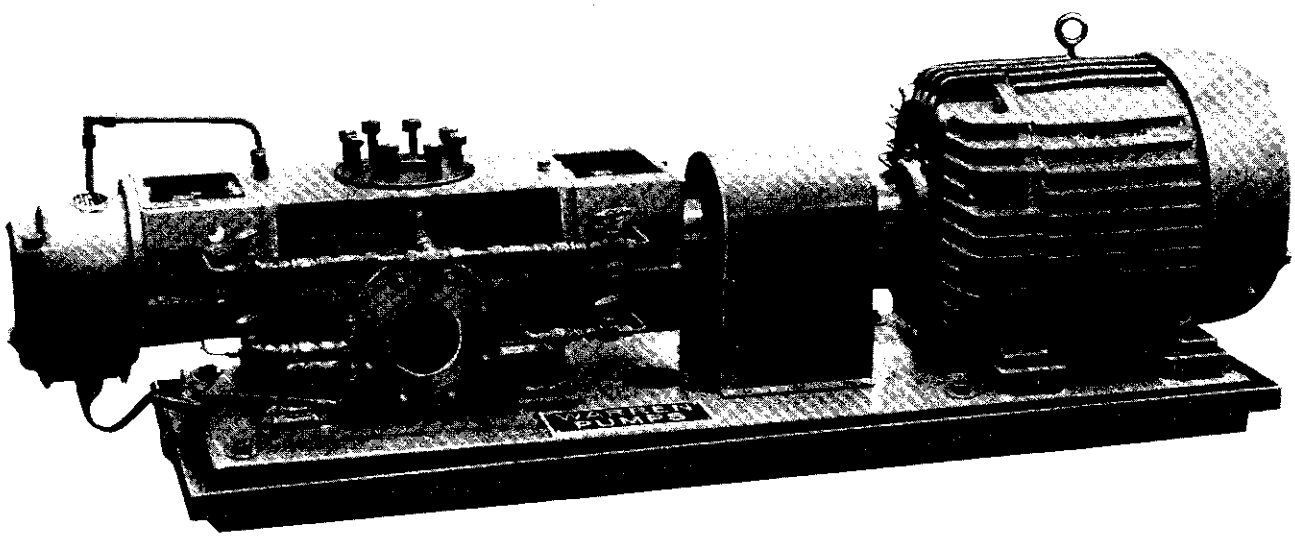
# INSTALLATION OPERATION MAINTENANCE



# 2200 SERIES SCREW PUMPS EXTERNAL GEAR AND BEARING



**PLEASE READ THESE INSTRUCTIONS BEFORE INSTALLING PUMP**

MEMBERS OF THE HOUDAILLE PUMP GROUP

Warren Pumps Division
Warren, Massachusetts
Peace Dale, Rhode Island
Rockaway, New Jersey

Viking Pump Division
Cedar Falls, Iowa

Houdaille International, Inc.
Alphen a/d Rijn
The Netherlands

# CAUTION
# IMPORTANT SAFETY NOTICES

This equipment is the responsibility of the equipment owner. Prior to operating the equipment, all necessary steps must be taken by the owner to comply with various federal, state, local and OSHA laws or requirements relating to installation and safe operation.

This pump is not to be operated at speeds, working (discharge) pressures or temperatures higher than, nor used with liquids other than stated in the original order acknowledgement without written permission of Warren Pumps Division, Houdaille Industries, Inc. Refer to the manuals provided by manufacturers of other related equipment for their separate instructions.

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# INTRODUCTION

This manual is intended to assist those concerned with installation, operation and maintenance of 2200 Series Warren screw pumps. It is the manufacturer's hope that the following discussions will be clearly and easily understood. Should questions arise that cannot be answered by the material contained in this manual, we suggest that the Warren Service Department be contacted.

# SECTION 1 — GENERAL INFORMATION

The Warren 2200 Series screw pump is a positive displacement unit capable of handling viscosities to 150,000,000 ssu. The pump is made up of two sets of opposed screws. Each set of screws conveys liquid toward the center of the pump where the discharge port is located. Since hydraulic forces are opposite and equal, the rotor is hydraulically balanced in an axial direction.

Body passages are designed to eliminate dead spaces to prevent liquid stagnation. Direct flow path from suction opening to entrance of pumping screws has a constant area. Result: Uniform velocity changes for lower entrance friction losses, higher suction lift capabilities.

Pumps are available with either integral screws and shafts or separate screws and shafts. The rugged integral screws and shafts (machined from one piece of metal) with larger diameter mean less deflection and closer clearances for alloy construction allowing higher pressure applications. Separate screw and shaft construction is also available. This is sometimes preferred on lower pressure applications or for screw replacement capability. It is also used when extra high torque shaft alloys are necessary in conjunction with softer screw material. Shaft sleeves are a standard feature on this construction.

Timing gears are used to transmit power from the drive to the idler shaft and to prevent metal contact between the meshed, rotating screws. These helical type herringbone timing gears are of steel construction. The "timing" or placement of the gears on the shaft prevents rotational contact of the pumping screws. The herringbone configuration of the gear teeth maintains the axial positioning of the pumping screws in relation to each other.

Radial loading is handled by heavy duty roller bearings at five locations . . . sized to handle maximum loads. They are oil lubricated and are located externally to the liquid being pumped. The heavy duty double row ball thrust bearing locks the drive shaft in position axially. Result: Wide temperature range capability and internal clearance stability. Bearing cooling provisions are available for high horsepower or high ambient temperature conditions.

Bearing brackets are box type for higher strength in both X and Y planes. Added strength means greater torsional load carrying capability. Larger openings to stuffing boxes for easier repacking. Bearing brackets jacketed at the stuffing box are available to protect seals or packing at temperatures above 350°F. as necessary.

Stuffing boxes are under suction pressure only. They are drilled and tapped for lantern ring connections and designed to accommodate standard mechanical seals as options. Split Teflon lantern rings are available for high suction lift applications. Shafts are normally packed with a square braided packing material. If your application requires a special packing, this can be furnished. On applications where hazardous or expensive liquids are being pumped and when gland leakage is objectionable, your Warren pump can be equipped with mechanical seals.

The timing gears and bearings of the pump are oil-bath lubricated. The only parts in contact with the liquid pumped are the pumping screws, the body and the stuffing boxes.

The outside diameter of the pumping screws can be furnished with hard coatings. Pump casings bores can be lined with hard chrome. Both coated screws and lined casings bores are for abrasions resistance and to reduce galling in stainless steel pumps.

## 1-1 RECOMMENDED BASIC SAFETY PRACTICES

1. **Never** work on a pump unless it has been locked out both electrically and hydraulically, from the system (this should be done with an appropriate tag-out system on electrical controllers and on any valves involved).
2. Be sure proper hoist or crane is used when rigging heavy assemblies for removal, installation, etc.
3. Be sure all liquid fittings are properly tightened to prevent leak hazards to personnel.
4. Be sure the coupling guards and/or belt guards are of an approved type and are properly installed.
5. Be sure relief valves are operating at the correct capacities and pressures.
6. Be sure speed limiting and speed regulating governors are set at the designed speeds and that they are operating properly.
7. Do not operate at higher speeds or pressures than specified without first consulting Warren Pumps Division, Houdaille Industries, Inc. Failure to do so could result in serious personal injury or property damage.

## 1-2 PRODUCT WARRANTY

1. Warren warrants its products to be free of defects in material and workmanship for a period which ends on the earlier of one year from date of product start-up or eighteen (18) months from date of shipment by Warren. Any part which fails during the warranty period due to defective materials or workmanship will be replaced without charge, F.O.B. Manufacturer's works, provided the party seeking warranty service (a) gives written notice of such defect within the warranty period to his immediate vendor (i.e., the person from whom the party bought the product); (b) obtains instructions from that vendor for the return of defective part(s) for service; and (c) delivers the defective part(s) to that vendor, transportation prepaid, and in accordance with its instructions.
2. Warren's liability for any damage caused by a product which fails due to defective materials or workmanship shall be limited to the replacement or repair (at Warren's option) of the defective part or parts as originally furnished by Warren. Warren shall not be liable for any loss, damage, or expenses directly or indirectly related to the use of its products or from any other cause or for consequential damages (including, without limitation, loss of time, inconvenience, and loss of production). It is expressly understood that Warren is not responsible for damage or injury caused to other products, machinery, buildings, property, or persons by reason of the installation or use of its products.
3. The warranty shall be null and void if any components of a product has been (a) tampered with, disassembled, repaired or altered (except as may be authorized by Warren in writing); (b) subject to misuse, neglect or accident; or (c) used to pump materials for which it was not designed to handle, which may attack or harm the materials used in construction of the pump, or which may otherwise harm the operation of the pump.
4. This warranty does not cover or apply to (a) the effects or corrosion, abrasion or normal wear; (b) repairs or service adjustments required due to lack of proper maintenance, natural causes or acts of God; or (c) any field expense for service or replacement of parts.
5. This is WARREN'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. This document and the warranty contained herein may not be modified and no other warranty, express or implied, shall be made by or on behalf of WARREN unless modified in writing and signed by the President or Vice President of WARREN.

# SECTION 2 — RECEIVING, HANDLING AND STORAGE

## 2-1 RECEIVING

Place equipment under adequate protection immediately upon receipt. Ordinary packing crates are not suitable for out-of-door storage beyond a 30 day limit including the duration of transport. This may be less if the atmospheric conditions are unfavorable. Contact the manufacturer for specific instructions. Improper storage can damage the equipment which would result in a non-warranty situation.

Special long term storage crating can be supplied upon request, at an additional cost.

Upon receipt of shipment, carefully inspect the pump, driver and individual parts to insure none are missing or damaged. Any damage must be reported promptly to the carrier and to Warren or your Warren distributor. Damage claims must be made at the time of receipt.

## 2-2 HANDLING

Take care when moving the unit about prior to installation. This is particularly important with large, heavy units. Rough handling and thoughtless selection of points from which to lift large units can cause permanent distortion of the base and/or casing which will affect the close operating clearance of the rotating assembly. Contact of the moving parts can cause a pump failure.

## 2-3 STORAGE AND PRESERVATION

Units are shipped on skids and suitably boxed or crated to help prevent damage from normal handling. All exterior, unpainted surfaces subject to corrosion are coated with a rust preventive compound. Pump openings are covered with blank flanges or special cups.

A packing list is furnished itemizing the contents of the shipment. When received, check the contents against the packing list. Report any discrepancies to Warren or your Warren distributor immediately.

If pump is not to be installed immediately and operated or if pump is not to be operated for some time after installation, the unit must be cared for as follows:

1. Store in a clean and dry location.
2. Be certain that blank flanges or cups covering pump openings are properly attached.
3. Rotate pump shaft through several turns at least weekly.
4. Recoat all exterior, unpainted surfaces subject to corrosion with a rust inhibiting compound.
5. Fill oil reservoirs completely full of oil.
6. Protect pump and driver with plastic or canvas covering.
7. Fill cast iron or cast iron fitted pumps with oil or a suitable preservative.

## SECTION 3 — INSTALLATION

IMPORTANT — The following installation instructions are a guide to assist you in proper installation procedures.

Probably the most important thing that can be done to extend the life and smooth operation of this machine is to plan your installation by following these installation procedures and other good machinery practices.

If questions should arise, contact the Warren Service Department for assistance.

NOTE — Protect your investment. A properly planned and executed installation is necessary for trouble free pump performance.

### 3-1 LOCATION

The pumps are purchased to deliver a specific capacity at a specific pressure. To accomplish this, the designer must take into consideration the conditions that will exist on the suction and discharge sides of the pump after installation such as suction lift or head and temperature. This information is given to the pump engineer by the purchaser and is based on a preplanned location of the pump in a system. In order for the pump to operate as designed, it must be located in this preplanned location. If, after receipt, another location is considered that might alter the preplanned conditions, it is recommended that Warren engineering be consulted to insure satisfactory operation of your pump.

Locating the pump as near as possible to the source of supply upon installation is recommended. Ideally, the location should be well lit and dry with enough room to perform routine maintenance and space enough for rigging, etc. If you find it necessary to locate the unit in a pit, be sure to make provisions to prevent flooding.

### 3-2 FOUNDATION

Foundations should be a suitable mass to absorb vibration and provide a rigid support for the unit. Use reinforced concrete as necessary.

A template should be made to position and hold the foundation bolts in place while pouring the concrete. Location and sizes of bolt holes are shown on the certified outline drawing supplied to the purchaser. Each bolt is installed in a pipe sleeve, the inside diameter of which should be three times the outside diameter of the bolt. The pipe sleeve allows for minor adjustments in bolt spacing after foundation is in place (Fig. 3-2). Two methods commonly used to secure and prevent bolts from turning are:

a. A washer is placed between the bolt head and pipe sleeve with a lug welded to the bolt head (Fig. 3-2).

b. The bolt may be of rod construction, bent 90° below the pipe sleeve.

Stuff waste paper between foundation bolts and sleeves to prevent concrete from entering while foundation is being poured. Foundation bolt must be long enough to allow from ¾" to 1" for grouting under the baseplate (Fig. 3-2). When pump is level, the bolts should extend ¼" through the nuts. Leave top surface of foundations rough for adherence of grout.

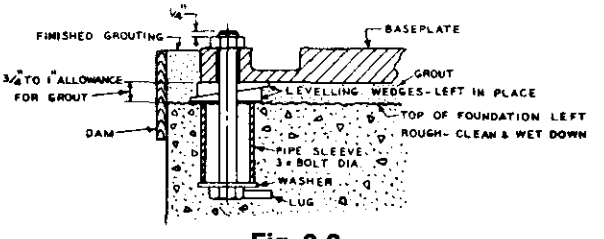



**Fig. 3-2**

### 3-3 BASEPLATE

1. **Leveling** — Before placing the unit on the foundation, be sure the surface of the foundation is clean and roughed. Place the leveling wedges adjacent to foundation bolts and remove waste paper from pipe sleeves. Clean underside of pump mounting base and lower unit over baseplate bolts and onto wedges. Adjust the wedges to allow for ¾" to 1" of grout, being sure pump flanges are true. This unit has been factory aligned and uneven bearing of wedges can cause misalignment. Snug up, but do not make up hard the foundation bolts. Check coupling alignment and correct as necessary. Avoid baseplate distortion. Level pump with a spirit level.

2. **Grouting** — Build a board dam around the foundation to the desired height for finished grouting (See Fig. 3-2). A mixture of one part portland cement to two parts clean sand with just enough water to mix to a thick creamy consistency should be made for grout. Wet the underside of the baseplate and foundation top, then pour the grout through the holes in the baseplate. Thoroughly puddle the grout during pouring to prevent air pockets and hollow spots. After grout has set sufficiently, remove the board dam and finish off the grout as desired. When grout has hardened, usually in about 48 hours, pull up on foundation bolts.

## 3-4 PIPING

1. Since the basic pump design incorporates close running clearances between the screws and the body, it is very important that suction side piping be thoroughly cleaned before connecting piping to the pump.
2. After the unit has been installed and secured on its foundation, pipe connections may be made up. See pump outline drawing for location of all pipe connections, flange sizes, drilling and other notes pertinent to piping. Piping runs should be as short and direct as possible. Use long radius elbows to change direction wherever possible. Discharge piping must be sized to give the required velocity based on the ideal flow condition for the type of fluids being pumped.
3. All major piping must be supported independently of the pump and properly aligned with pump flanges. Piping subject to high temperatures must be fitted with a means of absorbing expansion. Piping strain on the pump may cause distortion resulting in misalignment, vibration or mechanical damage.
4. If the pump is required to operate with a suction lift, the suction system MUST be properly sized and designed. The pump cannot be expected to overcome deficiencies in system design such as long runs of suction piping, possibly undersized and containing many elbows, valves and particularly high points that are above the pump suction. In such cases, cavitation will invariably occur.
5. To check piping alignment of pumps having bolted flanges, insert flange bolts through pipe and pump flange. If bolts are easily moved within the bolt holes and if flange faces are parallel with each other, piping is properly aligned.

## 3-5 PIPING SYSTEM ACCESSORIES

1. **Suction Strainers** — Warren recommends that suction strainers be installed on the suction side of the pump at least temporarily until the new system is deemed cleansed of foreign material. Strainers or screens should be constructed of 20 mesh wire and equipped with a backing plate. The total mesh opening should be 5 times the cross sectional area of the pipe. If liquid is in excess of 1000 SSU viscosity, 6 times the pipe area is recommended. Gauges should be installed on either side of the strainer to indicate when the strainer requires cleaning.

   Generally strainers can be used successfully on all liquids except those of a very high viscosity such as may be found in certain chemical industry applications. In these cases, thorough cleaning of the entire suction system is mandatory.
2. **Check Valves** — If the discharge piping system is subject to a high static head and if the liquid handled will flow easily, a check valve should be installed. This valve will prevent hydraulic shock acting upon the pump and will also prevent reverse rotation of the pump when stopping the unit and most importantly, it permits starting the pump when a sister pump is operating in a common system.
3. **Relief Valves** — Pressure relief valves should be installed between the discharge valve and discharge flange of screw pumps to protect both the pump and piping systems. The valve should be solidly constructed of proper material with ample opening for passage of full discharge capacity, because positive displacement pumps can build up pressure rapidly if the discharge is restricted or shut off. This type of relief valve should lead back to the source of supply particularly in pumps that operate unattended.
4. **Vent** — If pump is required to operate with a suction lift, a suitable means for venting the pump should be installed in the discharge piping adjacent to the pump.

## 3-6 FACTORY ALIGNMENT

Pumps supplied with driver base and coupling from the factory are aligned (coupling) prior to shipment. However, stresses caused by lifting and transportation often cause minor distortion which will disturb the factory alignment. Check coupling alignment after the baseplate has been leveled but prior to grouting.

If the coupling alignment has been disturbed by improper shimming of the baseplate, correct prior to continuing. After the base has been grouted and the piping connected, make a final pre-startup coupling alignment check. Additionally a hot alignment check must be made once the pump has been run up to its operating temperature (see Sect. 4, Coupling Alignment, for detailed procedures.)

## 3-7 DOWELING

After the unit has been running for about one week, the coupling halves must be given a final check for possible misalignment caused by pipe strain or temperature strains. This check must be made immediately after unit is shut down, before it has a chance to cool. If alignment is correct and unless Warren instructs otherwise, the driver must now be doweled on diagonal feet.

NOTE: Normally the pumps are doweled at the factory and the drivers are doweled in the field. The taper pin size for doweling the driver will normally be the same as that of the pump.

## SECTION 4 — COUPLING ALIGNMENT

### 4-1 ALIGNMENT

The flexible coupling supplied with your pump is not designed to operate with excessive misalignment. Reducing misalignment in your coupling installations will increase coupling life and greatly increase operating life of associated equipment such as bearings, packing and seals.

Check the following prior to aligning the pump and driver. Set the coupling gap within tolerances given on the supplied outline drawing. During any work performed on either pump or driver, BE ABSOLUTELY CERTAIN THAT ACCIDENTAL ENERGIZING OF THE SYSTEM WILL NOT OCCUR.

Coupling alignment must be handled in all three planes.

To set side to side alignment.

1. Mount a dial indicator rigidly on the driver half of the coupling and set the indicator button on the rim of the pump half (Fig. 4-1).
2. Facing the driver from the coupling end, set the indicator to zero at the 3 o'clock position. Match marks are usually stamped into the coupling rims. Magic marker or chalk marks will be satisfactory should the coupling not be stamped. Turn the two coupling halves together and record the reading at the 9 o'clock position. The purpose in rotating both halves together is to eliminate the possibility of inaccurate shaft centerline alignment due to coupling runout.
3. The indicator reading will show double the amount of correction required to true the coupling side to side. If the indicator moved in a counter-clockwise direction, the reading is considered negative. If the movement was clockwise, it is considered a positive reading.
4. If the reading was positive, push the motor in the 3 to 9 o'clock direction ½ the total indicator reading. Push the motor towards the starting point (3 o'clock) ½ the indicator reading if it was negative.
5. Return to the 3 o'clock position and reset at zero.
6. Turn the coupling halves together and recheck the alignment. If not quite zero at 9 o'clock, repeat the precedure until a 0-0 reading is obtained in the 3 and 9 o'clock positions.

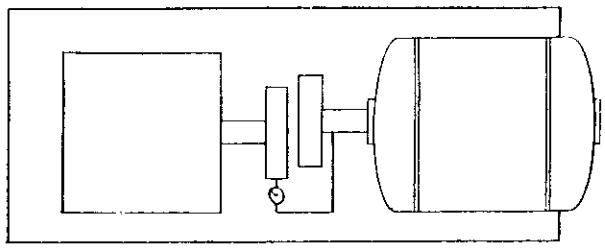


**Fig. 4-1 Rim Side to Side**

Once side to side alignment is set, face alignment can next be checked. The coupling gap can be accurately checked with either an indicator, set of feeler gauges or a wedge. Checking with feeler gauges is easiest to accomplish. The indicator can remain set up on the coupling rim and rotation of the coupling is not necessary to determine face alignment when using feeler gauges.

1. If the coupling gap is open at the bottom and closed at the top (Fig. 4-2), the front feet of the driver must be shimmed to equalize the gap. Should the top be open in relation to the bottom, the back feet must be shimmed.

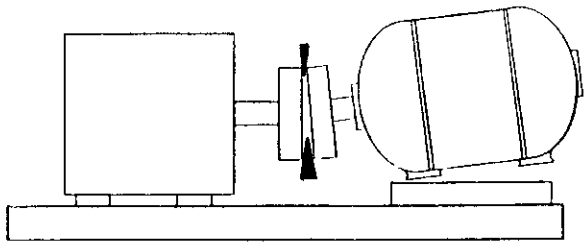


**Fig. 4-2 Face Top to Bottom**

2. Side to side variance in the coupling gap (Fig. 4-3) is compensated for by moving the back of the driver in the appropriate direction to equalize the gap.

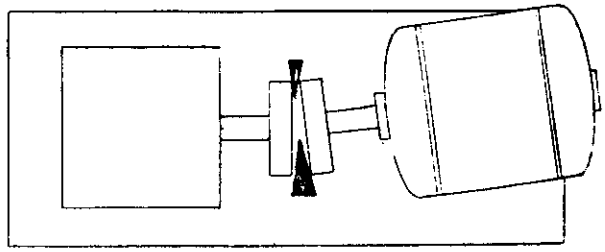


**Fig. 4-3 Face Side to Side**

Various factors affect the shimming of the driver feet to correct coupling gap. For example, the distance of the driver foot from the coupling will affect the amount of compensation seen when using a shim of specific thickness. In other words, the amount of correction seen using a .020" shim on the front feet of the driver will be different from the amount seen when that same .020" shim is used on the back feet. Each situation is sufficiently unique that the best results are achieved through experimentation.

Once the side to side and face alignment have been corrected, the correction of the vertical alignment may be accomplished.

1. Set the indicator to zero in the 12 o'clock position. (Fig. 4-4).
2. Turn both coupling halves together and take the readings in the 6 o'clock position.
3. If the reading is negative, place shim stock equivalent to half the indicator reading under each of the four driver feet. If the indicator has a positive reading, shims equivalent to ½ the reading must be removed from each of the driver feet.
4. Return to the 12 o'clock position and reset to zero. Turn the coupling halves and check the reading. If the reading is not zero, repeat the preceeding steps until the zero reading is obtained.

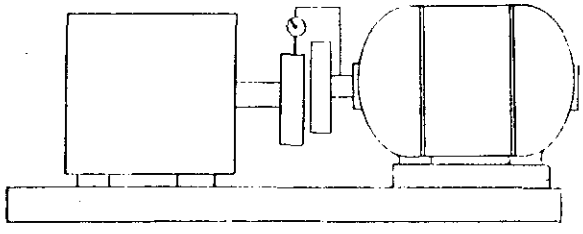


**Fig. 4-4 Rim Top to Bottom**

Upon completion of the alignment procedure for the third axis, the alignment in the other two axes must be checked.

Setting the vertical alignment may throw the side/side and/or face/face alignment out of tolerance. Due to the affect each axis has on the others, it is often necessary to operate at least one alignment axis approaching the allowable misalignment tolerance of .003".

The importance of checking the alignment once the unit has been piped and run cannot be understated. To insure that dangerous stresses are not imposed on pump or driver during operation, which would reduce operating life and may create hazards to operating personnel, the coupling alignment must be checked with the unit at operating temperature within a week after initial startup.

## 4-2 THERMAL EXPANSION

When operating units that have a high differential between centerline of driver and centerline of pump or in cases where the operating temperature of driver and pump vary considerably from ambient, the amount of thermal expansion in the pump/driver combination becomes important for proper alignment of the coupling. Failure to take into account thermal expansion when aligning the coupling can result in an extreme reduction in both coupling and bearing life.

The following explanations and worked through example should illustrate the simplicity of these calculations and the necessity that they be made.

The formula itself is expressed as the following:

coefficient of expansion X temperature rise X centerline height.

The coefficient of expansion is a specific figure for each material expressed in millionths of an inch per inch per degree Fahrenheit temperature rise. In the Warren Series 2200 pumps, three materials of construction are used in the pump bodies. These materials are cast iron, cast steel and stainless steel. The coefficient of expansion should be used with the corresponding casing material when making calculations.

A010A (Cast Iron) ..... 6.0 (32-212°F)
B061A (Cast Steel) ..... 6.5 (78-400°F)
B407G (Stainless Steel) ..... 9.4 (70-212°F)

If your operating temperature exceeds the above range listed with its corresponding coefficient, consult Warren.

The second piece of the formula deals with temperature rise and is fairly straight forward. Simply stated, the temperature rise is the difference between ambient and operating temperature (in degrees Fahrenheit).

The third piece of the formula, centerline height, is simply the distance (in inches) from the bottom of the pump and driver feet to the center of their respective shafts. Check the supplied outline drawing for pump and driver centerline heights.

The following is a sample calculation using an actual outline and consequently existing centerline differences from a previous pump sale.

Example:

ambient temperature ..... 80°F

pump operating temperature ..... 200°F
pump centerline height ..... 12"
pump material ..... 316SS

motor operating temperature ..... 160°F
motor centerline height ..... 10"
motor material ..... Cast Iron

**pump rise due to thermal expansion = coefficient of expansion x temp. rise x centerline height,** where
coefficient of expansion is 9.4 x $10^{-6}$ in/in/°F
temp. rise is 120°F (200°F — 80°F)
centerline height is 12″
pump rise = 9.4 x $10^{-6}$ x 120 x 12
pump rise = .014″

**motor rise due to thermal expansion = coefficient of expansion x temp. rise x centerline height,** where
coefficient of expansion is 6 x $10^{-6}$ in/in/°F
temp. rise is 80°F (160° — 80°F)
centerline height is 10″
motor rise = 6 x $10^{-6}$ x 80 x 10
motor rise = .005″

This would result in an additional .009″ (.014″ — .005″) of misalignment when the pump and motor warmed up to operating temperatures. The necessity of making an allowance for thermal expansion is illustrated, as well as the need to check the alignment of the unit while hot. Further the statement should be made that the thermal growth formula is the best method of determining centerline rise without actually checking a hot unit. However, the method is just an approximation and does not account for the influences of piping, casing geometry and hot and cold spots created by circulating air.

In conclusion, the following steps should be taken to insure proper coupling alignment during operation.

1. Calculate thermal growth and compensate accordingly when aligning the coupling.
2. Whenever possible allow pump and driver to warm up prior to start up.
3. Check coupling alignment while both pump and driver are hot to insure alignment is correct for the operating conditions.

# SECTION 5 — LUBRICATION

## 5-1 LUBRICATION SPECIFICATIONS

Warren recommends the use of high grade non-detergent oils with anti-foaming agents; oxidation and corrosion inhibitors. It is suggested that the oils conform approximately to the following characteristics:

| | |
|---|---|
| ISO VG | 150 |
| Viscosity cST @ 40°C | 135-165 |
| SSU @ 100°C | 800 |
| Viscosity index min. | 80 |
| Flash Point OC °C | 200°C |
| Gravity °API | 28 |

(These are to guide you and are not rigid specifications). The following oils are satisfactory and fall in the general range of the above specifications:

| | |
|---|---|
| EXXON | Teresstic 150 |
| MOBIL | DTE Extra Heavy |
| SHELL | Turbo 150 |
| SUNOCO | Sunvis 775 |
| TEXACO | Regal R&O 150 |
| GULF | Harmony 150 N |

**IMPORTANT**
The oil level should be maintained at the recommended point in the sight glass when the pump is not running, as a false reading can occur while the pump is running. The gear and bearing housings should be thoroughly cleaned and filled with new oil at least once every three months or more often if there are any adverse atmospheric conditions (dust etc.), or other factors which might contaminate or break down the oil.

## 5-2 COOLING

The Series 2200 pump may require cooling of the timing gear housing. This determination is made when the service is examined and the selection made. If the pump requires cooling the pump will be constructed with a heat exchanger. It will be necessary to supply water at a maximum of 50 psig. Flow requirements will vary according to a particular installation but you should insure that a supply of 2 gpm is available. Once the pump is run the flow can be adjusted to keep bearing and gear temperatures within prescribed limits.

In unusual circumstances (i.e. extremely high product temperatures or ambient conditions) a more sophisticated cooling system may be required. Consult Warren for guidance.

# SECTION 6 — PRE-STARTUP

## 6-1 PRE-STARTUP

Pre-startup checks for trouble free initial startup are essential to avoid operational difficulties.

Listed below are several items which should be checked prior to the release of equipment to regular operation:

1. Inspect all piping. Check for leaks and unnecessary piping strain on the equipment. Flush all piping to insure removal of foreign material from the system. Check that all valves and remote control equipment is functional.

2. Check rotating element to see that it turns freely. Jacking may be necessary on large units. If there is any rubbing or binding at this point, the equipment must not be started until the cause of this rubbing or binding has been located and corrected.

3. Before making up the pump and driver coupling halves, check that driver rotation is correct. Rotation is shown by the directional arrow attached to the pump.

4. Align coupling halves, lubricate and make up the coupling. See Section 4.

5. Check oil level at both ends of pump. Drain any oil remaining from storage. Recharge with new oil as prescribed in LUBRICATION Section 5. Check to insure that oil is at the proper level in both oil reservoirs. This is at the center of the sight glass when the pump is **not** running as a false level may be indicated when the pump is running. **Do not overfill.**

## 6-2 START-UP

1. If pump is jacketed for heating, introduce heating medium and allow pump to heat.

2. Open both suction and discharge valves wide.

   **CAUTION:** Since this is a positive displacement pump, never operate with the suction or discharge valve closed or partially closed. When pumping hot liquids, open valves slowly to allow all parts to expand evenly.

3. If pump operates with a suction lift, open vent in discharge piping and the body must be filled with liquid prior to initial start-up AFTER installation or overhaul and possibly after lengthy periods of idle time. Once initial prime has been attained, the pump will not require priming on each start-up. If the pump operates under a flooded suction, open the valves and allow the liquid to flood the pump. Rotate pump by hand to permit proper flooding when pumping viscous liquids.

4. Start driver.

5. When your Series 2200 pump has external sealing and lubrication liquid to stuffing box from the discharge of pump, the valve or valves, depending on pumping conditions, should always be throttled to prevent excessive pressure at the gland. This is applicable to pumps equipped with packing or mechanical seals.

6. Adjust gland leakoff as necessaary. Do not stop gland leakoff entirely. a constant leakoff is required to provide lubrication for the packing.

## 6-3 WHEN PUMP IS RUNNING

1. Check unit for unusual noise or vibration. Any unusual vibration or change in sound must be investigated as it may be the first sign of impending trouble.

2. Check bearing housing temperature. Bearing temperatures can safely rise to approximately 180°F.* Product and/or ambient temperatures should be considered when making judgments as to whether or not the temperatures are excessive.

3. Check gland leakoff on packed pumps. If necessary, adjust packing compression and/or gland seal pressure to achieve a slight, constant leakoff. If excessive leakoff is observed and gland travel is used up, packing rings are worn and must be replaced. (See PACKING INSTRUCTIONS, Section 8-7).

   If the pump is fitted with mechanical seals, check for leakage.

4. On pump fitted with cooling water to timing gear housing, open valve and regulate so temperature of lube oil is held between 140° and 170°.

*Bearing temperature up to 180°F. are normal. Within limits, the stability of the temperature rather than the number of degrees is the best indication of normal operation. A sudden increase in temperature indicates that a bearing problem is developing and a check of the bearing should be made.

Do not attempt to measure temperature by hand. Above 120° the human hand is worthless in estimating temperature. Use a sensing device to check temperatures.

## 6-4 TO STOP PUMP

1. Stop driver.
2. Close suction and discharge valves.
3. Close seal line valves.

# SECTION 7 — PREVENTIVE MAINTENANCE

## Periodic Inspection

## 7-1 DAILY

1. Check oil level in bearing housings.
2. Listen for unusual noise or vibration.
3. Inspect pump for leaks if pump is in use.
4. Check pipe connections and valves for leakage if pump systems are in use.
5. Check stuffing boxes to see if insufficient or excessive leakage exists. If excessive leakage is observed but gland travel is used up, packing rings are worn and must be replaced. For mechanical seal installation it must be understood that all seals leak to some extent. In most cases the product vaporizes resulting in no observable leakage. However, for some applications, a modest amount of leakage is acceptable. Bearing this in mind, check to see if there is

any change in leakage rate which would indicate a seal problem.

6. Adjust flushing cooling liquid as necessary.
7. Make a general survey of the area and note any conditions which could lead to future problems.

## 7-2 WEEKLY

1. Run idle pumps under power.
2. Check operation of suction and discharge valves.
3. Check all automatic controls and regulators.

## 7-3 QUARTERLY

1. Check all foundation bolts and holddown bolts for tightness.
2. Remove half gland and check packing if pump has been left idle for long periods of time. If packing has become hard or otherwise unusable, it should be replaced.
3. Oil should be changed at least every three months or more often if there are any adverse atmospheric conditions (dust, etc.) or other factors which might contaminate or break down the oil.

## 7-4 ANNUALLY

1. Check existing pump capacity, pressure and power requirements against pump and motor nameplate data. If pressure and capacity have dropped off excessively, the pump should be disassembled and worn parts replaced. See applicable disassembly and reassembly sections in Section 8 — MAINTENANCE. If pump performance is satisfactory, the pump need not be disassembled for inspection.
2. Check alignment of pump and driver coupling hubs preferably after an operating period when pump and driver are still at operating temperature. Correct alignment if necessary and relubricate coupling at this time.

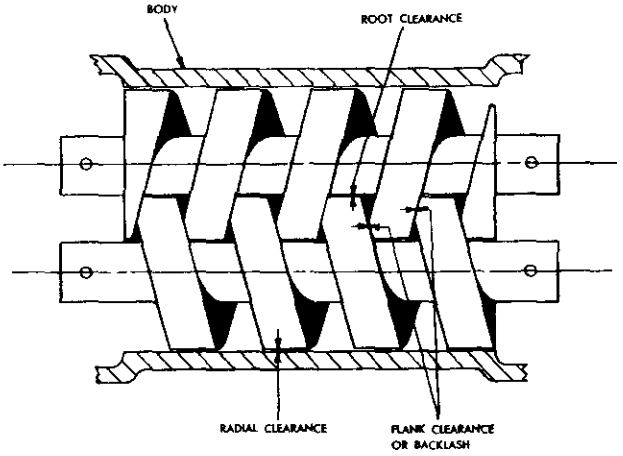
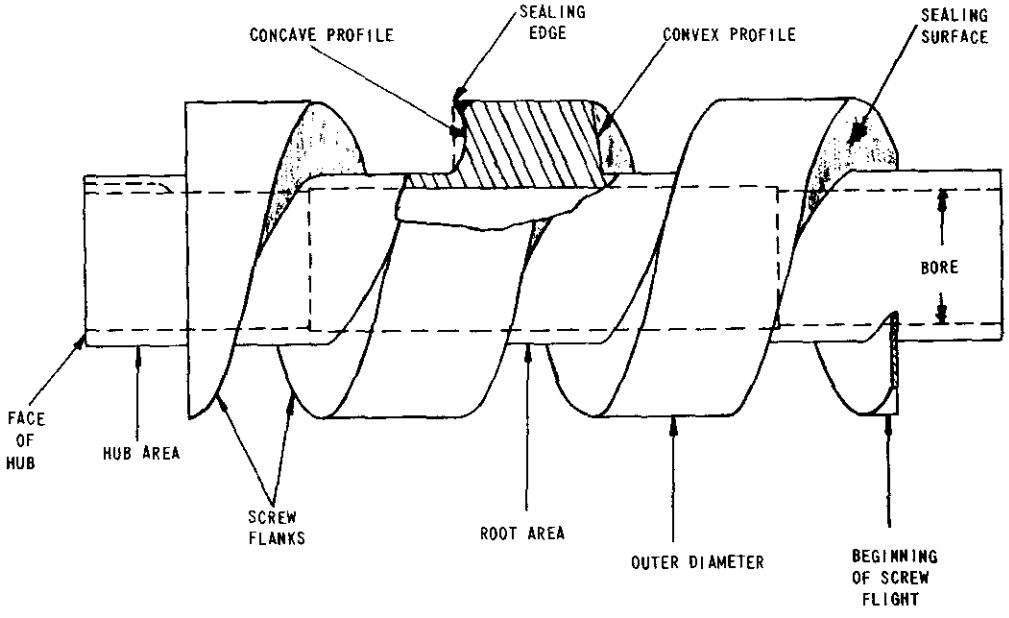



**Fig. 7-4a**




NOTE - 360° or (1) Turn
Make one complete flight

**Fig. 7-4b**

## SECTION 8

### 8-1 DISASSEMBLY (packed pump one piece brackets) Refer to Dwg. A-1828 (standard body) A-1893 (hopper body)

1. Close pump suction and discharge valves. LOCKOUT VALVES WITH APPROVED LOCKOUT SYSTEM.
2. Disconnect all electrical sources. LOCKOUT WITH APPROVED LOCKOUT SYSTEM.
3. Disconnect miscellaneous secondary piping such as timing gear cooling, jacketing, seal/packing flush lines etc.
4. **Remove pump** from base.
5. Remove pump coupling half and coupling key (46).
6. Drain oil from front head (41) and timing gear housing (32).
7. Remove nuts (34) which secure the gear housing (32) to the rear bearing bracket (13).
8. Remove gear housing (32) from rear bearing bracket (13). Outer races and rollers of outboard roller bearing (38) will remain in gear housing (32).
9. Remove nuts (15) which secure the front head (41) to the front bearing bracket (12). Remove bolt (72) if fitted.
10. Remove front head (41) and front head cover (71) if fitted from front bearing bracket (12).
11. **Remove oil seal** (42) from front head (41).
12. Heat and remove inner races of outboard roller bearings (38) from shafts.
13. Remove timing gear locknuts (48) and lockwashers (49).
14. Remove timing gears (50) from the shafts. Before removing the gears, match mark the ends of the gear teeth at their point of mesh. Also, mark one gear to indicate which shaft the gear was removed from. Gear removal is best accomplished by using two (2) sets of gear pullers as both gears must be removed at the same time.
15. Remove timing gear keys (47) from their keyways.
16. Remove gear and bearing spacers (51). Mark one (1) spacer to indicate which shaft it was removed from.
17. Loosen gland nuts (22). Move gland swing bolts (18) out of the way. Slide gland (17) away from the stuffing box to loosen packing (16).
18. Remove nuts (3) and taper pins (9) which secure front bearing bracket (12) to the body (1).
19. Remove front bearing bracket (12) from body (1). Oil seals (25) and outer races and rollers of roller bearings (23) will remain in the bracket (12).
20. Remove outer races and rollers of roller bearing (23) from front bearing bracket (12).
21. Remove oil seals (25) from front bearing bracket (12).
22. Remove packing (16) and lantern ring (27) if fitted from front bearing bracket (12).
23. Remove nuts (3) and taper pins (9) which secure the rear bearing bracket (13) to the body (1).
24. Loosen gland nuts (22). Move gland swing bolts (18) out of the way. Slide gland (17) away from the stuffing box to loosen packing (16).
25. Remove rear bearing bracket (13) from body (1). Oil seals (25), outer race and rollers of roller bearing (23) and thrust bearing (24) will remain in the bracket (13.).
26. Remove outer race and rollers of roller bearing (23) from rear bracket (13).
27. Remove socket head capscrews (30), shakeproof washers (31) and bearing keeper (68) from rear bearing bracket (13).
28. Remove thrust bearing (24) from rear bearing bracket (13).
29. Remove oil seals (25) from rear bearing bracket (13).
30. Remove packing (16) and lantern ring (27) if fitted from rear bearing bracket (13).
31. Remove rotating assembly (44) (45) from the body (1).
32. Heat and remove inner races of roller bearings (23) from shafts (44) (45).
33. Remove all gaskets as necessary.

### 8-2 REASSEMBLY (packed pump/one piece brackets) Refer to Dwg. A-1828 (standard body) A-1893 (hopper body)

1. Heat and shrink inner races of roller bearings (23) onto shafts (44) (45).
2. Swab shafts (44) (45) and bores of body (1) with oil and insert rotors into body.
3. Install oil seals (25) into front bearing bracket (12).
4. Apply Loctite on outer race O.D. of roller bearings (23) and install outer races and rollers of roller bearings (23) into front bearing bracket (12).

5. Position gaskets (10) on both faces of body (1).
6. Slide front bearing bracket (12) over shafts (44) (45) and seat against gasket (10). It is necessary to install lantern rings (27) if fitted and glands (17) on shafts (44) (45) as they protrude from the stuffing boxes.
7. Align front bearing bracket (12) to body (1) with taper pins (9) and secure with nuts (3).
8. Install oil seals (25) into rear bearing bracket (13).
9. Apply Loctite on outer race O.D. of roller bearing (23) and install outer race and rollers of roller bearing (23) into rear bearing bracket (13). (short shaft side only).
10. Slide rear bearing bracket (13) over shafts (44) (45) and seat against gasket (10). It is necessary to install lantern rings (27) if fitted and glands (17) on shafts (44) (45) as they protrude from the stuffing boxes.
11. Align the rear bearing bracket (13) to the body (1) with taper pins (9) and secure with nuts (3).
12. Apply Loctite on outer race O.D. of thrust bearing (24) and install thrust bearing into bracket by sliding over shaft (44) and tapping into place. Tap bearing on inner race **only.** Refer to A-1828 or A-1893 for proper mounting of duplex bearing J-10's only.
13. Secure thrust bearing (24) with bearing keepers (68), socket head capscrews (30) and shakeproof washers (31).
14. Install bearings spacers (51) on shafts (44) (45) and seat against thrust bearing (24) and roller bearing (23). Make sure spacers are installed correctly on their respective shafts.
15. Install timing gear keys (47) onto shafts (44) (45).
16. Install timing gears (50) onto shafts (44) (45) making sure that they are meshed properly at their match marks and installed on their respective shafts.
17. Secure timing gears (50) with locknuts (48) and lockwashers (49).
18. Heat and shrink inner races of outboard roller bearings (38) on shafts (44) (45).
19. Apply Loctite on outer race O.D. of roller bearings (38) and install outer races and rollers of outboard roller bearings (38) into timing gear housing (32).
20. Position gasket (29) on face of rear bearing bracket (13).
21. Install timing gear housing (32) onto rear bearing bracket (13), seating against gasket (29), secure with nuts (34).
22. Install oil seal (42) into front head (41).
23. Position gasket (64) on front bearing bracket (12).
24. Install front head (41) onto front bearing bracket (12), seating against gasket (64), and secure with nuts (15). Install head cover (71) if fitted and secure with nuts (15) and bolt (72).
25. Install pump half coupling and coupling key (46).
26. Install pump packing. See PACKING INSTRUCTIONS, Section 8-7.
27. Reinstall pump on base and reconnect all piping.
28. Add lubricant to the timing gear housing and front head at oil fittings (35). See LUBRICATION, Section 5-1.

## 8-3 DISASSEMBLY (mech. seal/ split bracket)

**Refer to Dwg. D-4538 (standard body) D-4542 (hopper body)**

1. Close pump suction and discharge valves. LOCKOUT VALVES WITH APPROVED LOCKOUT SYSTEM.
2. Disconnect all electrical sources. LOCKOUT WITH APPROVED LOCKOUT SYSTEM.
3. Disconnect miscellaneous secondary piping such as timing gear cooling, jacketing, seal/ packing flush lines etc.
4. **Remove pump** from base.
5. Remove pump coupling half and coupling key (46).
6. Drain oil from front head (41) and timing gear housing (32).
7. Remove nuts (34) which secure the gear housing (32) to the rear bearing housing (13).
8. Remove gear housing (32) from rear bearing housing (13). Outer races and rollers of outboard roller bearings (38) will remain in gear housing (32).
9. Remove nuts (15) which secure the front head (41) to the front bearing housing (12). Remove bolt (72) if fitted.
10. Remove front head (41) and front head cover (71) if fitted from front bearing housing (12).
11. **Remove oil seal** (42) from front head (41).
12. Head and remove inner race of outboard roller bearings (38) from shafts.
13. Remove timing gear locknuts (48) and lockwashers (49).
14. Remove timing gears (50) from the shafts. Before removing the gears, match mark the ends of gear teeth at their point of mesh. Also, mark one gear to indicate which shaft the gear was removed from. Gear removal is best accomplished

by using two (2) sets of gear pullers as both gears must be removed at the same time.

15. Remove timing gear keys (47) from their keyways.
16. Remove gear and bearing spacers (51). Mark one (1) spacer to indicate which shaft it was removed from.
17. Remove nuts (82) and taper pins (79) which secure the front bearing housing (12) to the front stuffing box housing (27).
18. Remove front bearing housing (12) from front stuffing box housing (27). Oil seals (25) and outer races and rollers of roller bearings (23) will remain in the housing (12).
19. Remove outer races and rollers of roller bearing (23) from front bearing housing (12).
20. Remove oil seals (25) from front bearing housing (12).
21. Remove nuts (22) and washers (74) which secure gland (17) to the front stuffing box housing (27).
22. Remove gland (17) from front stuffing box housing (27). The gland bushing (28) and stationary ring of the mechanical seal (16) will remain in the gland.
23. Remove mechanical seal (16). Method of removal will vary with type of seal. Consult seal drawing for proper procedure.
24. Remove nuts (3) and taper pins (9) which secure the front stuffing box housing (27) to the body (1).
25. Tighten down jackscrews (66) to break the bond between the front stuffing box housing (27) and the body (1).
26. Remove the front stuffing box housing (27) from the body (1).
27. Remove nuts (82) and taper pins (79) which secure the rear bearing housing (13) to the rear stuffing box housing (27).
28. Remove rear bearing housing (13) from the rear stuffing box housing (27). Oil seals (25) outer race and rollers of roller bearing (23) and thrust bearing (24) will remain in the bearing housing (13).
29. Remove outer race and rollers of roller bearing (23) from rear bearing housing (13).
30. Remove socket head capscrews (30), shakeproof washers (31) and bearing keeper (68) from rear bearing housing (13).
31. Remove thrust bearing (24) from rear bearing housing (13).
32. Remove oil seals (25) from rear bearing housing (13).
33. Remove nuts (22) and washers (74) which secure the gland (17) to the rear stuffing box housing (27).
34. Remove gland (17) from rear stuffing box housing (27). The gland bushing (28) and stationary ring of the mechanical seal (16) will remain in the gland.
35. Remove rotating portion of mechanical seal (16) from shafts. Method of removal will vary with type of seal. Consult seal drawing for appropriate procedure.
36. Remove all stationary rings of mechanical seals (16) from gland bushings (28).
37. Remove all gland bushings (28) and "O" Rings (20) from glands (17).
38. Remove nuts (3) and taper pins (9) which secure the rear stuffing box housing (27) to the body (1).
39. Tighten down jackscrews (66) to break the bond between the rear stuffing box housing (27) and the body (1).
40. Remove the rear stuffing box housing (27) from the body (1).
41. Remove rotating assembly (44) (45) from the body (1).
42. Heat and remove inner races of roller bearings (23) from shafts (44) (45).
43. Remove all gaskets as necessary.

## 8-4 REASSEMBLY (Mech. Seal-Split Bracket) Refer to Dwg. D-4538 (standard body) D-4542 (hopper body)

1. Heat and shrink inner races of roller bearing (23) onto shafts (44) (45).
2. Swab shafts (44) (45) and bores of body (1) with oil and insert rotors into body.
3. Position gaskets (10) on both faces of body (1).
4. Slide front and rear stuffing box housings (27) over shafts (44) (45) and seat against gaskets (10).
5. Align front and rear stuffing box housings (27) to body (1) with taper pins (9) and secure with nuts (3).
6. Install rotating portions of front mechanical seals (16). Method of installation will vary with type of seal. Consult seal drawing for appropriate procedure. Do not secure at this time.
7. Position gasket (19) on face of front stuffing box housing (27).
8. Install gland bushing (28) and O-ring (20) into front gland (17).

9. Install stationary ring and O-ring of mechanical seal (16) into gland bushing (28). Be sure that anti-rotation pin (21) is properly inserted into the drill hole in the gland bushing (28).
10. Slide gland (17) over shafts (44) (45). Handle with caution to prevent damage to the mechanical seals. Do not secure at this time.
11. Install oil seals (25) into front bearing housing (12).
12. Apply Loctite on outer race O.D. of roller bearings (23) and install outer races and rollers of roller bearings (23) into front bearing housing (12).
13. Slide front bearing housing (12) over shafts (44) (45) and seat against front stuffing box housing (27).
14. Align front bearing housing (12) to front stuffing box housing (27) with taper pins (79) and secure with nuts (82).
15. Install rotating portion of rear seals (16). Method of installation will vary with type of seal. Consult seal drawing for appropriate procedure. Do not secure at this time.
16. Position gasket (19) on face of rear stuffing box housing (27).
17. Install gland bushing (28) and O-ring (20) into rear gland (17).
18. Install stationary ring and O-ring of mechanical seal (16) into gland bushing (28). Be sure that anti-rotation pin (21) is properly inserted into the drill hole in the gland bushing (28).
19. Slide gland (17) over shafts (44) (45). Handle with caution to prevent damage to the mechanical seals. Do not secure at this time.
20. Install oil seals (25) into rear bearing housing (13).
21. Apply Loctite on outer race O.D. of roller bearing (23) and install outer race and rollers of roller bearing (23) into rear bearing housing (13).
22. Slide rear bearing housing (13) over shafts (44) (45) and seat against rear stuffing box housing (27).
23. Align rear bearing housing (13) to rear stuffing box housing (27) with taper pins (79) and secure with nuts (82).
24. Apply Loctite on outer race O.D. of thrust bearing (24) and install thrust bearing (24) into rear bearing housing (13) by sliding over shaft (44) and tapping into place. Tap bearing on inner race **only.**

    Refer to D-4538 or D-4542 for proper mounting of duplex bearing on J-10's only.
25. Secure thrust bearing (24) with bearing keepers (68), socket head capscrews (30) and shakeproof washers (31).
26. Install bearing spacers (51) on shafts (44) (45) and seat against thrust bearing (24) and roller bearing (23). Make sure spacers are installed correctly on their respective shafts.
27. Install timing gear keys (47) onto shafts (44) (45).
28. Install timing gears (50) onto shafts (44) (45) making sure that they are meshed properly at their match marks and installed on their respective shafts.
29. Secure timing gears (50) with locknuts (48) and lockwashers (49).
30. Heat and shrink inner races of outboard roller bearings (38) on shafts (44) (45).
31. Apply Loctite on outer race O.D. of roller bearings (38) and install outer races and rollers of outboard roller bearings (38) into timing gear housing (32).
32. Position gasket (29) on face of rear bearing housing (13).
33. Install timing gear housing (32) onto rear bearing housing (13), seating against gasket (29), and secure with nuts (34).
34. Install oil seal (42) into front head (41).
35. Position gasket (64) on front bearing housing (12).
36. Install front head (41) onto front bearing housing (12), seating against gasket (64), and secure with nuts (15). Install gasket (57) and head cover (71) if fitted and secure with nuts (15) and bolt (72).
37. Secure front and rear rotating portions of mechanical seal (16). Method of installation will vary with type of seal. Consult seal drawing for appropriate procedure.
38. Secure front and rear glands (17) to stuffing box housings (27) with washers (74) and nuts (22). Tighten the nuts evenly to prevent cracking the seals.
39. Install pump half coupling and coupling key (46).
40. Reinstall pump on base and reconnect all piping.
41. Add lubricant to the timing gear housing and front head at oil fittings (35) (75). See LUBRICATION, Section 5-1.

## 8-5 REMOVAL AND INSTALLATION OF PUMPING SCREWS

NOTE: This section deals with the removal and installation of pumping screws on shafts and applies only to those pumps incorporating pinned screws. If your pump features integral shafts and screws (normal construction) this section does not apply.

1. Remove shaft sleeves (55 & 56). These parts are a slip fit and are sealed to the shaft with an epoxy adhesive. To remove it will be necessary to apply heat to break down the epoxy adhesive.
2. After removing shaft sleeves, carefully and accurately measure from the timing gear ends of each shaft to the shoulder or face of the pumping screw hub. Record these measurements.
3. Before removing pumping screws from shafts, make a rough sketch to a) indicate the direction of screw pitch of each screw and b) to indicate where the screw flights end in respect to each other. A sample is shown below:

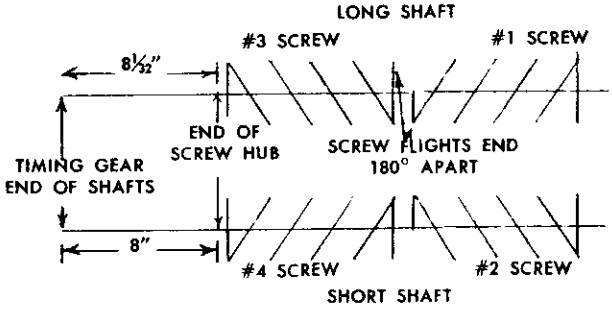



**Fig. 8-1**

4. Taper pins (58) hold the pumping screws (54) on the shafts. The screws are also bonded to the shafts with epoxy resin. Grind the small end of the pins (58) flush with the screws to remove the peened over portion and drive the pins out. Heat the pumping screw roots to approximately 900°F to destroy the adhesive strength of the epoxy. Immediately apply hydraulic pressure to the pumping screw or to the shaft to force the screw off the shaft. **Press each screw from the center out as screw bores are stepped with small diameter outboard.**
5. Place the pumping screw taper pins into the holes drilled in the shafts, drive them tight and grind them off flush with the shaft.
6. Place each shaft in a lathe and check the shaft runout which should not exceed .002".
7. Measure the bore diameter of the new pumping screws (54) to assure .002" to .004" clearance between the bore of the screw and the shaft.
8. New replacement screws are stamped with numbers 1, 2, 3 and 4. Screws numbered 1 and 2 are installed on different shafts so that they will mesh. Screws numbered 3 and 4 also mesh with each other.
9. Mix the epoxy adhesive per instructions packed with the adhesive. Spread a thin layer of the mixed epoxy over the long shaft in the area where the pumping screws will be installed, and also spread a small amount in the screw bore.
10. Place screw marked No. 1 on the long shaft over the coupling end. Refer to your sketch and measurement for proper positioning of the screw.
11. Place screw marked No. 3 on the opposite end of the long shaft. Push it up to but do not move the No. 1 screw. Again, refer to your sketch for proper positioning of this screw as regards the end of the screw flights of the two screws.
12. When you are satisfied that the measurement from the end of the shaft to the No. 3 screw hub is correct and that both screws are properly placed and positioned, drill and ream for taper pins **being very careful not to move the screws.** Install the taper pins and peen over the small end. Be sure **not** to drill through the shaft at the location of the original taper pins.
13. Spread a thin layer of the epoxy mixture over the short shaft screw area (just that part over which the coupling end screw will fit. Do not cover the entire area for both screws).
14. Place screw marked No. 2 on the short shaft over the coupling end. Refer to your sketch and measurement for the proper positioning of this screw. When you are satisfied that this screw is properly positioned on the shaft, drill and ream for taper pin. Install the taper pin and peen over the small end.
15. Mesh the coupling end screws together. Hold one shaft stationary and turn the other. The threading action of the meshed screws will draw the rotated shaft axially. Rotate the one shaft as necessary to bring the timing gear ends of both shafts flush. Once this is achieved, turn the same shaft very slightly in the opposite direction. By doing this while looking down at the point of screw mesh, you will be able to see the flank clearance (clearance between meshed screw flight) become open. See sketch 8-2.

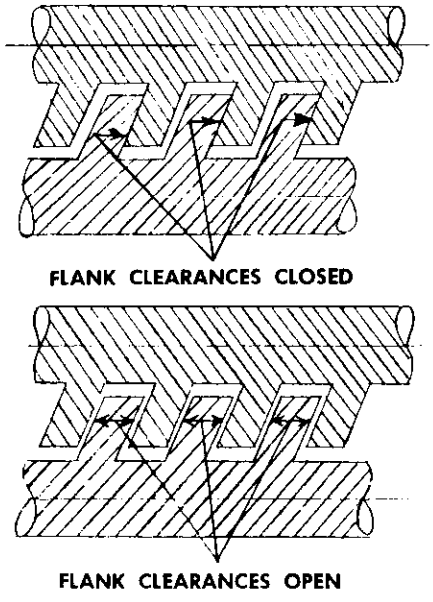



**Fig. 8-2**

16. Open flank clearances so that clearance is equal between the meshed screws. Measure the clearance and insert small strips of shim stock into all the clearances.
17. Wire the meshed screws tightly together and leave the shim in place.
18. Cover shaft in the No. 4 screw area with a mixed epoxy.
19. Place the remaining screw over the short shaft. By turning the screw on the shaft, the screw thread will engage the screw thread of the No. 3 screw and will be drawn into position. When the No. 4 screw hub contacts the No. 2 screw hub, again turn the No. 4 screw slightly backwards to open and equalize the flank clearances. Insert shim stock into the clearances, then drill and ream for taper pin. Drive the pin in peen over the small end.
20. Check pumping screw runout between lathe centers. Grind if necessary to true up pumping screw O.D. to .0015" maximum runout.
21. If shaft sleeves are replaced, they should be reinstalled prior to placing rotors in the body. The sleeves are sealed to the shaft by epoxy adhesive. Cover the shaft area with adhesive and slide the sleeve in place with its key. The sleeve should be twisted while sliding to prevent the sleeve keyway from plowing a leak path in the epoxy.
22. See "Installation of Replacement Timing Gears" for timing instructions.

## 8-6 INSTALLATION AND TIMING OF REPLACEMENT TIMING GEARS

Replacement timing gears are furnished as a matched set. One of the replacement gears includes a timing gear keyway pre-cut at the factory. The remaining gear does not have a pre-cut keyway. This keyway must be located and cut in the field. There are two methods which may be employed to field time this pump. The procedure may be accomplished in one of two ways; with rotor in brackets alone or in body and brackets. Additionally, there are two methods of establishing the relationship between the two shafts. One is to lock them rigidly using shim stock inserted between the flanks of the two opposing screws. The other method (usually used with rotors in the body) is to roll one shaft in both directions until flanks contact. The proper timing point is then half way between the contact points.

**METHOD 1** (In Body & Brackets)

1. Install timing gear key in the long shaft keyway only. Do not install short shaft timing gear key.
2. Fit timing gears to the shafts individually so that the gears are a slip fit onto the shafts. It is important that the short shaft gear be able to turn on the short shaft without turning the shaft itself.

**CAUTION:** The fit should only be loose enough to work with (light tap fit). Excessive clearances **must** be avoided.

3. Mesh timing gears together and install on lightly oiled shafts. Push gears onto the shafts until the long shaft key is about one-half covered by the timing gear. NOTE: When installed, timing gear teeth apexes must point in the direction that that particular shaft rotates.
4. Apply bluing to the inside face of the short shaft timing gear.
5. Grind one end of the short shaft timing gear key flat then stand the key vertically in the shaft keyway so that the key extends up across the timing gear face. **It is VERY important that the key fit tightly and squarely in the keyway.**
6. Set up a dial indicator with its button resting against the side of the long shaft keyway.
7. Lock the short shaft to prevent its rotation. Rotate the long shaft in both directions and record the total indicator reading.
8. Rotate the long shaft until it is positioned such that the dial indicator reads one half the total reading.
9. Turn the short shaft gear to bring the drive side of the long shaft gear teeth in contact with the driver side of the short shaft gear teeth. This removes gear backlash.
10. Scribe a line on both sides of the vertical key on the blued face of the short shaft gear. These lines indicate where the keyway is to be cut.
11. Match mark the timing gears at their point of mesh.
12. Remove the timing gears from their shafts and cut the keyway as marked. Be careful to cut the keyway accurately at the scribed lines.

NOTE: If, upon installation and **securing** of the gears on their shafts, there is flank contact due to some inaccuracy in setting the keyway it is possible to compensate by reducing the thickness of one of the gear spacers. Determine which side of the screws is in contact and machine the appropriate spacer to reposition the screws.

**METHOD II** (In Brackets)

1. Mesh rotors together and reinstall bearing brackets and bearings so that the rotor assembly is set up as shown in the following sketch (Fig. 8-3).

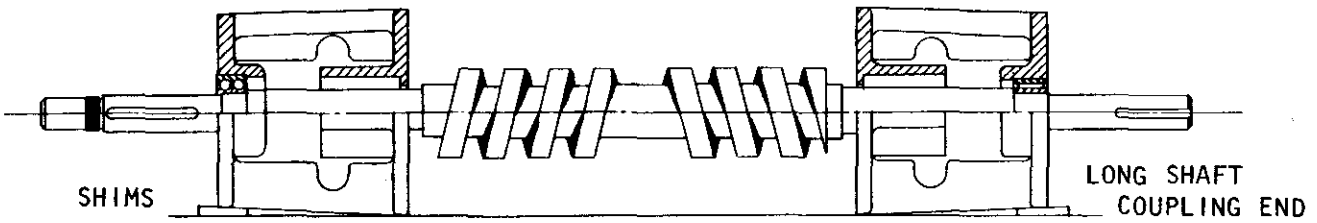



**Fig. 8-3**

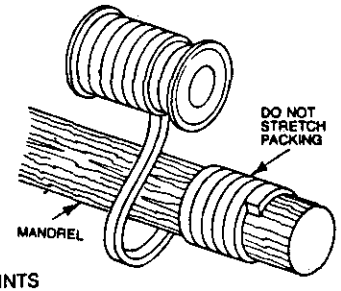
2. Fit timing gears to the shafts individually so that the splined gear is a snug fit to its shaft and the unsplined gear is a close sliding fit (.001″ to .0015″) to its shaft.
3. The shafts should now be leveled in their brackets length-wise and across.
4. Install timing gears on shafts with the apex of the gear teeth pointing in the direction of rotation of its respective gear. The splined gear should be installed with its key. The gears should be installed so that approximately one-half of the key is covered. Lightly oil shafts prior to gear installation.
5. Turn gears in direction of rotation to remove backlash.
6. Determine the total existing flank clearance between meshed screws. Rotate one screw slightly to equalize the flank clearances, then insert sufficient shim stock into the flank clearances to fill the clearance and hold the shafts stationary.
7. Apply bluing to the inside face of the short shaft timing gear.
8. Grind one end of the short shaft timing gear key flat then stand the key vertically in the shaft keyway so that the key extends up across the timing gear face. It is **very** important that the key fit tightly and squarely in the keyway.
9. Recheck to see that shafts are level lengthwise and across.
10. Using a sharp scribe, scribe a line on either side of the vertical key using the key as a guide.
11. Match mark the timing gears at their point of mesh.
12. Remove the unsplined timing gear from the shaft and cut the keyway.

    **NOTE:** If, upon installation and **securing** of the gears on their shafts, there is flank contact due to some inaccuracy in setting the keyway it is possible to compensate by reducing the thickness of one of the gear spacers. Determine which side of the screws is in contact and machine the appropriate spacer to reposition the screws.

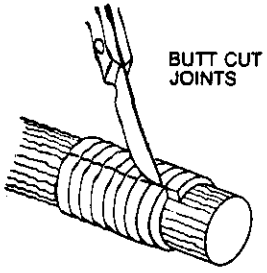
## METHOD OF INSTALLATION

1

Wrap the packing around the mandrel a sufficient number of times for the amount of rings being made. Hold the packing firmly on the mandrel. DO NOT STRETCH IT.

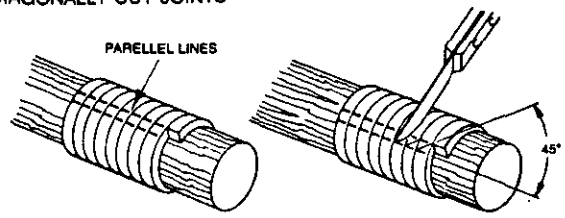



BUTT CUT JOINTS



Cut directly across the packing.

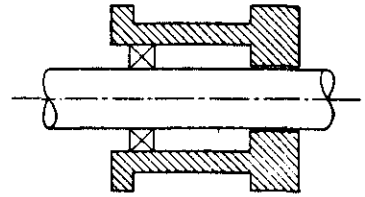
DIAGONALLY CUT JOINTS



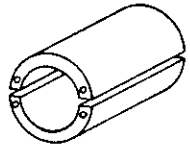

Draw two parallel lines on the packing, then individually cut each ring at a 45° angle.

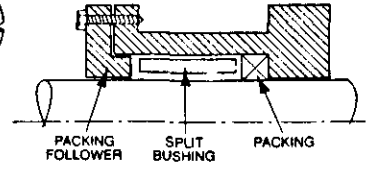
2

A. Install one ring at a time.
B. Make sure the ring is clean.
C. Where compatible, lubricate lightly on ID and OD with a suitable lubricant.

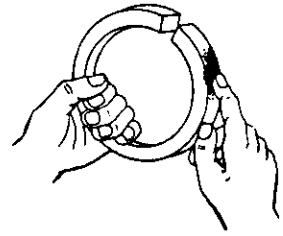


D. Use split bushings to install each ring.



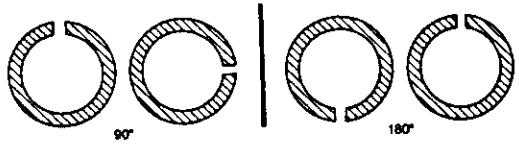



A tamping stick may be used, if split bushings are not available.
DO NOT USE A SCREWDRIVER.

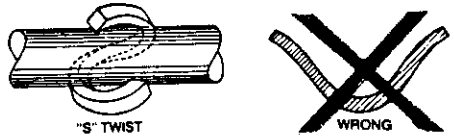


3

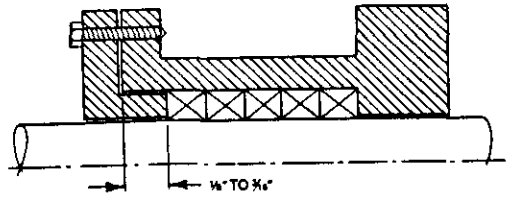
E. Stagger joints 90° apart. If only two rings are used, stagger joints 180° apart.




F. When putting rings around the shaft use an "S" twist. DO NOT BEND OPEN.




G. When the last ring has been installed, there should be enough room to insert the gland follower 1/8" to 3/16".



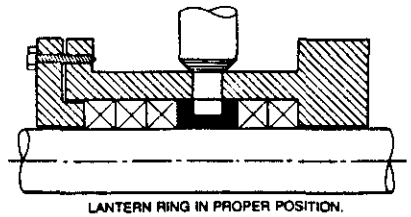

4

H. Take up on the gland bolts with a wrench to seat and form the packing to the stuffing box and shaft. Loosen gland nuts, and let packing expand. Rotate shaft by hand to get running clearance. Then re-tighten gland nuts finger tight only. Again rotate shaft by hand to make sure packing is not too tight.

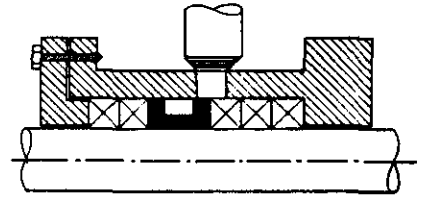
I. Start the pump, allowing the stuffing box to leak freely, then take up on the gland bolts one flat at a time until the desired leakage is obtained, and the pump is running cool.

J. To insure long service life, allow adequate break in time for a set of new packings.

K. If a lantern ring (seal cage, water cage) is provided, make sure the lantern ring is installed under the pipe tap hole.



LANTERN RING IN PROPER POSITION.



LANTERN RING NOT IN PROPER POSITION.

***NOTE: If lubrication is not used, remove lantern ring and replace with packing.***

## 9-1 PARTS INFORMATION

| | J-10X | J-20X | J-30X | J-40X | J-50X | J-60X | J-70X | J-80X |
|---|---|---|---|---|---|---|---|---|
| THRUST BEARING | ND OLO5 DB MTG. | SKF 5206 | SKF 5306 | SKF 5209 | SKF 5211 | SKF 5211 | ND5216 | ND5220 |
| Thrust Bearing Shaft Fit | .0000/.0005 Tight | .0000/.0005 Tight | .0000/.0005 Tight | .0000/.0006 Tight | .0000/.0006 Tight | .0000/.0006 Tight | .0000/.0008 Tight | .0000/.0009 Tight |
| Thrust Bearing Housing Fit | .0007/.0002 Loose/Tight | .0008/.0002 Loose/Tight | .0008/.0002 Loose/Tight | .0008/.0003 Loose/Tight | .0009/.0003 Loose/Tight | .0009/.0003 Loose/Tight | .0008/.0004 Loose/Tight | .0007/.0006 Loose/Tight |
| INBOARD RADIAL BEARING | McGill MR-20 MI-16 | McGill MR-24N MI-20N | McGill MR-24 MI-20 | Hyatt A5211TS | Hyatt A5211TS | Hyatt A5211TS | Hyatt A5216TS | Hyatt A5220TS |
| Inboard Radial Brg. Shaft Fit | .0001/.0009 Loose/Tight | .0000/.0010 Tight | .0000/.0010 Tight | .0004/.0010 Tight/Tight | .0005/.0012 Tight/Tight | .0005/.0012 Tight/Tight | .0008/.0015 Tight/Tight | .0010/.0019 Tight/Tight |
| Inboard Radial Brg. Housing Fit | .0011/.0002 Loose/Tight | .0013/.0002 Loose/Tight | .0013/.0002 Loose/Tight | .0008/.0003 Loose/Tight | .0009/.0003 Loose/Tight | .0009/.0003 Loose/Tight | .0008/.0004 Loose/Tight | .0007/.0006 Loose/Tight |
| OUTBOARD RADIAL BEARING | McGill MR-18 MI-14 | McGill MR-18 MI-14 | McGill MR-18 MI-14 | Hyatt A5207TS | Hyatt A5209TS | Hyatt A5209TS | Hyatt A5214TS | Hyatt A5317TS |
| Outboard Radial Brg. Shaft Fit | .0001/.0009 Loose/Tight | .0001/.0010 Loose/Tight | .0001/.0010 Loose/Tight | .0004/.0008 Tight/Tight | .0004/.0010 Tight/Tight | .0004/.0010 Tight/Tight | .0008/.0015 Tight/Tight | .0010/.0019 Tight/Tight |
| Outboard Radial Brg. Housing Fit | .0009/.0002 Loose/Tight | .0009/.0002 Loose/Tight | .0009/.0002 Loose/Tight | .0008/.0002 Loose/Tight | .0008/.0003 Loose/Tighr | .0008/.0003 Loose/Tight | .0008/.0004 Loose/Tight | .0007/.0006 Loose/Tight |
| REAR & FRONT BRACKET SEAL | Victor 64382 | Victor 63294 | Victor 63294 | Victor 62432 | Victor 62496 | Victor 62496 | Victor 63386 | Victor 49939 |
| FRONT HEAD SEAL | Victor 64222 | Victor 64346 | Victor 64346 | Chicago 17402 | Chicago 21120 | Chicago 21120 | National 455156 | Chicago 38706 |
| SHAFT DIAMETERS @ COUPLING | .9370/.9375 | 1.1870/1.1875 | 1.1870/1.1875 | 1.7495/1.7500 | 2.1245/2.1250 | 2.1245/2.1250 | 3.1245/3.1750 | 3.8745/3.8750 |
| SHAFT DIAMETER @ STUFFING BOX | 1.250 | 1.500 | 1.500 | 2.375 | 2.750 | 2.750 | 3.750 | 5.000 |
| PACKING SIZE | 1/4 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 | 1/2 | 5/8 |
| PACKING NO. OF RINGS | 8 | 7 | 7 | 8 | 9 | 9 | 9 | 9 |
| STUFFING BOX LENGTH | 2 | 2 11/16 | 2 5/8 | 3 1/16 | 3 7/16 | 3 7/16 | 4 9/16 | 5 11/16 |
| STUFFING BOX I.D. | 1.781/1.796 | 2.281/2.296 | 2.281/2.296 | 3.156/3.171 | 3.531/3.546 | 3.531/3.546 | 4.781/4.796 | 6.281/6.296 |
| STUFFING BOX LANTERN RING TO END | 3/4 | 1 3/8 | 1 5/16 | 1 3/16 | 1 9/16 | 1 9/16 | 2 1/16 | 2 9/16 |
| GASKETS | 1/64 | 1/64 | 1/64 | 1/64 | 1/64 | 1/64 | 1/64 | 1/64 |
| PUMP CLEARANCES (TOTAL) FLANK | .003 | .004 | .004 | .005 | .006 | .007 | .008 | .009 |
| PUMP CLEARANCES (TOTAL) DIAMETRAL | .004 | .005 | .0055 | .0065 | .008 | .009 | .011 | .012 |
| MAX. TORQUE (In Lbs.) | 1398 | 2904 | 3946 | 8134 | 13078 | 16980 | 36534 | 65178 |
| ROTOR WK² (Lbs./Ft.²) | .076 | .293 | .564 | 1.95 | 4.68 | 9.30 | 38.44 | 113.85 |
| MAX. JACKET PRESSURE | 150 PSIG | 150 PSIG | 150 PSIG | 150 PSIG | 150 PSIG | 125 PSIG | 100 PSIG | 100 PSIG |
| * WEIGHT (Pump Only) IN LBS. | 280 | 370 | 500 | 920 | 1300 | 2100 | 3600 | 8700 |

* These weights are **approximate.** Weight will vary with actual pump construction.

## 9-2 MATERIAL SPECIFICATIONS

| PART | CAST IRON | | ALL #316 STAINLESS STEEL | |
|---|---|---|---|---|
| | Material | Warren Spec. No. | Material | Warren Spec. No. |
| Body | Cast Iron | A010A | #316 St. Stl. | B407A |
| Integral Screws/Shafts | Steel | F164A | #316 St. Stl. | G232X |
| Alternate Separate Shafts | Steel | F084A | #316 St. Stl. | G232A |
| Option: Separate Screw | Cast Iron | A010A | #316 St. Stl. | B407X |
| Shaft Sleeves | Steel | M030A | #316 St. Stl. | B407A |
| Brackets | Cast Iron | A010A | #316 St. Stl. | B407A |
| Heads | Cast Iron | A010A | Cast Iron | A010A |
| Glands | #316 St. Stl. | B407A | #316 St. Stl. | B407A |
| Timing Gears | Heat Tr'd. Stl. | F164A | Heat Tr'd. Stl. | F164A |
| Gear Housing | Cast Iron | A010A | Cast Iron | A010A |

NOTE: Ductile iron and cast steel bodies also available. Baseplates are fabricated steel.

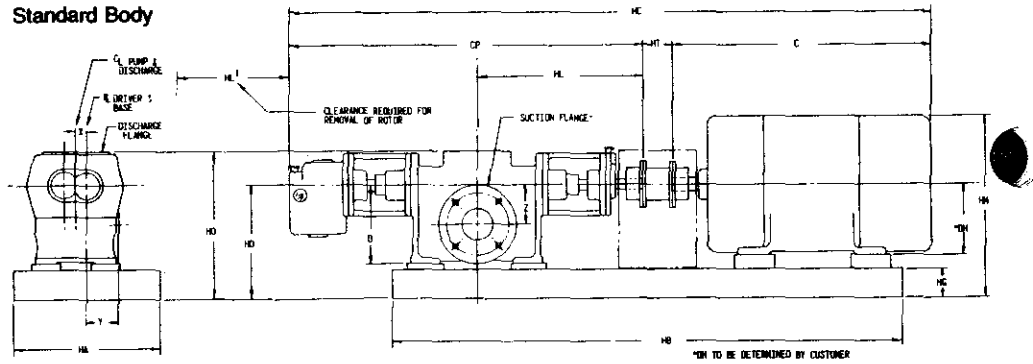
| WARREN SPEC. | EQUIV. ASTM | WARREN SPEC. | EQUIV. ASTM |
|---|---|---|---|
| A010A | A48 Cl. 48 | G232A | A276 Type 316 |
| B407A | A743 Gr. CF-8M | G232X | A276 Type 316 (Hd. Surfaced) |
| B407X | A743 Gr. CF-8M (Hd. Surfaced) | M030A | A519 |
| F084A | A434 Gr. 4140 | | |
| F164A | Type 4140 Steel | | |

# 9-3 APPROXIMATE DIMENSIONS

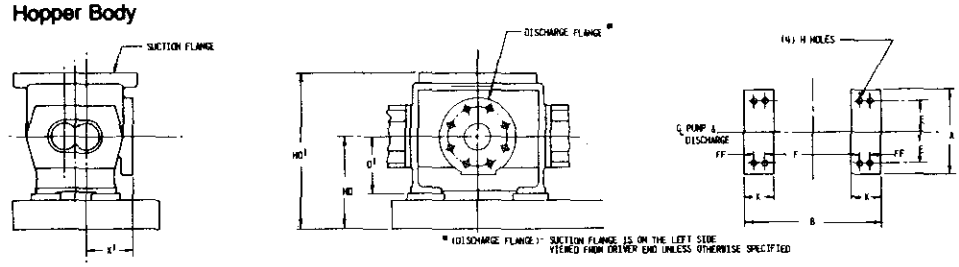
| PUMP SIZE | SUCTION 150# ASA STANDARD BODY | DISCHARGE 300# ASA STANDARD BODY | SUCTION 150# ASA HOPPER BODY | DISCHARGE 300# ASA HOPPER BODY | MOTOR HP | MOTOR RPM | MOTOR FRAME | C | CP | D | D' | HA | HB | HC | HD | HG | HL | HM | HO | HO' | HT | X | X' | Y | Z | HL' |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J-10X | 2½" | 1½" | 6" | 2" | 10 | 1150 | 256T | 23 9/16 | 34 1/8 | 7 | 4 7/8 | 15 | 45 1/4 | 62 11/16 | 10 7/8 | 3 3/8 | 17 | 18 1/8 | 13 3/4 | 16 3/8 | 5 | 29/32 | 4 3/32 | 3 3/32 | 3½ | 23 |
| | | | | | 25 | 1750 | 284T | 24 9/16 | 34 1/8 | 7 | 4 7/8 | 15 | 46 | 63 11/16 | 10 7/8 | 3 3/8 | 17 | 18½ | 13¾ | 16 3/8 | 5 | 29/32 | 4 3/32 | 3 3/32 | 3½ | 23 |
| J-20X | 3" | 2" | 8" | 2½" | 15 | 1150 | 284T | 24 9/16 | 39 13/16 | 7¾ | 6 1/8 | 15 | 49 15/16 | 69 3/8 | 11 5/8 | 3 3/8 | 19½ | 19¼ | 15 1/8 | 18 3/8 | 5 | 13/16 | 5 1/16 | 3 9/16 | 3 7/8 | 27 |
| | | | | | 40 | 1750 | 324T | 27 3/16 | 39 13/16 | 7¾ | 6 1/8 | 18 | 52 9/16 | 72 | 12½ | 4 | 19½ | 21 5/16 | 15 1/8 | 18 3/8 | 5 | 13/16 | 5 1/16 | 3 9/16 | 3 7/8 | 27 |
| J-30X | 4" | 3" | 8" | 3" | 25 | 1150 | 324T | 27 3/16 | 44 13/16 | 9 | 6 | 18 | 56¾ | 77 | 13½ | 4 | 22 1/8 | 22 3/16 | 17½ | 20½ | 5 | 15/16 | 4 15/16 | 3 13/16 | 4½ | 31 3/8 |
| | | | | | 60 | 1750 | 364T | 33 1/16 | 44 13/16 | 9 | 6 | 20 | 58 3/8 | 82 3/8 | 13½ | 4 | 22 1/8 | 23¼ | 17½ | 20½ | 5 | 15/16 | 4 15/16 | 3 13/16 | 4½ | 31 3/8 |
| J-40X | 6" | 4" | 10" | 4" | 40 | 1150 | 364T | 33 1/16 | 54 7/16 | 10¾ | 6 1/8 | 20 | 65 3/8 | 92½ | 15¼ | 4 | 26 7/8 | 25 | 19¾ | 23 5/16 | 5 | 1 1/16 | 5 1/16 | 4 9/16 | 5 | 38 3/8 |
| | | | | | 100 | 1750 | 405T | 38 11/16 | 54 7/16 | 10¾ | 6 1/8 | 22 | 70¾ | 98 1/8 | 15¼ | 4 | 26 7/8 | 26 1/16 | 19¾ | 23 5/16 | 5 | 1 1/16 | 5 1/16 | 4 9/16 | 5 | 38 3/8 |
| J-50X | 8" | 6" | 12" | 6" | 50 | 1150 | 365T | 34 1/16 | 61½ | 12½ | 7½ | 20 | 72 3/8 | 100 9/16 | 17 | 4 | 30½ | 26¾ | 22 3/8 | 26¼ | 5 | 2 | 6 | 5 3/8 | 5¾ | 44 |
| | | | | | 150 | 1750 | 445T | 44 5/8 | 61½ | 12½ | 7½ | 24 | 81 3/8 | 111 1/8 | 17 | 4 | 30½ | 29 1/16 | 22 3/8 | 26¼ | 5 | 2 | 6 | 5 3/8 | 5¾ | 44 |
| J-60X | 10" | 8" | 16" | 8" | 75 | 1150 | 405T | 38 11/16 | 68 11/16 | 15 | 8 5/8 | 22 | 83 1/8 | 112 3/8 | 21½ | 6 | 34¼ | 32 5/16 | 28 | 33 | 5 | 2¼ | 8½ | 6½ | 7 | 50¾ |
| | | | | | 200 | 1150 | 8110 | 65 5/8 | 68 11/16 | 15 | 8 5/8 | 27 | 107 1/8 | 139 5/16 | 21½ | 6 | 34¼ | 36¼ | 28 | 33 | 5 | 2¼ | 8½ | 6½ | 7 | 50¾ |
| J-70X | 12" | 10" | | | 150 | 1150 | 8188 | 58 5/8 | 89 3/8 | 20 7/8 | | 27 | 115 | 153 | 27 7/8 | 6 | 44 | 42 5/8 | 35 3/8 | | 5 | 3 | | 7½ | 11 3/8 | 65 5/8 |
| | | | | | 400 | 1150 | 8288 | 71 5/8 | 89 3/8 | 20 7/8 | | 31 | 125 | 166 | 27 7/8 | 6 | 44 | 71 7/8 | 35 3/8 | | 5 | 3 | | 7½ | 11 3/8 | 65 5/8 |
| J-80X | 16" | 12" | | | 250 | 870 | 8288 | 71 5/8 | 105¼ | 23½ | | 31 | 135 5/8 | 181 7/8 | 30½ | 6 | 49 1/8 | 74½ | 39½ | | 5 | 3¾ | | 9¼ | 11¾ | 75¾ |
| | | | | | 500 | 870 | 8309SU | 82¾ | 105¼ | 23½ | | 36 | 143½ | 193 | 30½ | 6 | 49 1/8 | 71½ | 39½ | | 5 | 3¾ | | 9¼ | 11¾ | 75¾ |

| PUMP SIZE | FOOT DIMENSIONS BODY TYPE | A | B | E | F | FF | K | H |
|---|---|---|---|---|---|---|---|---|
| J-10X | STANDARD | 8 | 12 | 3 | 8¾ | | 2 5/8 | 11/16 |
| | HOPPER | 8 | 12 | 3 | 8¾ | | 2½ | 11/16 |
| J-20X | STANDARD | 9 | 15 | 3½ | 11½ | | 2¾ | 11/16 |
| | HOPPER | 9 | 15 | 3½ | 11½ | | 3 | 11/16 |
| J-30X | STANDARD | 10 | 18½ | 4 | 14¼ | | 3 | 11/16 |
| | HOPPER | 10 | 18½ | 4 | 14¼ | | 3 | 11/16 |
| J-40X | STANDARD | 9½ | 23 | 3¾ | 19 | | 3 | 11/16 |
| | HOPPER | 10 | 23 | 4 | 19 | | 3 5/8 | 11/16 |
| J-50X | STANDARD | 14¼ | 27 | 6 | 23 | | 2 5/8 | 11/16 |
| | HOPPER | 13 | 27 | 5 | 21 | | 4 5/8 | ¾ |
| J-60X | STANDARD | 17¼ | 33 | 6 | 27 | | 4¾ | 13/16 |
| | HOPPER | 17 | 33 | 6½ | 27 | | 5 | 13/16 |
| J-70X | STANDARD | 20 | 43¼ | 8¼ | 32¼ | 3 | 6½ | (8) 13/16 |
| | | | | | | | | |
| J-80X | STANDARD | 25½ | 53¼ | 10¼ | 37¾ | 3½ | 9½ | (8) 15/16 |
| | | | | | | | | |

Standard Body

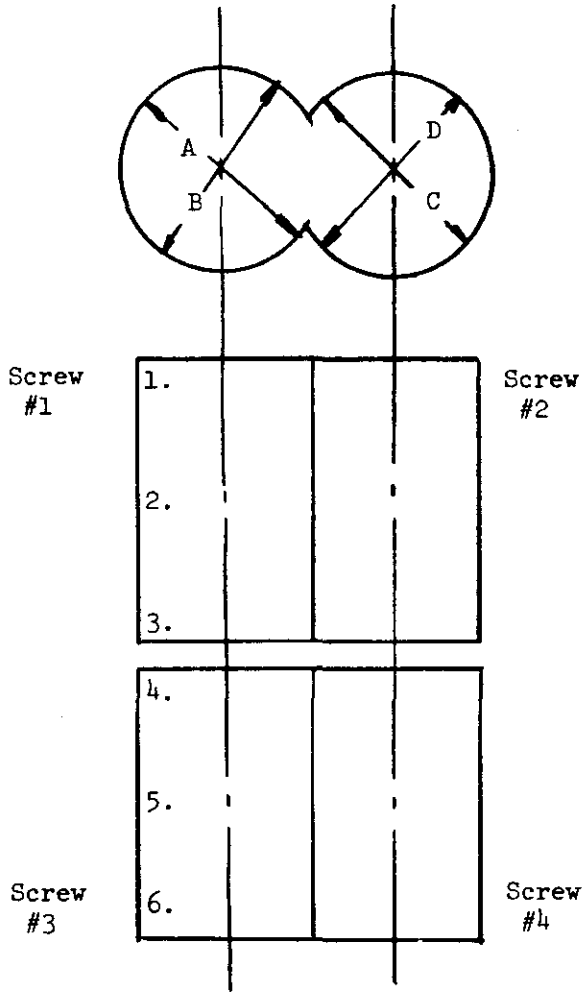


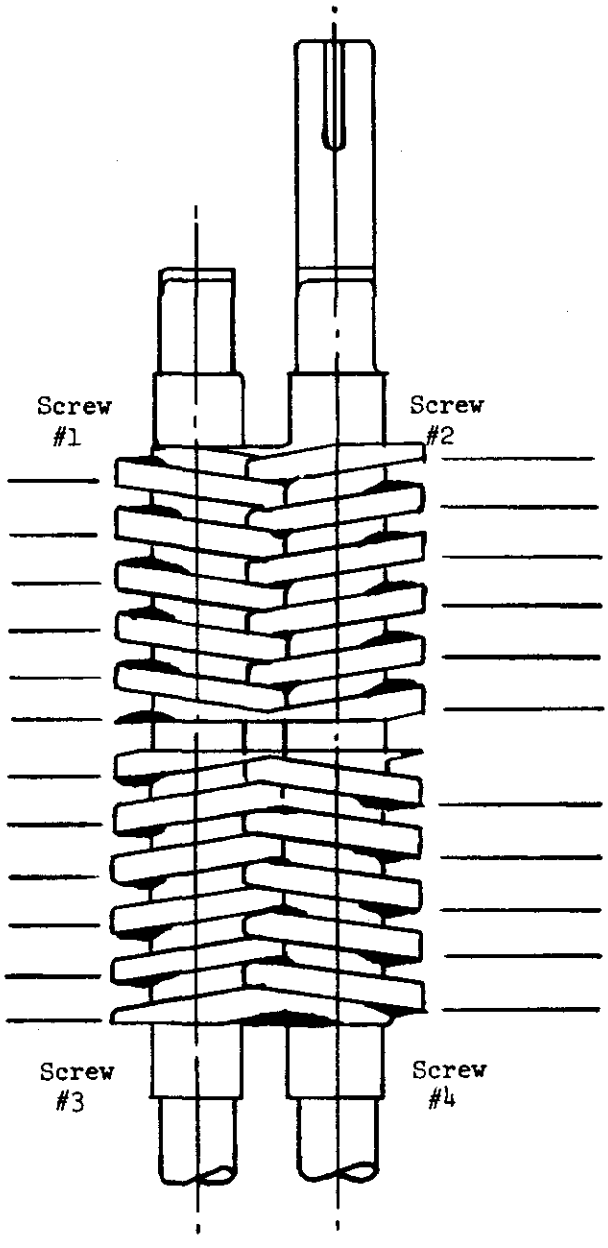

Hopper Body



SK-2642

## 9-4 Machinery Record Sheet




| | | A | B | C | D | |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |

Screw #1 design O.D. _____
Screw #2 design O.D. _____
Screw #3 design O.D. _____
Screw #4 design O.D. _____

Body bore #1 design I.D. _____
Body bore #2 design I.D. _____
Body bore #3 design I.D. _____
Body bore #4 design I.D. _____

FLANK CLEARANCE
Screws 1 & 2 _____
Screws 3 & 4 _____

| RUNOUT | Long Shaft | Short Shaft |
|---|---|---|
| cpl brgs | | |
| inb tg brgs | | |
| otb tg brgs | | |
| t gear area | | |
| cpl end hub | | |
| tg end hub | | |
| screws | | |

You may wish to keep a machinery record sheet similar to that illustrated. This is provided as a guideline for the types of data which should be recorded.

## SECTION 10 — TROUBLESHOOTING

| Symptons | Possible Cause of Trouble |
|---|---|
| Pump does not discharge | 1-2-3-4-17-18-19-24 |
| Insufficient discharge | 2-3-4-5-6-11-14-16-18-19-24 |
| Excessive load on driver | 12-14-15-19 |
| Loss of suction (after period of satisfactory operation) | 2-4-7-19-24 |
| Hammer, noise, vibration | 7-8-9-10-13-19-20-21-22-23-25 |

1. Pump not primed
2. Suction lift too high
3. Starved or impaired suction
4. Air leaks in suction
5. Insufficient NPSH (hot liquids)
6. Foot valve or strainer too small or plugged
7. Air or gases in liquid
8. Suction velocity too high
9. Abrupt changes of direction in suction piping/velocity too high
10. Insufficient immersion of suction piping
11. Liquid less viscous than specified
12. Liquid more viscous than specified
13. Discharge line obstructed
14. Discharge pressure too high
15. Speed too high
16. Speed too low
17. Incorrect rotation
18. Relief valve improperly set
19. Mechanical defect (inspect pump)
20. Relief valve chatter
21. Improperly supported piping/piping strain
22. Improperly constructed foundation/grouting
23. Cavitation
24. System valves and/or controller operating improperly
25. Mechanical defect (driver)

# SECTION 11 - REPLACEMENT PARTS

## 11-1 GENERAL

Your inventory of spare parts should be based upon the application and the importance of continued operation. The quantity of spares will also vary with number of units in operation with interchangeable parts. The more units you have, the fewer spares per unit will be required. Individual replacement parts or spares can be ordered as needed when down time is not critical.

## 11-2 ORDERING INSTRUCTIONS

When placing an order for replacement parts, please provide the following information with your order:

1. Original order number pump was sold on.
2. Serial number of pump. (Example: No. 72345).
3. Type of pump. (Example: Series 2200, J-50X).
4. Name of part required and part number from drawing. (Pc. 23, roller bearing).
5. Quantity required.
6. Purchase order number.
7. Complete shipping and invoicing instructions.

## PARTS LIST — 2200 SERIES SCREW PUMP

| Part No. | Part |
|---|---|
| 1 | Body |
| 2 | Stud |
| 3 | Hex Nut |
| 4 | Stud |
| 5 | Hex Nut |
| 6 | Stud |
| 7 | Hex Nut |
| 8 | Pipe Plug |
| 9 | Taper Pin |
| 10 | Gasket |
| 11 | Pipe Plug |
| 12 | Front Bearing Housing |
| 13 | Rear Bearing Housing |
| 14 | Stud |
| 15 | Hex Nut |
| 16 | Mechanical Seal |
| 17 | Gland |
| 18 | Gland Stud |
| 19 | Gasket/O-Ring |
| 20 | Gland Bushing O-Ring |
| 21 | Anti-Rotation Pin |
| 22 | Gland Nut |
| 23 | Inboard Roller Bearing |
| 24 | Thrust Bearing |
| 25 | Oil Seal |
| 26 | Pipe Plug |
| 27 | Stuffing Box Housing |
| 28 | Gland Bushing |
| 29 | Gasket |
| 30 | Soc. Hd. Capscrew |
| 31 | Shakeproof Washer |
| 32 | Gear Housing |
| 33 | Stud |
| 34 | Hex Nut |
| 35 | Oil Fitting |
| 36 | Sight Glass |
| 37 | Pipe Plug |
| 38 | Outboard Roller Bearing |
| 39 | Nameplate |
| 40 | Drive Screw |
| 41 | Front Head |
| 42 | Oil Seal |
| 43 | Pipe Plug |
| 44 | Integral Shaft & Screw, Long |
| 45 | Integral Shaft & Screw, Short |
| 46 | Coupling Key |
| 47 | Timing Gear Key |
| 48 | Lockout |
| 49 | Lockwasher |
| 50 | Timing Gear |
| 51 | Bearing Spacer |
| 52 | Long Shaft |
| 53 | Short Shaft |
| 54 | Screw |
| 55 | Shaft Sleeve |
| 56 | Shaft Sleeve |
| 57 | Gasket |
| 58 | Taper Pin |
| 59 | Gear Housing |
| 60 | Heat Exchanger |
| 61 | Stud |
| 62 | Hex Nut |
| 63 | Pipe Plug |
| 64 | Gasket |
| 65 | Cover |
| 66 | Jackscrew |
| 67 | Gasket |
| 68 | Bearing Keeper |
| 69 | Sight Gage |
| 70 | Capscrew |
| 71 | Head Cover |
| 72 | Hex Bolt |
| 73 | Key, Shaft Sleeve |
| 74 | Gland Bolt Washer |
| 75 | Oil Fitting |
| 76 | Gasket |
| 77 | Pipe Plug |
| 78 | Pipe Plug |
| 79 | Taper Pin |
| 80 | Pipe Plug |

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