OPERATION & MAINTENANCE MANUAL

FOR

NON-CLOG TYPE PUMPS

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SAFETY PRECAUTIONS

WARNING ! ! Read this manual carefully before attempting to install, operate, or repair this pump.

To insure safe operation, read and implement each warning in this manual. As a safeguard to keeping the warranty valid, instructions should be followed carefully. Failure to comply with installation, operating and maintenance instructions will void the **WARRANTY** and may result in bodily injury, as well as damage to the pump.

This manual is intended to be part of the pump installation and should be maintained in a convenient location for ready reference.

NOTE: The descriptions and instructions included in this book cover the standard design of the equipment. This book does not provide for every possible contingency, which may be encountered. When information cannot be found in this book, contact the nearest Patterson Pump Company representative or the factory.

The size and type of pump was selected to meet conditions specified by the purchaser. Among the more important conditions are:

Flow Rate
Temperature of the Liquid and the Specific Gravity
Suction Conditions
System Characteristics
Driver Speed

If any one of these conditions has changed since the order was placed, it is recommended that the change be reviewed with a Patterson Pump Company representative.

CAUTION: Operation of the pump under conditions differing widely from those, on which the pump selection was based, may result in cavitation or shortened life of bearings, seals, packing, and shaft.

WARNING! ! The equipment has been found satisfactory for the conditions for which it was sold, but its operation in excess of these conditions may subject it to stresses and strains which it was not designed to withstand.

For equipment covered by this instruction manual, it is important to observe safety precautions to protect personnel from possible bodily injury. Among the many considerations, personnel should be instructed to:

- avoid contact with rotating parts

- avoid removing or rendering inoperative any safeguards or protective devices

- avoid extended exposure in close proximity to machinery with high noise levels

- use proper care and procedures in handling, lifting, installing, operating, or repairing the equipment

- avoid modification of the equipment; consult the factory if modification is deemed necessary

- use only repair parts supplied by the equipment manufacturer

Safe maintenance practices with qualified personnel are imperative.

FAILURE TO HEED THIS WARNING MAY RESULT IN AN ACCIDENT CAUSING PERSONAL INJURY.

FOR DETAILS, REFER TO THE JOB ASSEMBLY DRAWING ENCLOSED WITH THIS MANUAL.

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SECTION I

GENERAL INFORMATION

This manual covers the installation, operation and maintenance of Patterson non-clog type pumps. The pump is a centrifugal, single stage, single suction type. When properly installed and when given reasonable care and maintenance, centrifugal pumps should operate satisfactorily for a long period of time. Centrifugal pumps use the centrifugal force principal of accelerating the liquid within a rotating impeller, and then collecting it and converting it to pressure head in a stationary volute.

The pump consists of two assemblies:

1. Casing assembly or stationary parts.
2. Rotating element or moving parts.

The pump is designed to allow complete removal of the impeller and rotating element without disturbing suction and discharge piping.

The volute cover collects stuffing box leakage, which may be drained using the drilled and tapped hole provided. Suction and discharge flanges are drilled and tapped for gauge connections. Pump casing is drilled and tapped on the underneath side for drainage of pump. Wear rings may be provided if specified to minimize internal by-passing of the liquid being pumped, and to better efficiency, as well as to reduce the replacement of major components (such as casing and impeller). Pump may be either a horizontal or vertical model driven by an engine or motor thru flexible coupling (horizontal and vertical) or thru intermediate shafting (vertical).

SECTION II

STORAGE AND PROTECTION

There are occasions when considerable time elapses between the delivery date and the time pump is put into operation. Equipment which is not in service should be kept in a clean, dry area. If equipment is to be stored for long periods of time (6 months or more), the following precautions should be taken to insure that the equipment remains in good condition:

1) Be sure that bearings are fully lubricated.
2) Unpainted machined surfaces which are subject to corrosion should be protected by some corrosive resistant coating.
3) The shaft should be rotated 10 to 15 revolutions by hand periodically in order to spread lubricant over all the bearing surfaces. Suitable intervals are from one to three months, depending on atmospheric conditions, etc. In order to insure that the pump shaft does not begin to sag in horizontal pumps, do not leave the shaft in the same position each time. For example, if the coupling key is at the top when rotation begins, it should be at the right when rotation ends. If periodical rotation of the shaft is not possible, the bearings should be cleaned and packed with petrolatum or other suitable anti-rust agents, according to the advice of a reputable supplier.

4) Space heaters on motors and controllers should be connected and fully operable if atmospheric conditions approach those experienced in operation. Consult instruction manuals for other precautions concerning storage of individual components supplied with pumping unit.

5) Fresh lubricant must be applied to bearings upon removal of equipment from storage or when started for the first time.

SECTION III

INSTALLATION

3-1 Location:

Several factors should be considered when selecting a location for the pumping unit (pump, base, drive, and coupling). The unit should be accessible for both inspection and maintenance. Head room should be provided for the use of crane, hoist or other necessary lifting devices. The pump should be located as close as possible to the liquid supply so that the suction line is short and direct. Location should require a minimum of elbows and fittings in the discharge line to minimize friction losses. The unit should be protected against flooding.

3-2 Foundation:

The foundation should be sufficiently substantial to absorb vibration and to form a permanent rigid support for the base plate. Concrete is most widely used for foundation. Before pouring concrete, locate anchor bolts per general arrangement drawing. Allow for grout between foundation and base plate as indicated or about% in. to 1% in. The top surface of foundation should be roughened to provide a good bond for the grout. Coupling halves should be disconnected when mounting pumping unit on foundation. Wedges should be used to support the unit at time of grouting (Fig. 1). Wedges should be located adjacent to anchor bolts. Adjust the wedges to raise or lower the unit as required to align suction and discharge flanges to piping and to level the baseplate. Leveling bolts are useful when leveling large baseplates, but should not replace shims or blocks for supporting the load.

3-3 Lifting:

WARNING ! ! Use extreme caution when lifting pumping unit. When lifting a horizontal pump with base and drive equipment, use lugs provided in the base. When lifting a vertical pump, eyebolts may be installed in the tapped holes in the pump casing. Before lifting, any pump should be secured in a manner that will maintain the pump in a stable, upright position while lifting. While lifting, stand clear and lift slowly.

3-4 Alignment:

WARNING ! ! Disconnect all electrical connections to insure that pump will not start during coupling or intermediate shaft alignment and installation.

Reliable, trouble-free and efficient operation of unit depends upon correct alignment. Misalignment may be the cause of noisy pump operation, vibration, premature bearing failure, or excessive coupling wear. Factors that may change the alignment of the pumping units are settling of the foundation, springing of the baseplate, piping strains, settling of the building, bearing wear, loose nuts or bolts on the pump or drive assembly, and a shift of pump or drive on the foundation. When checking coupling alignment, remember, flexible couplings are not intended to be used as universal joints. The purpose of a flexible coupling is to compensate for temperature changes and to permit end movement of the shafts without interference with each other.

Two types of misalignment may exist: 1) parallel misalignment and 2) angular misalignment. Limits of misalignment are stated in coupling or shafting manufacturer's instructions, but should be kept to a minimum for maximum life of equipment components.

To check coupling alignment, the following procedure should be followed: (Fig. 2)

1. Set the coupling gap to the dimensions shown on the outline drawing.
2. Check for parallel misalignment by placing straight edge across both coupling halves at four points goo apart. Correct alignment occurs when straight edge is level across the coupling halves at all points.
3. Check angular misalignment with a feeler gauge at four points 90° apart. Correct alignment occurs when the same gauge just enters between the halves at all four points.

Angular and parallel misalignment are corrected by shifting the motor and adding or removing shims from under the motor feet. After each change, it is necessary to recheck the alignment of the coupling halves. Adjustment in one direction may disturb adjustments already made in another direction.

An alternative method for checking coupling alignment is by use of a dial indicator. Proceed as follows: (Fig.3)

1. Scribe index lines on coupling halves or mark where the indicator point rests.
2. Set indicator dial to zero.
3. Slowly turn both coupling halves so that index lines match, or indicator point is always on the mark.
4. Observe dial reading to determine whether adjustments are needed. Acceptable alignment occurs when total indicator reading does not exceed 0.004 in. for both parallel and angular alignment.

For alignment instructions for installations having intermediate shafting, refer to shafting manufacturer's instructions. The importance of correct alignment cannot be overemphasized. Alignment should be checked and corrected as required after:

1. Mounting
2. Grout has hardened
3. Foundation bolts are tightened
4. Piping is connected
5. Pump, driver, or baseplate is moved for any reason.

After unit has been in operation for about a week, check alignment. After making any required adjustments, dowel pump and motor to base.

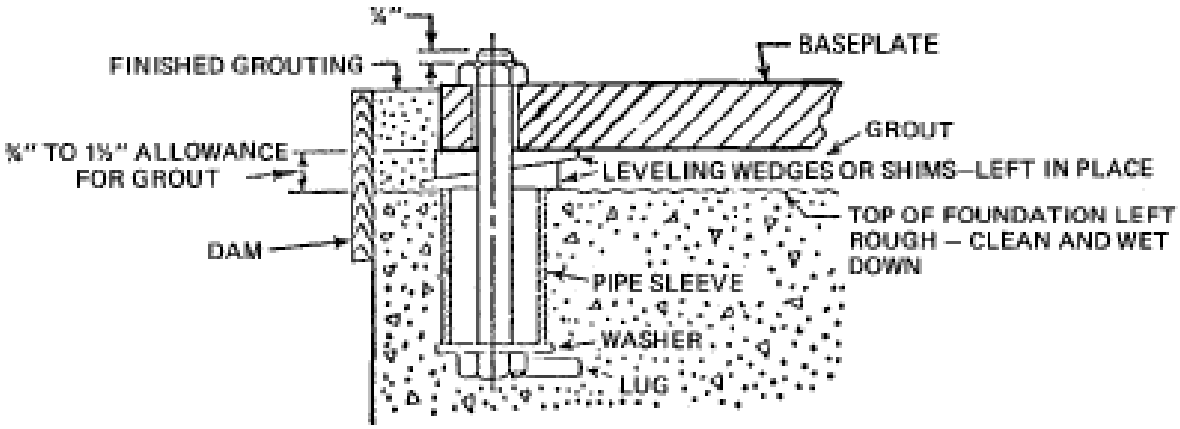


FIG. 1 TYPICAL FOUNDATION BOLT DESIGN

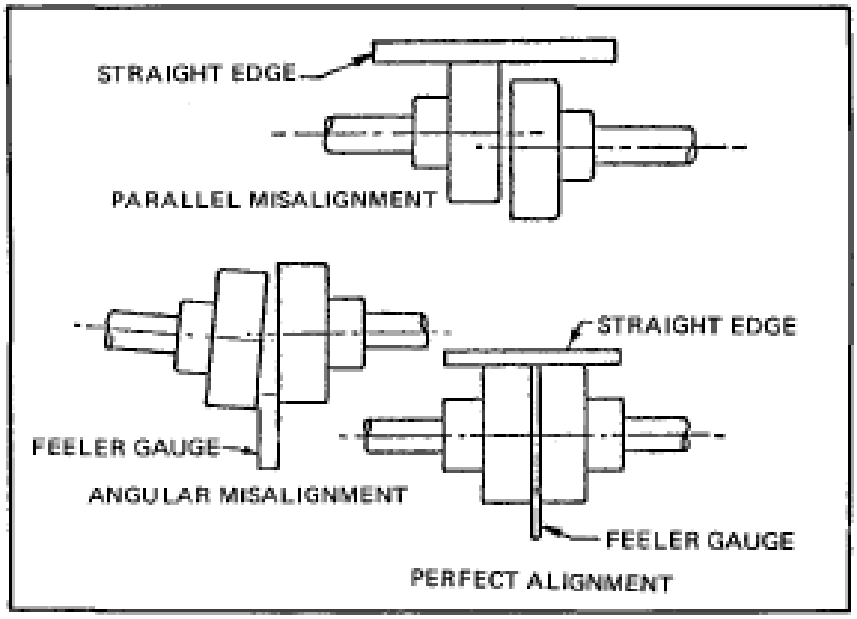


FIG. 2 TESTING ALIGNMENT, STRAIGHTEDGE

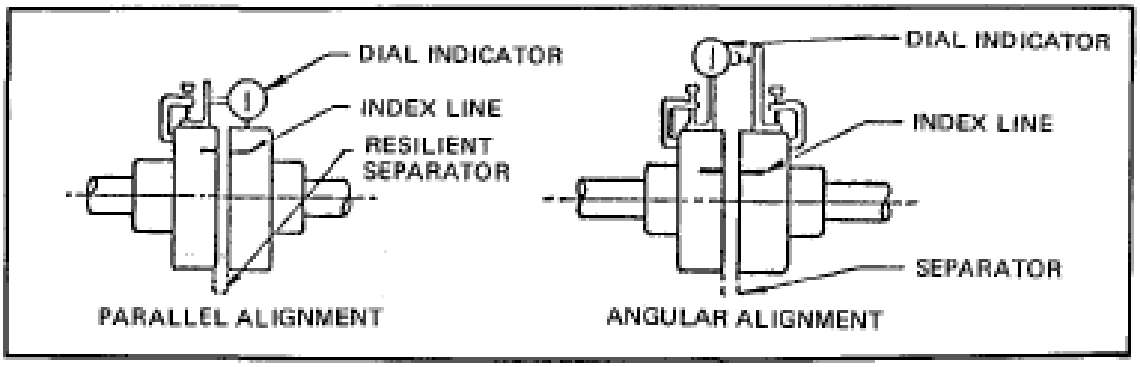


FIG. 3 TESTING ALIGNMENT, DIAL INDICATOR

3-5 Grouting:

Grout compensates for unevenness in the foundation and distributes the weight of the unit uniformly on the foundation. It also prevents lateral shifting of the baseplate and reduces vibration. Use a non-shrinking grout. Foundation bolts should be tightened evenly, but not too firmly. Grout the unit as follows:

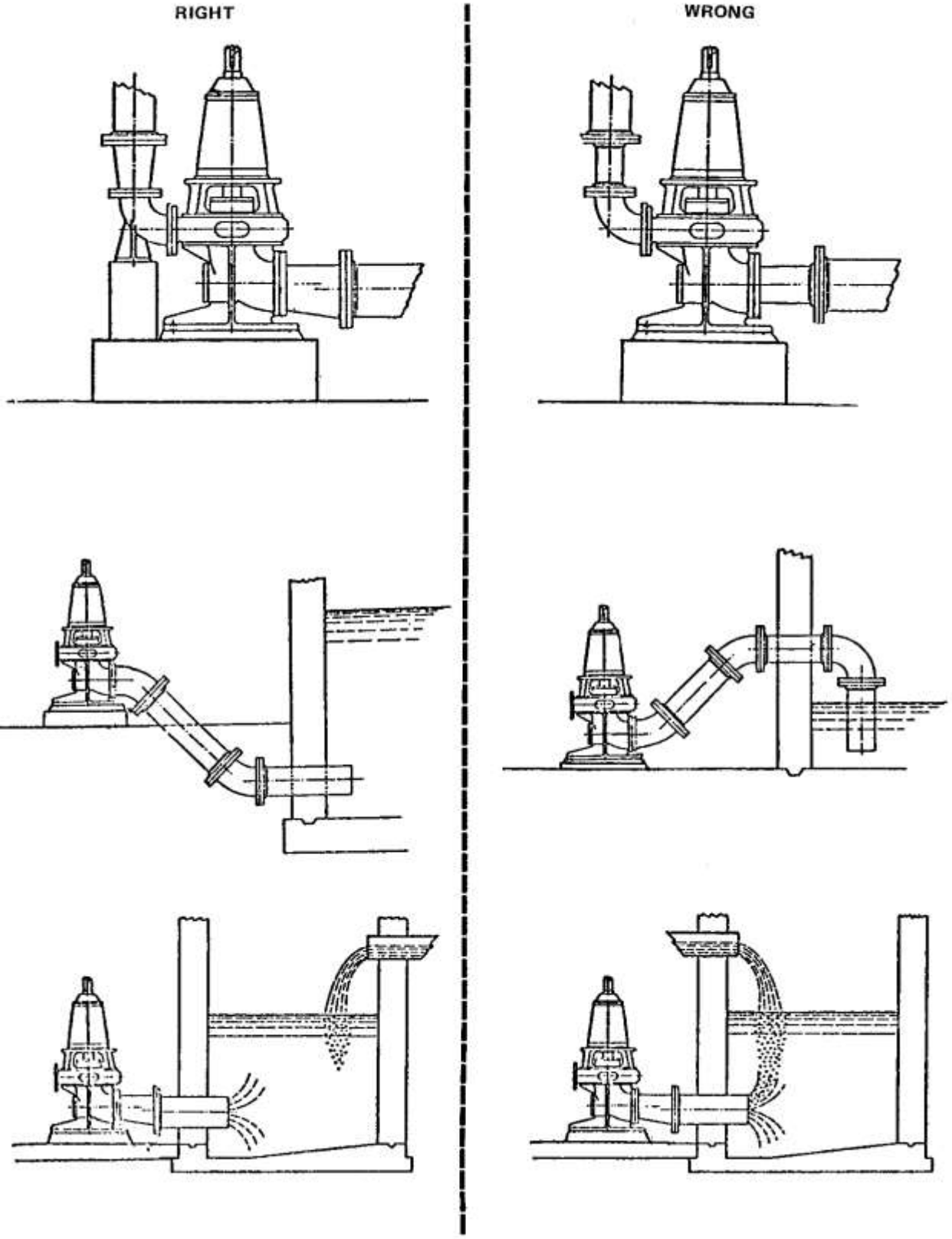
1. Build a strong form around the base or soleplate to contain the grout.
2. Soak the foundation top thoroughly, and then remove surface water.
3. Pour grout. Tamp liberally while pouring in order to fill all cavities and prevent air pockets. The space between the foundation and base or soleplate should be completely filled with grout. Wedges or leveling screws may be left in place.
4. After the grout has hardened (usually about 48 hours), thoroughly tighten foundation bolts and check alignment.
5. Approximately 14 days after the grout has been poured or when it is thoroughly dry, apply an oil base paint to exposed edges of the grout contact with the grout.

3-6 Piping:

Connect pipe lines after the grout has thoroughly hardened. The suction and discharge piping should be installed with the shortest and most direct runs. Elbows should preferably be of the long radius type. Pipes must line up naturally. The piping must never be pulled into position by the flange bolts. Such action may draw the pump out of alignment. Pipes should be supported independently of pump so as not to put any strain on pump casing. Suction piping, if not properly installed, is a potential source of faulty operation. Suction lines should be free of air leaks, and arranged so there are no loops or high spots in which air can be trapped. If the suction line is larger than the pump suction nozzle, eccentric reducers should be used. Eccentric reducers are not necessary in vertical suction pipes. If the liquid supply is located below the pump centerline, the reducer should be installed with the straight side up.

Installation with a static suction lift preferably should have the inlet of the vertical suction piping submerged in the liquid a depth up to 4 times the piping diameter. A large suction pipe will usually prevent the formation of vortices, especially if the entrance is flared. A stream of liquid falling into the sump near the intake pipe will churn air into the liquid (Fig. 4). The supply line should extend down into the sump. Liquid supply entering a well perpendicular to the intake line tends to rotate the liquid which interferes with the flow into the suction line. A baffle placed in front of the supply pipe will remedy this situation. A short elbow should never be bolted directly to the pump suction nozzle. The disturbance in the flow caused by the sharp bend so near the pump inlet may result in noisy operation, loss in efficiency and capacity, and heavy end thrust. A long sweep or long radius elbow placed as far away from the pump as practicable should be used if a bend is necessary in the suction line. If separate suction lines cannot be used for each pump, then a tapering header with Y branches should be used. A straight branch header should never be used. Prior to installing pump, suction piping and pump should be inspected internally for foreign matter that might be drawn into impeller passages and clog them. A strainer should be in the suction line with openings smaller than the sphere size allowed by the impeller. The openings in the screen must be checked and cleaned periodically.

PIPING
FIG. 4



Discharge piping should be installed with a check valve and gate valve, with the check valve being between the pump and the gate valve. The check valve prevents reverse flow and protects the pump from excessive back pressure. The gate valve is used to isolate the pump for maintenance, priming and starting. If a diffuser is used, it should be placed between the pump and the check valve.

3-7 Stuffing Box Lubrication:

Refer to Assembly Drawing for the particular job (Not typical drawing)

a) For Pumps Equipped with Grease Lubrication of Stuffing Box

Pumps having grease lubricated stuffing box are normally supplied with a grease fitting at the stuffing box. Check to see that this grease fitting is present and that the stuffing box is properly lubricated with grease.

If lubrication of the stuffing box is to be accomplished by means other than a grease gun, remove the grease fitting and install automatic lubricator and/or lubrication line as dictated by the job requirements. Refer to lubricator manufacturer's instructions.

b) For Pumps Equipped with Water Lubrication of Stuffing Box

If the liquid being pumped is not suitable for stuffing box lubrication, fresh cool water from an outside source should be piped to the stuffing box at a pressure about one atmosphere higher than maximum discharge pressure.

WARNING ! ! Improper seal water conditions can cause air leakage into the pump, excessive seepage out of the pump, overheating of packing and premature failure of packing and scoring of shaft sleeve.

Note: Some pump models having either grease or water lubricated stuffing boxes require the installation of an additional lubrication line at a connection shown on the pump assembly section drawing leading to a bushing located between the stuffing box and impeller.
Water lubrication is required through this line for pumps having either water or grease lubricated stuffing boxes. The bushing requires 3 to 4 GPM (10 to 15 lpm) of fresh cool water at a pressure approximately one atmosphere above maximum discharge pressure.

WARNING ! ! Failure to observe these instructions may result in damage to the pump due to seizure of the rotating element.

3-8 Bearing Oiler Installation:

(Model FS Pumps Only)

Each Model FS Pump is normally supplied with a Trico Optomatic Oiler as standard to maintain a constant oil level in the spherical roller thrust bearing. Install the oiler according to the instructions given herein.

From figure 5a it may be seen that the actual oil level obtained in the pump corresponds to the top of the slanted cut on the tube which is attached to the bottom of the oiler sight glass.

Note: The oil level in the pump is not related to the oil level in the sight glass.

On the assembly section drawing for the particular job (not the typical drawing in this manual) is given a dimension which locates the correct oil level required with respect to the top of the bearing housing of the pump. The top of the slanted cut on the sight glass tube must correspond to the oil level required as shown on the assembly section drawing in order to proper bearing lubrication and prevent damage to the pump. This is accomplished in 2 steps; 1) installation and 2) adjustment:

1) Installation:

The oiler should be installed such that a pipe extends from the pump bearing housing connection and using an elbow and pipe nipple, connects to the bottom connection of the oiler with the sight glass mounted vertically. The length of the pipe nipple should be selected such that when the oiler is installed, the centerline of the side connection of the oiler is as close as possible to, but not less than 7 /32" below the oil level indicated on the assembly section drawing. When installing be sure that oiler is level, that all chips and dirt are carefully removed, and that thread compound is used on all threaded connections. When installation is complete according to these instructions, the oiler is ready for adjustment.

2) Adjustment:

The oiler must now be adjusted to properly locate the top of the slanted cut at the bottom of the sight glass tube. The tube and hence oil level may be raised or lowered quickly and easily as required by loosening set screws as shown in Figure 5b.

Warning: Failure to attain correct oil level will result in improper thrust bearing lubrication conditions and possible bearing failure and other damage to the pump.

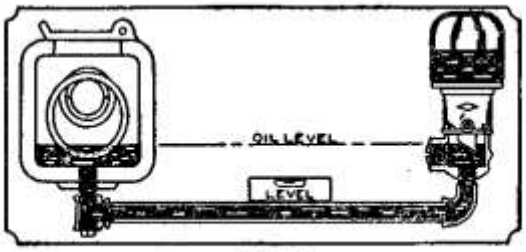
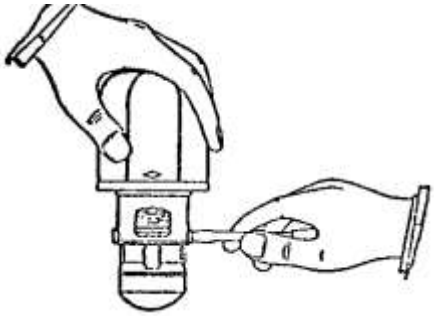


FIG. 5a


SIMPLE, QUICK LEVEL ADJUSTER
The oil level can be raised or lowered quickly. Loosen set screws, adjust level and tighten screws.
FIG. 5b

SECTION IV

OPERATION

4-1 Preparation:

At initial startup, before bolting coupling halves together, check the drive rotation to see that it matches the pump rotation.

WARNING! Do not operate pump in reverse.

For a three-phase motor, rotation may be reversed, if necessary, by interchanging any two of the three power leads. Rotation of single-phase motors is fixed by internal wiring. Prior to each startup, check the shaft alignment as covered in **Installation.** Check the bearing and stuffing box for proper lubrication and install oil in pumps with oil lubricated bearings. Check to see that V-ring seals (if supplied) are properly seated against bearing covers.

WARNING!! Pumps having oil lubricated bearings are normally shipped without oil and oil must be added at initial startup. Refer to Maintenance Section on Bearings Lubrication for bearings having either grease or oil lubrication. Operation of the pump without proper lubrication will cause damage to the pump and possible personal injury.

4-2 Starting:

Check that the shaft turns freely by hand. Check that the shaft guard is in place. Check the bearing lubricant.

Open valve in the pump suction line, if fitted.

WARNING! Any valve in the suction line must be completely open.

Close discharge valve.

Prime the pump in one of the following ways:

a) If the pump operates under positive pressure, open the vent valve on top of the pump casing. After all entrained air has escaped, close the vent valve. Rotate the shaft, if possible, to allow any air trapped in the impeller passages to escape.

b) If the pump operates on a suction lift and a foot valve is included in the system, fill the pump and suction line with liquid from an outside source. Trapped air should be allowed to escape through the vent valve while filing.

c) If the pump operates on a suction lift and no foot valve is provided; use a vacuum pump or ejector operated by air, steam, water, etc., to evacuate air from the pump case and the suction line by connecting the ejector to the priming connection on top of the pump case.

Open valves in the stuffing box seal line and water lubrication line near the stuffing box, if fitted. Start driver. Open discharge valve slowly when the pump is up to speed. **CAUTION!** Overheating and/or loss of prime will result if the pump is operated against a closed valve for more than a few minutes.

Adjust the packing gland until there is a slight leakage from the stuffing box. (See **Maintenance on Adjustment of Packing**). Mechanical seals need no adjustment. Note: Should pump fail to build up pressure or discharge water when discharge valve is opened, stop pump and read section, **Locating Operating Difficulties.**

4-3 Shutdown:

The pump may be stopped with the discharge valve open without causing damage. However, in order to prevent water hammer effects, the discharge valve should be closed first.

A. Close the discharge valve. (**CAUTION: -** Do not operate pump with the valve closed for more than a few minutes.)

B. Stop the driver.

C. Close the water seal and the lube lines, if applicable.

D. Close valve in the pump section line if the pump is to be removed. If danger of freezing exists, drain the pump completely.

4-4 Minimum Flow Limitation:

As a rule, a centrifugal pump should be operated as close as possible to its best efficiency point (BEP); refer to performance curve. However, all centrifugal pumps have limitations on the minimum flow at which they should be operated. The most common limitation is to avoid excessive temperature build up in the pump because of absorption on the input power into the pumped fluid. Other less understood reasons for restrictions are:

1. Increased radial reaction at low flows in a single volute casing.

2. Increased NPSHR at low flows.

3. Noisy, rough operation and possible physical damage due to internal re-circulation.

4. Increased suction and discharge pulsation levels.

The size of the pump, the energy absorbed, and the liquid pumped is among the consideration in determining these minimum flow limitations. For example, most small pumps such as domestic home circulators, service water pumps, and chemical pump have no limitations, except for temperature buildup considerations while many large, high horsepower pumps have limitations as high as 40 - 50% of the best efficiency point capacity.

Contact the factory if a minimum flow recommendation for your pump is desired. In doing so give the pump serial number for each pump for which a minimum flow recommendation is requested.

SECTION V

MAINTENANCE

5-1 Couplings:

Couplings with rubber drive elements do not require lubrication. Most other couplings require some form of lubrication. Consult manufacturers' instructions for recommendations.

5-2 Bearings:

WARNING ! ! Proper bearing lubrication is essential to pump operation. Do not operate pump if sufficient lubricant is not present in bearing housing or if lubricant is contaminated with dirt or moisture. Operation of the unit under these conditions will lead to impaired pump performance and possible bearing failure. Do not operate pump with excessive amount of lubricant. Such action will cause bearings to overheat. Mixing of different greases or oils and use of the wrong grease or oil will damage the bearings.

MODEL F PUMPS ONLY (For Model FS, see page 13)

Refer to Actual Assembly Drawing for the particular job (Not Typical Drawing)

a) Grease Lubrication (Model F Pumps)

All pump bearings having grease lubrication are lubricated at the factory. However, bearing lubricant should be checked before starting. If moisture is present, bearings should be cleaned and grease applied. Bearings which are dismantled are more easily cleaned than bearings which stay in assembled equipment; solvents can be used more freely and effectively. The use of chlorinated solvents of any kind is not recommended in bearing cleaning.

Operating conditions and atmospheric conditions existing in the area of installation must be considered when determining how often lubrication is necessary. Refer to Table I in this section. If operating under favorable conditions that do not warrant frequent lubrication, the grease inlets should be equipped with plugs that are replaced with grease fittings only during lubrication.

Allow only experienced maintenance personnel to lubricate this unit. Before attempting to lubricate this unit, refer to your specific assembly drawing to determine the specific type and location of bearings that are used. The bearings will accept grease while operating.

The following steps constitute the procedure for lubricating the bearings:

1. Clean the exterior of the unit around the grease and drain plugs.

2. Remove the drain plugs and if grease holes are plugged, remove the plugs and install grease fittings in their place.

3. Slowly introduce recommended grease, per Table II into the bearings. DO NOT over lubricate. Churning of the grease may result in harmful overheating of bearings.

4. Before replacing the relief plug, operate the unit for approximately 15 minutes to expel any excess pressure from the bearing chambers. Wipe off all grease from around relief hole and grease fittings. Replace relief plug.

5. If the unit is being operated under normal conditions, and does not require frequent lubrication, replace grease fittings with plugs as a precaution against personnel over lubricating bearings.

TABLE 1
SUGGESTED RE-LUBRICATION INTERVALS FOR VARIOUS ENVIRONMENTAL, OPERATING AND TEMPERATURE CONDTIONS (GREASE LUBRICATED BEARINGS)

AMBIENT CONDITIONS		OPERATING CONDITIONS		BEARING OPERATING TEMPERATURE		SUGGESTED GREASING INTERVALS**	USE THESE GREASES
Dirt	Moisture	Load	Speed	Low	High		
Clean	Dry	Light to medium	Slow to medium	0°F (-18°C)	120°F (49°C)	2 to 6 months	High quality NGLI No. 1 or 2 multipurpose bearing greases are generally satisfactory. Consultation with a reputable lubricant supplier is recommended.
				120°F (49°C)	200°F (93°C)	1 to 2 months	
Moderate to dirty	Dry	Light to medium	Slow to medium	0°F (-18°C)	120°F (49°C)	1 to 4 weeks	
				120°F (49°C)	200°F (93°C)	1 to 7 days	
Extreme dirt	Dry	Light to medium	Slow to medium	0°F (-18°C)	200°F (93°C)	Daily flushing out dirt	
	High humidity Direct water Splash	Light to heavy	Slow to medium	32°F (0°C)	200°F (93°C)	1 to 4 weeks grease at shutdowns	Lithium or other corrosion control grease
		Heavy to very heavy	Slow	0°F (-18°C)	200°F (93°C)	1 to 8 weeks	High viscosity lubrication
				-20°F (-29°C)	120°F (49°C)	1 to 8 weeks	
		Light	High speed	100°F (38°C)	200°F (93°C)	1 to 8 weeks	Channeling (high speed) type grease
	Possible frost	Light to heavy	Slow to medium	-65°F (-54°C)	+250°F (121°C)	1 to 4 weeks grease at shutdown	Wide temperature range Diester-type greases (Silicone-Diester-Polyester lubricants)
Clean to moderate	Dry	Light to medium	Slow to medium	80°F (27°C)	250°F (121°C)	1 to 8 weeks	Good quality high temperature type greases
Clean to dirty	Dry	Light	Slow	80°F (27°C)	300°F (149°C)	1 to 4 weeks	Synthetic type greases

**Suggested starting interval for maintenance program. Check grease conditions for oiliness and dirt and adjust greasing frequency accordingly. Watch operating temperatures as sudden rises may show need for grease or indicate over lubrication on higher speed applications.

Recommended Grease, Table II

The greases listed here are recommended for use in all grease lubricated bearings in your pump. All old grease must be flushed out from the bearing chambers before lubricating, if another type of grease has been used.

COMPANY	GREASE
*Fina Shell Texaco Gulf Texaco Standard	Lithium 2-R Alvania EP No. 2 Premium RB No. 2 Gulfcrown EP No. 2 Multifak EP No. 2 Amolith EP No. 2

***Note:** All grease lubricated bearings are factory lubricated with this grease before shipment.

MODEL FS PUMPS ONLY (For Model F, See page 11)

Refer to Actual Assembly Drawing for the particular job (Not typical drawing)

Each Model FS pump is supplied with an oil lubricated spherical roller thrust bearing and a grease lubricated antifriction bearing to absorb the radial thrust at the thrust bearing end of the pump.

a) Grease Lubricated Antifriction Bearings (Model FS Pumps)

The instructions given under the section, Grease Lubrication - Model F Pumps Only, will apply for the grease lubricated antifriction bearing in a model FS pump, with the exception that substitution of the other greases for Fina Lithium 2R grease is not recommended due to some mixing of grease with the oil in the oil lubricated thrust bearing. If substitution of grease is desired, please contact factory for recommendations.

> **WARNING!!** Failure to observe this may cause premature bearing failure and subsequent damage to the pump.

b) Oil Lubricated Thrust Bearings (Model FS Pumps)

The following instructions will apply to the oil lubricated spherical roller thrust bearing supplied in a model FS pump. CAUTION: Pumps with oil lubricated bearings are shipped from the factory with oil drained out. Oil must be added prior to initial startup. Before placing pump into operation, check oil for presence of moisture. If present, clean the bearing and replace oil.

Oil for spherical roller thrust bearing on the pump should be Fina GL-5140. If substitution for this oil is desired, please contact factory for recommendations.

> **WARNING ! !** Use of improper oil can cause premature bearing failure and subsequent damage to the pump.

These bearings have a normal operating temperature of 190° -F (88° C) approximately.
Unless otherwise specified, a standard Model FS pump is fitted with a Trico Optomatic Oiler which will add make-up oil if the oil level is the thrust bearing should drop, and also give an indication of any loss of oil.

It is extremely important that the oil level setting be checked and properly set if required. This can be easily accomplished as follows: The proper oil level is given on the pump assembly section drawing. The minimum oil level setting is 7 /32 in. (about 6 mm) above the centerline of the side outlet of the oiler. To set the oil level required, the dimension given on the assembly section drawing is the oil level setting and also is the dimension from the reference to the top of the slant tube. If the oil level is too low, simply loosen the set screws and raise the slant tube and bowl to the proper dimensions, as shown on Figure 5b.

To fill the bearing housing, fill the bottle, screw it in the lower reservoir of the Optomatic oiler and allow the oil to flow into the bearing housing. Several fillings may be required before the oil level in the bearing chamber is equal to the level for which the oiler is adjusted. NEVER FILL THE BEARING CHAMBER THROUGH THE BASE OF THE OILER. Inspect the oil from time to time by draining a small amount from bearing housing (31). If foaming occurs, moisture is present. If the oil is black, the bearing is running hot and burning the oil. If the oil is brown, contaminants have mixed with the oil. In each of these cases, the oil must be drained, the bearing cleaned and the oil replaced.

It is normal that some of the grease from the radial bearing will mix with the oil with a tendency to thicken the oil. Drain and replace the oil from time to time as required.

Whenever the grease lubricated bearing is cleaned without dismounting by flushing hot, light (no heavier than SAE 10) oil through the housing, the thrust bearing oil should be replaced as it will be contaminated by the oil used for flushing.

5-3 Stuffing Box:

The purpose of a stuffing box is to limit or eliminate leakage of the pumped fluid and to prevent air from entering the pump. Pumps are equipped with packing or mechanical seals. Normally, the pumped liquid is not used to lubricate the stuffing box seal, as the liquid is usually dirty, gritty, or contains material that would jam the seal, and a sealing liquid from an external source should be used. For pumps equipped with mechanical seals, see Mechanical Seal Section of this manual. For pumps equipped with packing, there must always be a slight leakage from the glands. The amount of the leakage is hard to define, but a steady dripping of liquid through the gland is recommended. Stuffing box glands should be adjusted after the pump is started. When leakage is excessive, adjust the valve in the seal water line until desired amount of leakage is achieved. Be sure the stuffing box doesn't over heat. If overheating does occur, increase the flow rate until the temperature stabilizes. The gland may need to be adjusted to achieve a proper balance between gland tightness and seal water flow rate. Be sure to tighten gland bolts evenly, a little at a time. Allow some time for packing to adjust to new position. Never tighten gland to be leakproof as this will cause overheating and undue wear on shaft sleeves.

Replace the stuffing box packing as follows:

1. Shutdown the pump.
2. Take precautions to prevent the driver from being inadvertently started.
3. Remove the gland bolt nuts and gland.
4. Remove and discard the old packing rings – note the location of the lantern ring. When repacking the stuffing box, the lantern ring must be positioned such that the water seal connection is opposite the lantern ring.
5. Clean out the stuffing box.
6. Inspect the shaft sleeve for wear, if it is scored or grooved, it should be replaced.
7. Make sure the stuffing box bushing (if furnished), is set at the bottom of the box.
8. Insert the rings of packing and tap lightly to seat against the bushing. Be sure the rings are of the proper size and length and installed with cuts staggered. The lantern rings must be installed opposite the sealing water connection.

9. Install the gland and tighten, finger tight. With the pump running, adjust the gland as described previously. Care should be taken during the first hour of operation to take up on the packing gradually just enough to maintain the required amount of leakage.

If the pump is operated daily, the stuffing box packing should be renewed about every two or three months before it gets hard and scores the shaft sleeve.

Mechanical seals should be removed, assembled, and/or adjusted according to the seal manufacturers' instructions. There should be no leakage from the gland if mechanical seals are used, except for a brief run-in period.

5-4 Wear Ring Clearance:

Running clearance between impeller ring (8) and suction wearing ring (25) when new are indicated in the table below. When these running clearances double or the capacity of the pump is reduced by 5 to 10% the impeller ring and the suction wearing ring should be renewed. The purpose of these rings is to keep the internal by-passing of the liquid being pumped to minimum. Clearances should be checked whenever pump is opened up_ Check with feeler gauge or by direct measurement. Measure ID of case ring and OD of impeller ring, then compute clearance (ID minus OD).

PUMP SIZE	DIAMETRAL RUNNING CLEARANCE
8 and 10	.020 to .026 in. (0.51 to 0.66 mm)
12 thru 16	.022 to .0028 in. (0.56 to 0.71 mm)
20 and 24	.024 to .030 in. (0.61 to 0.76 mm)
30 and 36	.028 to .036 in. (0.71 to 0.91 mm)

SECTION VI

REPAIRS& REPLACEMENT

6-1 To Remove Rotor, Model F and FS Pumps

Refer to Assembly Drawing for the particular job (Not Typical Drawing)

Step

1. **WARNING !** ! Disconnect electric power lines to motor avoid any possibility of starting unit. March mark leads so rotation will not be reversed at assembly.

2. Disconnect coupling at pump shaft. Comply with further instructions listed below, depending upon the type of unit:

Close Coupled Vertical Units: Remove the bolts holding the motor stand to the pump, remove motor and motor stand and set to one side. CAUTION: Refer to motor instructions.

Remote Coupled Vertical Units: Secure shafting safely out of the way or remove shafting if this is not possible (refer to shafting instructions).

Horizontal Units: Remove bolts holding the motor to the base and other connections, and then remove the motor from the base. CAUTION: Refer to motor instructions.

3. Remove lubrication lines to stuffing box connection and connection leading to bearing below the stuffing box (if so equipped).

4. If unit was supplied with bearing temperature detectors, vibration detectors, or other accessories subject to damage, these should be removed with care, so as not to damage them in any way.

5. Any dowel pins that may have been supplied between volute (1) and volute cover (11) joints or other joints affecting bearing alignment should now be removed. Some taper pins are provided with threaded ends. To remove simply tighten the nut which is provided until the taper pin breaks free.

6. Remove bolts securing volute cover (11) to volute (1).

7. Rig lifting apparatus to pump so that complete rotating assembly, including volute cover can be safely removed from volute (1) and set to one side (on timbers to protect finished surfaces) for further disassembly.

On vertical units, an eyebolt placed in the tapped hole at the end of the pump shaft may be used in removing the rotor. Care should be taken not to rub wear rings (8 and 25, if so equipped) against each other or otherwise damage them. The rotating assembly should be pulled straight out until the impeller (2) is clear of volute (1).

WARNING ! ! Use caution while lifting.

NOTE: If pump is a horizontal unit, it will be necessary to remove bolts securing volute cover support and bearing housing supports to baseplate in order to remove the rotating assembly from the volute (1). In addition, the supports may need to be unbolted from the pump if obstructed during removal of rotor.

WARNING ! ! Proper support of rotor for horizontal unit is essential during disassembly.

6-2 Disassembly of Rotating Element:

Refer to Assembly Drawing for the particular job (Not Typical Drawing)

1) MODEL F PUMPS ONLY, (Continued from Step No. 7 above)

NOTE: If pump is a Model FS pump, disregard Steps 8A and continue with Steps 8B – 24B on Page 19.

Step

8A Remove socket head cap screws and lockwashers in impeller nut (26). Impeller nut can now be removed using the special wrench provided.

9A Remove Impeller (2) take care not to damage the wear rings (if so equipped).

NOTE: On pump sizes F12 and above, the impeller is provided with a tapered bore. If pump size is F10 and below, the impeller is provided with a straight bore. Do not lose impeller key (32).

10A Remove packing gland (17).

11A Remove bolting from between volute cover (11) and bearing housing (19).

12A Remove bearing housing assembly with bearing housing (19), shaft (6) and bearings (16 & 18) as a unit from the volute cover (11).

13A Shaft sleeve (14) can now be removed from shaft (6).

14A Remove packing rings (13) and lantern ring (29).

15A Loosen set screws in shaft sleeve nut (20) and unscrew shaft sleeve nut from shaft (6).

16A If pump was supplied with metal flinger (40). loosen set screws and slide off of shaft. If pump was supplied with flexible V-rings, these can now be removed from the radial bearing cover (35) and thrust bearing cover (37) by stretching them as needed to remove from shaft (6).

17A Remove radial bearing cover (35).

18A Unscrew and remove short section of pipe provided as thrust bearing grease drain (if applicable) protruding from side of bearing housing (19) at the thrust bearings.

19A Remove bolting holding thrust bearing cover (37) and lift cover from pump.

20A Removing bolting between thrust bearing cartridge (141) and bearing housing (19), if applicable.

21 A Remove shaft (6), bearings (16 & 18), and thrust bearing cartridge (141) from bearing housing (19) as a unit.

22A Loosen and remove locknut (22) and lockwasher (69) holding radial bearing (16) to shaft.

23A Press radial bearing (16) from shaft WORKING AGAINST THE INNER RACE OF THE BEARING. (Refer to Figure6)

WARNING ! ! Failure to use this procedure can damage the bearing.

24A Remove locknut (22) and lockwasher (69) holding thrust bearings (18) to shaft (6).

25A Press thrust bearing cartridge (141) towards impeller end of shaft until free from thrust bearings (18).

26A Thrust bearings (18) can be removed by WORKING AGAINST THE INNER RACE OF THE INNER MOST BEARING. (Refer to Figure 6)

WARNING ! ! Failure to use this procedure can damage the bearing.

27A Slide thrust bearing cartridge (141) off shaft.

28A If pump was provided with grease seals (51) for the thrust (37) and radial (35) bearing covers and the thrust bearing cartridge (141) these should be inspected for any visible damage and replaced, if necessary.

29A Pump is now completely disassembled with the exception of the wear rings (8 & 25) and stuffing box bushing (15 & 27, if supplied). All of these items have an interference fit with their respective pieces. To disassemble, remove their respective locking devices and pry out working uniformly at 180° points.

NOTE: Wear rings and stuffing box bushings should not be removed unless it is necessary to replace them with new parts.

2) MODEL FS PUMPS ONLY (Continued from Step No. 7, Page 16).

NOTE: If pump is a Model F pump, disregard 8B - 24B, and continue with Steps 8A - 29A on page 16.

Step

8B Unbolt and remove bearing cover (37). This procedure disconnects Item 51 from Item 33.

9B Unbolt and remove radial bearing housing (33).

10B Remove locknut (22) and lockwasher (69).

11B To remove the radial bearing (16), place puller around the bearing spacer (78) using the groove. Do not apply puller to grease retainer (51). Pull bearing spacer (78) from shaft. Radial bearing (16) and grease retainer (51) will slide off along with the bearing spacer (78).

12B Remove thrust bearing (18) and springs. Retain the springs. They must be re-installed at assembly.

13B Remove thrust bearing housing (31). The oil retainer (107) is bolted to the bearing housing and will come out with the housing.

14B Slide flinger seal (40b) off of shaft.

15B Remove packing gland (17).

16B Loosen set screws and turn shaft sleeve nut (20) off of shaft.

17B Remove packing rings (13) - slide lantern ring (29) from shaft.

18B Remove bolting from impeller nut (26) - turn impeller nut from shaft and slide the impeller (2) from the shaft. Retain the impeller key for use at assembly.

19B Remove bolting from retaining ring (1 80) and slide the lower bearing housing (99) from the volute cover (11). Retain locking key - it must be used at assembly.

20B Carefully slide the shaft (6) from the volute cover (11). It will contain the shaft journal (74) locknut (22-I) and shaft sleeve (14).

21B Slide the shaft sleeve (14) from the shaft. Pin must be used at assembly.

22B To remove shaft journal (74), loosen set screw and turn journal locknut (22-I) from shaft. Slide shaft journal (74) from shaft. Handle with care.

23B To remove bearing bushing (39), remove locking plate and press out of housing using a follower as large as bore in piece (99) will permit.

24B Pump is now completely disassembled with the exception of the wear rings (8 & 25, if supplied). These items have an interference fit with their respective pieces. To disassemble, remove their respective locking devices and pry out working uniformly at 180° points.

NOTE: Wear rings should not be removed unless it is necessary to replace them with new parts.

6-3 To Remove Impeller Rings:

It is not necessary to remove impeller from the shaft to replace the impeller rings. First, remove the rotating element. Remove the locking set screws from the rings. The rings may now be pulled from the impeller, cut off with a chisel, or turned of if a suitable lathe is available. **DO NOT CUT INTO THE BODY OF THE IMPELLER!** When new rings are installed, new holes for locking setscrews may have to be made.

6-4 Inspection:

Visually inspect the parts for damage affecting serviceability. Check o-rings and gaskets for cracks, nicks, or tear; packing the rings for excessive compression, fraying or shredding, and embedded particles. Replace if defected in any way. Mount the shaft between the lathe centers and check eccentricity throughout the entire length. Eccentricity should not exceed .002 inches. The bearing surfaces and shoulders should be smooth and free of nicks.

Measure OD of impeller hub or impeller wear rings and ID of casing wear rings. Compute diametral clearance (ID minus OD) and compare with clearance given under Section entitled **Wear Ring Clearance**. Surface must be smooth and concentric. Examine impeller passages for cracks, dents or embedded material. Examine shaft sleeve for wear.

6-5 Assembly:

Assembly is the reverse of the disassembly procedure.

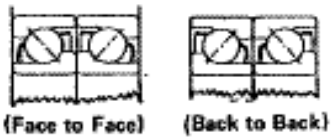
ALL PARTS INSIDE AND OUT MUST BE ABSOLUTELY CLEAN! Dirt and grit will find their way into, and damage bearings, shaft sleeves or both. Check all machine surfaces and registered fits for any nicks or abrasions that might interfere with alignment. Make sure all parts are fully seated and pulled up tight at this time. **(Read the Maintenance Instructions).** When repacking the stuffing box, if so equipped, be sure new packing rings are the correct size and length and installed with cuts staggered, and also that the packing rings do not block off the opening for the water seal ring.

> **WARNING ! !** If unit is equipped with angular contact ball bearings as thrust bearings (18), bearings must be installed as indicated by the assembly section drawing in order to properly accommodate the axial thrust produced by the pump. Improper assembly could cause each bearing to separate and the rotor to drop, thereby causing damage to the pump.

Care must be taken to see that the hole for the thrust bearing drain pipe removed instep No. 18A is properly aligned when assembling rotor. After the drain pipe is installed, a sealing material such as caulk should be applied around the pipe where it enters into the bearing housing to prevent water, dust, etc., from entering and damaging the bearings.

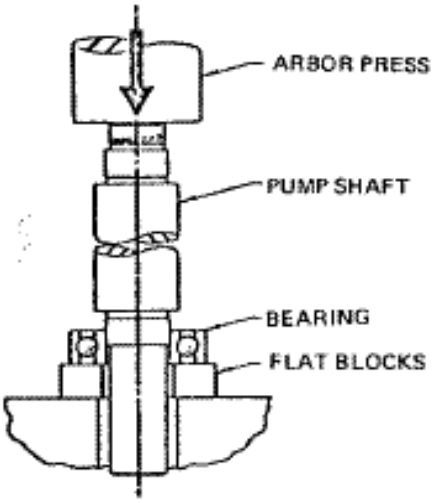
In re-installing the impeller on the shaft, the impeller nut is best tightened with an impact wrench using the impeller nut wrench provided. As it is unlikely that the lock screw holes in the impeller nut will properly re-align, new holes for the lock screws may need to be drilled and tapped. When installing the rotor in the pump during reassembly, take care not to allow the wear rings (if so equipped) to become damaged and/or pick up burrs. After reassembly is complete, check that all bolts are tight and check that the rotor turns freely by hand.

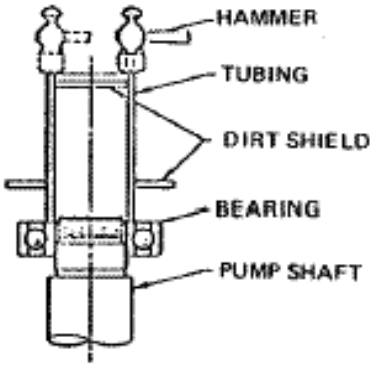
> **WARNING ! !** Failure to follow these precautions could result in pump seizure and damage to the pumping u



USING AN ARBOR PRESS

1. PLACE THE BEARING ON TWO FLAT BLOCKS SO THAT THEY CONTACT THE INNER RING OR BOTH RINGS OF THE BEARING.
2. HOLD SHAFT STRAIGHT – FORCE THE SHAFT BY A STEADY PRESSURE, UNTIL THE BEARING IS SEATED AGAINST THE SHAFT SHOULDER.





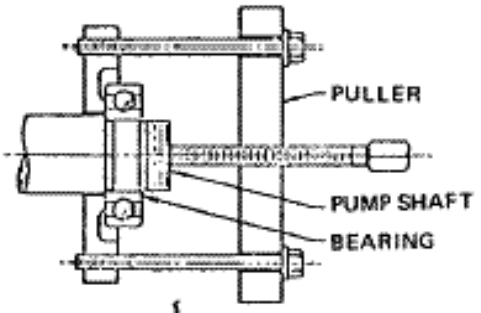
USING TUBING

1. PLACE THE BEARING ON SHAFT.
2. PLACE TUBING OVER SHAFT IN CONTACT WITH THE INNER RING OF THE BEARING.
3. APPLY HAMMER ALTERNATELY AT OPPOSITE POINTS – AVOID COCKING.

BEARING MOUNTING

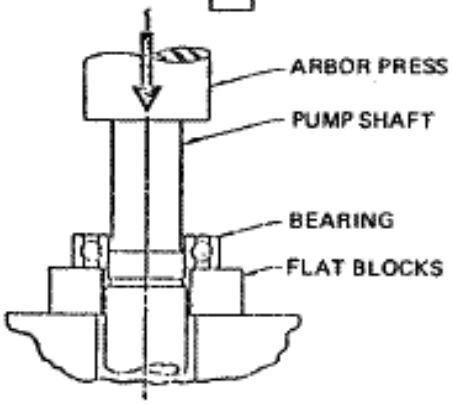
USING A BEARING PULLER

1. PLACE BEARING PULLER BEHIND BEARING INNER RING. SET PULLER JAWS SO THAT THEY WILL NOT SLIP OVER THE INNER RING AND DAMAGE SEPARATOR OR SHIELD WHEN PRESSURE IS APPLIED.
2. FORCE BEARING OFF SHAFT BY A STRAIGHT PULL. DO NOT COCK BEARINGS.



USING AN ARBOR PRESS

1. REST THE BEARING INNER RING OR BOTH RINGS (NEVER THE OUTER RING ONLY) AGAINST A PAIR OF FLAT BLOCKS.
2. FORCE THE SHAFT OUT BY A STEADY PRESSURE–KEEP SHAFT STRAIGHT–DO NOT ALLOW SHAFT TO COCK OR DROP.



BEARING REMOVAL

FIGURE 9. BEARING REMOVAL AND MOUNTING

BEARING DEFECTS

(Failures – Replace if Found)

DEFECT (Failure)	APPEARANCE	PROBABLE CAUSE
Flaking and cracking	In the early stages the surfaces of the inner and outer races develop small cracks, which flake. The cracks and flaking ultimately spread over the entire race surface.	1. Normal fatigue failure. 2. Bearing loads in excess of bearing capacity caused by misalignment.
Indentations	Indentations or cavities in the inner and outer races.	1. Dirt in the bearings. 2. Excessive impact loading of the bearing, such as improper mounting or removal.
Broken Separator (cage)	Cracked separator or separator in pieces.	1. Poor lubrication. 2. Misalignment of the shaft. 3. Excessive shaft deflection.
Wear	Bore and OD of outer ring of bearing galled or braided.	1. Fit on the shaft or in housing too loose. 2. Bearing locked by dirt and turning of shaft or in housing.
Fractured Ring	Hairline cracks or complete fracture.	1. Forcing a cocked bearing on or off a shaft. 2. Too heavy a press fit.
Discoloration	Balls and races darker than normal appearance of bearing metal. (Moderate discoloration of balls and races not a reason for discard).	1. Inadequate lubrication.
Corrosion	Balls and raceways rusted.	1. Water entering the housing. 2. Condensation inside the housing. 3. Lubricant breaks down into acid. (Wrong lubricant).

SECTION VII

LOCATING OPERATING DIFFICULTIES:

In the majority of cases, operating difficulties are external to the pump and following causes should be carefully investigated before undertaking repairs:

No Water Delivered:

a. Pump not primed – indicated by no pressure on discharge.
b. Speed too low – indicated by low pressure on discharge.
c. Discharge valve closed – indicated by high discharge head.
d. Impeller completely plugged up or Suction Valve closed - indicated by low discharge pressure.
e. Wrong direction of rotation.

Abnormally Small Quantities Delivered:

a. Air leaks in suction pipe or stuffing boxes.
b. Speed too low.
c. Discharge head higher than anticipated.
d. Impeller partially plugged up.
e. Obstruction in suction line.
f. Mechanical defects: Casing or packing defective; impeller damaged; suction and/or impeller rings worn.

Insufficient Pressure:

a. Speed too low, which might be caused by low voltage or current characteristics different from the nameplate reading on the motor.
b. Air in the water will cause the pump to make cracking noise.
c. Mechanical defects: Damaged impeller; defective casing or packing; suction and/or impeller rings worn.

Intermittent Operation:

a. Leaky suction line.
b. Water or grease seal plugged (hence, leaky stuffing box).
c. Suction lift too high.
d. Air, gas, or vapor in liquid.

Pump Overloads Drive:

a. Speed too high.
b. Head lower than rated, hence pumping too much water. (This is valid for low specific speed pump.)
c. Mechanical defects: Stuffing boxes too tight; shaft bent; rotating element binds.
d. Rubbing due to foreign matter in the pump and between the suction rings and impeller rings.

Pump Vibrates:

a. Misalignment
b. Foundation not sufficiently rigid.
c. Impeller partially clogged.
d. Mechanical defects: Bent shaft; rotating element binding; bearing worn; coupling defective.
e. Suction and discharge pipe not anchored.
f. Pump cavitation from too high a suction lift.
g. Pump is being operated beyond the minimum flow limitation (consult factory).
h. Air entrainment in the pump suction due to low submergence.

SECTION VIII

RECOMMENDED PARTS
(FOR MINIMUM LOSS OF SERVICE)

ASSEMBLY DWG.	PART NO.	DESCRIPTION
8		Impeller Rings (if so equipped)
13		Packing Rings (if so equipped)
14		Shaft Sleeve
25		Suction Piece Ring (if so equipped)
65		Mechanical Seal (if so equipped)
COMPLETE ROTATING ELEMENT		

WHEN ORDERING PARTS, PLEASE GIVE ALL THE FOLLOWING INFORMATION:

Patterson Pump Serial Number
Assembly Drawing Number
Name of Part
Item Number

WARNING ! ! Do not attempt to substitute with parts manufactured or supplied by any concern other than Patterson Pump Company as subsequent damage to the pump may occur.

DIRECT ORDERS TO:

Patterson Pump Company
P.0. Box 790
Toccoa, GA. 30577

Area Code: (706) 886-2101

1	CASING
2	IMPELLER
6	SHAFT
8	IMPELLER WEAR RING
11	VOLUTE COVER
13	PACKING
14	SHAFT SLEEVE
16	RADIAL BEARING
17	GLAND
18	THRUST BEARING
19	BEARING HOUSING
20	SHAFT SLEEVE NUT
22	BEARING LOCKNUT
25	SUCTION WEAR RING
26	IMPELLER NUT
29	LANTERN RING
32	IMPELLER KEY
35	RADIAL BEARING COVER
37	THRUST BEARING COVER
38	O-RING
40	FLINGER
47	RADIAL BEARING GREASE SEAL
49	THRUST BEARING GREASE SEAL
57	SUCTION FITTING
59	CASING HANDHOLE COVER
59-1	SUCTION FITTING HANDHOLE COVER
69	BEARING LOCKWASHER
73	GASKET
73-1	GASKET
125	GREASE FITTING
141	THRUST BEARING CARTRIDGE
169	THRUST BEARING CARTRIDGE SEAL

NOTE: VARIOUS FEATURES ARE SHOWN ROTATED FOR CLARITY.

A subsidiary of The Gorman-Rupp Company

ASSEMBLY SECTION

FOR

TYPE F VERTICAL SEWAGE PUMP

DWN M. MERCK	DATE [illegible]	DWG No. FIG. 7-1
SCALE 1/4" = 1"	APPVD EJC 12/12/79	

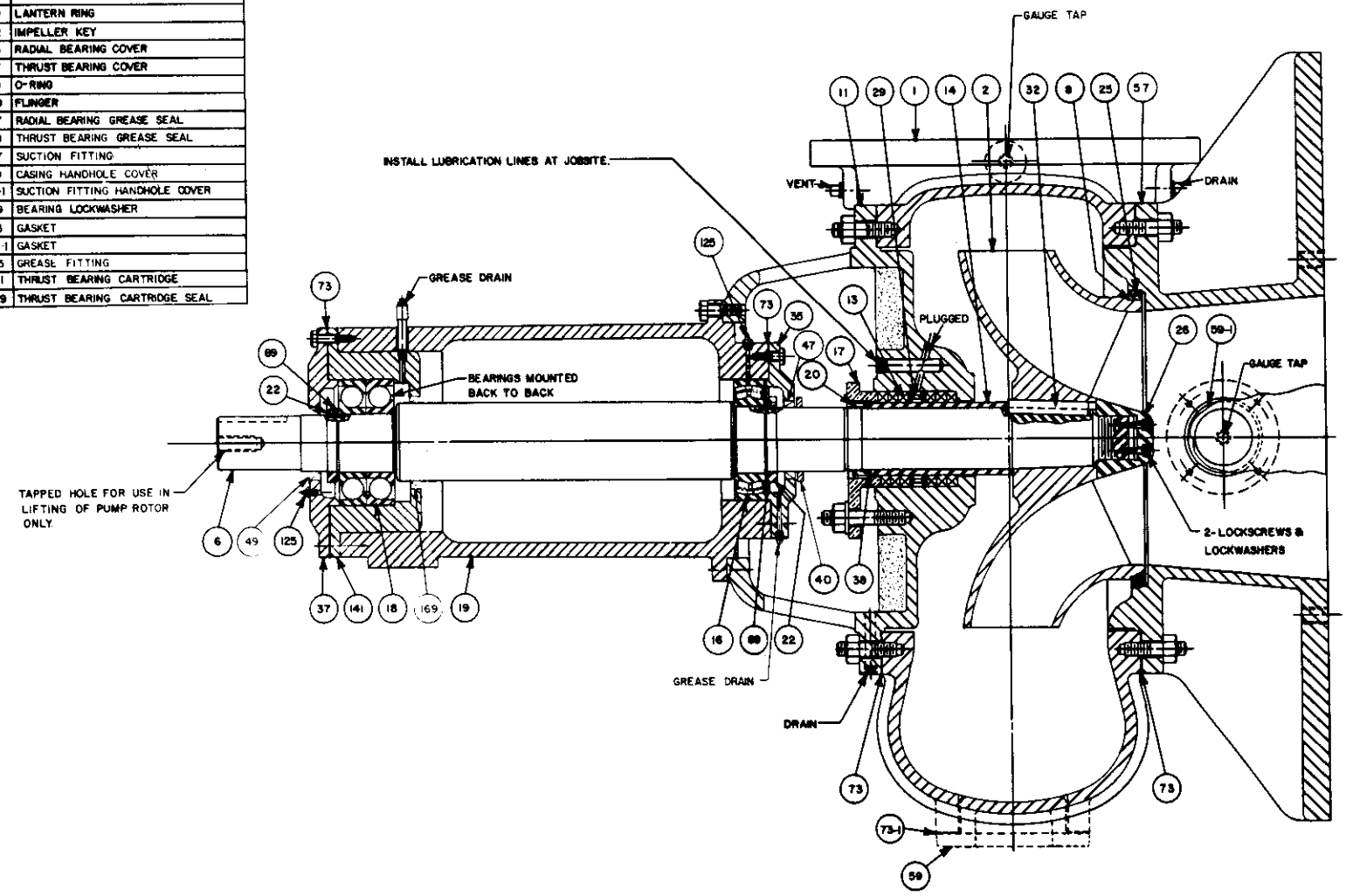


FIG. 7-1

ITEM	DESCRIPTION
1	CASING
2	IMPELLER
6	SHAFT
8	IMPELLER RING
11	VOLUTE COVER
13	PACKING
14	SHAFT SLEEVE
16	RADIAL BEARING
17	PACKING GLAND
18	THRUST BEARING
20	SHAFT SLEEVE NUT
22	BEARING LOCKNUT
22-1	JOURNAL BEARING LOCKNUT
25	SUCTION WEAR RING
26	IMPELLER NUT
29	LANTERN RING
31	THRUST BEARING HOUSING
32	IMPELLER KEY
33	RADIAL BEARING HOUSING
37	BEARING COVER
39	BEARING BUSHING
40A&B	FLINGER/SEAL (MERKEL-FORSHEDA V-RING)
51	GREASE RETAINER
59	HANDHOLE COVER
69	BEARING LOCKWASHER
73	O-RING
73-1	GASKET
74	BEARING JOURNAL
77	OIL LUBRICATOR
78	BEARING SPACER
99	BEARING BUSHING HOUSING
107	OIL RETAINER
125	GREASE FITTING
180	RETAINING RING
181	SLEEVE DRIVE PIN
182	BEARING KEY
183	BEARING HOUSING LOCK PIN

A Subsidiary of The Gorman-Rupp Company

ASSEMBLY SECTION
FOR
TYPE FS VERTICAL SEWAGE PUMP

DWN	DATE	DWG No.
M. MERCK	11-27-79	FIG. 8
SCALE NONE	APPRVD EJC 12/12/79	

NOTE: VARIOUS FEATURES ARE SHOWN ROTATED FOR CLARITY.

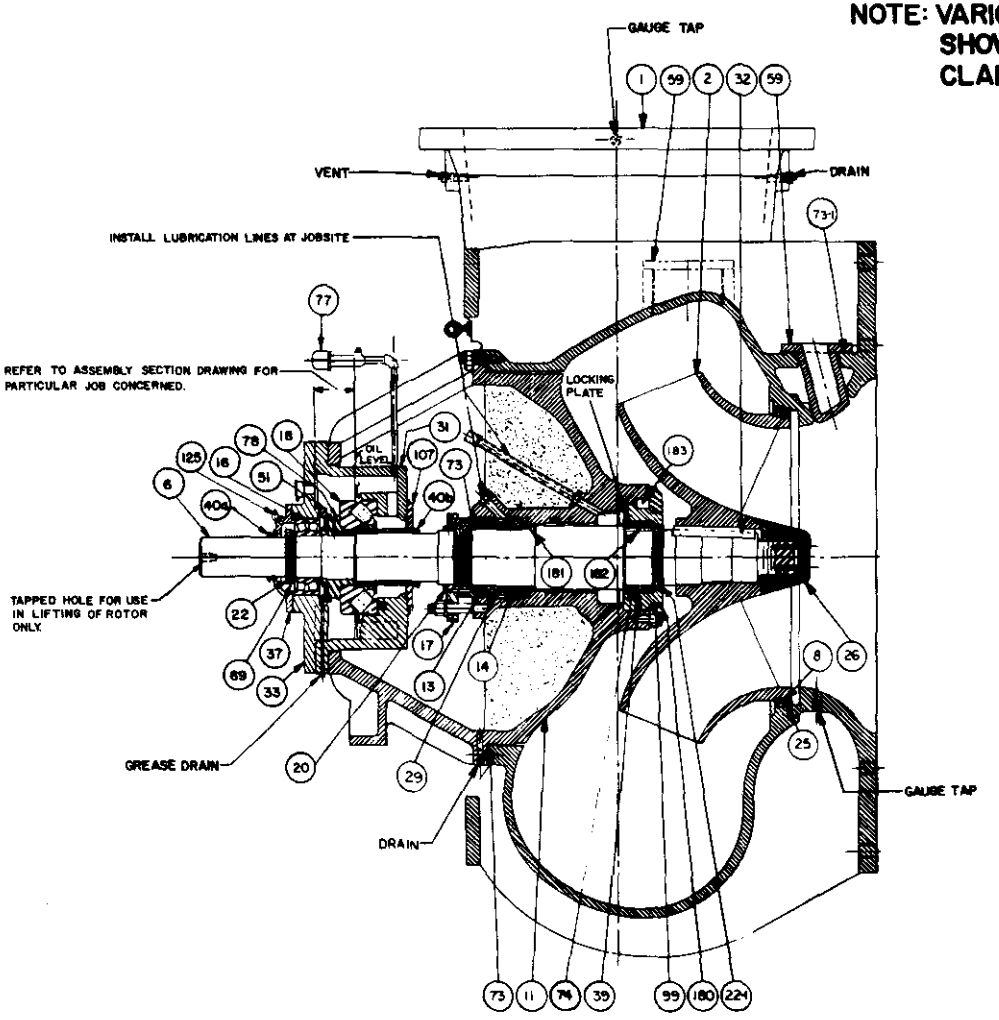


Fig. 8