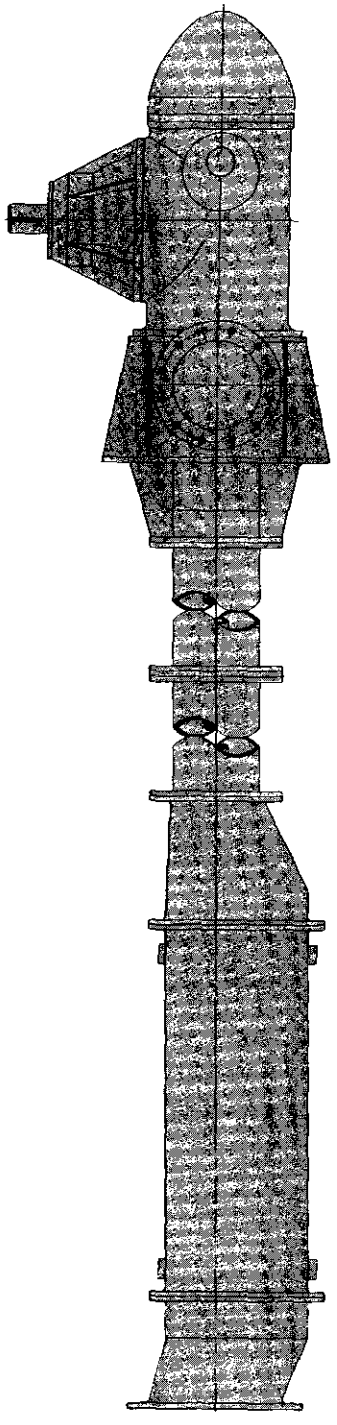
WARREN PUMPS

SECTION 2201
PAGE M2201
ISSUE A



INSTALLATION
OPERATION
MAINTENANCE

2201 SERIES J-70 WET PIT AND DRY PIT SCREW-TYPE BARGE PUMPS

PLEASE READ THESE INSTRUCTIONS BEFORE INSTALLING PUMP

Warren Pumps Inc., Warren, Massachusetts 01083

This pump is not to be operated at higher speeds, higher working (discharge) pressures or higher temperatures or with different liquids than those stated in the original order acknowledgement without written permission of Warren Pumps, Inc.

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INTRODUCTION

This manual is intended to assist those concerned with installation, operation and maintenance of the Warren J70B Barge pump. 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

General — The Warren 2201 Series pump is a positive displacement screw pump featuring a four screw design for excellent suction-lift capability. A major feature of this design is its extremely low maintenance requirements. Special bearing construction provides wide liquid handling capabilities. Pump fits standard barge dimensions. Overall length of pump can be tailored to a particular barge depth. Design handles both light oil and heavy oil barge requirements . . . pumps light hydro-carbons as well as viscous asphalts. The pump is designed for easy removal by lifting a deck-mounted carrying plate. It can be driven by diesel engine through standard right angle, deck-mounted gear reducers or by direct drive electric motor.

Positive Displacement — (Four Screw Pump) Each of two sets of opposed screws conveys liquid to provide perfect hydraulic balance regardless of discharge pressure . . . ideal for tank stripping. This positive displacement screw pump is self-priming over a wide range of viscosities. Inherent in its design is its high pressure capability, high volumetric efficiency, constant pulse-free flow and low internal velocity . . . under varying viscosity and suction/discharge pressure conditions.

Timing Gears — Timing Gears are used to transmit power from the drive shaft to the idler shaft and to prevent metal to metal contact between the meshed, rotating screws. These timing gears use helical, herringbone teeth of hardened steel. 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.

The outside diameter of the pumping screws and the pump body bores can be furnished with hard coatings to resist wear and the galling properties of similar metals such as stainless steel.

SECTION 2 — RECEIVING, HANDLING AND STORAGE

2-1 Receiving

The equipment should be placed 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.

Special long term storage crating can be supplied upon request.

Each shipment should be carefully examined upon arrival. Any damage should be reported promptly to the carrier and to the nearest office of Warren Pumps. 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 may cause permanent distortion of the carrying plate and or column which will affect the close operating clearances of the rotating assembly. Contact of the moving parts could 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 agent 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 should 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. Protect pump and driver with a plastic or canvas covering.
   c. 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 pre-planned location. If, after receipt, another location is considered that might alter the pre-planned conditions, it is recommended that Warren engineering be consulted to insure satisfactory operation of your 2201 series pump.

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.

3-3 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 should be as short and direct as possible. Use long radius elbows to change direction wherever 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. To check piping alignment of the pump, insert flange bolts through pipe and pump flange. If bolts are easily moved within the bolt holes and if flange faces are square with each other, piping is properly aligned.
6. Maintain sufficient gap between flange faces for inserting the gasket. Flanges should not butt tightly before being secured.

3-4 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.
2. Check Valves — If the discharge piping system is subject to a high static head, 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.
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 system. 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 to prevent product loss particularly in pumps that operate unattended.
4. Vent — If pump is required to operate with a suction lift at times, a suitable means for venting the pump should be installed in the discharge piping adjacent to the pump.

SECTION 4 — START-UP/OPERATION

4-1 Pre-Startup

Pre-startup checks for trouble free initial start-up are essential to avoid operational difficulties. Once installed and operating it will be difficult to make any adjustments.

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. 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. Install carrying plate packing and lubricate with suitable grease using grease connection provided.
4. Read Safety Precautions (Section 8) prior to start-up.

4-2 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 (pump not immersed in liquid), 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. If the pump operates under a flooded suction, simply open the valves and allow the liquid to flood the pump.
4. Start driver.

4-3 Pump Operation

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 suction and discharge pressure gauges where installed for proper readings.

SECTION 5 — PREVENTIVE MAINTENANCE

5-1 Periodic Inspection

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

DAILY

1. Listen for unusual noise or vibration.
2. Inspect packing gland for excessive leakage.

WEEKLY

1. Run idle units under power for a minimum period of 30 minutes if possible.
2. Check all automatic controls and/or regulators.

QUARTERLY

1. Check all foundation and hold-down bolts tightnesss.

ANNUALLY

1. Check existing pump capacity and power requirements against pump nameplate data.

5-2 Capacity Check

Check existing pump capacity and power requirements against pump nameplate data. A Warren Series 2201 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 and worn parts replaced. If pump performance is satisfactory, the pump need not be disassembled for inspection. Refer to Fig. 5-1 and 5-2 for terminology used when discussing or referring to particular screw areas. See Section 5-3 for rotating assembly examination procedure.

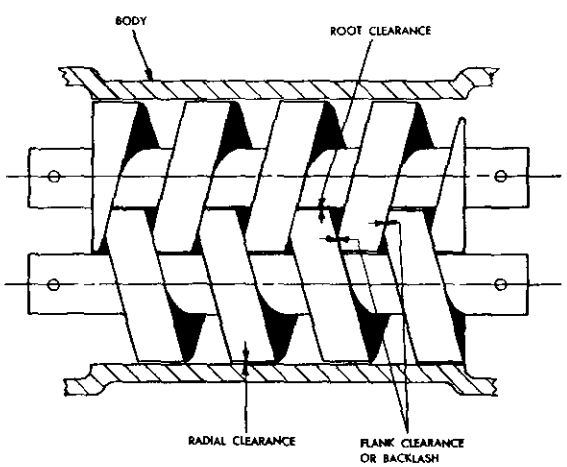


Fig. 5-1

5-3 Rotating Assembly Examination Procedure

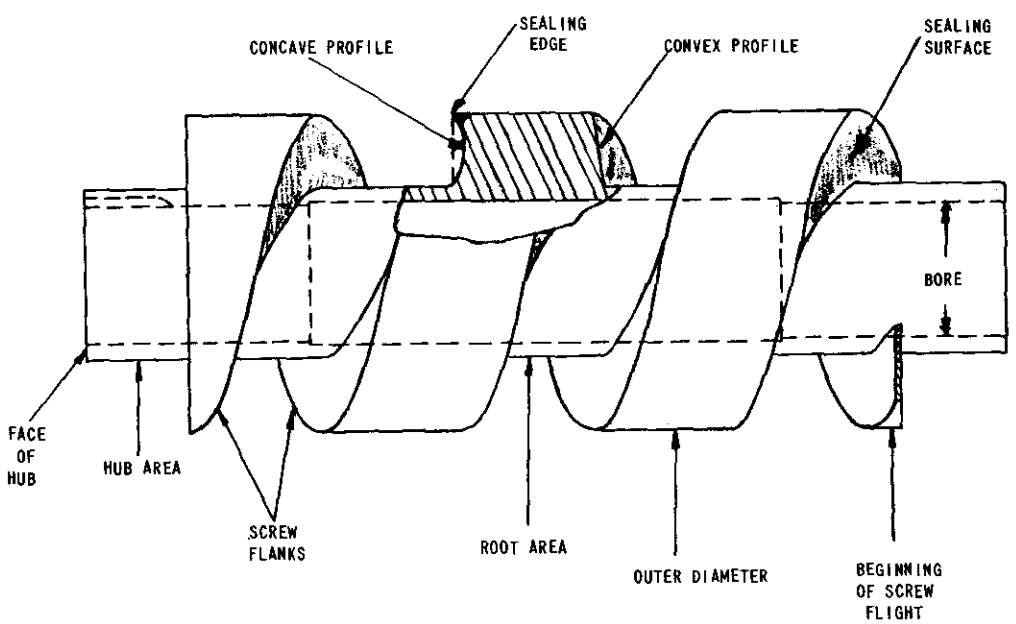
(Use Machinery Record Sheet Fig. 5-3)

1. Flank Clearance
   a. Mesh screws together and place in checking stands made up to Fig. 5-4.
   b. Level shafts, both lengthwise and across.
   c. Check flank clearance with feeler gauges. See Fig. 5-1. Check original operating clearance table (See Table 5-1).
2. Diametral Clearance
   a. With outside micrometer, check outside diameter of screw (25) at several locations. Record reading. Use parallel or keystock to obtain two opposite points for measuring.
   b. With inside micrometer, take reading of bore of pump body (1). Take reading at several locations along centerline and at 8-2 o'clock and 4-10 o'clock (See Fig. 5-3) and average the readings.
   c. Subtract O.D. of screw (25) from bore of pump body (1). This will give you total diametral clearance. Record reading and compare to original operating clearance table (See Table 5-1). At this clearance opens up, capacity and/or pressure will be reduced.
3. Run Out — At this point, shafts should be checked for runout with a dial indicator on a lathe. If runout is over .003, shaft should be straightened. If runout cannot be corrected, the shaft should be replaced. Record reading on Machinery Record Sheet (See Fig. 5-3).
4. Timing Gears — Good timing gear maintenance will result in longer pump life and smoother operation. Timing gear teeth should be examined for wear and chipping or scoring caused by foreign material in the lubricant.
5. Keyways — Keyways must be a light tap fit. If not, replace.
6. Basic Operating Clearances.

	Total Diametral Clearance	Total Flank Clearance (when screws are centralized axially)
J-70 B	.011	.008

Table 5-1

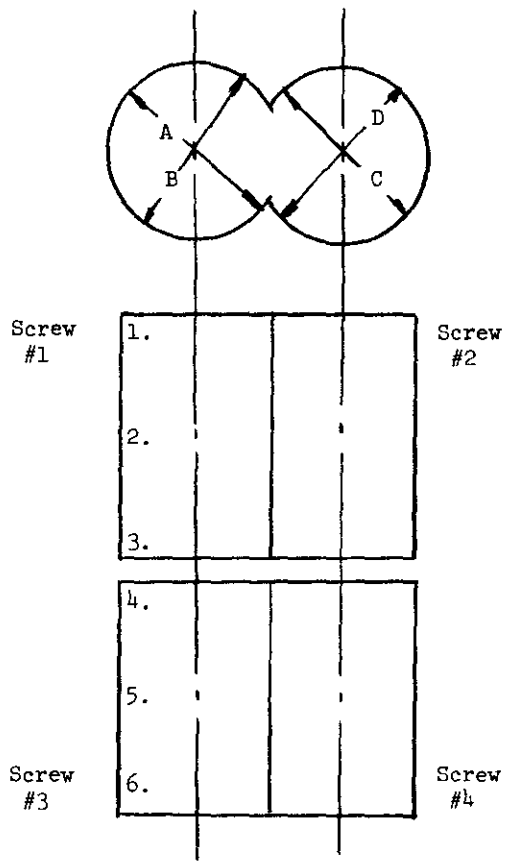
It is suggested that upon any occasion where diametral and flank clearances are checked, they be recorded. Use Machinery Record Sheet Fig. 5-3.

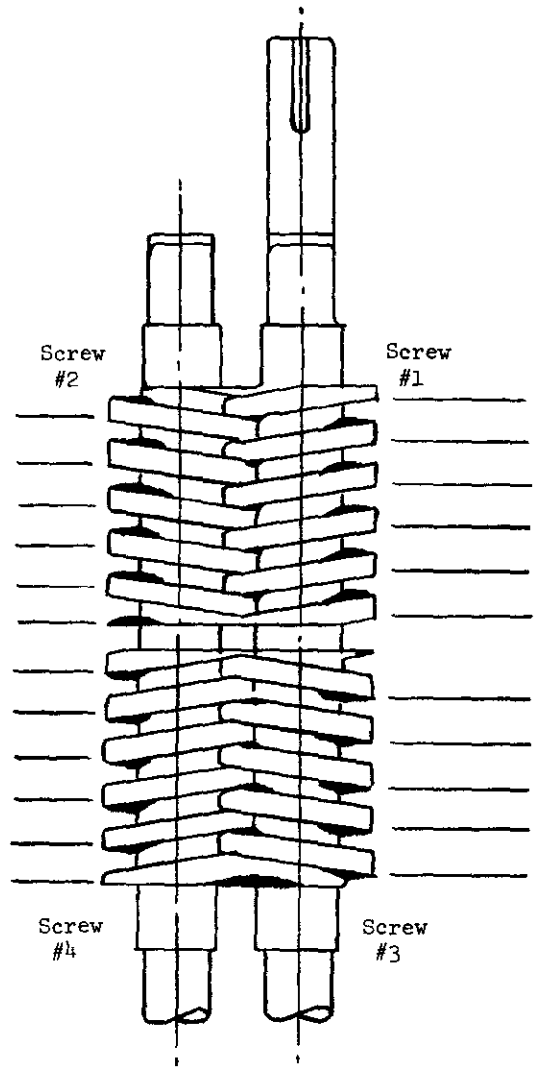


NOTE - 360° or (1) Turn
Make one complete flight

Fig. 5-2

5-4 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 grgs		
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.

SK-2642

Fig. 5-3

5-5 Checking Stands

1. General — Checking stands will be a good way to properly inspect your pumping screws and shafts. The checking stands should be used in conjunction with your Machinery Record Sheet (See Fig. 5-3).
2. Checking Stands — A simple and inexpensive way of making checking stands is to cut a piece of kiln dried hard wood to the dimensions shown in Table 5-2. After the checking stand bore diameters ("E" dimension) have been bored, it would be necessary to accurately cut the piece of wood in half. Each half would then be used for either the front part of the screws or the rear part.

Care should be taken to insure that the bores do not become nicked or marred. It is important that screws are level in both directions after they are placed in the stands. Shim stand to make screws level.

Before using, lubricate the cradles.

Pump Size	Checking Stand Dim. (L-W-H)	Dim. "D"	Dim. "E"
J70	18x4½x14	6.000 +.001 −.000	3.001 +.001 −.000

Table 5-2

CHECKING STANDS

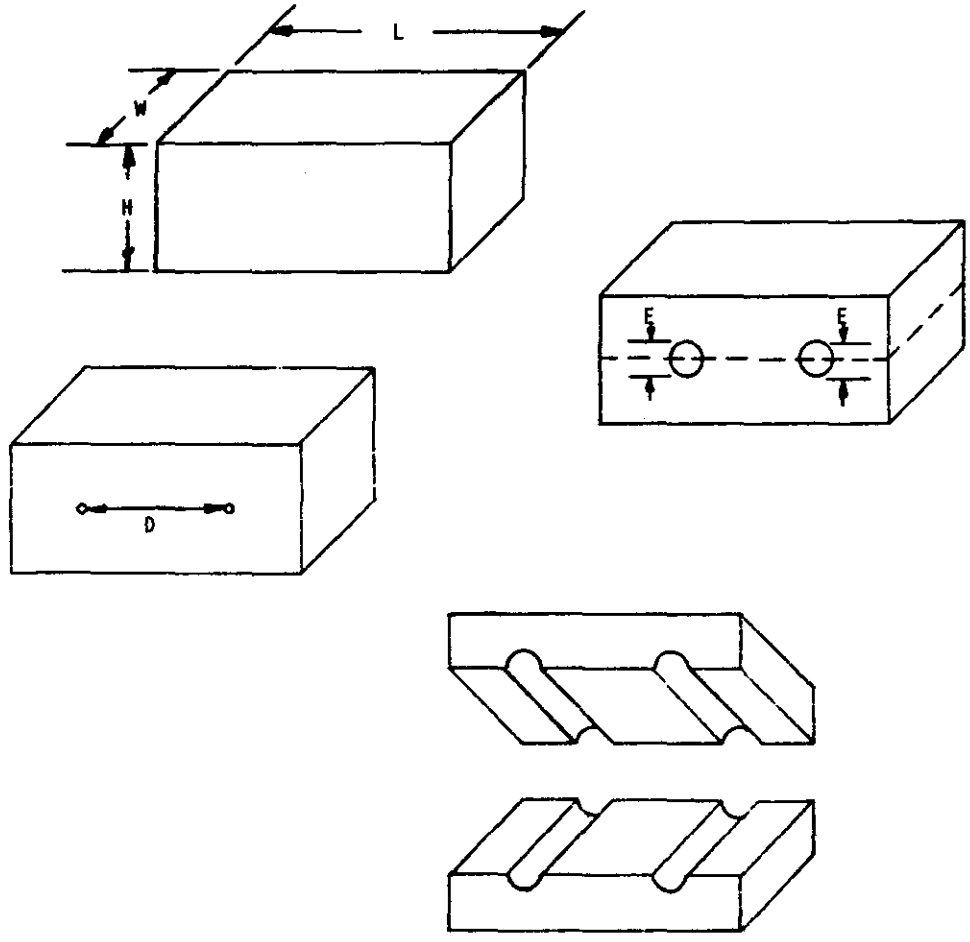


Fig. 5-4

SECTION 6 — MAINTENANCE

6-1 Disassembly

Before disassembling pump, it should be isolated hydraulically and the driver isolated from its source of power. Read carefully the applicable sectional assembly drawing. Use this drawing as a guide for proper sequence of parts removal. Listed below are some points of caution and instructions to ease disassembly. Read carefully before proceeding. Refer to Sectional Assembly Drawing (Section 10) and Parts List (Section 11).

To remove the pump from the storage tank, proceed as follows:

1. Disconnect driver from upper jackshaft as appropriate. Upon removal of gear, upper jackshaft (57) should stay coupled to lower jackshaft (40). Properly rig pump for removal from deck.
2. Disconnect suction and discharge flanges.
3. Remove foundation bolts from carrying plate (15).
4. Attach suitable lifting gear for pump removal.
5. Remove any braces which secure pump to tank.
6. Remove pump from storage tank.
7. After unit has been thoroughly cleaned, match mark all flange connections to facilitate reassembly.
8. It is suggested that a cradle be used to hold the pump in a horizontal plane for disassembly, inspection and reassembly of the pump.
9. Remove nuts (17) from studs (16). Then remove split gland (19), packing (22), lantern ring (62) and packing (22) from upper jackshaft (57).
10. Remove taper pins (13), hex head bolts (60) with nuts (61) from carrying plate (15). Then remove carrying plate (15).
11. Remove gasket (14) from upper stand pipe (59).
12. Remove hex bolt (65) from handhole cover (64). Then remove handhole cover (64) from upper stand pipe (59).
13. Remove gasket (63) from upper stand pipe (59).
14. Remove taper pins (50), hex nuts (12) and hex bolts (11) from upper stand pipe (59), intermediate bearing housing (49) and lower stand pipe (10). Remove upper stand pipe (59).
15. Remove hex nuts (54), lockwashers (53) from body fit bolts (52). Then remove body fit bolts (52) from rigid coupling (51).
16. Remove upper jackshaft (57). Then remove key (56) from upper jackshaft (57).
17. Remove rigid coupling (51) from lower jackshaft (40). Then remove key (55) from lower jackshaft (40).
18. Remove taper pins (50), hex nuts (12) and hex bolts (11) from lower stand pipe (10), intermediate bearing housing (47) and upper bearing housing (8).
19. Do not remove intermediate bearing plate capscrews. Bearing housing is secured to the stand pipe by two ⅜-16 cap screws 180° apart. This will facilitate disassembly.
20. Remove lower stand pipe (10), along with intermediate bearing housings (49) and (47) and lower jackshaft (40) from upper bearing housing (8).
21. Remove lower jackshaft (40) from stand pipe by carefully sliding it through the intermediate bearing housings.
22. Remove bearing housing capscrews from bearing plates and remove intermediate bearing housings (47) and (49) from stand pipe.

    NOTE: Bearing housing cap screws are not included in Sectional Assembly Drawing.

23. Remove pump half coupling (43) from long shaft (23).
24. Remove key (29) from long shaft (23).
25. Remove taper pins (4) and nuts (3) from lower bearing housing (6).
26. Remove lower bearing housing (6) with gasket (5) from body (1).
27. Remove rotating elements from the suction end, which is comprised of long shaft (23), short shaft (24), locknut (27), lockwasher (28), timing gears (26), key (30), balancing disc (32), screws (25), taper pins (31), setscrews (33), thrust assembly (34), thrust bearing plate (35), thrust bearing (36), bearing seat (37), pins (38) from body (1).
28. Remove taper pins (4) and nuts (3) from upper bearing housing (8).
29. Remove upper bearing housing (8) with gasket (5) from body (1).

6-2 Gear Removal — Bearings

NOTE: Removal of timing gears will be required when;

a. Gears are damaged or worn and must be replaced.

b. Pumping screws are damaged or worn and must be replaced.

1. Remove timing gears (26), if required, from shafts. Before removing gears, match mark 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 a gear puller.
2. Bearings — Considering the time and work required to remove and rebuild this unit, Warren advises that **all bearings** be replaced to improve pump life after reinstallation. Follow all general and caution notes on Sectional Assembly Drawing pertaining to installation of sleeve bearings.

6-3 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, this section does not apply.

1. 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.
2. 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:

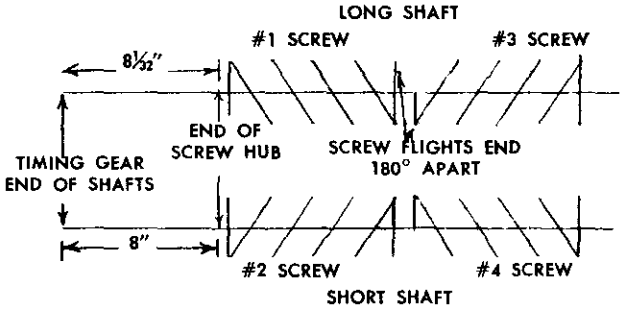


Fig. 6-1

3. Taper pins (31) hold the pumping screws (25) on the shafts. The screws are also bonded to the shafts with epoxy resin. Grind the small end of the pins (31) 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.
4. Place the pumping screw taper pins into the holes drilled in the shafts, drive them tight and grind them off flush with the shaft.
5. Place each shaft in a lathe and check the shaft runout which should not exceed .002".
6. Measure the bore diameter of the new pumping screws (25) and machine or grind the shafts in the pumping screw area to allow .002" to .004" clearance between the bore of the screw and the shaft.
7. 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.
8. 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.
9. 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.
10. 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.
11. When you are satisfied that the measurement from the end of the shaft to the No. 1 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.
12. 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).
13. 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 pins. Install the taper pins and peen over the small end.

14. 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 flights) become open. See sketch:

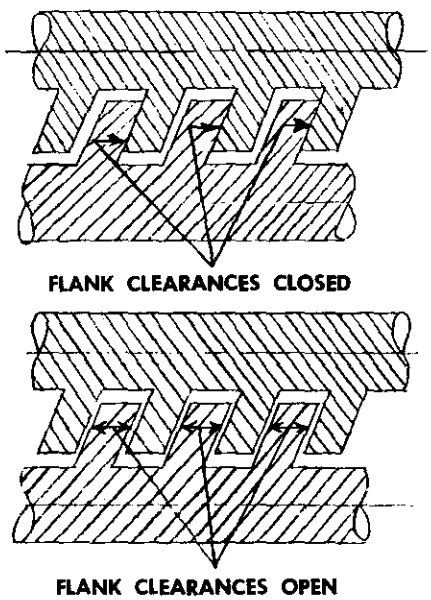


Fig. 6-2

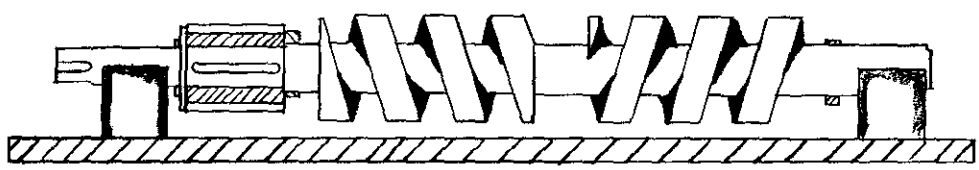
15. Open flank clearances so that clearance is equal between the meshed screws. Measure the clearance and insert small strips of shim stock into all the clearances.
16. Wire the meshed screws tightly together and leave the shim stock in place.
17. Cover shaft in the No. 4 screw area with a mixed epoxy.
18. 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 pins. Drive the pins in and peen over the small end.
19. Check pumping screw runout between lathe centers. Grind if necessary to true up pumping screw O.D. to .0015″ maximum runout.
20. See "Installation of Replacement Timing Gears" for timing instructions.

6-4 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 precut keyway. This keyway must be located and cut in the field.

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. With screws meshed together, install timing gears on shafts with the apex of the gear teeth pointing in the direction of rotation of its respective shaft. The splined gear should be installed on the long shaft with a key installed. The short shaft will have no key, allowing the shaft to turn freely within the gear, for scribing. Lightly oil shafts prior to gear installation.
4. Keeping screws meshed together with gears in place, set element into wooden checking stands as shown in Fig. 6-3. It will be necessary to accurately level the rotating assembly, lengthwise and across, to insure correct setting of the clearances.



ELEMENTS IN CHECKING STANDS

Fig. 6-3

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.

    CAUTION: 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.

Installation of Rotor (See Sectional Drawings)

6-5 Reassembly

1. Install complete rotating assembly in pump body from the suction end.
2. Install upper bearing housing (8) with gasket (5) on body (1). Use taper pins (4) to align this part with body (1); then secure with nuts (3).
3. Install lower bearing housing (6) with gasket (5) on body (1). Use taper pins (4) to align this part with body (1); then secure with nuts (3).
4. Turn long shaft (23) slowly by hand to check freedom of rotation. Rotor must turn freely at this point. If rotors bind or hesitate at some point in a revolution, recheck assembly.
5. Insert key (29) into long shaft (23) and install pump half coupling (43).
6. Secure intermediate bearing housings (47) and (49) and gaskets (14) on lower stand pipe (10) with ⅜ cap screws. Use taper pins (50) to align these parts to stand pipe (10) then remove taper pins.
7. Install lower jackshaft (40) with coupling half (42) and key (41) through intermediate bearing housing (47), stand pipe (10) and intermediate bearing housing (49).

   CAUTION: Do not damage bearings while installing jackshaft.

8. Assemble pieces (10), (47), (49) and (40) to upper bearing bracket (8). Install taper pins (50) to align parts previously assembled to upper bearing bracket (8).

   NOTE: Piece (42) pre-assembled on jackshaft (40) should be installed by sliding over piece (43). This should be done simultaneously with aforementioned assembly procedure (Item 8).

9. Temporarily remove upper taper pins (50) from lower stand pipe (10) and intermediate bearing housing (49).
10. Install upper stand pipe (59) with gasket (14) to intermediate bearing housing (49) and lower stand pipe (10).
11. Reinstall taper pins (50) to align parts (59), (49) and (10) with lower stand pipe (10), secure with bolts (11) and nuts (12).
12. Install rigid coupling (51) with key (56) onto upper jackshaft (57).
13. Install key (55) onto lower jackshaft (40).
14. Couple upper jackshaft (57) to lower jackshaft (40) with coupling (51) then secure with bolts (52), lockwashers (53) and nuts (54).
15. Install carrying plate (15) with gasket (14) over upper jackshaft (57) onto upper stand pipe (59).
16. Install taper pins (13) to align carrying plate (15) with upper stand pipe (59); then secure with bolts (60) and nuts (61).
17. Install gaskets (63), handhole covers (64) onto upper stand pipe (59) and secure with bolts (65).
18. Install pump into storage tank.
19. Install drive assembly on upper jackshaft (57).
20. Install pump packing (22). Refer to installation of pump packing.
21. Reinstall and connect all piping to unit.
22. Reinstall and connect power source to unit.
23. When unit is returned to service, see Section 4 Start-Up.

6-6 Installation of Pump Packing

Refer to Sectional Assembly Drawing (Section 10) and Parts List (Section 11). Packing should be replaced when gland travel is used up.

Install new packing as follows:

1. Remove gland nuts (17) from gland studs (61). Remove cap screws (20), separate gland halves (19) and remove from pump.
2. Remove all old packing (22) and lantern ring (62) from stuffing box.
3. Clean gland halves and stuffing box of old packing material. Note condition of shaft in the stuffing box area. If shaft is scored, it should be repaired or replaced or the new packing will not last.
4. Prepare new packing rings (22) and lantern ring (62). Refer to Section 11 for type of material, number of rings required and dimensions. If rings are cut from a spiral coil and must be recut to proper dimensions, cut these rings so the ends meet squarely when wrapped around the shaft.

   If packing rings are preformed, they do not require fitting prior to installation. When installing these rings, do not pull the ends directly apart. This may split the ring which is opposite the butt joint. Preformed packing should be installed by twisting the ring to provide sufficient opening to pass the shaft.

NOTE: Prior to installation of packing rings, the rings should be thoroughly soaked in lube oil.

5. Install one packing ring (22). If possible, tamp this ring firmly into the stuffing box as it must seal against the stuffing box throat as well as the shaft and bore of the stuffing box.
6. Install remaining packing rings (22) and lantern ring (62). The joint of each succeeding ring should be offset 90° from joint of the preceding ring.
7. Replace gland halves (19) and secure together with soc. hd. capscrews (20).
8. Replace nuts (17) on gland studs (16). Tighten gland nuts firmly and evenly to compress the packing. Maintain pressure for 15-20 minutes to allow packing rings to cold flow and adjust to gland pressure.
9. Back off gland nuts and re-tighten finger tight.
10. On initial start-up of the pump after repacking, check carefully that gland nuts are only tight enough to prevent entrance of air into the pump.

SECTION 7 — TROUBLE SHOOTING

	Trouble	Cause of Trouble
7-1	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.
7-2	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.
7-3	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.
7-4	Loss of Suction (After Period of Satisfactory Operations):	1. Air leaks in suction line. 2. Suction lift too high. 3. Air or gases in liquid. 4. Mechanical defect (inspect pump).
7-5	Hammer, Noise, Vibration:	1. Air or gases in liquid. 2. Suction velocity too high. 3. Bearings improperly fit. 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 liquid.

SECTION 8 — SAFETY PRECAUTIONS

8-1 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 speed 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.

SECTION 9 — REPLACEMENT PARTS

9-1 General

The following information should be referenced when ordering replacement parts from the factory:

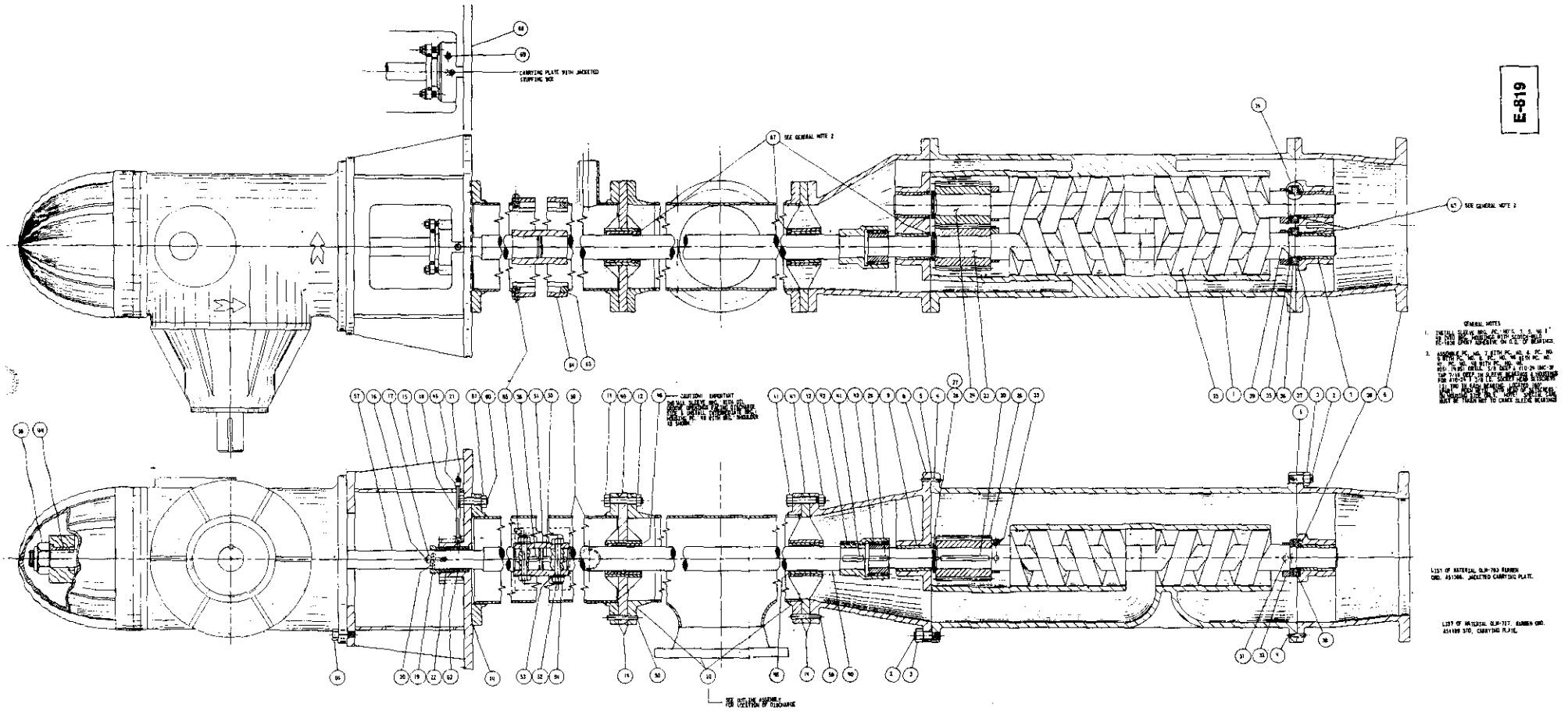
Type of pump, manufacturer's service part number and quantity for each part required. See Sectional Assembly Drawing (Section 10) for service part numbers. Also provide:

(a) Serial number of pump.
(b) Name of part required.
(c) Drawing number of piece number of part required.

9-2 Parts List

A complete list of pump parts is shown in Section 11.

SECTION 10 — SECTIONAL ASSEMBLY DRAWING



SECTION 11

PARTS LIST — 2201 SERIES BARGE-TYPE SCREW PUMP
(Refer to Dwg. E-819)

Part No.	Part	Part No.	Part
1	Body	36	Thrust Bearing
2	Stud	37	Bearing Seat
3	Nut	38	Pin
4	Taper Pin	39	Pin
5	Gasket	40	Jack Shaft, Lower
6	Bearing Housing, Lower	41	Key
7	Sleeve Bearing	42	Coupling, Driver Half
8	Bearing Housing, Upper	43	Coupling, Pump Half
9	Sleeve Bearing	44	Key
10	Stand Pipe, Lower	45	Coupling
11	Bolt	46	Sleeve Bearing
12	Hex Nut	47	Int. Bearing Housing
13	Taper Pin	48	Sleeve Bearing
14	Gasket	49	Int. Bearing Housing
15	Carrying Plate	50	Taper Pin
16	Stud	51	Rigid Coupling
17	Hex Nut	52	Body Fit Bolt
18	Pipe	53	Lockwasher
19	Gland	54	Hex Nut
20	Soc. Head Capscrew	55	Key
21	Grease Fitting	56	Key
22	Packing	57	Jack Shaft, Upper
23	Long Shaft	58	Elastic Stop Nut
24	Short Shaft	59	Stand Pipe, Upper
25	Screws	60	Hex Head Bolt
26	Timing Gear	61	Hex Nut
27	Locknut	62	Lantern Ring
28	Lock Washer	63	Gasket
29	Key	64	Hand Hole Cover
30	Key	65	Hex Head Bolt
31	Taper Pin	66	Hex Head Bolt
32	Balancing Disc	67	Soc. Head Set Screw
33	Soc. Head Setscrew	68	Carrying Plate, Jacketed
34	Thrust Bearing Assembly	69	Pipe Plug
35	Thrust Bearing Plate		