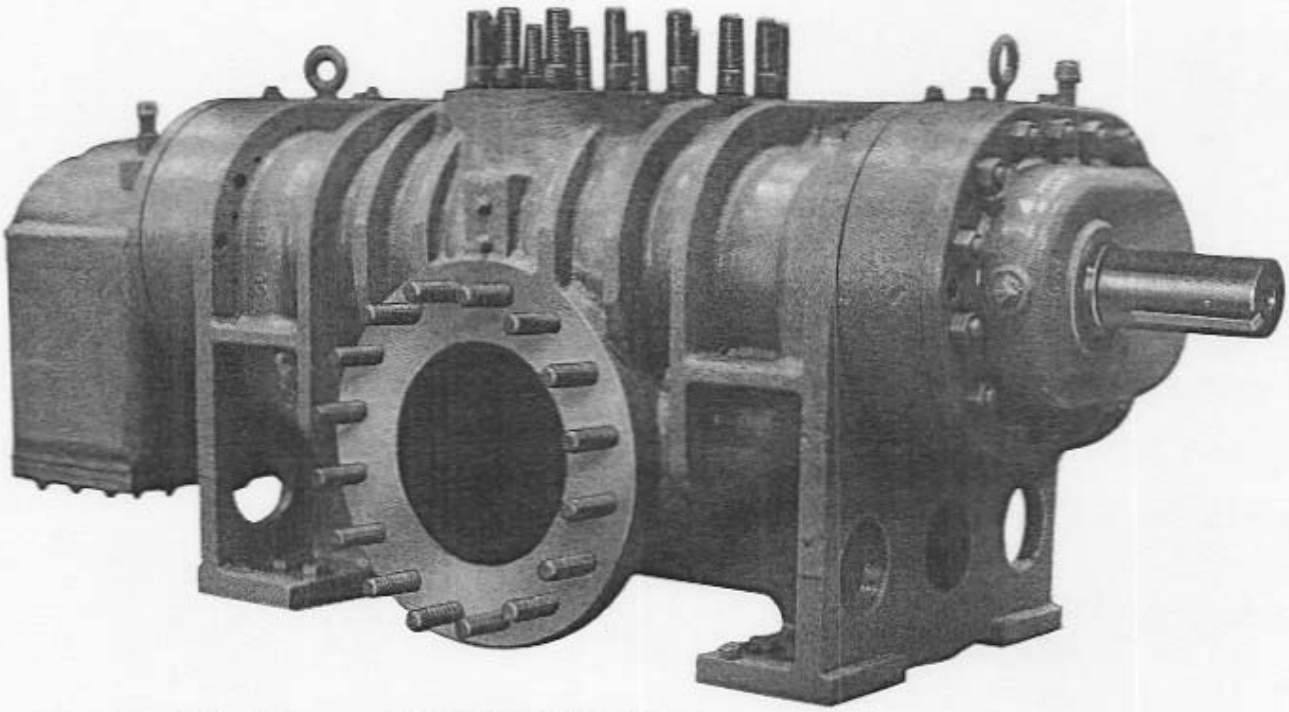
WARREN PUMPS

INSTALLATION
OPERATION
MAINTENANCE



2300 SERIES HIGH PRESSURE SCREW PUMPS

PLEASE READ THESE INSTRUCTIONS BEFORE INSTALLING PUMP

Warren Pumps Inc., Warren, Massachusetts 01083

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 Inc. Refer to the manuals provided by manufacturers of other equipment for their separate instructions. (Motor, turbines, couplings, etc.)

TABLE OF CONTENTS

PAGE

INTRODUCTION 1

SECTION 1 — GENERAL INFORMATION 1

SECTION 2 — RECEIVING, HANDLING, STORAGE 1

SECTION 3 — INSTALLATION

3-1 Location 2
3-2 Foundation 2
3-3 Baseplate 3
3-4 Piping 3
3-5 Piping System Accessories 3
3-6 Doweling 4

SECTION 4 — COUPLING ALIGNMENT

4-1 Alignment 4
4-2 Thermal Expansion 5

SECTION 5 — LUBRICATION

5-1 Lubrication Specifications 6
5-2 Cooling 6

SECTION 6 — START-UP/OPERATION

6-1 Pre-Start Up 7
6-2 Start-Up 7
6-3 Pump In Operation 7

SECTION 7 — PREVENTIVE MAINTENANCE

7-1 Periodic Inspections 8
7-2 Capacity Check 8
7-3 Original Operating Clearances 8

SECTION 8 — MAINTENANCE

8-1 Disassembly 9
8-2 Reassembly 10
8-3 Installation and Timing of Replacement Timing Gears 10

TABLE OF CONTENTS (Cont'd)

PAGE

SECTION 9 — MAINTENANCE DATA

9-1 Parts Information 12
9-2 Material Specifications 12
9-3 Machinery Record Sheet 13

SECTION 10 — TROUBLESHOOTING

10-1 Pump Does Not Discharge 14
10-2 Insufficient Discharge 14
10-3 Excessive Load on Driver 14
10-4 Loss of Suction 14
10-5 Hammer, Noise, Vibration 14

SECTION 11 — REPLACEMENT PARTS

11-1 General 15
11-2 Ordering Instructions 15

SECTION 12 — SAFETY PRECAUTIONS 15

LIST OF FIGURES

FIGURE NO. TITLE PAGE

3-2 Baseplate/Foundation 3
6-1 Removal of Shipping Plugs 7
7-2a Typical Screws With Clearance Nomenclature 8
7-2b Typical Screw Showing Nomenclature 8
8-3 Rotor Set-Up for Method II Timing Procedure 11

LIST OF DRAWINGS

DRAWING NO. TITLE PAGE

Exploded View 19
Sectional Assembly (A-2155-A REV B) 20

INTRODUCTION

This manual is intended to assist those concerned with installation, operation and maintenance of Warren 2300 Series 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 through your local Warren representative or directly.

SECTION 1 — GENERAL INFORMATION

The Warren 2300 Series screw pump is a positive displacement type capable of discharge pressure to 1400 psig. Basically, the pump is made up of two pairs of opposed screws. Each pair of screws conveys liquid to the center of the pump where the discharge port is located. Because the hydraulic forces generated are opposite and equal, the rotor is axially balanced hydraulically.

The pumps have the shortest possible span between bearings. This design produces a rigid rotor capable of continuous duty and permits high pressure operation with low lubricity, low sulphur or dirty oils without wear, pressure drop or capacity loss. The usual stuffing box castings — called "brackets" — are eliminated.

Body — The pump body is a high pressure type and is also designed to strengthen low NPSH, high suction lift capabilities. It is available in ductile iron or steel.

Integral Screw/Shaft — Screws and shafts are machined from one piece of metal. This rugged, integral design with larger shaft diameters means less deflection, closer clearances and larger bearing diameters for longer rotating element life.

Bearing Brackets — The Warren Series 2300 screw pump incorporates a leak path design bearing bracket. If the mechanical seals should leak, this leakage is allowed to escape to atmosphere or a suitable collection device. There is also a pipe connection at the top of the bracket for a mechanical seal back flush line.

Hardened Steel Herringbone Timing Gears — Timing gears are used to prevent metal-to-metal contact between the meshed rotating screws. The clearance between the pumping screws means longer pump life and higher average efficiencies over the life of the pump. Timing gear tooth profile is designed for efficient, quiet, positive drive. Gears are oil bath lubricated and are sealed off from the pumpage by internal mechanical seals which are under suction pressure only. The gear housing has a oil-cooler for control of lubricating oil temperature.

Bearings — Radial loading is handled by heavy duty roller bearings at five locations . . . sized to handle maximum loads. They are oil lubricated and are sealed off from the pumpage by internal mechanical seals which are under suction pressure only. The heavy duty double row thrust bearing locks the drive shaft in position axially.

Back Pull Out — Rotor removes for inspection or repair without disturbing piping or driver.

SECTION 2 — RECEIVING, HANDLING AND STORAGE

2-1 Receiving

Place the 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 atmosphere conditions are unfavorable.

Special long term storage crating can be supplied upon request.

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 body which affect the close operating clearances 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 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 local Warren distributor immediately.

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

1. Select a clean dry storage 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. If area where pump is stored or installed is a moist or dusty atmosphere:
   a. Recoat all exterior, unpainted surfaces subject to corrosion with a rust inhibiting compound.
   b. Fill oil reservoirs completely full of oil.
   c. Protect pump and driver with a plastic or canvas covering.
   d. 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 you can do to enhance 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

Screw 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, temperature and viscosity of the oil. 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 2300 Series Screw Pump.

Locating the pump as near to the source of supply as possible is advisable. 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.

Refer to the HL[1] dimension on the "Approximate Dimension Chart" at the rear of the manual for the clearance required to affect the back pullout feature of the pump rotor. This HL[1] dimension is extremely important for ease of rotor maintenance.

3-2 Foundation

Foundations should be a suitable mass to absorb vibration and provide a rigid support for the unit. Use reinforcing steel 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 between foundation bolts and sleeves to prevent concrete from entering while foundation is being poured. Foundation bolts 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.

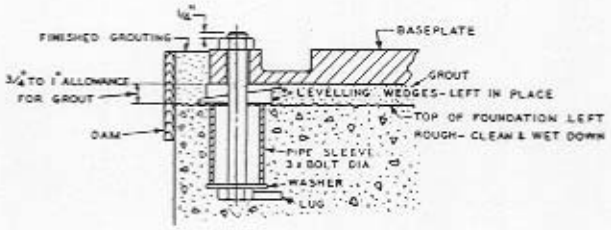


Fig. 3-2

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 from pipe sleeves. Clean underside of pump foundation 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 plumb. 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 rotor design incorporates very close running clearances, it is very important that suction side piping be thoroughly cleaned before connecting piping to the pump.

2. 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, the pump will invariably be noisy and troublesome.

3. 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 must be as short and direct as possible. Use long radius elbows to change direction whereever possible.

4. 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 or vibration.

5. If pumps have studded flanges, piping alignment is correct if flange studs are centered within holes of pipe flanges and if pump and pipe flange faces are parallel with each other.

   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.

6. Maintain sufficient gap between flange faces for inserting the gasket. Flanges must not butt tightly before being secured.

3-5 Piping System Accessories

1. 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 must be constructed of 20 mesh wire and equipped with a backing plate. The total mesh opening must be 5 times the cross sectional area of the pipe. Gauges must be installed on either side of the strainer to indicate when the strainer requires cleaning (normally when down stream gauge reads 15″ vacuum).

2. Check Valves — If the discharge piping system is subject to a high static head, a check valve must 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.

3. Relief Valves — Pressure relief valves must be installed between the discharge valve and discharge flange of screw pumps to protect both the pump and piping system. The valve and piping system must 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 must lead back to the source of supply or other suitable collecting point to prevent product loss and an excessive temperature rise of the recirculated fluid in pumps that operate unattended.

4. Vent — If pump is required to operate with a suction lift, a suitable means for venting the pump must be installed in the discharge piping adjacent to the pump.

5. Foot Valves — For pumping low viscosity liquid with a high static lift, where the pump may completely dry out while idle, a foot valve may be used to help keep the pump primed. Foot valves are not usually required when handling liquids of higher viscosity.

3-6 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 strains or strains caused by thermal growth. 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: With the exception of vertical units which are completely doweled at the factory, the pumps are normally doweled at the factory and the drivers are doweled in the field. The dowel size for the driver will usually be the same size as the pump dowels.

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 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.

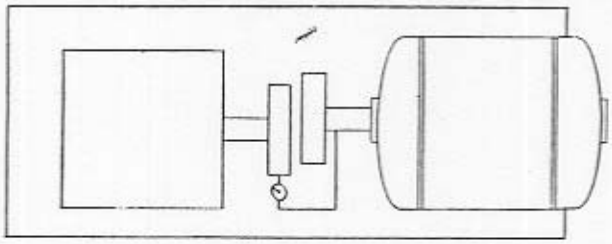


Fig. 4-1 Rim Side to Side

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.

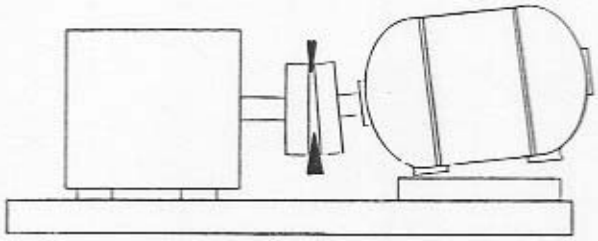


Fig. 4-2 Face Top to Bottom

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.

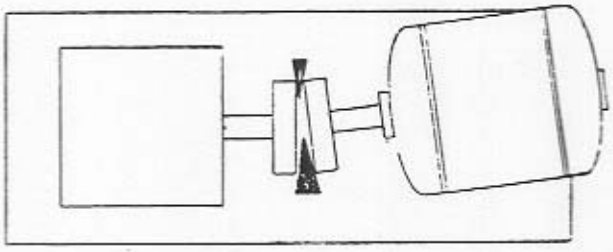


Fig. 4-3 Face Side to Side

Various factors affect the shimmiing 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 soecific 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.

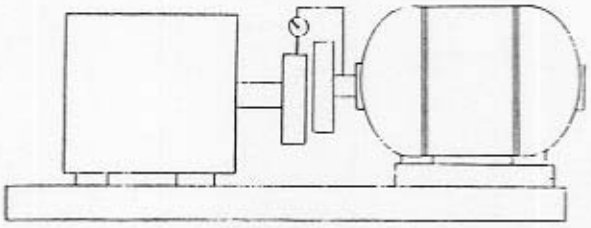


Fig. 4-4 Rim Top to Bottom

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 or 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.

The series 2300 pump is available in several materials. Below are listed the coefficient of expansion for these materials (x10-^{6} in/in/°F).

A010A	Cast Iron	6.0 (32°F-212°F)
A414A	Ductile Iron	6.6 (70°F-400°F)
A422A	Ductile Iron	6.6 (70°F-400°F)
B021A	Cast Steel	6.5 (70°F-400°F)
B407A	316SS	9.4 (70°F-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 simple the instance (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.

EXAMPLE:

Ambient temperature 80°F.

PUMP
Operatingf temp ..... 160°F
CL height ..... 13″
Material 316SS

Pump rise = 9.4x10-^{6}x(160-80) x 13
= 9.4x10-^{6}x80x13
= .010″

Difference = .010″-.005″
= .005°

MOTOR
Operating Temp ..... 160°F
CL height ..... 11″
Material ..... cast iron

Motor rise = 6.0x10-^{6}x(160-80) x 11
= 6.0x10-^{6}x80x11
= .005″

In this example, the pump should be set .005″ low in order that proper alignment is achieved at 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 concluding, 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 are adverse atmospheric conditions (dust etc.), or other factors which might contaminate or break down the oil.

5-2 COOLING

The Series 2300 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.

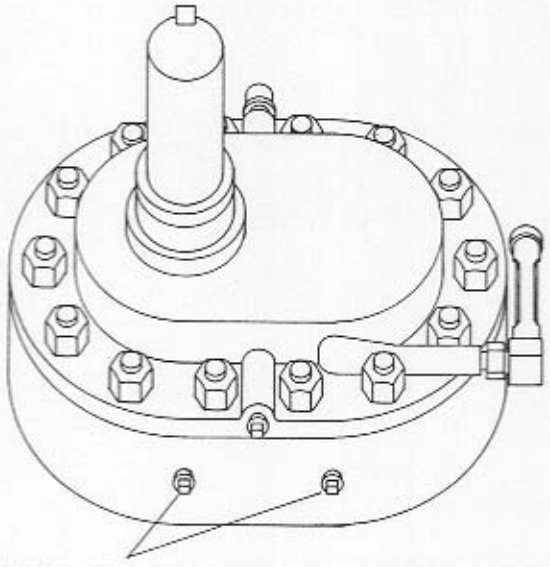
In unusual circumstances (i.e. extremely high product temperatures or ambient conditions) a more sophisticated cooling system may be required. Consult Warren for guidance.

SECTION 6 — START-UP/OPERATION

6-1 Pre-Startup

Pre-startup checks for trouble free initial start-up 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 should 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 ALIGNMENT 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.
6. Removal of shipping plugs:



THESE PLUGS MUST BE REMOVED

Fig. 6-1

These openings are connected to the mechanical seal cavity. They will show seal leakage or failure if it occurs. They should be left open or piped to a suitable drain. If the plugs are not removed and this cavity pressurized, it will cause the lip seal to fail.

NOTE: These plugs are located on both ends of the pump. There are a total of 8 plugs; 4 on each end, 2 on top and 2 on bottom. The 2 bottom plugs on the back end of the pump are in the same approximate position as the 2 in the front as shown (Fig. 6-1).

6-2 Start-Up

1. Fully open suction and discharge valves.
   CAUTION: Never start the pump with suction and discharge valves CLOSED OR THROTTLED.
2. If operating with hot liquids, open valves to admit liquid to the pump and allow sufficient time to elapse for pump to warm up and expand prior to starting.
3. If pump operates on a suction lift, 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. A vent would be helpful for initial priming.
   If the pump operates under a flooded suction, simply open the valves and allow the liquid to flood the pump while venting air from some convenient point in the discharge system.
4. Open cooling water valve to timing gear housing oil cooler.
5. Start driver.

6-3 Pump in Operaton

1. Check unit for unusual noise or vibration. Any unusual vibration or change in sound should be investigated as it may be the first sign of impending trouble.
2. Check the pump body for localized heating. This is an indication of a mechanical rub.
3. Check bearing housing temperature by touch, however, it should be remembered that this method is not too reliable. The hand will register 130°F as very hot whereas bearing temperature can safely go to 180°F. If in doubt, check temperature with a thermometer.
4. Check suction and discharge pressure gauges where installed.
5. On pumps fitted with cooling water to timing gear housing, regulate cooling water flow so temperature of lube oil is held below 180°F.

SECTION 7 — PREVENTIVE MAINTENANCE

7-1 Periodic Inspection

Following are periodic inspection procedures which, if carried out conscientiously, should contribute to longer intervals between shutdowns.

Daily

1. Check oil level in bearing housings.
2. Listen for unusual noise or vibration.

Weekly

1. Run idle units under power for a minimum period of 10 minutes.
2. Check all automatic controls and/or regulators.

Quarterly

1. 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.
2. Check all foundation and hold-down bolts for tightness.

Annually

1. 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.
2. Check existing pump capacity, power and horsepower requirements against pump nameplate data.
3. Good timing gear maintenance will result in longer pump life and smoother operation. Timing gears should be examined for wear and chipping or scoring. At this time it would also be advisable to insure that all parts are properly secured.

7-2 Capacity Check

A Warren 2300 Series screw pump is a positive displacement pump. With a constant system and viscosity, pump wear is indicated when capacity is off or if sufficient pressure cannot be developed. If capacity is low, or if pump will not develop sufficient discharge pressure, pump should be disassembled; screws and body dimensioned for wear and replaced as necessary. (This is meant only as guideline and the exact time for disassembly and inspection is left to the discretion of the customer). If pump performance is satisfactory, the pump should not be disassembled for inspection. Refer to Fig. 7-2a and 7-2b for terminology used when discussing or referring to particular screw areas.

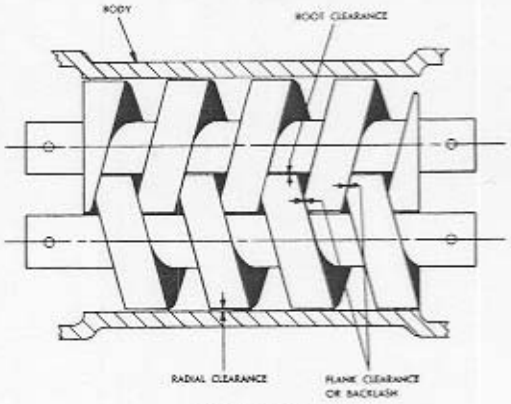


Fig. 7-2a

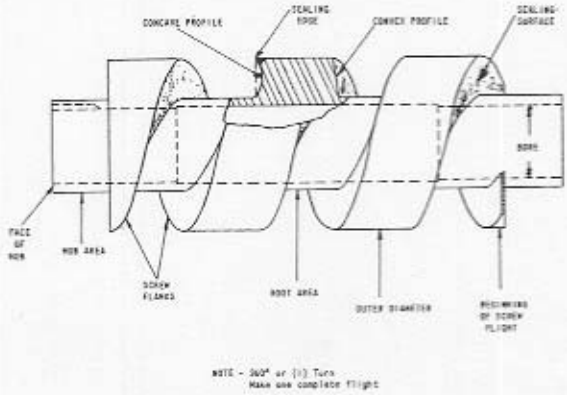


Fig. 7-2b

7-3 Original Operating Clearances

Pump Model	Total Flank Clearance	Total Diametric Clearance
360	.005/.007"	.006/.008"
655	.006/.008"	.008/.010"
1250	.007/.009"	.009/.011"
2030	.0075/.011"	.011/.012"
2530	.008/.012"	.012/.014"
3830	.009/.013"	.013/.015"

It is suggested that when these clearances are checked, they be recorded. An example of a typical machinery record sheet may be found in Section 9-3.

SECTION 8 — MAINTENANCE

Part numbers shown inside ( ) refer to part numbers on drawing A-2155-A rev. B on page 20.

The following discussion covers the disassembly and reassembly procedure for all pump parts. Procedures for maintenance of specific areas will follow and refer the reader to these disassembly and reassembly procedures for instruction concerning the removal, handling and replacement of associated parts.

8-1 Disassembly (Refer to drawing A-2155-A REV B)

1. Isolate pump hydraulically and the motor electrically.
2. Drain oil from the timing gear housing (48) and front bearing housing (30). Pipe plugs are provided for this purpose.
3. Disconnect cooling water piping from the timing gear housing oil cooler.
4. Remove the coupling spacer piece then remove the pump half coupling hub and key.
5. Loosen setscrews securing the external mechanical seal (43) to the long shaft then remove the part or remove oil seal (43).
6. Remove dowel pins (67) and nuts (52) securing the timing gear housing cover (50) to the timing gear housing (48). Remove timing gear housing cover.
7. Remove bearing spacer rings (21) and (24) from the timing gear housing (48).
8. Remove the lockwire (28) from the three adjusting sleeve capscrews (27). Unscrew and remove these three capscrews (27).
9. Remove nuts securing the timing gear housing (48). Break the joint between the timing gear housing (48) and bearing housing (30) then remove the timing gear housing (48) from the pump. NOTE: These pumps are fitted with straight dowel pins, **not** taper pins. These dowel pins are a press fit into the body (1) and are not to be removed.

   When the timing gear housing (48) is removed, the outer race and roller assembly of bearing (19) and the entire thrust bearing assembly consisting of thrust bearing (22) and bearing sleeve (25) will be removed with the timing gear housing. After removal, tap the thrust bearing assembly (25) (22) out of its bore in the timing gear housing.
10. Remove nuts securing the front head (38) and remove this part.
11. Loosen setscrews (12) then unscrew and remove bearing locknuts (11) from the coupling end of the long and short shafts.
12. Remove three cap screws (32) securing the front bearing housing (30) to the body (1) then remove the bearing housing (30).
13. On pump sized 2030, 2530 and 3830 remove snap ring (20) holding the short shaft, timing gear end, roller bearing (19) in place on the short shaft. Remove the inner race from the shaft. If necessary, the timing gear locknut (17) may be backed off and used to force the inner race far enough away from its shoulder to permit use of a bearing puller to remove this bearing race. This step is not necesssary on pump sizes 360, 655 and 1250.
14. Remove timing gear locknuts (17) and lockwashers (18). These are both R.H. threaded nuts. On pump size 360 loosen the setscrews (69) on both locknuts. The short shaft locknut (68) is right hand thread. The long shaft (thrust bearing shaft) locknut (75) is left hand thread.
15. Match mark timing gear teeth at their point of mesh. Also mark the long shaft timing gear in such a manner that it may be identified when the pump is reassembled.
16. Remove timing gears (15) from the short and long shafts as a pair. If necessary, pulling gear may be used to remove these parts from the shaft.
17. Remove timing gear key (16).
18. Remove timing gear and bearing spacers (14). NOTE: Mark or tag one spacer to identify which shaft it is removed from so that it can be replaced on the same shaft.
19. Repeat step 12 and remove rear bearing housing (30).
20. Slide the shaft and pumping screws out of the body (1). Note which bore holds the long shaft.
21. Remove the four mechanical seals (9) from the long and short shafts. Use extreme care when removing these parts to prevent damaging them.
22. Inner rings or races of all roller bearings are shrunk on the shaft. Do not remove these parts unless they are to renewed. To remove, apply heat lightly to expand the bearing rings then knock them off the shaft using a hammer and drift pin.

23. Outer races of all roller bearings are secured in their seats with LOCTITE. Do not remove these parts from their seats unless they are to be renewed. If they are to be removed, they must be driven out of their seats using a drift pin and hammer.

8-2 Reassembly (Refer to drawing A-2155-A REV B)

1. Mesh the pumping screws and shafts together. To do this, lay the rotors side by side with the timing gear ends of the shafts flush with each other. Rotate one of the shafts only. At some point in one complete rotation, the pumping screws will mesh. Since the screws will mesh at only one point, when they do mesh, this is the correct point.
2. Wire the ends of the shafts tightly together to hold the screws in mesh.
3. Wipe the body bores clean then swab with lube oil.
4. Insert the meshed rotors into the body bores. Be sure the long shaft enters the correct bore.
5. Remove the restraining wires from the shaft.
6. Oil the shafts in way of the internal mechanical seal (9). Install the rotating parts of these seals over the shafts. Be sure that the seal springholder (inner most piece) is seated against the pumping screw hub.
7. Install outer bearing races in the bearing housings (30). These surfaces should first be carefully cleaned and then coated with LOCTITE just prior to installation. (On pump size 360 the coupling end bearing housing has only a single row type roller bearing rather than the pictured double row. The timing gear end bearing bracket does have the double row bearing shown).
8. Install a stationary mechanical seal seat ring in each bearing housing (30).
9. If new roller bearings (10) are being installed, heat the inner bearing races to 200°F with an induction type bearing heater or in an oil bath to expand the races sufficiently for installation on the shaft. When installed, be sure the rings seat firmly against the shaft shoulders.
10. Install both front and rear bearing housings (30) and secure to the body by tightening the three capscrews (32).
11. Replace front roller bearing locknuts (11), tighten and secure with setscrew (12).
12. Install front head (38) and secure.
13. Install timing gear and bearing spacers (14). Be sure the spacer marked for the long shaft is replaced on that shaft.
14. Install timing gear keys (16) in their keyways.
15. Mesh timing gears (15) together at the marked mesh point then install on the shafts. Be sure the gear marked for the long shaft is installed on that shaft.
16. Replace timing gear lock washers (18) and lock nuts (17). Tighten these lock nuts (17) up solidly. On pump size 360 the short shaft lock nut (68) is right hand thread. The long shaft (thrust bearing shaft) lock nut (75) is left hand thread. Secure both lock nuts with setscrew (69).
17. a. If removed, shrink the inner race of roller bearing (19) on the short shaft and secure with snap ring (20).

    b. If removed, replace the outer bearing race (19) in the timing gear housing (48).
18. Replace the timing gear housing (48) and secure.
19. Obtain two pieces of threaded stock 6" long that can be threaded into the tapped holes in the end of the long shaft. These rods will serve as guides for replacing thrust bearing assembly (22) (25). Install this assembly over the threaded rods into its bore in the timing gear housing. Remove the threaded rods then install and tighten the three cap screws (27). Replace lock wire (28). On pump size 360 the thrust bearing is the angular contact type. These bearings should be mounted back to back.
20. Replace bearing spacers (21) and (24).
21. Replace timing gear housing cover (50). Install and secure dowel pins (67) and nuts (52).
22. Replace ext. mechanical seal (43), if fitted or oil seal (43), if fitted. For proper set dimension for the mechanical seal see drawing A-2155-A Rev B.

8-3 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 several methods which may be employed to field time this pump. The procedure may be accomplished in one of three ways: with rotor in brackets alone, in body and brackets or in the special timing stands (see Sec. 9-3). 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 then the proper timing point is half way between the contact points.

Method I (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 slip fit for approximately 30% of their length and then a tap fit for the remaining 70%.

   CAUTION: The fit should only be loose enough to work with. Excessive clearance 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 the 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. Lock the short shaft then turn the long shaft in the direction of rotation until you can feel flank contact. Turn the short shaft gear to bring the drive side of the long shaft gear in contact with the driven side of the short shaft gear. This removes gear backlash.
7. Using a sharp scribe, scribe a short line up one side of the gear face using the vertical key as a guide.
8. Turn the long shaft in the opposite direction until again you can feel flank contact. Remove backlash as described in Item 6.
9. Scribe another short line up the other side of the gear face using the vertical key as a guide.
10. Turn the long shaft again in the direction of rotation until the vertical key splits the distance between the two scribe marks.
11. Scribe a line on both sides of the vertical key. Make these lines longer to differentiate them from the previous lines. These two lines indicate where the keyway is to be cut.
12. Match mark the timing gears at their point of mesh.
13. Remove the timing gears from the shaft and cut the keyway in the blank timing gear.

    CAUTION:
    1. Be very careful to cut the keyway accurately between the scribed lines and also be careful to cut the keyway square with the gear face.
    2. It may be necessary to grind gear spacers to compensate for inherent inaccuracies in cutting the keyway. The grinding will move the respective shaft with respect to the other shaft.

Method II (In Brackets Only)

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)

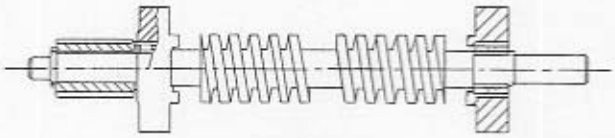


Fig. 8-3

2. Fit timing gears to the shafts individually so that the gears are a slip fit for approximately 30% of their length and then a tap fit for the remaining 70%.

   CAUTION: The fit should only be loose enough to work with. Excessive clearances MUST be avoided.
3. The shafts should now be leveled in their brackets crosswise at both ends.
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 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.

CAUTION: 1. Be very careful to cut the keyway accurately between the scribed lines and also be careful to cut the keyway square with the gear face.

2. It may be necessary to grind gear spacers to compensate for inherent inaccuracies in cutting the keyway. The grinding will move the respective shaft with respect to the other shaft.

SECTION 9 — MAINTENANCE DATA

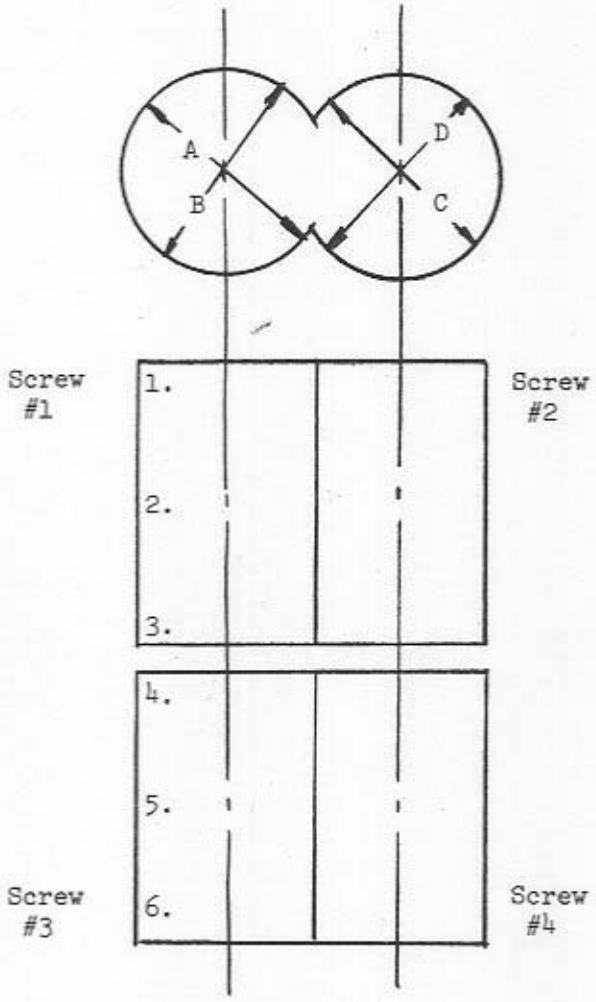
9-1 Parts Information

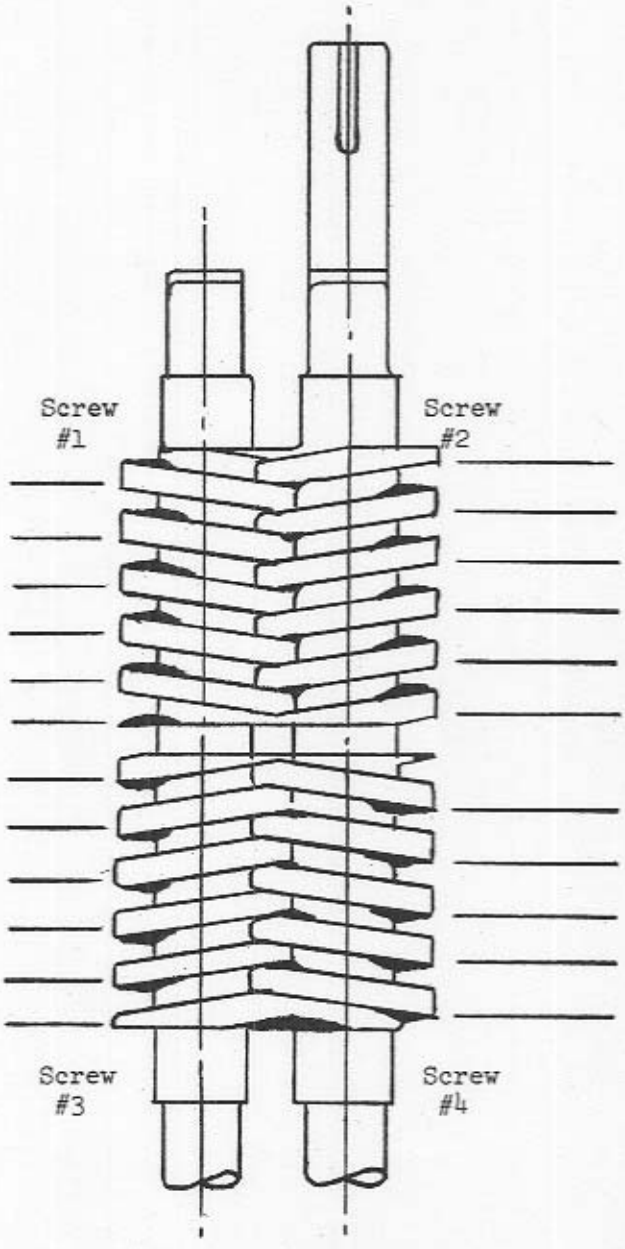
PUMP MODEL	360 FSXA	655 FSXA	1250 FSXA	2030 FSXA	2530 FSXA	3830 FSXA
Thrust Bearing	SKF 7306-BG	SKF 22210C	SKF 22311C	SKF 22312C	SKF 22317C	SKF 22317C
Inboard Radial Bearing	Rollway E-5207-U Rollway E-6207-U	Hyatt A-6210-TS	Hyatt A-6212-TS	Hyatt A-6214-TS	Rollway E-6219-B	Rollway E-6220-B
Outboard Radial Bearing	Rollway E-5206-U	Hyatt A-6207-TS	Hyatt A-6207-TS	Hyatt A-6212-TS	Rollway E-6216-B	Hyatt A-5316-TS
Shaft Diameter at Coupling	1.2500/1.2495	1.7500/1.7495	2.250/2.249	2.625/2.624	3.500/3.499	3.7500/3.7495
Shaft Diameter at Inboard Mechanical Seals	1.875/1.874	2.500/2.499	2.875/2.874	3.375/3.374	4.625/4.624	4.875/4.874
Inboard Mechanical Seals	Durametallic RO-HD 1⅞	Durametallic RO-HD 2½	Durametallic RO-HD 2⅞	Durametallic RO-HD 3⅜	Durametallic RO-HD 4⅝	Durametallic RO-HD 4⅞
Front Head Mechanical Seal (if fitted)	B-7996-08 Garlock 15140 1¼	B-7996-12 Garlock 15456 1¾	B-7996-16 Garlock Style B 2¼	B-7996-19 Garlock Style B 2⅝	John Crane Type 9 3½	Durametallic RO 3¾
Maximum Torque (In Lbs.)	3375	11024	19546	30484	61822	74884
Rotor Wk^2 (Lbs. $In.^2$)	115	716.8	820	2165	7576	20004
Bearing Housing Oil Seal	482439 National	62467 Victor	60972 Victor	62581 Victor	49805 Victor	455217 Victor
Keyway Size at Coupling	¼ x ⅛	⅜ x 3/16	½ x ¼	⅝ x 5/16	⅞ x 7/16	⅞ x 7/16
Front Head Oil Seal (if fitted)	J. Crane 5-01250-02000 012-010400	J. CRANE 5-01750-02500 012-010400	J. CRANE 5-02250-03000 014-010400	J. CRANE 5-02620-03370 012-010400	J. CRANE 5-03500-04370 012-010400	J. CRANE 5-03750-04620-021-010400

9-2 Material Specifications

PART	MATERIAL	WARREN SPEC. NO.	EQUIVALENT ASTM
Body	Cast Iron	A010A	Class 35 Gray Iron
Body	Ductile Iron	A414A	ASTM A536 Grade 80-55-06
Body	Ductile Iron	A422A	ASTM A395 Grade 60-40-18
Body	Cast Steel	B021A	ASTM A216 Grade WCB
Body	316SS	B407A	ASTM A743 Grade CF-8M
Integral Screws/Shafts	Resulfurized Steel	F160A	Type 4140 (HR, annealed)
Timing Gears	Resulfurized Steel	F164A	Type 4140 (HR & Heat Treated)
Bearing Housing	Cast Iron	A010A	A48 C1 35
Gear Housing	Aluminum	E110A	B26 Alloy SG70A Cond. T6
Mechanical Seals	Standard: Bronze on TC		

9-3 Machinery Record Sheet





		A	B	C	D	
1						
2						
3						
4						
5						
6						

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		

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. _____

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

	Trouble	Cause of Trouble
10-1	Pump Does Not Discharge:	1. Pump not primed. 2. Suction lift too high. 3. Clogged suction. 4. Incorrect rotation. 5. Air leaks in suction line. 6. Relief valve improperly adjusted.
10-2	Insufficient Discharge:	1. Speed too low. 2. Suction lift too high. 3. Air leaks in suction. 4. Foot valve or strainer too small or plugged. 5. Not enough suction head (hot liquids). 6. Starved or impaired suction line. 7. Mechanical defect (inspect pump). 8. Liquid less viscous than specified. 9. Relief valve improperly adjusted. 10. Discharge pressure too high.
10-3	Excessive Load On Driver:	1. Speed too high. 2. Liquid more viscous than specified. 3. Total discharge head higher than specified. 4. Discharge line obstructed. 5. Mechanical defect (inspect pump). 6. Defective discharge gauge.
10-4	Loss of Suction (After Period Of Satisfactory Operation):	1. Air leaks in suction line. 2. Suction lift too high. 3. Air or gases in liquid. 4. Mechanical defect (inspect pump).
10-5	Hammer, Noise, Vibration:	1. Air or gases in liquid. 2. Suction velocity too high. 3. Bearings improperly fitted. 4. Abrupt changes of direction in suction line, and suction velocity too high. 5. Suction pipe not immersed deep enough. 6. Relief valve chatter. 7. Mechanical defect (inspect pump). 8. Improperly supported piping and/or piping strain. 9. Problems in foundation or grouting. 10. Defective motor bearings. 11. Cavitation due to highly viscous fluid.

SECTION 11 — REPLACEMENT PARTS

11-1 General

Your inventory of spare parts should be based upon the application and the importance of continued operation. Individual replacement parts or spares can be ordered as needed when down time is not critical.

Warren recommends the following be held in your stock as minimum spare parts inventory:

1. One set of bearings.
2. One set mechanical seals.

11-2 Ordering Instructions

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

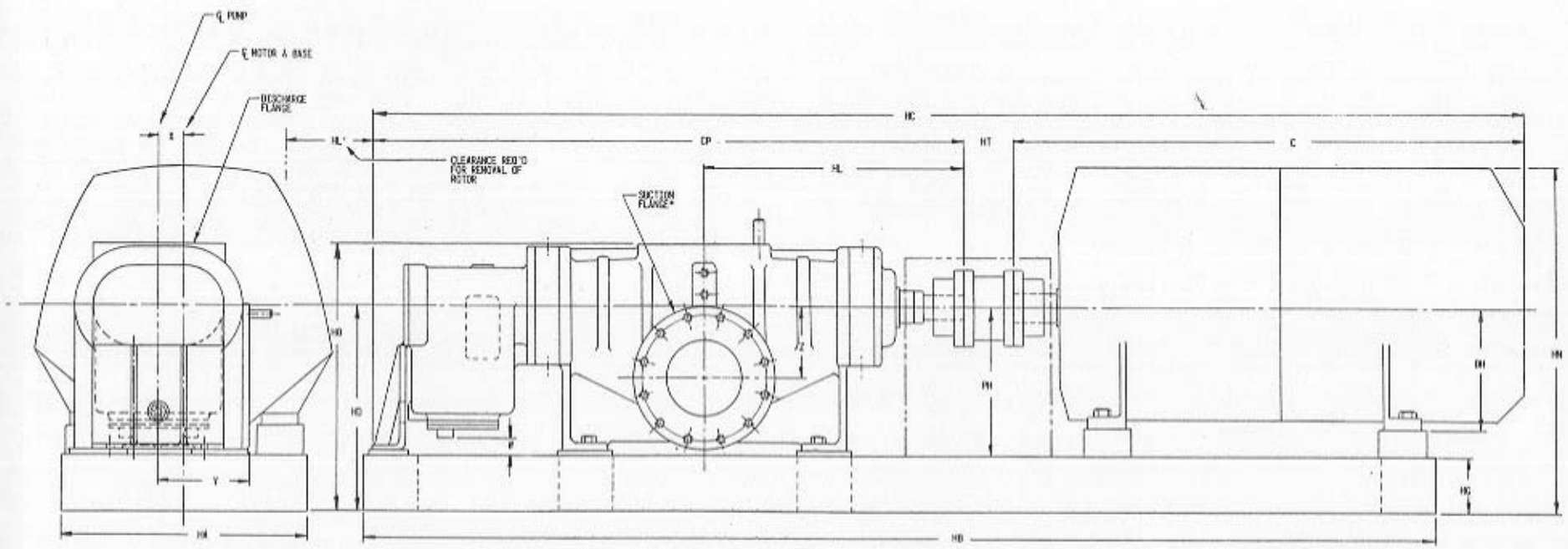
1. Serial number of pump. (Example: No. 72345)
2. Type of pump (Example: 1250 FSXA).
3. Name of part required and part number from drawing (Example: Mechanical Seal — No. 9).
4. Quantity required.
5. Purchase order number.
6. Complete shipping and invoicing instructions.

SECTION 12 — SAFETY PRECAUTIONS

12-1 Recommended Basic Safety Practices

1. **Never** work on a pump unless it has been isolated 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 relief valves are operating at the correct capacities and pressures.
3. Be sure limiting and speed regulating governors are set at the designed speeds and that they are operating properly.
4. Be sure the coupling guards are of an approved type and are properly installed.

Tabulated Outline A-1918



*SUCTION FLANGE IS ON THE LEFT SIDE VIEWED FROM DRIVER END UNLESS OTHERWISE SPECIFIED.

PUMP SIZE	SUCTION	DISCH.	MOTOR HP	MOTOR RPM	MOTOR FRAME	C	CP	HA	HB	HC	HD	HG	HL	HM	HQ	HT	X	Y	Z	HL'	PH	DH	#
#36D △ FSXA	2½-300#	2"-600#	60	1150	404T	36½	33¾	21	61½	79⅞	13½	3	17½	24½	17½	5	1½	5½	3½	26½	10½	□	—
			100	1750	405TS	35⅝	33¾	21	60½	77⅞	13½	3	17½	24½	17½	5	1½	5½	3½	26½	10½	□	—
#65S △ FSXA	4"-300#	3"-600#	75	1150	405T	38½	40½	20	69½	90½	14½	¾	23¾	25¼	18¼	5	1¼	6½	5	34¾	10½	□	—
			200	1750	447TS	43¼	40½	23	74½	96½	15½	¾	23⅞	23⅞	20¼	5	1⅛	6½	5	34¾	11½	□	—
#125D FSXA	6"-300#	4"-600#	125	1150	449T	44¼	55⅛	23	86½	104½	17	¾	29½	28½	23	5	2½	8½	6½	37½	13	□	1⅛
			250	1750	447TS	43¼	55⅛	23	86½	104½	17	¾	29½	28½	23	5	2½	8½	6½	37½	13	□	1⅛
#203D FSXA	8"-300#	6"-600#	200	1150	447T	47½	63½	23	109	115⅝	21½	¾	28½	33⅜	28	5	2½	9½	7½	40½	15½	□	1¾
			400	1750	5010S	58½	63½	26	122	127⅝	21½	¾	28½	36⅜	28	5	2½	9½	7½	40½	15½	□	1¾
#253D FSXA	10"-300#	8"-600#	250	870	5010L	59½	78	26	130¼	142½	24½	¾	34½	39¾	32½	5	3½	11½	8½	53½	16½	□	1⅞
			600	1150	6609L	75	78	34	155½	158½	24½	¾	34½	43½	32½	5	3½	11	8½	53½	16½	□	1⅞
#303D FSXA	12"-300#	10"-600#	350	870	5609L	63¾	87½	30	148½	155⅞	25½	¾	40	46¾	38½	5	3½	12½	10½	62	21½	□	2¼
			1000	1150	6611L	65½	87½	34	166¼	173¾	25½	¾	40	48½	38½	5	3½	12½	10½	62	21½	□	2¼

ALL DIMENSIONS IN INCHES. DIMENSIONS NOT TO BE USED FOR CONSTRUCTION PURPOSES.

□ TO BE DETERMINED BY CUSTOMER

△ PUMP SIZE #36D AND #65S DO NOT HAVE GEAR HOUSING FOOT

PARTS LIST — WARREN 2300 SERIES SCREW PUMPS

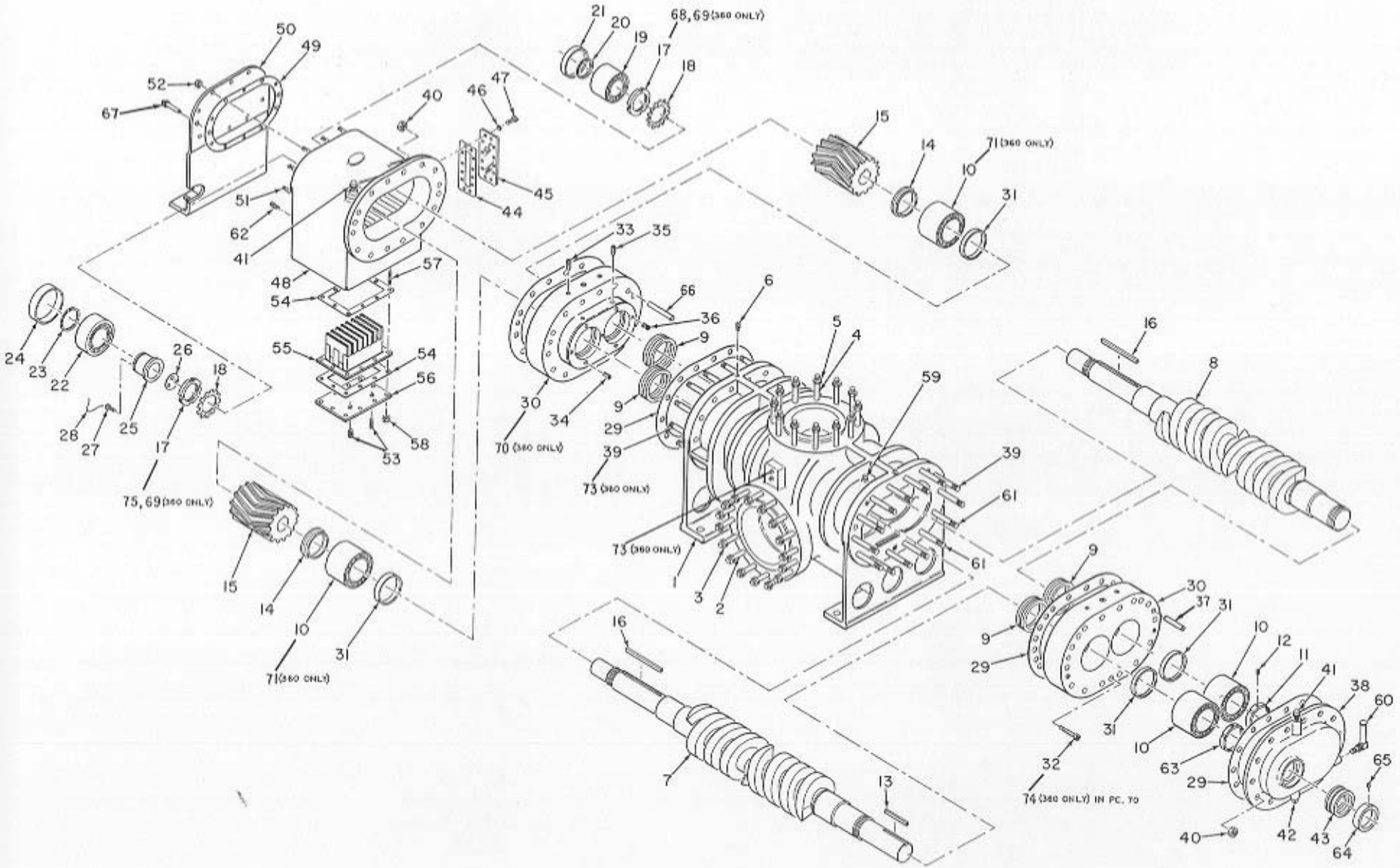
(Refer to Drawing A-2155-A REV B)

Part No.	Part
1.	Body
2.	Stud
3.	Hex Nut
4.	Stud
5.	Hex Nut
6.	Pipe Plug
7.	Long Shaft and Screws
8.	Short Shaft and Screws
9.	Mechanical Seal
10.	Bearing, Roller
11.	Locknut
12.	Set Screw
13.	Key
14.	Gear and Bearing Spacer
15.	Timing Gear
16.	Timing Gear Key
17.	Locknut
18.	Lockwasher*
19.	Bearing, Roller
20.	Snap Ring
21.	Bearing Spacer
22.	Thrust Bearing
23.	Snap Ring
24.	Bearing Spacer
25.	Bearing Sleeve
26.	Shims
27.	Adjusting Sleeve Capscrew
28.	Lockwire
29.	Gasket
30.	Bearing Housing
31.	Oil Seal
32.	Cap Screw
33.	Pipe Plug
34.	Pipe Plug*
35.	Pipe Plug*
36.	Pipe Plug*
37.	Dowel Pin
38.	Front Head
39.	Stud
40.	Hex Nut
41.	Vent and Fill Plug
42.	Pipe Plug
43.	Mechanical Seal — Oil Seal***
44.	Gasket
45.	Cover
46.	Washer
47.	Bolt
48.	Timing Gear Housing
49.	Gasket
50.	Timing Gear Housing Cover
51.	Stud
52.	Hex Nut
53.	Pipe Plug
54.	Gasket
55.	Heat Exchanger
56.	Cover
57.	Stud
58.	Hex Nut
59.	Pipe Plug
60.	Oil Sight Glass
61.	Stud
62.	Pipe Plug
63.	Locknut*
64.	Shaft Collar
65.	Setscrew
66.	Dowel Pin
67.	Taper Pin w/Nut
68.	Locknut (R.H.)**
69.	Set Screw**
70.	Bearing Housing**
71.	Bearing, Roller**
72.	Stud**
73.	Pipe Plug**
74.	Capscrew**
75.	Locknut (L.H.)**

** Not applicable for 360 FSXA

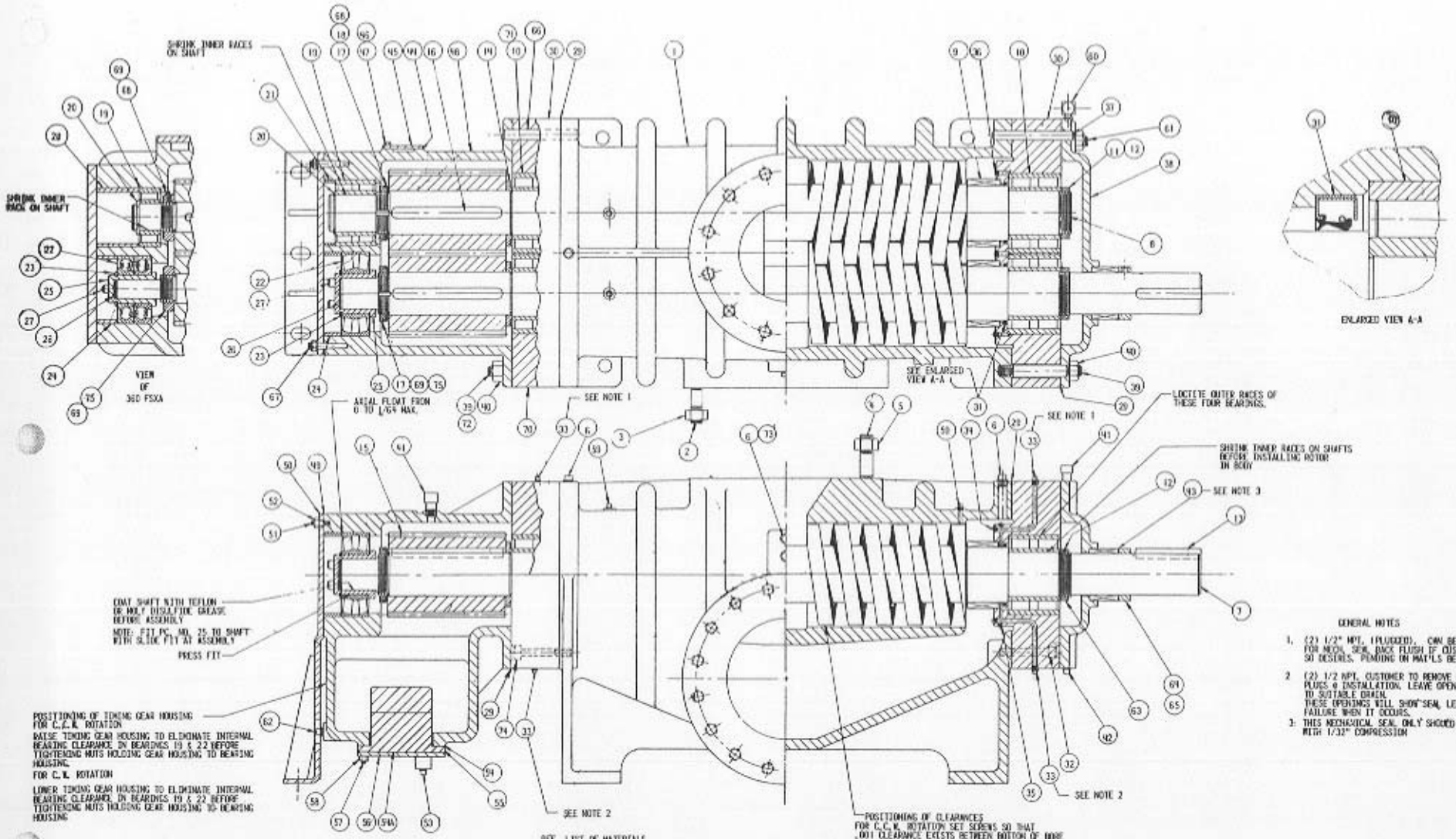
** Applicable for 360 FSXA only

***Pumps may be fitted with an oil seal or mechanical seal. When ordering parts, indicate which of the options you wish to order. Part numbers 64 & 65 are deleted when the oil seal is installed.



Exploded View

SECTIONAL ASSEMBLY A-2155-A REV. B



REF. LIST OF MATERIALS

1250 FSXA - QUK - 612 -A
2030 FSXA - QUK - 639 -A
2530 FSXA - QUK - 599 -A
3030 FSXA - QUK - 800 -A
655 RSXA - QUK - 902 -A
360° FSXA - QUK - 700 -A

GENERAL NOTES

1. (2) 1/2" NPT. (PLUGGED). CAN BE USED FOR MECH. SEAL BACK FLUSH IF CUSTOMER SO DESIRES. PENDING ON MAT'LS BEING PUMPED
2. (2) 1/2 NPT. CUSTOMER TO REMOVE SHIPPING PLUGS @ INSTALLATION. LEAVE OPEN OR PIPE TO SUITABLE DRAIN. THESE OPENINGS WILL SHOW SEAL LEAKAGE OR FAILURE WHEN IT OCCURS.
3. THIS MECHANICAL SEAL ONLY SHOULD BE SET WITH 1/32" COMPRESSION

Warren Pumps Inc., Warren, Massachusetts 01083