BLACKMER POWER PUMPS

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

MODELS: NP1.5B, NP2E, NP2.5E, NP3E, NP4E

DISCONTINUED MODELS: NP1 1/2A, NP2C, NP2 1/2C, NP3C, NP4C

NOTE: "B" & "E" model suffixes indicate Viton replaces Buna-N as the standard elastomer.

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INSTRUCTIONS NO. 185/F 9506

Section	100
Effective	June 1995
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This document covers discontinued models. Jan.2002

PUMP DATA

	Pump Size	
	1 1/2", 2", 2 1/2", 3"	4"
Maximum Pump Speed	640 RPM	500 RPM
Maximum Temperature*	240°F (115°C)	
Maximum Viscosity*	20,000 SSU (4,250 Cs)	
Maximum Differential Pressure*	150 psi (1034 kPa)	
Maximum Working Pressure* (Inlet Pressure + Differential Pressure)	175 psi (1207 kPa)	

* Operating limits are for STANDARD pump materials only. For expanded operating limits, consult Blackmer Material Specs 103/91.

WARNING

THIS PRODUCT MUST ONLY BE INSTALLED IN SYSTEMS WHICH HAVE BEEN DESIGNED BY THOSE QUALIFIED TO ENGINEER SUCH SYSTEMS. THE SYSTEM MUST BE IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS AND SAFETY CODES AND WARN OF ANY HAZARDS UNIQUE TO THE PARTICULAR SYSTEM.

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INSTALLATION

CLEANING PRECAUTIONS

Foreign matter entering the pump can cause extensive damage. The suction tank and piping should be cleaned and flushed before installing the pump.

LOCATION AND PIPING

Pump life and performance can be significantly reduced when installed in an improperly designed system. Before starting the layout and design of the piping system, consider the following suggestions:

1. Locate the pump as near as possible to the source of supply to minimize inlet losses. The inlet line should be at least as large as the intake port on the pump. Care should be taken to eliminate restrictions such as sharp bends, globe valves, unnecessary elbows, and undersized strainers.

2. It is recommended a strainer be installed in the inlet line to protect the pump from foreign matter. The strainer should be located at least 24" (0.6 m) from the pump, and have a net open area of at least four times the area of the intake piping. Strainers must be cleaned regularly to avoid pump starvation.

3. The intake system must not contain any air leaks. If practical, this should be verified by applying air pressure to the system.

4. Expansion joints, placed at least 36" (0.9 m) from the pump, will compensate for expansion and contraction of the pipes.

5. The use of a check valve or foot valve at the supply tank is generally not recommended with a self-priming, positive displacement pump. If this type of valve is to be used, it should be located near the pump on the discharge side.

INSTALLATION

MOUNTING THE PUMPING UNIT

A solid foundation reduces noise and vibration, and will improve pump performance. On permanent installations it is recommended the pumping unit be secured by anchor bolts as shown in Figure 1. This arrangement allows for slight shifting of position to accommodate alignment with the mounting holes in the base plate.

For new foundations, it is suggested that the anchor bolts be set in concrete. When pumps are to be located on existing concrete floors, holes should be drilled into the concrete to hold the anchor bolts.

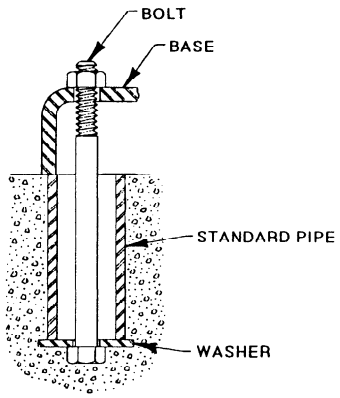

Figure 1 - Pipe Type Anchor Bolt Box.

JACKETED PUMPS

Heating jackets (or jacketed heads on $1\frac{1}{2}$" models) are recommended for heating highly viscous liquids, or to "thaw out" liquids that have congealed in the pumping chamber and packing area. Hot oil or steam can be circulated through the heating jackets by $\frac{1}{2}$" SAE connections in the ports directly above and below the shaft. $1\frac{1}{2}$" models have $\frac{3}{8}$" NPT connections on the jacketed heads. For steam circulation use **EPR** jacket O-rings; for hot oil circulation use **Viton** jacket O-rings. Maximum recommended steam pressure is 150 psi (1034 kPa).

When installing a heating jacket on a pump that was not previously equipped with a jacket, the following steps must be performed to ensure proper installation and sealing.

1. Use a paint solvent to remove all traces of paint from the outside surface of the head, in the area where the jacket will attach.
2. Inspect the surface of the head for any burrs, nicks or dents. The jacketed surface of the head must be clean and smooth to ensure proper sealing. Replace the head, if necessary.
3. Refer to step 3 of "Pump Assembly" for heating jacket installation instructions.

OPERATION

PRE-START UP CHECK LIST

1. Check the alignment of the pipes to the pump. Pipes should be supported so that they do not spring away or drop down when the pump flanges or union joints are disconnected.
2. Alignment is critical to good pump performance and is frequently disturbed during shipment, handling or installation. Before operating the pump, check the alignment between the driver, gear reducer, and the pump (see Figure 2).

   a. To check for parallel alignment, the use of a dial indicator is preferred. If a dial indicator is not available use a straight edge. Turn both shafts by hand, checking the reading through one complete revolution. Maximum offset should be less than .005" (.127 mm).

   b. To check for angular alignment, insert a feeler gauge between the coupling halves. Check the spacing in 45 degree increments around the coupling (four check points). Maximum variation should not exceed .005" (.127 mm).

   NOTE: After the pump has been in operation for a week or two, completely recheck alignment.

3. Couplings with rubber inserts do not require lubrication. All other couplings are pre-lubricated at the factory, but require frequent lubrication to prevent excessive wear.

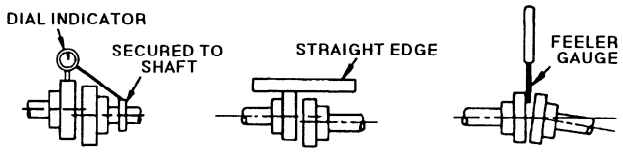

Figure 2 - Alignment Check

4. Blackmer helical gear reducers are shipped from the factory without oil in the gearcase. Fill with the grade of oil indicated on the reducer tag. For more specific instructions on Blackmer gear reducers, refer to Parts Lists 186/B1 through 186/B8.
5. Check the entire pumping system to verify that the proper inlet and discharge valves are fully open, and that the drain valves and other auxiliary valves are closed.
6. Install vacuum and pressure gauges in the threaded connections on the pump cylinder. These can be used to check the actual suction and discharge conditions after pump start-up.
7. Check the wiring of the motor, and briefly turn on the power to make sure that the pump rotates in the direction of the rotation arrow.

OPERATION

START UP PROCEDURE

If there is a problem with any of the following items, or if the pump is abnormally noisy, see "General Pump Troubleshooting" for possible causes.

1. Start the motor. Priming should occur within one minute.
2. Check the vacuum and pressure gauges to see if the pump is operating within the expected conditions.
3. Check for leakage from the piping and equipment.
4. Check for overheating of the pump, reducer, and motor.
5. If possible, check the flow rate.
6. Check the pressure setting of the relief valve by briefly closing a valve in the discharge line and reading the pressure gauge. This pressure should be 15 - 20 psi (103 - 138 kPa) higher than the maximum operating pressure, or the external bypass valve setting (if equipped). **CAUTION: Do not run the pump for more than 10 - 15 seconds with the discharge valve completely closed.** If adjustments need to be made, refer to "Relief Valve Setting and Adjustment."
7. If necessary, adjust the packing. Refer to "Packing Adjustment" in the Pump Assembly Section of this manual.

RUNNING THE PUMP IN REVERSE

It is sometimes desirable to run the pump in reverse to drain a line. The pump is satisfactory for this type of operation, but the flow rate will decrease depending on the system conditions and the pump speed. When running the pump in reverse, a separate relief valve is recommended to protect the pump from excessive pressures.

FLUSHING THE PUMP

1. To flush the pump, run the pump with the discharge valve open and the intake valve closed. Bleed air into the pump through the intake gauge plug hole or through the larger auxiliary fitting on the intake line. Pump air for 30 second intervals to clean out most of the pumpage.
2. Run cleaning fluid through the pump for one minute to clean out the remainder of the original pumpage. It is recommended to keep the pump full of cleaning fluid until the pump is used again. NOTE: The cleaning fluid must be compatible with the O-rings and vane material if the fluid is to be left in the pump for an extended period of time.
3. Flush out the cleaning fluid using the same procedure as in step 1.

PUMP ROTATION

To determine pump rotation:

If the intake port and the relief valve are on the right, with the drive end of the shaft pointing towards the observer, the pump is right-hand (clockwise rotation).

If the intake port and relief valve are on the left, with the drive end of the shaft pointing towards the observer, the pump is left-hand (counterclockwise rotation).

TO REVERSE PUMP ROTATION

To reverse pump rotation, both heads must be removed, and the cylinder rotated 180 degrees. The vanes must also be reversed, so that the relief grooves face in the direction of rotation. See "Maintenance" for removal and replacement of the pump parts.

RELIEF VALVE

Blackmer relief valves are designed for satisfactory operation with a partially closed discharge line on most types of installations. This allows for reduction of the flow without slowing down the speed of the pump—for a limited time.

The purpose of the relief valve is to protect the pump or pumping system from excessive pressure. The valve is not meant to be used for prolonged recirculation.

When pumping highly volatile liquids under a high suction lift, and cavitation or starving of the pump exists, partial closing of the discharge valve will result in excessive noise in the relief valve. A separate bypass valve, piped back to the storage tank, is recommended when operating under these conditions.

RELIEF VALVE SETTING AND ADJUSTMENT

The relief valve pressure setting is marked on a metal tag attached to the valve cover. Generally, the relief valve should be set at least 15 - 20 psi (103-138 kPa) higher than the operating pressure, or the external bypass valve setting (if equipped).

1. **To increase the pressure setting** , remove the relief valve cap, and turn the adjusting screw *inward*, or clockwise.
2. **To decrease the pressure setting**, remove the relief valve cap, and turn the adjusting screw *outward*, or counterclockwise.

Refer to the individual pump parts lists for various spring pressure ranges.

MAINTENANCE

MAINTENANCE AND TROUBLESHOOTING MUST BE DONE BY AN INDIVIDUAL EXPERIENCED WITH PUMP MAINTENANCE AND THE TYPE OF SYSTEM INVOLVED.

MAINTENANCE

NOTE: Before work is started on the pump, make sure the pressure is relieved, and the liquid is drained. During disassembly, be careful of sharp edges on worn or damaged parts.

LUBRICATION

Sleeve bearings (bushings) are lubricated by the liquid being pumped. Additional lubrication is not required.

Blackmer helical gear reducers are shipped from the factory without oil in the gearcase. Fill with the grade of oil indicated on the reducer tag. The oil should be changed after the first 48 hours of use, and approximately every 500 hours thereafter.

REPLACING VANES ONLY

1. Remove the head capscrews and head assembly from the **outboard** (non-driven) side of the pump.
2. Turn the shaft by hand until a vane comes to the top (12 o'clock) position of the rotor.
3. Remove and replace the vane, making sure the rounded edge is outward to contact the liner, and the relief grooves are facing in the direction of rotation (see Figure 3).
4. Rotate the shaft by hand until the next rotor slot is in the top position, and replace the vane.
5. Continue this procedure until all new vanes are in place. This method of vane replacement prevents the push rods from falling out.

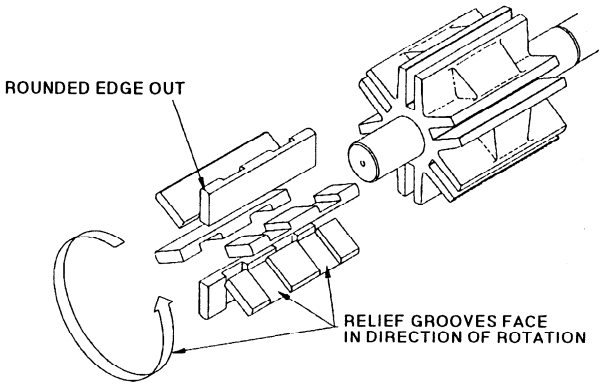

Figure 3 - Vane Installation*

*1 1/2 and 2 - inch models use only four vanes.

PUMP DISASSEMBLY

NOTE: The numbers in parentheses, following individual parts, indicate reference numbers on the parts list.

If the pump is equipped with an optional shaft support bearing, it should be removed prior to removing the inboard head. Refer to "Optional Shaft Support Bearing" for disassembly and assembly instructions.

1. Starting on the **inboard** (driven) end of the pump, clean the pump shaft thoroughly, making sure the shaft is free of nicks and burrs. This will prevent damage to the packing or mechanical seal when the inboard head assembly is removed.
2. Remove the packing follower stud nuts (18) and slide the packing follower (75) out of the stuffing box. A slight pry may be necessary.
3. Pull the packing rings (19) and pack washer (58) from the stuffing box with the use of a corkscrew tool or screwdriver. Be careful not to scratch or damage the shaft.

NOTE: If the pump is equipped with a commercial mechanical seal refer to the seal manufacturer's instructions for removal.

4. On pumps equipped with a heating jacket, remove the jacket/head capscrews (21A) and gently pry the jacket away from the inboard head assembly. The head assembly (20) can then be removed from the cylinder, with a slight pry, if necessary.
5. If the pump is not equipped with a heating jacket, remove the inboard head capscrews (21) and pry the head assembly away from the cylinder and off the shaft.
6. The sleeve bearing (24) is press fit into the head and should not be removed unless replacement is necessary (see "Sleeve Bearings").
7. Gently pull the rotor & shaft (13) out of the cylinder. While one hand is pulling the shaft, the other should be cupped underneath to prevent the vanes and push rods from falling out.
8. From the opposite (outboard) side of the pump, remove the bearing cover capscrews (28), bearing cover (27), and bearing cover O-ring (26).
9. Remove the outboard head (23) (and heating jacket, if equipped) as instructed in steps 4 - 6 above.

OPTIONAL SHAFT SUPPORT BEARING

Disassembly

1. Remove the four bearing housing locknuts and washers (106A & 106F), and the housing cover plate (106C) from the shaft support studs.
2. With an allen-wrench, loosen the setscrew in the lock collar (106B).
3. Using a punch tool and hammer, tap the bearing lock collar in the opposite direction of pump rotation (see Figure 4).
4. Once the lock collar is loosened, the bearing housing (106), and bearing & collar assembly (106B) can be pulled from the shaft. Use care not to drop and damage the individual parts.
5. Remove the two additional locknuts (packed pump models only), and the bearing stand-offs (106D) from the studs.
6. Proceed with steps 1 - 8 of "Pump Disassembly" to finish disassembling the pump.

MAINTENANCE

OPTIONAL SHAFT SUPPORT BEARING

Assembly - Pumps Equipped with Packing

1. If necessary, install the four bearing support studs (106E) into the tapped holes in the inboard head.
2. The packing and packing follower should be installed and adjusted (see "Packing Adjustment") prior to installing the shaft support bearing.
3. Slide the two bearing stand-offs (106D) onto the shaft support studs.
4. Install an additional locknut (106A) onto each of the two packing adjustment studs.
5. If necessary, arbor press the bearing (106B) into the bearing housing (106) until it is flush with, or slightly recessed in the housing.
6. Slide the bearing & housing assembly over the shaft, against the stand-offs.
7. Install the bearing lock collar against the bearing. Push firmly inward while tightening the allen-head set screw in the lock collar
8. Lock the collar to the shaft by tapping it in the direction of pump rotation with a punch tool and hammer (Figure 4).
9. Hand tighten the two locknuts against the backside of the bearing housing.
10. Place the bearing housing cover plate (106C) against the housing, and install the four washers and locknuts (106F & 106A). Hand tighten the locknuts.
11. With a counter wrench holding the locknuts on the backside of the housing, tighten the locknuts securely against the bearing cover.

Assembly - Pumps Equipped with Mechanical Seal

1. If necessary, install the four shaft support bearing studs (106E) into the tapped holes in the inboard head.
2. The mechanical seal should be properly secured in place on the shaft support bearing studs prior to installing the shaft support bearing. Refer to the manufacturer's instructions for mechanical seal installation.
3. Slide the four bearing stand-offs (106D) over the studs, against the mechanical seal locknuts.
4. If necessary, arbor press the bearing (106B) into the bearing housing (106) until it is flush with, or slightly recessed in the housing.
5. Slide the bearing & housing assembly over the shaft, against the stand-offs.
6. Install the bearing lock collar against the bearing and push firmly inward while tightening the allen-head setscrew in the lock collar.
7. Lock the collar to the shaft by tapping it in the direction of pump rotation with a punch tool and hammer (Figure 4).
8. Attach the bearing housing cover plate (106C) and install the washers and locknuts (106F & 106A). Tighten the locknuts.

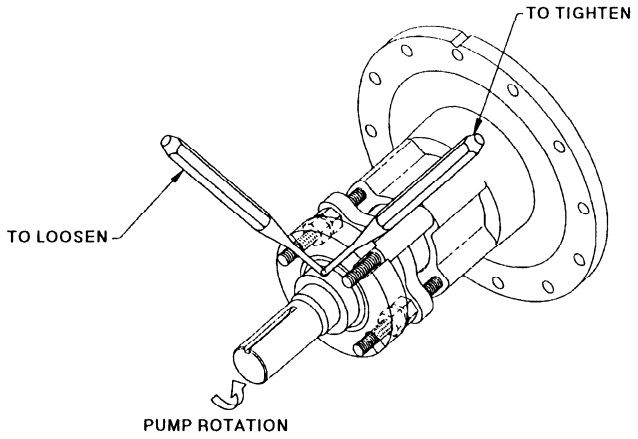

Figure 4 - Shaft Support Bearing

NOTE: After installation of the shaft support bearing, the rotor & shaft must turn freely when rotated by hand. If it does not turn freely, loosen the lock collar and make sure the bearing is firmly seated in the housing. Re-tighten the lock collar and test again.

PARTS REPLACEMENT

1. If any of the O-rings have been removed or disturbed during pump disassembly, it is recommended they be replaced with new O-rings.
2. Excessive or continuous leakage from the stuffing box in the head or around the pump shaft may be an indication of worn packing, a damaged mechanical seal, or a damaged or worn sleeve bearing.
   a. If the packing is leaking excessively refer to "Packing Adjustment." If this does not solve the problem, a complete new set of packing rings should be installed. (See "Pump Assembly" steps 8 & 9.)
   b. If the mechanical seal has been leaking, it is recommended the entire seal be replaced. Refer to the mechanical seal manufacturer's instructions.
   c. If the pump shaft indicates and excessive amount of "radial play," the sleeve bearing in the head should be replaced. (Refer to "Pump Assembly" step 1.)

PUMP ASSEMBLY

Pump assembly is generally the opposite of pump disassembly. Before reassembling the pump, clean each part thoroughly. Wash out the stuffing box and remove any burrs from the rotor and shaft.

1. SLEEVE BEARINGS

If the sleeve bearing has been removed from either head, a new bearing must be installed before reattaching the head to the cylinder.

a. To aid installation and prevent bearing damage, heat the head in an oven at 200°F (93°C) before installing the bearing.

b. Coat the bearing with grease and place it in the bearing bore on the inside face of the head, with the notched end outward. Align the notch in the bearing with the groove in the head (see Figure 5).

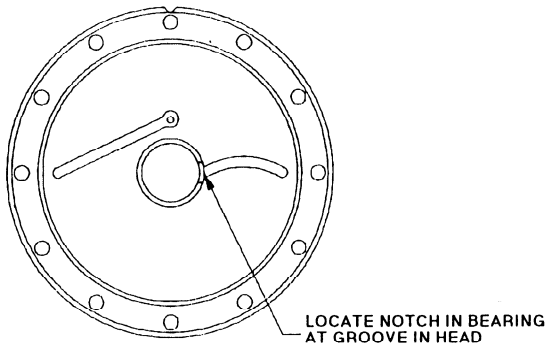

Figure 5 - Bearing Location

c. Using an arbor press, press the bearing into the head in one continuous motion, until it is flush with the inside face of the head or slightly recessed (.015" maximum). Make sure the bearing is properly aligned before starting the pressing motion. Starting and stopping the pressing motion may result in a cracked bearing.

2. OUTBOARD HEAD ASSEMBLY

If both head assemblies have been removed, it is easiest to install the **outboard** head assembly first.

NOTE: When installing the outboard head (23), make sure the relief valve and intake port on the pump cylinder are towards the *left* for clockwise (right-hand) rotation, or towards the *right* for counterclockwise (left-hand) rotation.

a. Apply a small amount of grease on the head O-ring (72), and install in the groove on the inside face of the head.

b. For *clockwise* (right-hand) rotation, place the outboard head (23) on the cylinder with the V-notch upward, in the 12 o'clock position. For *counterclockwise* (left-hand) rotation, place the outboard head (23) on the cylinder with the V-notch downward, in the 6 o'clock position.

c. Install the head capscrews (21) and uniformly tighten. NOTE: If the pump is equipped with an outboard heating jacket, the jacket capscrews (21A) will be used to hold the jacket *and* head in place.

3. HEATING JACKET (If Equipped)

a. Before installing the heating jacket, check the head for any nicks, dents or burrs. If the head is damaged in any way, the heating jacket will not seal properly. If necessary, replace the head.

b. Grease the machined area of the head and the inner surface of the heating jacket with a light grease.

c. Insert the jacket O-rings (72A and 72B) into the O-ring grooves.

d. Slide the heating jacket (20A) over the head, and position it so that the pipe plugs are vertically aligned in the 12 and 6 o'clock positions.

e. Install the jacket/head capscrews (21A) and uniformly tighten.

4. BEARING COVER

Install the bearing cover O-ring (26) and attach the bearing cover (27) to the outboard head. Install and uniformly tighten the bearing cover capscrews (28).

5. VANES AND PUSH RODS

It is necessary to install the bottom vanes and push rods prior to inserting the rotor and shaft into the pump.

a. Insert the vanes (14) into the bottom rotor slots with the rounded edges facing outward, and the relief grooves facing in the direction of rotation. (Refer back to Figure 3.)

b. Hold the vanes in place while inserting the push rods (77) from the top, as shown in Figure 6.

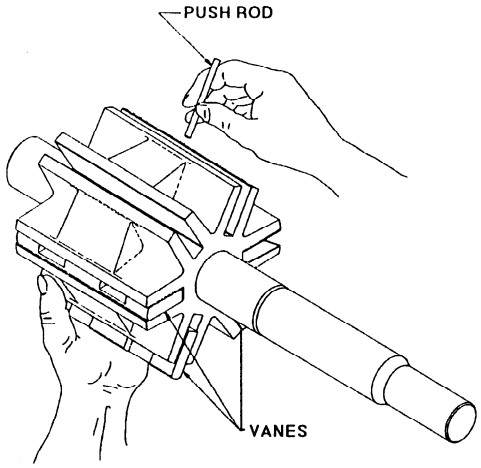

Figure 6 - Push Rod Installation*

*1 1/2 and 2 - inch models use four vanes and two push rods.

6. ROTOR AND SHAFT

a. While holding the vanes in place, carefully slide the non-driven end (shorter end) of the pump shaft into the open end of the pump cylinder and into the installed outboard head.

b. Install the remaining vanes into the top slots of the rotor with the relief grooves facing in the direction of rotation and the rounded edges outward.

7. INBOARD HEAD ASSEMBLY / HEATING JACKET

Follow the same procedures for installing the inboard head (20) and heating jacket (if equipped), as instructed previously in steps 2 and 3.

MAINTENANCE

8. PACKING AND PACKING FOLLOWER

When necessary to re-pack, use a full set of new packing rings. Packing is furnished in sets with the correct number of rings. Never add new rings to an old set of packing.

a. Insert the pack washer (58) into the stuffing box of the inboard head (20).

b. Insert each of the packing rings (19) separately into the stuffing box, staggering the split joints 180 degrees, so that they are not overlapping or near the joint of the preceding ring. Use the packing follower to properly seat each ring after placement.

c. After all of the packing rings are in place, slide the packing follower (75) against the packing. Install and hand-tighten the stud nuts (18) evenly.

NOTE: Adjustment to the packing follower should be made while pumping liquid (see "Packing Adjustment").

9. PACKING ADJUSTMENT

It is important that the packing be properly adjusted to prevent overheating.

a. While the liquid is being pumped, uniformly tighten the packing follower stud nuts (18) a very small amount at a time.

b. Check the stuffing box temperature several minutes after each adjustment for signs of overheating.

c. Adjust the nuts until leakage is controlled, and no excess heat develops.

d. Check the packing after 20 to 30 minutes of running the pump, and readjust, if necessary.

NOTE: Some leakage is desirable to lubricate the packing, but in some cases it is unacceptable, depending on the application.

10. OPTIONAL LIP SEAL ASSEMBLY

a. Insert the wave spring (152D) into the stuffing box of the inboard head.

b. Lightly grease the inboard shaft to facilitate lip seal installation. With the lip seal spring facing the pump, slide the lip seal assembly (152) into the stuffing box, against the wave spring.

c. Install the seal follower (75) against the lip seal assembly. Install and tighten the follower capscrews (16).

NOTE: When installed properly, lip seals should require no adjustment.

11. COMMERCIAL MECHANICAL SEAL

On pumps equipped with a commercial mechanical seal, refer to the separate literature accompanying the mechanical seal for installation instructions.

GENERAL PUMP TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE
Pump Not Priming	1. Pump not wetted. 2. Suction valve closed. 3. Air leaks in the suction line. 4. Suction line or valves clogged or too restrictive. 5. Wrong rotation on motor. 6. Broken drive train. 7. Pump vapor-locked. 8. Pump speed too low for priming. 9. Worn vanes.
Reduced Capacity	1. Suction valves not fully open. 2. Air leaks in the suction line. 3. Excessive restriction in the suction line (i.e.: undersized piping, too many elbows & fittings, etc.). 4. Damaged or worn parts (refer to "Parts Replacement"). 5. Excessive restriction in discharge line causing partial flow through the relief valve. 6. Relief Valve worn, set too low, or not seating properly. 7. Vanes installed backwards (see "Replacing Vanes Only").

GENERAL PUMP TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE
Noise	1. Excessive vacuum on the pump due to: a. Undersized or restricted fittings in the suction line. b. Pump speed too fast for viscosity of liquid. c. Pump too far from fluid source. 2. Running the pump for extended periods with a closed discharge line. 3. Misalignment of the pump, reducer, or motor. 4. Sleeve bearings worn or damaged (refer to "Parts Replacement"). 5. Vibration from improperly anchored piping. 6. Baseplate not securely mounted. 7. Bent shaft. 8. Excessively worn rotor. 9. Malfunctioning valve in the system. 10. Insufficient oil in the gear reducer. 11. Damaged vanes (see following category).
Damaged Vanes	1. Foreign objects entering the pump. 2. Running the pump dry for extended periods of time. 3. Cavitation. 4. Viscosity too high for the vanes and/or the pump speed 5. Incompatibility with the liquids pumped. 6. Excessive heat. 7. Worn or bent push rods, or worn push rod holes. 8. Settled or solidified material in the pump at start-up. 9. Hydraulic hammer - pressure spikes.
Broken Shaft	1. Foreign objects entering the pump. 2. Viscosity too high for the pump speed. 3. Relief valve not opening. 4. Hydraulic hammer - pressure spikes. 5. Pump-driver misalignment. 6. Over-tightened V-belts, if used. 7. Excessively worn vanes or vane slots. 8. Settled or solidified material in pump at start-up
Overload on Motor	1. Horsepower of motor not sufficient for application. 2. Improper wire size or wiring. 3. Misalignment. 4. Excessive viscosity, pressure, or speed. 5. Faulty or worn sleeve bearings. 6. Rotor rubbing into head. 7. Excessively tight packing (see "Packing Adjustment.). 8. Unevenly tightened stud nuts, causing shaft interference with the packing follower.

NOTE: For commercial mechanical seal troubleshooting, refer to manufacturer's instructions.

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