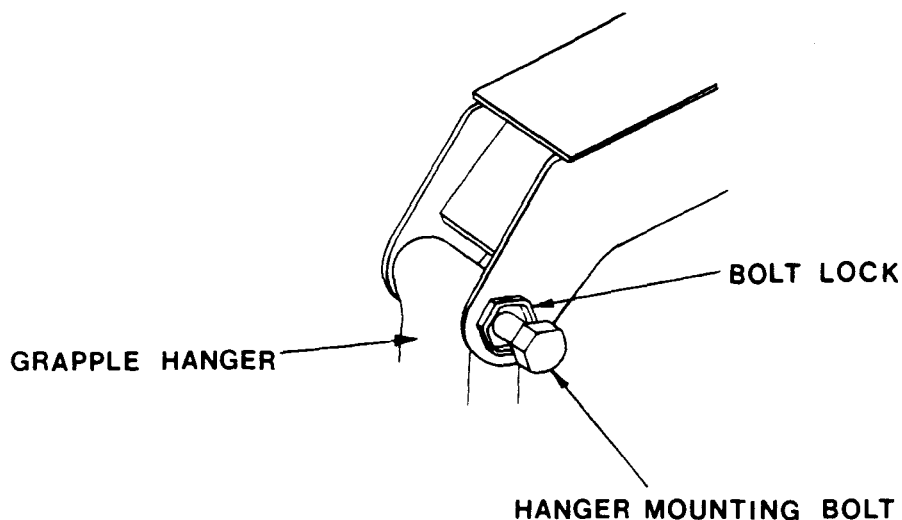
Proceed with the following steps to attach the grapple to the loader boom.

1. Set grapple upright on a solid surface to prevent tipping during installation.
2. Position loader so that the end of the boom can be manipulated over and onto the grapple hanger. Align mounting bolt holes, and install bolt and nut. See illustration.

#### A CONTINUOUS ROTATION GRAPPLE



NOTE: Make sure the head of the hanger mounting bolt aligns with the bolt lock on the left side of the boom.

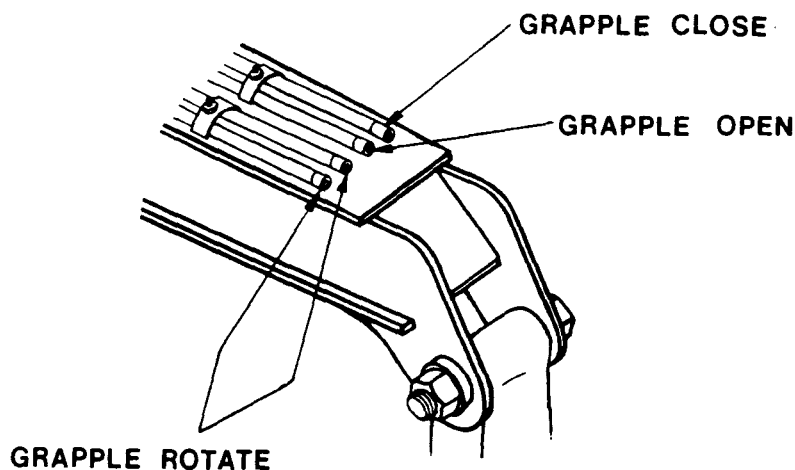


CAUTION: Do not put fingers into the hole to check for alignment.

CAUTION: Keep hands away from moving parts during this procedure.

3. Tighten nut

4. Connect grapple hoses to the boom tubing. (See illustration). Refer to Parts Manual in Grapple section for the Attachment Kit, which lists the hoses and part numbers.



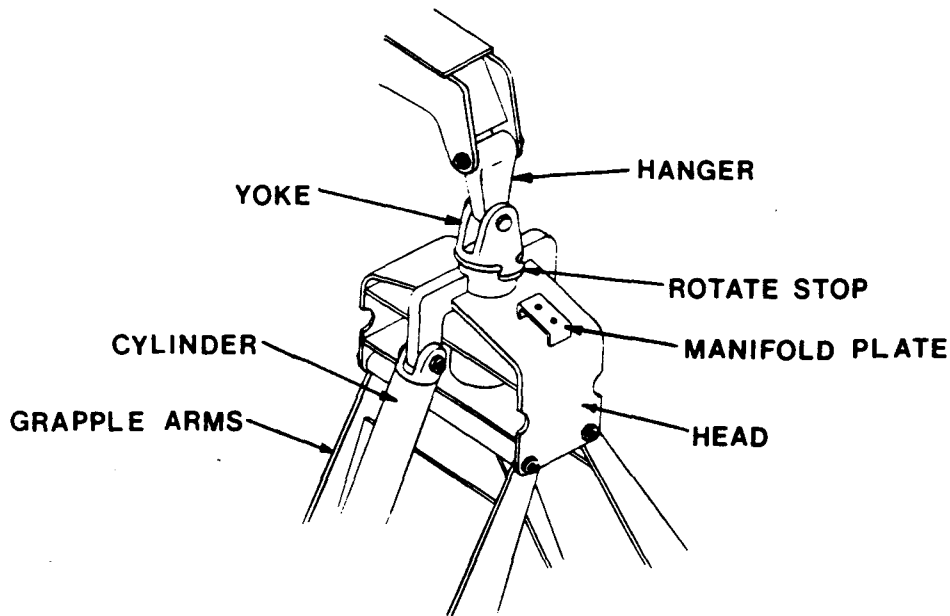
5. Check to make sure all bolts, and nuts are properly installed and tightened.

6. Lift the boom and slowly try the grapple rotate function and grapple open and close function. Watch for hydraulic oil leaks. If the functions perform according to the instructions on the control levers, connections have been properly made.

## INSTALLING A 280° ROTATION GRAPPLE AND A 360° NON-CONTINUOUS ROTATION GRAPPLE

When mounting either of these grapples, be sure to mount them with the manifold plate, located on the head, positioned away from the loader. See illustration.

The 280° grapple also has a rotate stop located on the yoke. This, too, must be positioned away from the loader.



### A 280° ROTATION GRAPPLE

NOTE: The 280° grapple uses a vane motor which, along with the rotate stop, help stop the rotation at 280 degrees. The 360° grapple must be stopped by the loader operator - it does not have any stops on it. If rotated continually, the hoses will be wrapped around the grapple causing them to break.

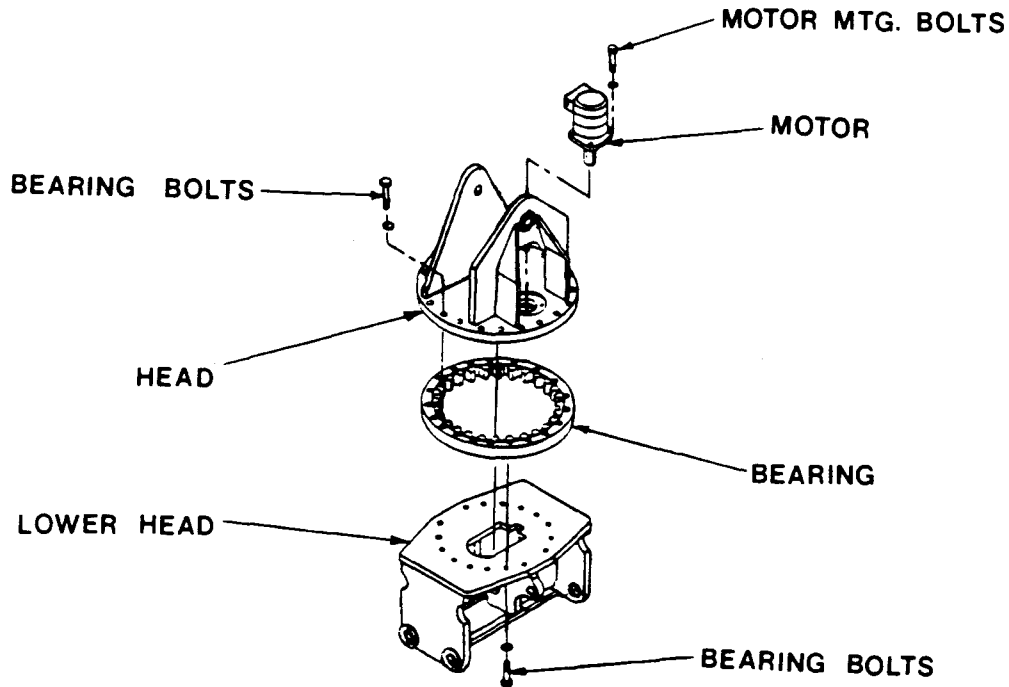
### LUBRICATION

Use a multi-purpose grease for all grapple lubricating. Lubricate grapple cylinders at grease fittings on each end. Lubricate grapple hanger at grease fittings also. The grapple head must be lubricated at the grease fitting, which is in varying locations on the head depending upon the grapple model. (See Parts Manual). The grapple arms also have grease fittings for lubrication. See the Lubrication Diagram for lube points, grease application, and interval.

## TORQUEING OF GRAPPLE BOLTS

On the Continuous Rotation Grapple, the bearing bolts must be torqued to 127 foot pounds, along with the motor mounting bolts which must be torqued to 64 foot pounds. This is lubricated torque, using anti-seize compound, part no. 514-00700.

The rest of the grapple models (280° rotation, 360° non-continuous rotation) do not have specific torque values on bolts, except for what are listed on the Torque Specifications Sheet in the Technical Data section.



### *III. TECHNICAL DATA*

#### CONTENTS

#### PAGE

Torque Specifications .....	7-1
General Trouble-shooting Guide .....	7-2

TECHNICAL  
DATA



# TORQUE SPECIFICATIONS


## SPECIAL TORQUE SPECIFICATIONS

Turntable Bearing Bolts	310 ft. lbs.
Swing Motor Bolts (secure motor to head)	175 ft. lbs.
Grapple Bearing Bolts	127 ft. lbs.
Grapple Motor Mounting Bolts	64 ft. lbs.

NOTE: This is lubed torque, using anti-seize compound part no. 514-00700.


## TORQUE SPECIFICATIONS FOR BARKO BOLTS

SAE GRADE 5  
RECOMMENDED TORQUE FOOT POUNDS




DIA.	COARSE	DRY FINE	*LUBRICATED COARSE	FINE
1/4	9	10	5	6
5/16	17	20	10	12
3/8	31	35	19	21
7/16	50	55	30	33
1/2	75	85	45	51
9/16	110	120	66	72
5/8	150	170	90	100
3/4	265	300	160	180
7/8	400	435	240	260
1	600	650	360	390
1-1/8	800	900	480	540
1-1/4	1120	1240	670	745
1-3/8	1470	1670	880	1000
1-1/2	1950	2200	1170	1320

SAE GRADE 8  
RECOMMENDED TORQUE FOOT POUNDS



DIA.	COARSE	DRY FINE	*LUBRICATED COARSE	FINE
1/4	12	14	7	9
5/16	25	27	15	17
3/8	44	49	26	30
7/16	70	78	42	47
1/2	107	120	64	72
9/16	154	171	92	102
5/8	212	240	127	144
3/4	376	420	226	252
7/8	606	668	364	400
1	909	995	545	597
1-1/8	1288	1444	773	866
1-1/4	1817	2012	1090	1207
1-3/8	2382	2712	1430	1627
1-1/2	3161	3557	1897	2134

BARKO GRADE 9 (BOWMALLOY)  
RECOMMENDED TORQUE FOOT POUNDS



DIA.	COARSE	DRY FINE	*LUBRICATED COARSE	FINE
1/4	17	19	10	12
5/16	34	37	20	22
3/8	60	68	36	41
7/16	96	108	58	65
1/2	145	165	87	100
9/16	210	235	125	140
5/8	290	330	175	200
3/4	515	575	310	345
7/8	830	980	500	590
1	1250	1350	750	810
1-1/8	1750	1950	1050	1170
1-1/4	2500	2750	1500	1650
1-3/8	3250	3700	1950	2220
1-1/2	4350	4850	2600	2900

\* LUBRICATE WITH ANTI-SEIZE COMPOUND (514-00700)

NOTE: 1. GRADE 9 BOLTS MUST BE USED WITH GRADE 9 WASHERS

## TROUBLE-SHOOTING GUIDE

GENERAL. The trouble-shooting charts and maintenance hints that follow are of a general system nature but should provide an intuitive feeling for a specific system. The more general information is covered in the immediately following paragraphs. Effect and probable cause charts start later in this section.

SYSTEM DESIGN. There is, of course, little point in discussing the design of a system which has been operating satisfactorily for a period of time. However, a seemingly uncomplicated procedure such as relocating a system or changing a component part can cause problems. Because of this, the following points should be considered:

A. Each component in the system must be compatible with and form an integral part of the system. For example, an inadequate size filter on the inlet of a pump can cause cavitation and subsequent damage to the pump.

B. All lines must be of proper size and free of restrictive bends. Undersize or restricted line results in a pressure drop in the line itself.

C. Some components must be mounted in a specific position with respect to other components or the lines. The housing of an in-line pump, for example, must remain filled with fluid to provide lubrication.

D. The inclusion of adequate test points for pressure readings, although not essential for operation, will expedite trouble-shooting.

KNOWING THE SYSTEM. Probably the greatest aid to trouble-shooting is the confidence of knowing the system. Every component has a purpose in the system. The construction and operating characteristics of each one should be understood. Some additional practices which will increase your ability and also the useful life of the system follow:

A. Know the capabilities of the system. Each component in the system has a maximum rated speed, torque, or pressure. Loading the system beyond the specification simply increases the possibility of failure.

B. Know the correct operating pressures. Always set and check pressures with a gauge.

DEVELOPING SYSTEMATIC PROCEDURES. Analyze the system and develop a logical sequence for setting valves, mechanical stops, interlocks, and electrical controls. Develop a cause and effect trouble-shooting guide similar to the charts on the following pages. The initial time spent on such a project could save hours of system down-time.

RECOGNIZING TROUBLE INDICATIONS. The ability to recognize trouble indications in a specific system is usually acquired with experience. However, a few general trouble indications can be discussed.

A. Excessive heat means trouble. A mis-aligned coupling places an excessive load on bearings and can be readily identified by the heat generated. A warmer than normal tank return line on a relief valve indicates operation at relief valve setting. Hydraulic fluids which have a low viscosity will increase the internal leakage of components resulting in a heat rise. Cavitation and slippage in a pump will also generate heat.

B. Excessive noise means wear, misalignment, cavitation or air in the fluid. Contaminated fluid can cause a relief valve to stick and chatter. These noises may be the result of dirty filters, or fluid, high fluid viscosity, excessive drive speed, low reservoir level, or loose intake lines.

MAINTENANCE. Three simple maintenance procedures have the greatest effect on hydraulic system performance, efficiency, and life. Yet, the very simplicity of them maybe the reasons they are so often overlooked.

A. Changing filters and strainers.

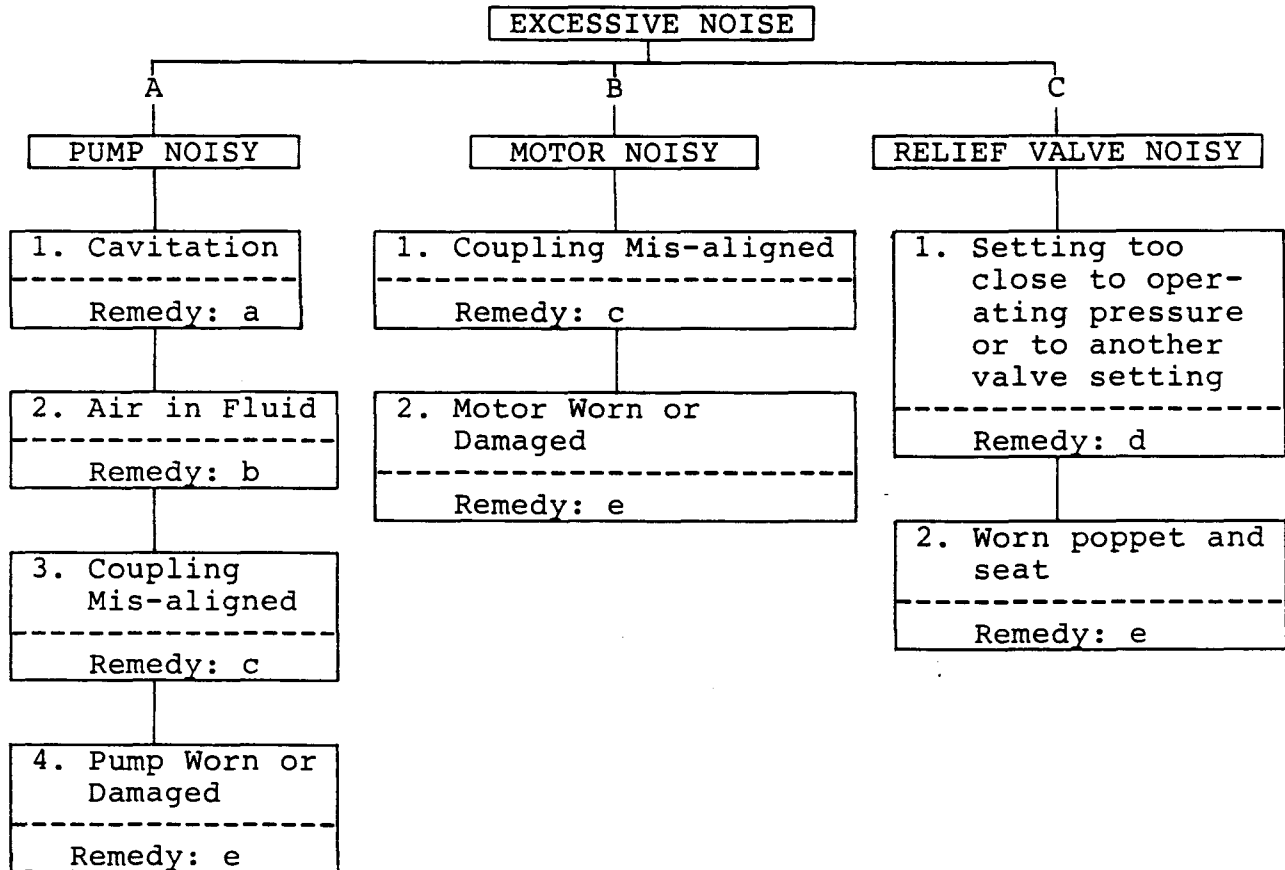
B. Maintaining a clean sufficient quantity of hydraulic fluid of the proper type and viscosity.

C. Keeping all connections tight, but not to the point of distortion, so that air is excluded from the system.

NOTE: For more detailed trouble-shooting information, see the Hydraulic System Section under the specific headings needed, in Service Manual.

The following charts are arranged in five main categories. The heading of each one is an effect which indicates a malfunction in the system. For example; if a pump is exceptionally noisy, refer to Chart I titled EXCESSIVE NOISE. The noisy pump appears in Column A under the main heading. In Column A there are four probable causes for a noisy pump. The causes are sequenced according to the likelihood of happening or the ease of checking it. The first cause is cavitation and the remedy is "a". If the first cause does not exist, check for cause number 2, etc.

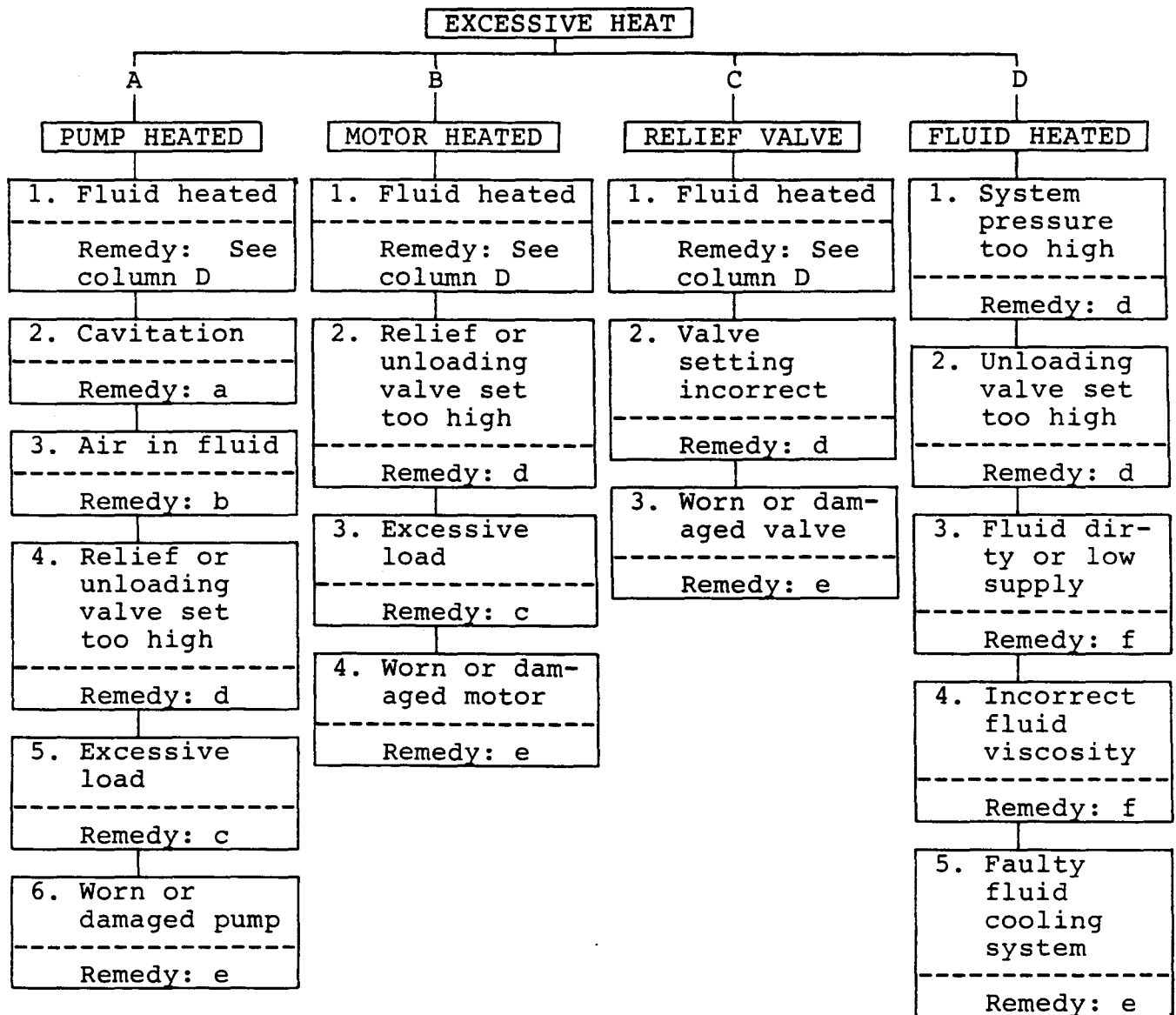
Chart I, Excessive Noise



REMEDIES:

- a. Any or all of the following: Replace dirty filters-Clean clogged inlet line-Clean reservoir breather vent-Change system fluid-Change to proper pump drive motor speed-Overhaul or replace supercharge pump
- b. Any or all of the following: Tighten leaky inlet connections-Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir)-Bleed air from system-Replace pump shaft seal
- c. Align unit and check condition of seals and bearings
- d. Install pressure gauge and adjust to correct pressure
- e. Overhaul or replace

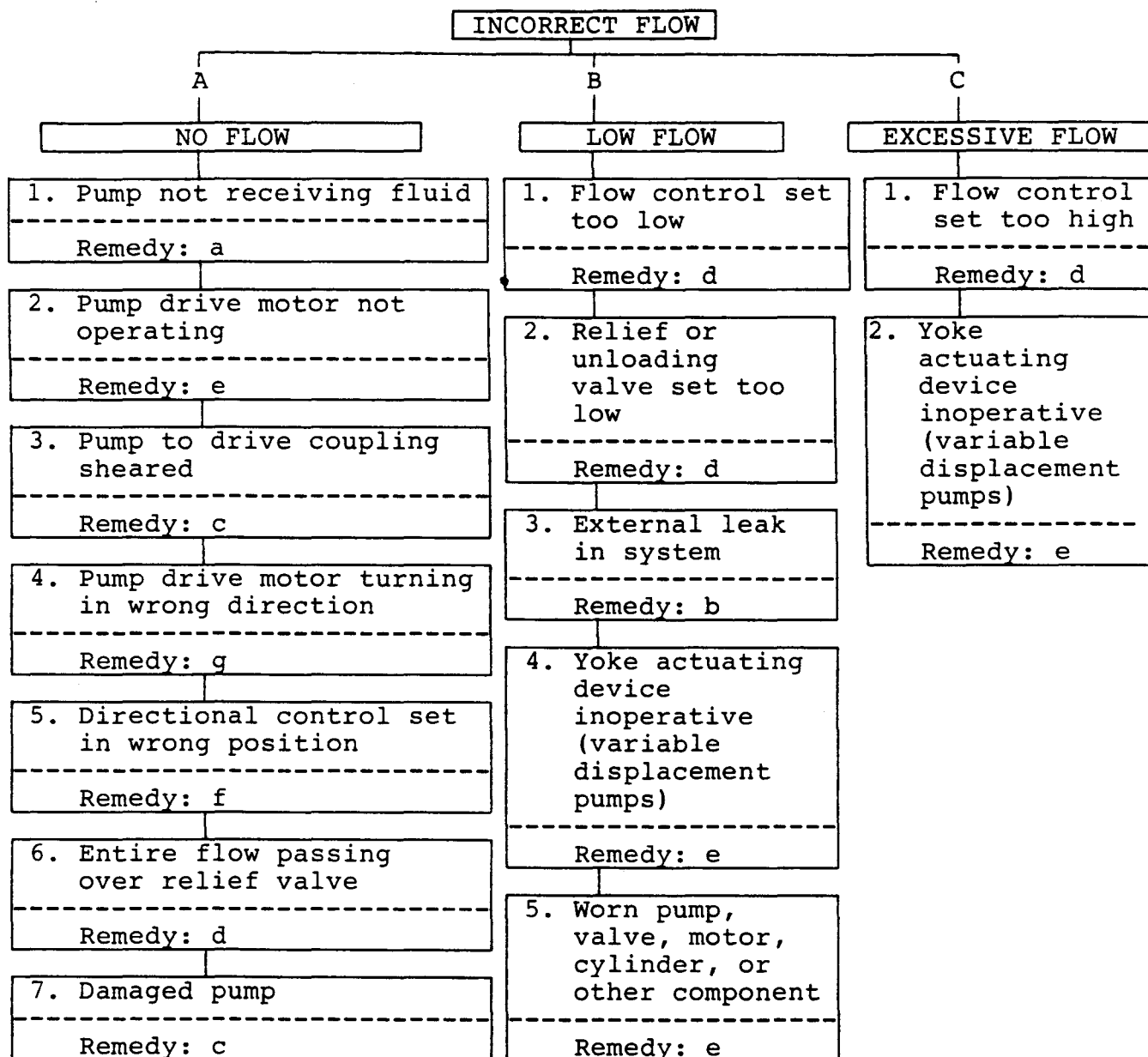
# Chart II, Excessive Heat



## REMEDIES:

- a. Any or all of the following: Replace dirty filters-Clean clogged inlet line-Clean reservoir breather vent-Change system fluid-Change to proper pump drive motor speed-Overhaul or replace supercharge pump
- b. Any or all of the following: Tighten leaky inlet connections-Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir)-Bleed air from system-Replace pump shaft seal
- c. Align unit and check condition of seals and bearings-Locate and correct mechanical binding-Check for work load in excess of circuit design
- d. Install pressure gauge and adjust to correct pressure
- e. Overhaul or replace
- f. Change filters and also system fluid if of improper viscosity-Fill reservoir to proper level

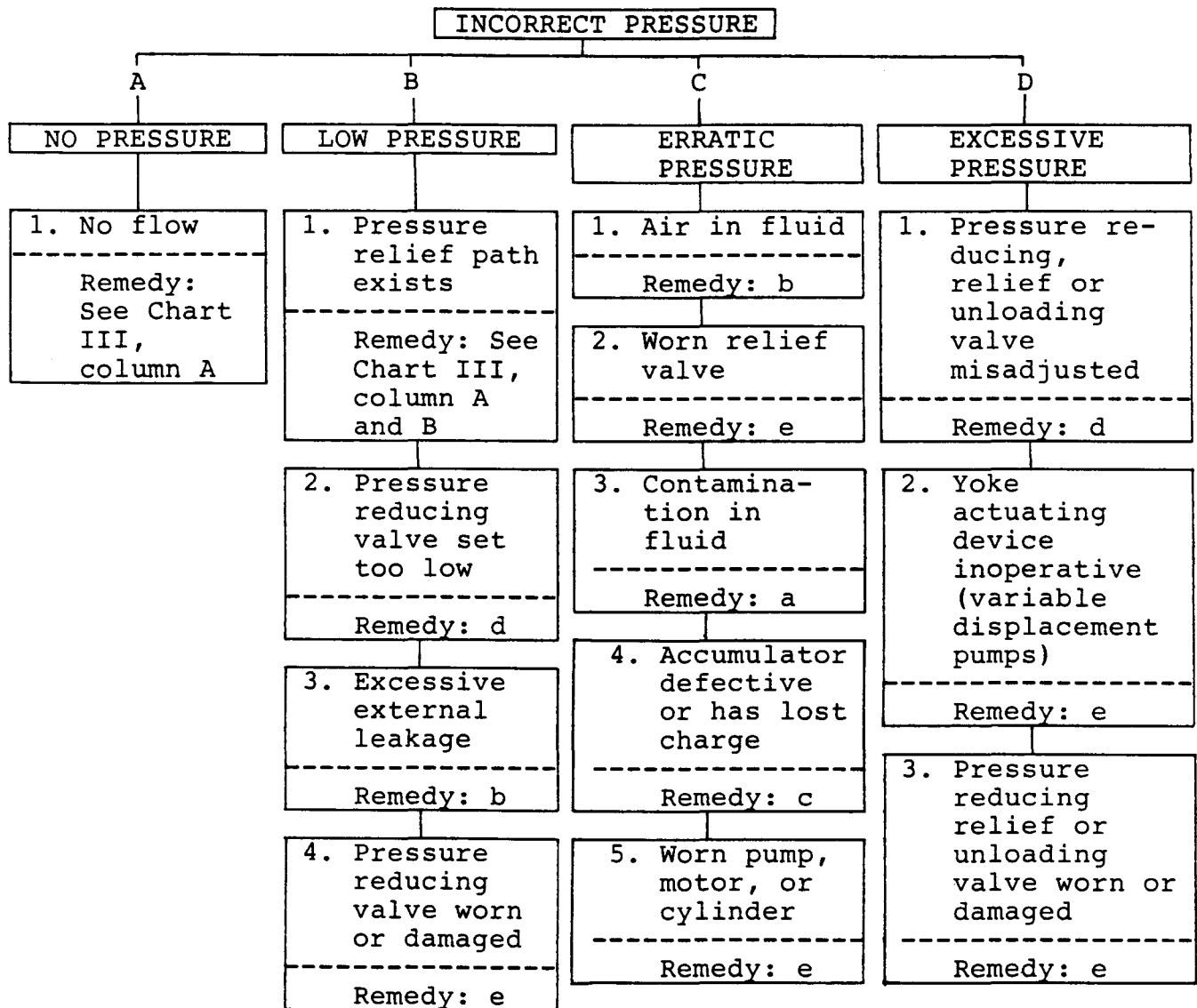
# CHART III, Incorrect Flow



## REMEDIES:

- a. Any or all of the following: Replace dirty filters-Clean clogged inlet line-Clean reservoir breather vent-Fill reservoir to proper level-Overhaul or replace supercharge pump
- b. Tighten leaky connections-Bleed air from system
- c. Check for damaged pump or pump drive-Replace and align coupling
- d. Adjust
- e. Overhaul or replace
- f. Check position of manually operated controls-Check electrical circuit on solenoid operated controls
- g. Reverse rotation

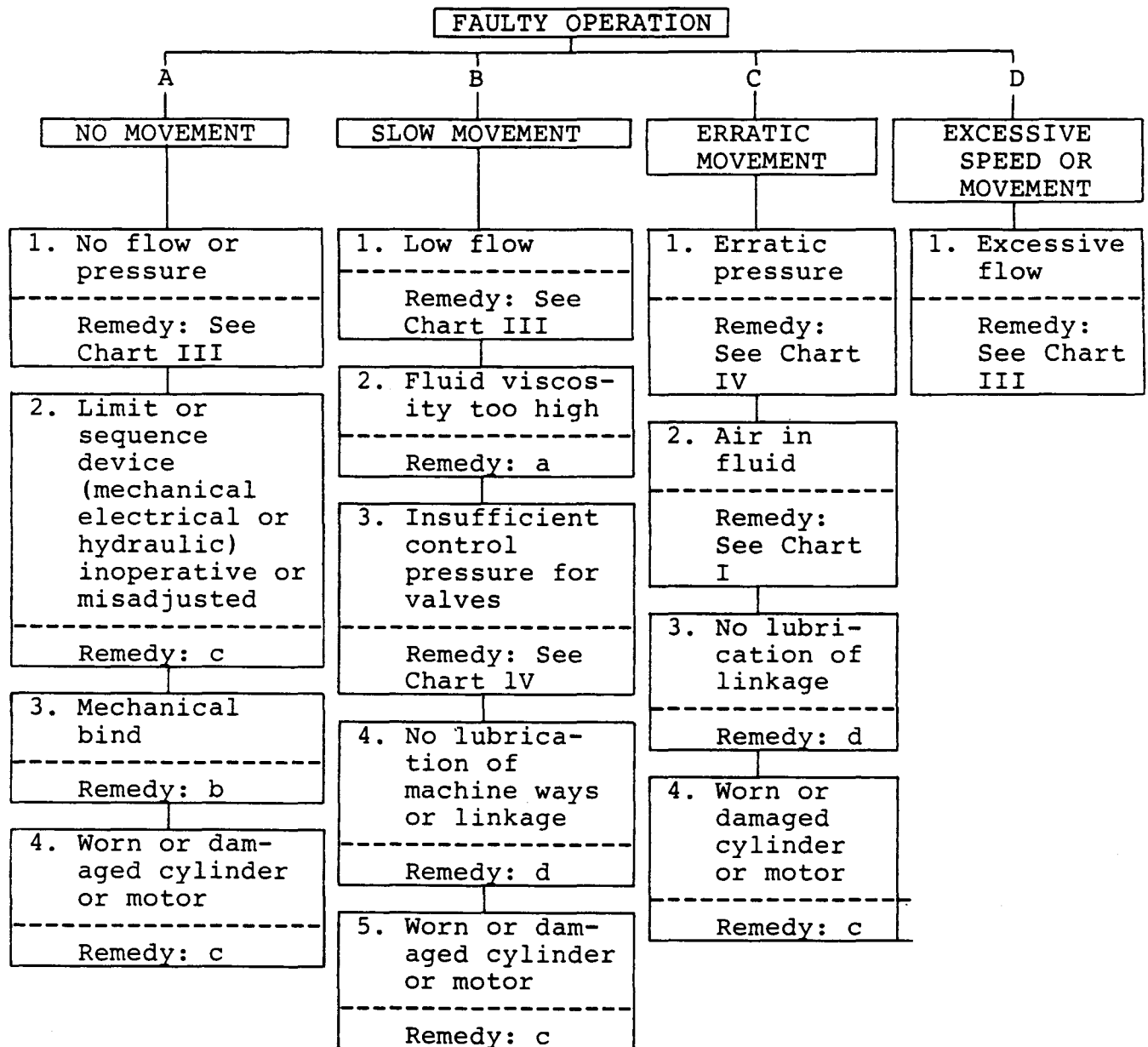
Chart IV, Incorrect Pressure



REMEDIES:

- a. Replace dirty filter and system fluid
- b. Tighten leaky connections (fill reservoir to proper level and bleed air from system)
- c. Check gas valve for leakage-Charge to correct pressure-Overhaul if defective
- d. Adjust
- e. Overhaul or replace

Chart V, Faulty Operation



REMEDIES:

- a. Fluid may be too cold or should be changed to clean fluid of correct viscosity
- b. Locate bind and repair
- c. Overhaul or replace
- d. Lubricate