OPERATION & MAINTENANCE

MANUAL

for

VERTICAL TURBINE

FIRE PUMPS

Rev. 1

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IMPORTANT NOTE

The descriptions and instructions included in this book cover the standard design of the equipment and any common deviations when possible. This book does not cover all design details and variations, nor does it provide for every possible contingency, which may be encountered. When information cannot be found in this book, contact the nearest Patterson Pump representative.

SAFETY PRECAUTIONS WARNING!!!!!

Never operate this equipment in excess of its rated speed or other than in accordance with the instructions contained in this manual.

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

When working on or around equipment described in this instruction book, it is important to observe safety precautions to protect personnel from possible injury.

The following is an abbreviated list of safe practices to keep in mind:

- avoid contact with rotating parts
- avoid bypassing or rendering any safeguards, or protective devices inoperative
- avoid extended exposure in close proximity to machinery with high noise levels
- use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment
- do not modify this equipment, consult factory if modification is deemed necessary
- use only OEM repair parts
- observe all caution and danger tags attached to the equipment or included in this manual

Safe maintenance practices with qualified personnel are imperative. Failure to heed this warning may result in an accident causing personal injury.

The following instructions should be completely read before starting to install the unit. The unit is capable of many years of trouble-free operation when properly applied, installed and maintained. These instructions present the basic information and methods required for proper installation and maintenance.

PROTECTIVE GUARDS

The responsibility for the installation of protective guards is the equipment owner. Protective guards for rotating equipment must be In place at all times during equipment operation.

STUDY THIS INSTRUCTION MANUAL

SECTION 1
GENERAL INFORMATION AND DESCRIPTION

> GENERAL INFORMATION:

The length of satisfactory service obtained from the equipment will, in part, depend on proper installation and maintenance. This instruction manual is provided to present the basic information for operation, maintenance, and management personnel. Due to the many variations and custom designed units it is impossible to cover every design variation or contingency which may arise, however, the basic information contained herein will cover most applications. Refer to the section under "Special Features" for any additional information regarding your particular unit.

> IDENTIFICATION:

Should questions arise concerning the pump, the factory will require the complete serial number to be of assistance. The serial number is stamped on a metal nameplate affixed to the discharge head assembly. The driver will have a separate nameplate attached to it– when requesting information on the driver, both the driver serial number and the pump serial number will be required.

> GENERAL DESCRIPTION:

The basic components of close coupled pumps are the driver, discharge head assembly, column assembly (when used), and bowl assembly. The pumps are normally shipped assembled and ready for installation. The drivers, couplings, and strainers (when used) are shipped loose to prevent damage.

- **Driver**

  A variety of drivers may be used, however, electric motors and right angle gears are most common. For the purposes of this manual, these types of drivers can be grouped into two categories:

  — Hollow shaft drivers: The pump shaft extends through a tube in the center of the rotor and is connected to the driver by a clutch assembly at the top of the driver.

  — Solid shaft drivers: The rotor shaft is solid and projects below the driver mounting base. This type driver requires an adjustable coupling between the pump and driver.

- **Discharge Head Assembly**

  The discharge head supports the driver and bowl assembly as well as supplying a discharge connection (the underground discharge connection will be located on one of the column pipe sections below the motor stand). A shaft sealing arrangement is located in the discharge head to seal the shaft where it leaves the liquid chamber. The shaft seal will usually be either a packing box or mechanical seal assembly.

- **Column Assembly**

  The column assembly is of two basic types, either of which may be used on close-coupled units:

  — open lineshaft construction utilizes the liquid being pumped to lubricate the lineshaft bearings
  — enclosed lineshaft construction has an enclosing pipe around the lineshaft and utilizes oil, grease, or injected liquid to lubricate the lineshaft bearings

  The column assembly will consist of column pipe, which connects the bowl assembly to the discharge head and carries the pumped liquid to the discharge head, the shaft, which connects the bowl assembly to the discharge head, the headshaft, which connects the lineshaft to the driver. Column pipe may be either threaded or flanged and may contain bearings if required for the particular unit.

  NOTE: Some units will not require a column assembly, having the bowl assembly connected directly to the discharge head.

- **Bowl Assembly**

  The bowl assembly consists of impellers rigidly mounted on the bowl shaft which rotate and impart energy to the fluid. The bowls (or diffusers) contain the fluid at increased pressure and direct it vertically to the nexf stage and eventually to the column pipe. The suction bell or case directs the fluid into the first stage impeller. Bearings are located in the suction bell, discharge case, and between each impeller.

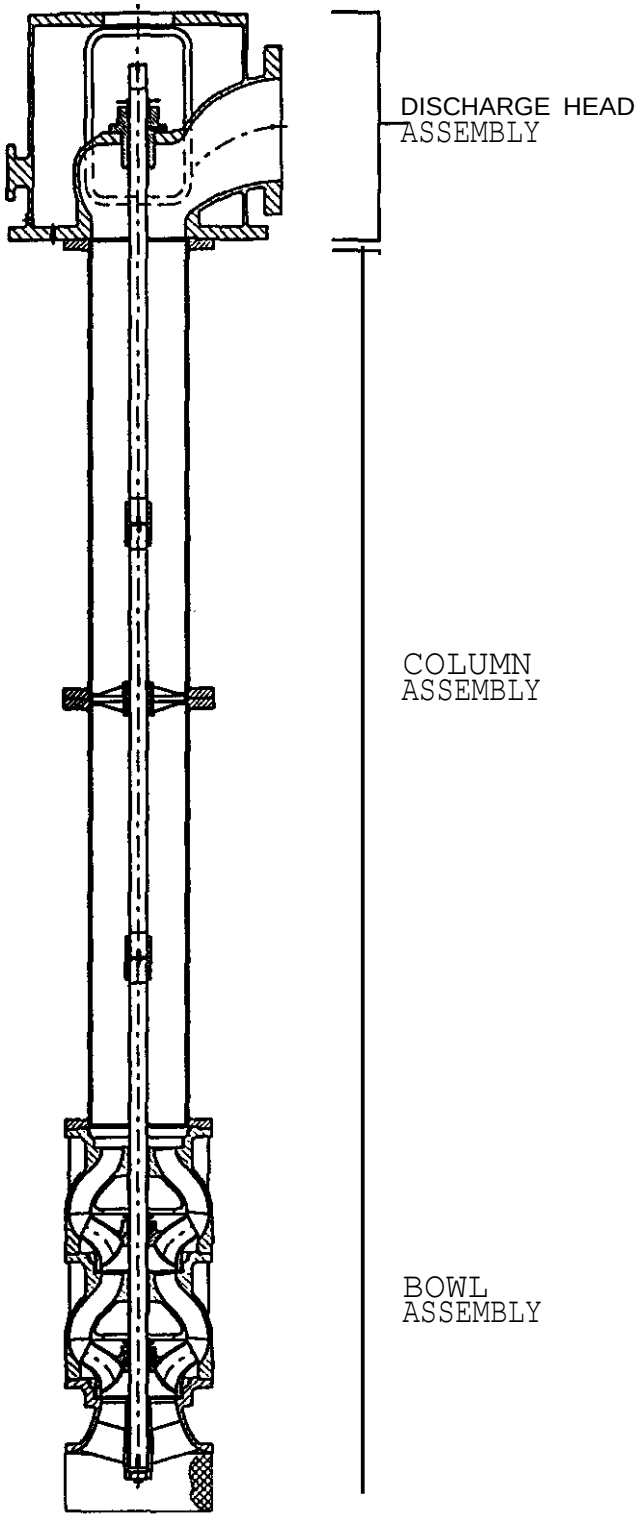


Figure 1-A
Typical Vertical Turbine Unit

SECTION 2

> STORAGE AND PROTECTION:

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

1. Be sure that bearings are fully lubricated.

2. Unpainted machined surfaces, which are subject to corrosion should be protected by some corrosion resistant coating.

3. The shaft should be rotated 1/4 to 1/2 revolution by hand periodically to insure that the pump shaft does not begin to sag. Suitable intervals are from one to three months.

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

5. Fresh lubricant must be applied to bearings (where applicable) upon removal of equipment from storage. Do not use petroleum or oil based lubricants on rubber bearing.

SECTION 3
PRE-INSTALLATION

> RECEIVING AND UNLOADING:

When the shipment is received extreme care should be exercised when unloading. Heavy parts should be skidded to the ground if lifting equipment is not available. Do not drop the unit, or any parts, as damage may cause trouble in assembly and operation of the unit.

Inspect the pump for signs of transit damage before beginning to uncrate or store. If damage is evident, the local transporting company agent should be notified before uncrating and a claim filed with the agent.

> UNCRATING AND CLEANING:

If the unit appears undamaged proceed with uncrating. The pump is shipped as a unit from the factory and it is advisable to lift it into the vertical position before uncrating. If this is not possible the longer units must be supported at more than one place when raising to the vertical position. At no time should any pump weight be placed on the suction bell.

Clean all parts of all dirt, packing materials and other foreign matter. Flush the pump inside and out with clean water. Clean all machined surfaces – these are coated with a rust preventative, which must be removed. Remove any rust spots found on the machined surfaces with fine emery cloth. Clean all threaded connections and any accessory equipment.

NOTE: Parts and accessories may be placed inside shipping containers or attached to skids in individual packages. Inspect all containers, crates and skids for attached parts before discarding.

> INSTALLATION EQUIPMENT AND TOOLS:

No installation should be attempted without equipment adequate for the job. The following list covers the principal items required for an installation.

1. Mobile crane capable of hoisting and lowering the weight of the pump or motor.
2. Cable sling for attaching to the pump and motor lifting eyes.
3. Ordinary hand tools – end wrenches, socket set, screw drivers, allen wrenches, etc.
4. Wire brush, scraper and fine emery cloth.
5. Thread compound and light machinery oil.

> PRE-INSTALLATION CHECK LIST:

The following checks should be made before starting actual installation to assure proper installation and prevent delays:

1. Where more than one unit is received, check the pump serial number against the packing slip to be sure the correct unit is being installed.

2. Check the driver horsepower and speed indicated on the driver nameplate, and the horsepower and speed indicated on the pump nameplate (located on the discharge head) to be sure they agree within 2%.

3. With motor driven units be sure the voltage and frequency on the motor nameplate agrees with the service available. Also make sure the horsepower and voltage rating of the control box or starter agrees with horsepower and voltage rating of the motor.

4. Check the depth of the sump against the pump length to be sure there will be no interference.

5. Check the proposed liquid level in the sump against the pump length – the bowl assembly must be submerged at all times.

6. Clean the sump and piping system before installing the pump.

7. Check the installation equipment to be sure it will safely handle the equipment.

8. Check all pump connections (bolts, nuts, etc.) for tightness. These have been properly tightened before leaving the factory; however, some connections may have worked loose in transit.

9. On hollow shaft drivers, check the clutch size against the shaft size, which must go through the clutch. Sometimes the shaft size coming through the discharge head is different from the shaft size going through the driver – be sure you check against the shaft, which will go through the driver.

10. On solid shaft drivers check the motor shaft size against the coupling bore size.

SECTION 4
INSTALLATION

> LOCATION:

Several factors should be considered when selecting a location for the pumping unit (pump, base, drive. and coupling). The unit should be accessible for both inspection and maintenance. Headroom should be provided for the use of a crane, hoist or other necessary lifting devices. The location should require a minimum of elbows and fittings in the discharge line to minimize friction losses, and the unit should be protected against flooding.

> FOUNDATION:

The foundation should be sufficiently substantial to absorb vibration and to form a permanent rigid support for the pump. Concrete is most widely used for foundations. Before pouring a foundation, locate anchor bolts per the outline drawing. Anchor bolts should be installed in sleeves twice the anchor bolt diameter to allow for alignment with the holes in the soleplate or discharge head, see **Figure 4-A.** Allow for 3/4 inch to 1-1/2 inches of grout between foundation and discharge head or soleplate. The top surface of the foundation should be roughened to provide a good bond for the grout.

> LEVELING THE UNIT:

Position the unit so the anchor bolts are aligned in the middle of the mounting holes in the base. Place metal shims or metal wedges directly under the part of the base carrying the greatest weight, and space them close enough to give uniform support and stability. Adjust the metal shims or wedges until the top flange of the discharge head is level. Tighten the foundation bolts snugly, but not too firmly, and recheck the alignment before grouting.

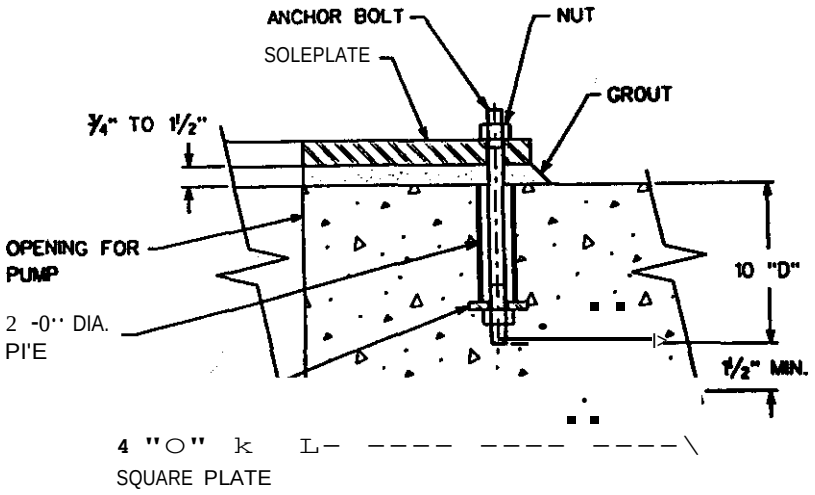


Figure 4-A
Recommended Anchor Bolt Arrangement

Note: The elevation of the pump soleplate may have to be adjusted to obtain alignment.

Level the pump to .001 inches per foot. This can be accomplished by utilizing A precision level on the motor mounting surface of the motor stand. This surface Has been machined perpendicular to the axis of the pump.

Note: The pump soleplate will have to be adjusted to obtain level. Adjust the Shims as necessary.

>

GROUTING:

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

1. Build a strong form around the baseplate to contain the grout.

2. Soak the foundation top thoroughly, then remove the surface water.

3. Pour grout. Tamp liberally while pouring to fill all vacancies and prevent air pockets. The space between the foundation and baseplate should be completely filled with grout. Wedges may be left in place. Adjust the metal shims or wedges until the top flange of the discharge head is level. Tighten the foundation bolts snugly, but not too firmly, and recheck the alignment before grouting. Utilize a level graduated in thousandths of an inch. The pump must be level to within 0.001 inch per foot of width.

4. After grout has hardened (usually about 48-hours), thoroughly tighten foundation bolts.

5. Approximately 14 days after the grout has been poured or when it is thoroughly cured and dry, apply an oil base paint to exposed edges of the grout to prevent air and moisture from coming in contact with the grout.

>

PIPING:

Connect pipelines after the grout has thoroughly hardened. The piping should be installed with the shortest and most direct runs. Elbows should be of the long radius type and pipes should line up naturally. Exterior strain must not be transmitted to the pump. The most common cause of trouble in this respect is forcing the piping to mate with the pump. This is especially critical on pumps with an

underground discharge where the discharge may be several feet below the supporting structure and a relatively small strain can cause misalignment.

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

> INSTALLING THE PUMP:

If the pump is shipped assembled, proceed to the next step. If the pump is shipped unassembled, see **Pump Assembly Section** for assembly instruction.

1. Position lifting equipment so it will center over the foundation opening.

NOTE: Sump and piping should be thoroughly cleaned of all loose debris before starting installation.

2. If a soleplate is used, level the mounting surface and grout and anchor in place. (see grouting in previous section).

3. Clean pump discharge flange.

NOTE: All machined surfaces are coated with rust preventative prior to shipment, this must be completely removed along with any paint over-spray or rust, which might be on the machined faces. The faces should be scraped and wire brushed first and then fine emery cloth used to remove any stubborn spots. Use a fine file to remove any nicks or burrs.

NOTE: All threads should be checked for damage and repaired if necessary. If filing is necessary, remove the part from the pump if possible, or arrange a rag to catch all filings so they do not fall into other parts of the pump. Clean all threads with wire brush and cleaning solvent. Ends of shafts must be cleaned and any burrs removed since alignment depends on the shaft ends butting squarely. Lubricate all screwed connections with a thread lubricant – an anti-galling compound such as "Never-Seez" should be used on stainless and monel mating threads.

CAUTION!! Apply thread lubricant sparingly to male shaft threads only when making up shaft connections – excess lubricant should not be allowed to get between the ends of the shaft.

4. Lift the pump and lower slowly into the sump, using the lifting lugs on the discharge head. Hand guide the pump as it is lowered and watch for any obstructions or binding of the pump, which can be felt through the hands. Stop lowering the unit when it is still a few inches off the foundation.

NOTE: Be particularly careful not to damage any piping, which may extend down along the column and/or bowl assembly. This piping (when

used) must remain open- should it be damaged it should be removed and replaced.

5. Rotate pump until discharge flange faces proper direction for alignment with piping and align anchor bolt holes.

6. Slowly lower pump onto the foundation.

7. Install anchor bolts or nuts, but do not tighten.

8. Pipe from discharge shifting the pump slightly on the foundation if required to facilitate alignment.

CAUTION!! Exterior stresses should not be transferred to the pump- all piping must be carefully aligned and supported to prevent this.

9. Tighten discharge flange bolting – be sure the flanges mate without forcing.

10. Tighten anchor bolting.

> **PUMP ALIGNMENT**

Note: Maximum run out measured by the dial indicator = 0.002 inches TIR maximum angular differential = .001 inches TIR per foot.

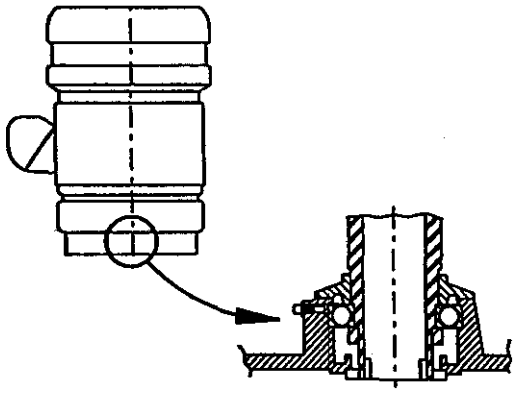
> **INSTALLING HOLLOW SHAFT DRIVER:**

1. Clean driver mounting flange on discharge head and check for burrs and nicks on the register and mounting face. Oil lightly.

2. Remove driver clutch.

3. Lift driver and clean mounting flange, checking for burrs and nicks.

4. Some electric motors will be supplied with a "lower guide bushing", which is installed at the bottom of the motor to stabilize the shaft. Some motor manufacturers mount this guide bushing before shipping while others will ship the guide bushing with instructions for field mounting. Check the packing slip to see if a guide bushing is required, if so, determine if the bushing is already mounted or not and proceed accordingly. **See Figure 4-B.**



GUIDE BUSHING LOCATED AT BOTTOM OF MOTOR INSIDE HOLLOW SHAFT

Figure 4-B
Motor Guide Bushing Location

5. Raise and center driver over the pump.

6. Lower carefully until about 1/4 inch above mounting flange. Rotate driver until junction box on motor or input shaft on gear drive is in correct position. Align bolt holes and insert bolts.

7. Lower carefully into place making certain that the female register on the driver mates over the male register on the pump.

8. Tighten mounting bolts.

9. Check driver manufacturer's manual for special requirements including lubrication instructions and follow all "startup" directions.

10. Electric drivers should be checked for rotation at this time. Make electrical connections and jog motor momentarily to check rotation. **DRIVER MUST ROTATE COUNTER-CLOCKWISE** when looking down at top end of the motor. To change the direction of rotation on a three-phase motor, interchange any two line leads.

CAUTION!! Reverse rotation with the pump connected can cause extensive damage to the pump- **ALWAYS** check rotation before connecting driver to the pump.

11. The mechanical seal should be installed at this time, if the pump is so equipped and the mechanical seal was shipped, not installed- see Section Mechanical Seal for further details.

NOTE: On units equipped with one-piece head shaft (no lineshaft coupling between driver and pump), Steps 12, 13, and 14 will not be applicable.

12. Clean all shaft threads (both ends of head shaft and on top shaft). Try the lineshaft coupling and headshaft nut on their respective threads. These should thread on by hand, if not, clean up threads with fine three cornered file. Check ends of shaft where they will butt inside lineshaft coupling, ends must be square and clean.

13. Lubricate top shaft threads and thread (left-handed threads) lineshaft coupling half way onto top shaft.

CAUTION!! Apply thread lubricant only to male shaft threads and sparingly to avoid buildup between ends of shaft, which could cause misalignment.

14. Lubricate headshafl threads and lower headshaft carefully down through driver and thread into lineshaft coupling. Shafts must butt against each other.

NOTE: Head shaft should stand centered (long shafts may lean slightly from own weight; however, they can be centered without effort) in the driver hollow shaft – if not check driver mounting flange for improper mounting and re- clean ends of shaft where coupled inside discharge head.

15. Install clutch on driver being careful that it fits down properly. See **Figure 4-C.**

16. Install gib key in clutch and shaft. This should be a slip fit.

17. Thread adjusting nut down (left-handed threads) on shaft until it bears against the clutch.

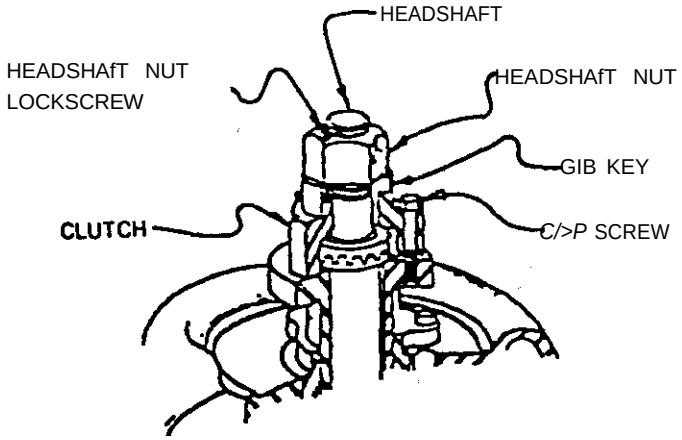


Figure 4-C
Hollow Shaft Driver Clutch

18. See **Impeller Adjustment- General Section** for impeller adjustment.

19. Adjust mechanical seal **AFTER** adjusting impellers.

> **INSTALLING SOLID SHAFT DRIVER:**

1. Clean driver mounting flange on discharge end and check for burrs or nicks on the register and mounting face. Oil lightly.

2. Clean headshaft threads, lubricate and try adjusting nut. The adjusting nut should run down on threads by hand.

3. Lift driver and clean the mounting flange, checking for burrs and nicks.

4. Install driver half-coupling on driver shaft. See **Figure 4-D.**

   - Place straight key into keyway, be sure the key is up far enough to clear the groove cut around the shaft near the end.
   - Slide driver half-coupling onto shaft far enough to insert the circular thrust ring into the shaft groove.
   - Install circular thrust ring in shaft groove – when properly positioned the half-coupling will slip down over the circular key and hold it in position. See **Figure 4-D.**

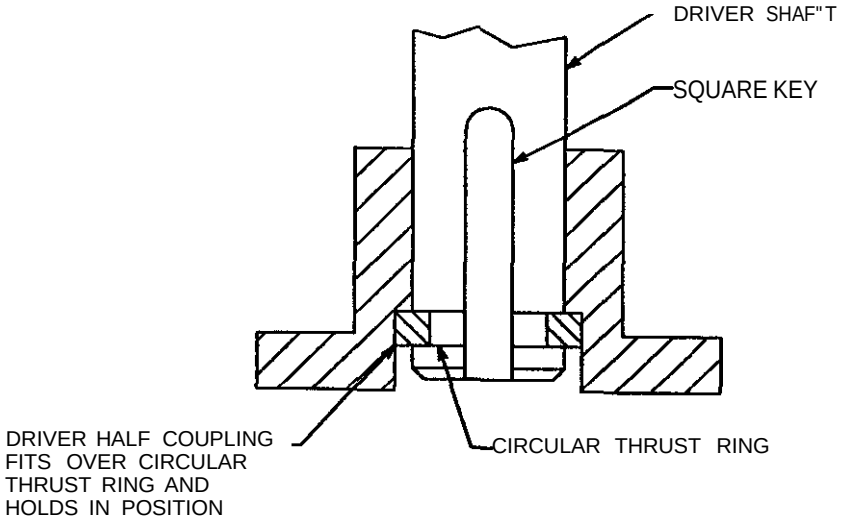


Figure 4-D
Driver Half-Coupling Correctly Positioned

5. The mechanical seal should be installed at this time if the pump is so equipped and the mechanical seal was shipped, not installed. See **Mechanical Seal Section** for further details.

6. Install pump half-coupling on headshaft:

   - Slide pump half-coupling onto shaft.
   - Install key and push down to clear threads.
   - Thread adjusting nut (left-handed threads) onto shaft until the end of the shaft is even with the top of the adjusting nut.

7. Center the motor over the pump and rotate to align the mounting holes.

   Electric motors – rotate junction box into desired position
   Gear drives – rotate input shaft into desired position

NOTE: Some gear drive units are supplied with an adapter plate where the gear BD does not match the head BD. This plate should be installed to the head prior to installing the gear.

8. Lower driver carefully into place making certain that the female register on the driver mates over the male register on the pump.

9. Bolt driver to discharge head.

10. Check driver manufacturer's instructions for special instructions including lubrication instructions and follow all "startup" instructions.

11. Electric drivers should be checked for rotation at this time. Make electrical connections and jog motor momentarily to check rotation. **DRIVER MUST ROTATE COUNTER-CLOCKWISE** when looking down at the top end of the motor. To change the direction of rotation on a three-phase motor, interchange any two line leads.

CAUTION!! Before jogging the motor make sure the coupling halves are not touching and that the driver can rotate freely without rotating the pump. The driver half-coupling must be in proper position as shown in **Figure 4-D** so that circular thrust ring will not come out.

CAUTION!! Reverse rotation with the pump connected can cause extensive damage to the pump- **ALWAYS** check rotation before connecting the driver to the pump.

12. On pumps using the spacer type coupling, bolt the spacer to the driver half-coupling.

13. Thread adjusting nut up until there is 3/16-inch gap between nut, the spacer or driver half-coupling.

14. See **Impeller Adjustment- General Section** for impeller adjustment.

NOTE: Adjust mechanical seal **AFTER** adjusting impellers.

> **IMPELLER ADJUSTMENT- GENERAL:**

Proper impeller adjustment positions the impeller inside the bowl assembly for maximum performance. The impeller must be raised slightly to prevent dragging on the bowl. Enclosed impellers should be raised 2 to 2 1/2 turns of the adjusting nut or approximately 1/4 inch.

CAUTION!! The impeller must be down against the bowl seat when starting impeller adjustment –**all** dimensions and instructions given above assume the impeller is initially all the way down. When the pumps are subjected to suction pressure the pressure acting against the shaft tends to raise it. If the suction pressure is great enough it can raise the shaft. Make sure the shaft is down when starting to adjust the impellers.

If after making the above adjustment, the pump does not deliver its rated capacity, the impellers can be lowered 1/4 to 1/2 tum at a time until the lowest possible adjustment is achieved without the impellers dragging. On the other hand, if the impellers appear to be dragging after the initial adjustment, the unit should be stopped and the impellers raised 1/4 to 1/2 tum. Dragging impellers will increase the load markedly and can usually be heard and felt as increased vibration.

)> **IMPELLER ADJUSTMENT- HOLLOW SHAFT DRIVER:**

Impeller adjustment when using hollow shaft drivers is accomplished at the top of the driver by the following procedure. The driver canopy will have to be removed before beginning.

1. Install headshaft as outlined in **Installing Hollow Shaft Driver Section,** if not already in place.

2. Install driver clutch in accordance with driver instruction manual and bolt into place.

3. Install gib key, making sure top of gib key pushes down below top of clutch.

4. Check shaft position – raise shaft slightly by hand and lower until there is a definite feel of metal contacting metal. This indicates the impellers are "on bottom" and is the correct starting position for impeller adjustment.

5. Thread headshaft nut down (left-handed threads) until the impeller is just lifted off the seat and the shaft will rotate freely.

6. Adjust impellers as outlined in **Impeller Adjustment- General.**

7. Lock headshaft nut with lock screws inserted down through holes in headshaft nut and threaded into driver clutch.

CAUTION!! Always lock the headshaft nut before starting the driver. Failure to do so could result in damage to the pump and driver.

)> IMPELLER ADJUSTMENT- SOLID SHAFT DRIVER:

Impeller adjustment when using solid shaft drivers is accomplished in the adjustable flanged coupling located below the driver.

1. Assemble coupling on the pump and driver as outlined in **Installing Solid Shaft Driver.**

2. Back adjusting nut up shaft (left-handed threads) until the nut bears firmly against spacer or driver shaft and headshaft will not move down. This will insure that the impellers are all the way down against their seat and in proper position for adjustment.

3. Thread adjusting nut down until the proper impeller adjustment as outlined in the **Impeller Adjustment – General Section** can be measured between the adjusting nut and spacer or driver half-coupling as shown in **Figure 4-E.**

4. Slide the pump half-coupling up the shaft and align adjusting nut bolt holes with those in pump half-coupling. Rotate driver shaft until bolts can be inserted and tightened.

5. Tighten all bolts, which will raise impellers to correct operating position.

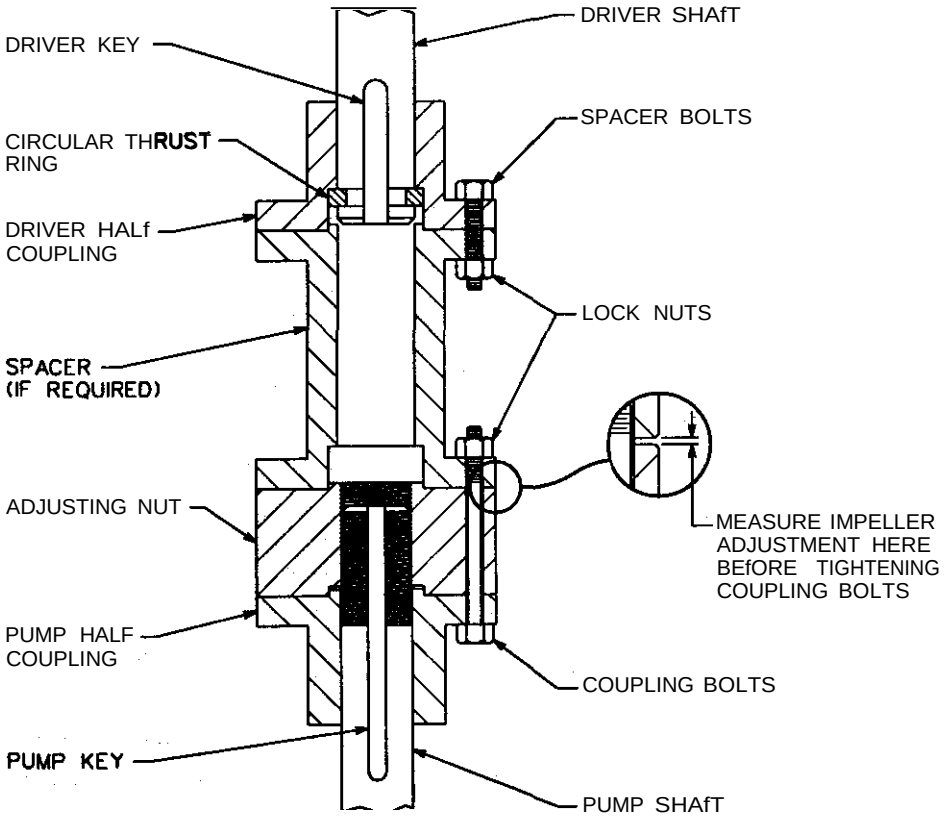


Figure 4-E
Adjustable Flanged Coupling (shown with spacer)

> **MECHANICAL SEAL:**

Because of the numerous mechanical seal arrangements available, separate instruction manuals are written to cover installation and operation of the seal. There are, however, comments, which apply to all seals.

1. The seal cavity must be clean before installing the seal.
2. The faces and register of the seal housing and seal housing cover must be clean and free of burrs.
3. The shaft seal is a precision product. Treat it with care. Take particular care not to scratch or chip the lapped faces of the runner or seat.
4. Circulation lines must remain in place and open. Do not remove.
5. Impeller adjustment must be made **PRIOR** to seal adjustment.

Read the Mechanical Seal Instruction Manual furnished with this unit.

PACKING BOXES:

Packing boxes are pre-packed at the factory and will be factory installed. Do not tighten the packing gland. See **Pre-Starting Check Section.**

ENCLOSING TUBE TENSION:

The enclosing tube (enclosed lineshaft design) tension is pre-adjusted at the factory before shipping. Additional adjustment will not be required. If assembly or adjustment is required for any reason, see **Assembly and Outline of Job Unit in Section 1.**

SECTION 5
OPERATION

PRE-STARTING CHECKS:
Before starting the pump the following checks should be made:

- ☐ Rotate the pump shaft by hand to make sure the pump is free and the impeller is correctly positioned.
- ☐ Make sure the shaft-adjusting nut is property locked into position.
- ☐ Be sure the driver has been properly lubricated in accordance with the instructions furnished with the driver.
- ☐ Check the driver rotation. Remember the pump must be disconnected from the driver before checking. The driver must rotate **COUNTER-CLOCKWISE** when looking down at the top of the driver.
- ☐ Check all connections to the driver and control equipment.
- ☐ Check that all piping connections are tight.
- ☐ Check all anchor bolts for tightness.
- ☐ Check all bolting and tubing connections for tightness (driver mounting bolts, flanged coupling bolts, seal housing cover bolts, seal piping, etc.).
- ☐ On pumps equipped with packing box make sure the gland nuts are only finger tight- **DO NOT** tighten packing gland before starting.
- ☐ On pumps equipped with mechanical seals clean fluid should be put into the seal chamber. The seal chamber should be flushed liberally with clean fluid to provide initial lubrication. Make sure the mechanical seal is properly adjusted and locked into place.

NOTE: After initial startup, pre-lubrication of the mechanical seal will usually not be required, as enough liquid will remain in the seal chamber for subsequent startup lubrication.

» **INITIAL STARTUP:**

1. If the discharge line has a valve in it, it should be partially open for initial starting.

2. Start lubrication liquid flow on enclosed lineshaft units.

3. Start the pump and observe the operation. If there is any excess noise or vibration, or if the pump seems sluggish, or will not run, disconnect the pump immediately and refer to **Section 6** for probable cause.

4. If the pump starts satisfactorily, open the discharge valve as desired.

5. Check complete pump and driver for leaks, loose connections or improper operation.

6. If possible, the pump should be left running for approximately 1/2 hour on the initial startup. This will allow the bearings, packing or seals, and other parts to "run-in" and reduce the possibility of trouble on future starts.

NOTE: If abrasives or debris are present upon startup, the pump should be allowed to run until the pumpage is clean. Stopping the pump when handling large amounts of abrasives (as sometimes present on initial starting) may lock the pump and cause more damage than if the pump is allowed to continue operating.

CAUTION!!! Every effort should be made to keep abrasives out of lines, sump, etc. so that they will not enter the pump.

» **PACKING BOX ADJUSTMENT:**

On the initial starting it is very important that the packing not be tightened too much. New packing must be "run-in" properly to prevent damage to the shaft and shortening of the packing life. See **Startup With New Packing Section** for further information.

The packing box must be allowed to leak for proper operation. The proper amount of leakage can be determined by checking the temperature of the leakage, this should be cool or just lukewarm **– NOT HOT –** usually 40 to 60 drops per minute will be adequate. When adjusting the packing gland, bring both nuts down evenly and in small steps until the leakage is reduced as required. The nuts should only be tightened about 1/2 tum at a time at 20 to 30 minute intervals to allow the packing to "run-in".

When adjusted properly, a set of packing will provide good service. Occasionally a new ring of packing may need to be added to keep the box full. After adding two or three rings of packing, or when proper adjustment cannot be achieved, the packing box should be cleaned completely of all old packing and re-packed.

J> LINESHAFT LUBRICATION:

Open lineshaft bearings are lubricated by the pumped fluid and on close coupled units (less than 30 feet long) will usually not require pre or post lubrication.

Enclosed lineshaft bearings are usually lubricated by oil or clean water, which is fed to the tensioner by either a gravity flow or pressure injection system. The gravity flow system utilizing oil is the most common arrangement. The oil reservoir must be kept filled with a good quality light turbine oil (about 150 SSU at operating temperature) and adjusted to fee 5-8 drops per minute.

Injection systems are designed for each installation – injection pressure and quantity of lubricating liquid will vary. Refer to packing slip or separate instruction sheet for requirements when unit is designed for injection lubrication.

The following oil can be recommended for Enclosed Lineshaft Bearing Lubrication under normal operating conditions.	
MANUFACTURER	**TRADE NAME OF OIL**
Continental Oil Company	Conoco Turbine Oil, light
ESSO Standard Oil Company	Teresso 43
Mobil Oil Company	Mobil DTE 797
Magnolia Petroleum Corporation	Mobil DTE 797
Shell Oil Company	Tellus 27
Standard Oil Company of California	Chevron OC Turbine 9
Socony-Mobil Oil Company, Inc.	Mobil DTE 797
Sun Oil Company	Sunvis 916
Texaco, Inc.	Texaco Regal A
Tide Water Oil Company	Tycol Aturbrio 50
Union Oil Company of California	Redline Turbine Oi1150
If none of the above oils are available, an oil with the following specifications should be obtained: Turbine type oil with rust and oxidation inhibitors added. Viscosity 145-175 SSU at 100 degrees F with a 90 minimum viscosity index. It is recommended that detergent type oils not be used.	

Figure 5-A Recommended Lineshaft Oil

» **SHUTDOWN:**

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

1. Close discharge valve.
2. Stop driver.
3. Tum off lubrication on enclosed pumps.

» **MINIMUM FLOW LIMITATION:**

All centrifugal pumps have limitations on the minimum flow at which they should be operated. The most common limitation is to avoid excessive temperature buildup in the pump because of absorption of the input power into the pumped fluid. Other less understood reasons for restrictions are:

1. Increased NPSHR at low flows.
2. Noisy, rough operation and possible physical damage due to internal re-circulation. (the noise may be under water and not audible).
3. Increased pulsation levels.

The size of the pump, the energy absorbed, and the liquid pumped are among the considerations in determining these minimum flow limitations. For example, some small pumps have no limitations, except for temperature build up considerations while many large, high horsepower pumps have limitations as high as 40-50% of the best efficiency point capacity. Safe flow for this pump is given under Pump Specifications.

SECTION 6
MAINTENANCE

> GENERAL:

A daily inspection is recommended as the best means of preventing breakdown and keeping maintenance costs to a minimum. Maintenance personnel should look over the whole installation with a critical eye each time the pump is inspected - a change in noise level, amplitude of vibration, or performance can be an indication of impending trouble.

Any deviation in performance or operation from what is expected can be traced to some specific cause. Determination of the cause of any misperformance or improper operation is essential to the correction of the trouble – whether the correction is done by the user, the dealer or the factory.

Variances from initial performance will indicate changing system conditions, wear, or impending breakdown on the unit.

> PERIODIC INSPECTION:

A periodic (once a month) detailed inspection is suggested for all units. During this inspection. The pump and driver should be checked for performance and change in noise or vibration level, loose bolts or piping, dirt and corrosion. Clean and repaint all areas that are rusted or corroded.

> PACKING BOX MAINTENANCE:

Maintenance of the packing box will consist of greasing the box when required, tightening the packing gland occasionally as the leakage becomes excessive, and installing new packing rings or sets as required.

> GREASING THE PACKING BOX:

Under ordinary operation once a month greasing of the packing box will be adequate. A good grade of grease such as Standard of California #TB-medium or Texaco Multifax #2-medium should be used.

> REPLACING PACKING:

Remove gland and all old packing. If the box contains a lantern ring remove this and all packing below it. Inspect shaft or sleeve for score marks or rough spots. Be sure bypass holes (if required) are not plugged. Repair or replace badly worn shaft or sleeve. If wear is minor, dress down until smooth and concentric. Clean the box bore.

Oil inside and outside of replacement rings lightly and install,in box, staggering joints 90 degrees. Be sure to replace lantern ring in proper position when used.

NOTE: Formed replacement packing rings are recommended and are available from the factory.

Replace gland and tighten nuts, making sure gland enters box squarely. Keep the packing under moderate pressure for one minute to allow it to cold flow and adjust itself. Back off on the gland until loose before starting the pump.

STANDARD TYPE				
SHAFT OR SLEEVE SIZE	NUMBER OF PACKING RINGS	PACKING RING SIZE	DEPTH OF BOX	O.D.OF PACKING
1 1/2	3	3/8	1 3/8	21/4
1 11/16	3	3/8	1 3/8	2 7/16
1 15/16	3	3/8	1 3/8	2 11/16
2 3/16	3	3/8	1 3/8	2 15/16
2 7116	3	3/8	1 3/8	3%

HI-PRESURE TYPE				
SHAFT OR SLEEVE SIZE	NUMBER OF PACKING RINGS	PACKING RING SIZE	DEPTH OF BOX	O.D.OF PACKING
1 1/2	4	3/8	2 1/8	2 1/4
1 11/16	4	3/8	21/8	2 7/16
1 15/16	4	3/8	2 1/8	2 11/16
2 3/16	4	3/8	2 1/8	2 15/16
2 7/16	4	3/8	2%	3%

All hi-pressure boxes will have three packing rings located above lantern ring. Recommended Packing: Graphite Impregnated

Braided Fiber similar to John Crane C1065

Figure 6-A
STANDARD PACKING DIMENSIONS

Replace gland and tighten nuts, making sure gland enters box squarely. Keep the packing under moderate pressure for one minute to allow it to cold flow and adjust itself. Back off on the gland until loose before starting the pump.

,. **STARTUP WITH NEW PACKING:**

Check that the bypass line {if used) is connected and packing gland is loose. Start pump and allow to run for 20 to 30 minutes, do not tighten the gland during this "run-in" period even if leakage is excessive. If the leakage continues to be more than normal, adjust as outlined in **Packing Box Adjustment Section.** Should the new packing cause excess heating during "run-in" flush the shaft and packing box area with cold water or shut the pump down and allow to cool if necessary.

,. **AUXILIARY PACKING BOX MAINTENANCE:**

Pumps equipped with mechanical seals may also be provided with an auxiliary packing box to restrict leakage should the mechanical seal fail. This packing gland must be left loose since under normal operation the packing will not be cooled and lubricated. This packing box arrangement is designed to help contain leakage past the mechanical seal; it is not designed as a primary seal and should not be used as such.

,. **MECHANICAL SEAL MAINTENANCE:**

Mechanical seals should not be readjusted. Best results will be obtained if the seal is properly set at startup and left that way. If the seal starts to leak after an extended operating period some extra service may be obtained by readjusting, however, it is usually best to plan on replacing the seal at the next maintenance period.

After impeller readjustment, seal leakage may occur due to improper seal adjustment or improper seating of the seal parts. If readjustment of the seal will not correct the problem, refer to the **Mechanical Seal Instruction Manual** for further information.

,. **IMPELLER READJUSTMENT:**

Ordinarily the impeller will not require frequent readjustment if properly set at initial installation. Almost no change in performance can be obtained by minor adjustment of enclosed impellers.

NOTE: All adjustments of the impeller will change the mechanical seal setting. Unless the adjustment is to be very minor, it is recommended that the seal be loosened from the shaft until the adjustment is complete and then reset.

I> **PUMP LUBRICATION:**

Other than the packing box lubrication outlined in the **Greasing The Packing Box Section** and lineshaft lubrication outlined in **Lineshaft Lubrication Section,** the pump will not require further periodic lubrication. The suction bearing on the bowl assembly should be repacked when repairs are made, however, no attempt should be made to repack until repairs to the bowl assembly are necessary.

,. **DRIVER LUBRICATION:**

Drivers will require periodic attention. Refer to the **Driver Instruction Manual** for recommendations.

TROUBLESHOOTING: Fiaure 6-B

CONDITION	PROBABLE CAUSE	REMEDY
Pump will not run	1. Motor overload protection contacts open: - incorrect control box - incorrect connections - faulty overloads - low voltage - ambient temperature of control box or starter too high 2. Blown fuse, broken or loose electric connection. 3. Defective motor. 4. Faulty control equipment. 5. Faulty switch. 6. Pump binding.	1. Check the following: - check nameplate for HP and voltage - check wiring diagram furnished with starter - replace - check voltage at pump side of control box - use ambient compensated relays 2. Check fuses, relays or heater elements for correct size and all electrical connections. 3. Repair or replace. 4. Check all circuits and repair. 5. Repair or replace. 6. Pull master switch, rotate pump by hand to check. 7. Check impeller adjustment or disassemble unit to determine cause.
Pump runs, but no water delivered	1. Line check valve backward. 2. Line check valve stuck. 3. Unit running backwards. 4. Lift too high for pump. 5. Pump not submerged. 6. Excessive amounts of air or gas. 7. Impeller plugged, or pump in mud or sand. 8. Impeller loose on shaft.	1. Reverse check valve. 2. Free the valve. 3. See Sections Installing Hollow Shaft Driver and Installing Solid Shaft Driver. 4. Check with performance curve. 5. Lower pump if possible or add fluid to system. 6. Correct conditions. 7. Start and stop pump several times or use line pressure if available to back flush. Pull pump and clean. 8. Pull unit and repair.
Reduced capacity	1. Bypass open. 2. Lift too high for pump. 3. Motor not coming up to speed. 4. Impeller partly plugged. 5. Scaled or corroded discharge pipe or leaks anywhere in system. 6. Excessive amounts of air or gas. 7. Excess wear due to abrasives. 8. Impeller not properly adjusted. g. Impeller loose on shaft. 10.Wrong rotation.	1. Check bypass valving. 2. Check performance curve. 3. Check voltage while unit is running. 4. Start and stop pump several times or use line pressure if available to back flush. Pull pump and clean. 5. Replace pipe or repair leaks. 6. Correct conditions. 7. Replace worn parts. 8. See Section Installing Solid Shaft Driver. 9. Pull unit and repair 10. Correct. See Sections Installing Hollow Shaft and Installing Solid Shaft Driver.

TROUBLESHOOT ING -continued.....

Motor overloaded	1. Line voltage not correct. 2. Faulty equipment used to check. 3. Specific gravity higher than design. 4. Operation at point on pump curve other than design. 5. Motor speed too high. 6. Impeller dragging. 7. Pump in bind.	1. Check and correct. 2. Check equipment. 3. Correct specific gravity or reevaluate system. 4. Check performance curve. 5. Line voltage too high or incorrect frequency. 6. Readjust. 7. Pull master switch, rotate pump by hand to check. 8. Disassemble unit to determine cause.
Pump vibration excessive and noisy	1. Unit running backwards. 2. Pump breaking suction and pumping air. 3. Loose fasteners. 4. Badly worn motor or pump bearings. 5. Impeller loose on shaft. 6. Pump and motor shafts misaligned 7. Stress due to piping misalignment.	1. See Sections Initial Starting of Unit, Installing Hollow Shaft Driver, and Installing Solid Shaft Driver. 2. Lower pump or reduce capacity. 3. Check all bolts, nuts, etc. 4. Pull unit and repair. 5. Pull unit and repair. 6. ull unit and repair. 7
Excess wear	1. Abrasives. 2. Pump in bind. 3. Vibration.	1. Change to harder materials. 2. Pull master switch, rotate pump by hand to check. 3. Disassemble unit to determine cause.
Corrosion	1. Impurities. 2. Corrosive liquid.	1. Analyze fluid. 2. Change to corrosion resistant materials.
Pumped liquid in enclosing tube	1. Insufficient pressure and flow lubricating system. 2. Worn bowl bearings. 3. Defective enclosing tube or connector bearing thread.	1. Adjust pressure/flow. Check for blockage. 2. Replace bearings. 3. Check and replace if necessary.
Excessive packing box leakage	1. Gland not properly tightened. 2. Ends of packing not staggered. 3. Worn packing or sleeve.	1. Adjust as necessary. 2. Replace per Section Replacing Packing. 3. Renl,.ce worn n"rts.
Overheating	1. Bearings. - shaft bent - rotating element binds - pipe strain - insufficient bearing lubrication - incorrect type grease or oil - flushing water not circulating through enclosing tube 2. Packing Box - packing gland too tight. - Water flush line plugged.	1. Bearings. - remove and straighten or replace - check for bent shaft - correct - increase lubrication - correct - check for blockage or insufficient pressure 2. Packing Box - loosen gland until temp drop adjust per Section Packing Box Adjustment - correct

SECTION 7
REPAIRS

» GENERAL:

It must be borne in mind that eventually repairs will have to be made, either to the pump or to the motor. When regular maintenance checks indicate unusual vibration levels or a drop in performance, an overhaul is probably imminent.

Repairs will consist of removal of the unit and disassembly to the point necessary for replacement of worn parts.

Disassembly should be performed in a clean area with sufficient space to lay out the parts in order of disassembly. Cleanliness throughout repairs is important – remember this is a close tolerance, high-speed machine and should be handled as such.

CAUTION!! Protect machined surfaces from burrs and scrapes, which will cause misalignment on re-assembly.

» EQUIPMENT AND TOOLS:

Required equipment and tools will be as listed in Section 3 and Section 4 of this manual.

CAUTION!! Always pull and lock the driver master switch before doing any work on the pump or driver.

» PACKING BOX REPAIRS:

Packing box repairs can be done without removing the complete unit. Packing replacement is outlined in **Section 4** can be accomplished without disturbing the pump or driver. The packing box bearing can be replaced if necessary by removing the driver and sliding the packing box off over the shaft.

» MECHANICAL SEAL REPAIRS:

Mechanical seal repairs can be effected without removing the complete unit. The mechanical seal assembly can be replaced by removing the spacer and lower half coupling on solid shaft units, or on hollow shaft units the driver shaft and shaft coupling inside the discharge head must be removed or lifted out of the way.

> **DISASSEMBLY:**

NOTE: Refer to Section 8 for parts drawings and identification.

1. Disconnect electrical leads from motor.

2. Loosen mechanical seal from shaft.

3. Disconnect pump shaft from driver.

   Hollow shaft – remove shaft nut lockscrew, adjusting nut gib key, and driver clutch. Unscrew headshaft (1OA) from the shaft coupling (70) inside discharge head and remove.
   Solid shaft- lower shaft and unbolt driver half coupling.

4. Remove bolts which attach driver to discharge head.

5. Lift driver off pump and set on wooden supports. With solid shaft drivers be sure supports are high enough to clear shaft and coupling half.

6. Disconnect discharge piping from pump.

7. Remove anchor bolts (or nuts).

8. Lift pump vertically until the pump suction clears the foundation.

9. Cover opening in foundation.

10. Lower pump and position horizontally on suitable support and in suitable area for disassembly. Be sure and support the bowl assembly when lowering, so that weight is not carried by the suction bell.

NOTE: If more than minor repairs are anticipated it is recommended that the unit be taken to a shop or other clear area with a smooth floor and overhead lifting equipment.

11. Remove gland (17).

NOTE: With sleeve mounted mechanical seals the seal and sleeve assembly should be removed with the cover. See **Seal Instruction Manual** for further details.

12. Remove capscrews, which attach the packing box or seal housing to discharge head.

13. Enclosed lineshaft construction – remove tensioner bolts and lubrication line and unscrew tensioner assembly. Threads are right-handed. See Figure 7-E.

14. Remove packing box tensioner or seal housing.

NOTE: Before proceeding further make sure the discharge head and bowl assembly are supported independently of each other.

15. Disconnect bowl assembly or top column from discharge head. This connection may be flanged or the column pipe or bowl assembly may be threaded into the discharge head. If threaded, the threads will be right-handed.

16. Remove discharge head (1) being careful not to damage shaft.

17. Disconnect top column pipe (101A), if present, at first joint below top and remove from shaft.

18. Open lineshaft construction – each time a lineshaft coupling (70) is exposed by removing a length of column pipe the lineshaft (12) and coupling should be removed by holding the coupling and turning the upper lineshaft in right-hand direction (lineshaft threads are left-handed).

CAUTION!! When using wrenches on shafting always place the wrenches on the same side of the shaft as illustrated in Figure 7-A to avoid excess side strain on the shafting.

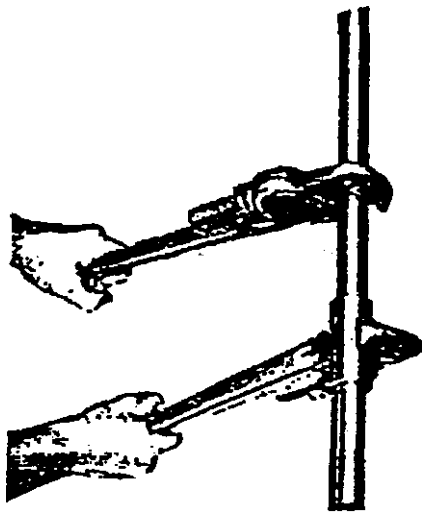


Figure 7-A
Correct Positioning of Wrenches on Shafting

19. Enclosed lineshaft construction – each time a length of column pipe is removed the enclosing tube (85) and lineshaft (12) must also be disassembled. Locate the joint (see Figure 7-B) and unscrew, right-handed threads, the enclosing tube (85) from the lineshaft bearing (103) which acts as a bearing for the shaft and also as an enclosing tube coupling. Leave the lineshaft bearing threaded into the enclosing tube not being removed to support the lineshaft. Slide the enclosing tube up to expose the lineshaft coupling and uncouple as outlined in Step 18 above.

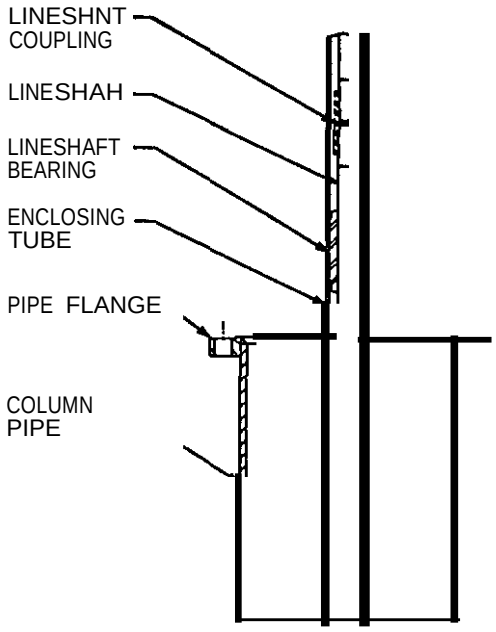


Figure 7-B
Standard Enclosing Tube and Lineshaft Projection

20. Disconnect each section of column pipe one at a time and remove along with shaft and enclosing tube as applicable until all are removed.

21. Remove bowl assembly to clear area and continue disassembly as outlined in the Bowl Disassembly, Inspection, Repair, and Reassembly Section.

> **INSPECTION AND CLEANING:**

After disassembly, all components should be thoroughly cleaned and examined for physical defects, wear, corrosion and damage.

Check all bearings for total clearance over the shaft diameter. It is recommended that all bearings indicating wear be replaced. The following indicates the maximum allowable diametrical clearance over existing shaft diameter:

SHAFT SIZE	MAXIMUM CLEARANCE
1"to 1-3/4"	.020"
1-15/16" to 2-7/16"	.025"
2-11/16" to 3-15/16"	.030"

Figure 7-C
Wear Ring Clearance

All bearings are pressed into their respective bores and can be either pressed out or machined on the inside diameter until the wall is thin enough to collapse. Rubber bearings are removed by collapsing the bearing and removing, or by trimming off one end and sliding the bearing out.

REPLACEMENT PARTS:

Parts showing signs of damage, cracks or excessive wear should be replaced. Use only genuine Patterson Pump parts for replacements. Order replacement parts as indicated in Section 8.

CAUTION!! When repairing a pump that has been in service for several years, the physical condition or strength of all parts such as capscrews, bowls, threads, etc., must be carefully checked to be sure these parts can continue to perform their function without failure.

LUBRICATION:

Repack suction bearing as outlined in the Bowl Disassembly, Inspection, Repair, and Reassembly Section.

Lubricate all metal bearings and impeller skirts with clean grease or oil. Thoroughly clean all threaded connections and flanges and paint with pipe joint compound.

> **ASSEMBLY:**

Assembly of the unit is basically the reverse of disassembly. Before proceeding with assembly, clean thoroughly and check all threads, registers and mating faces for burr. Clean up with file where required. Lubricate as outlined above. Open lineshaft bearings can be lubricated with a soap solution. Do not use oil on rubber bearings.

Proceed with assembly in reverse order of disassembly as outlined in the Disassembly Section above. Figure 7-D indicates recommended torque values for standard fasteners.

FASTENER SIZE	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4
TORQUE (FT-LB)	5.4	10	17	27	40	60	84	135

FIGURE 7-D
TORQUE VALUES FOR STANDARD FASTENERS

CAUTION!! Cleanliness and proper lubrication are very important since one small chip, burr or one dry bearing can be cause for redoing the whole job.

> **STUFFING BOX / TENSIONER ASSEMBLY AND ADJUSTMENT:**

Enclosed lineshaft units use a stuffing box / tensioner at the top of the enclosing tube which must be properly tightened for proper operation. General construction is shown in Figure 7-E.

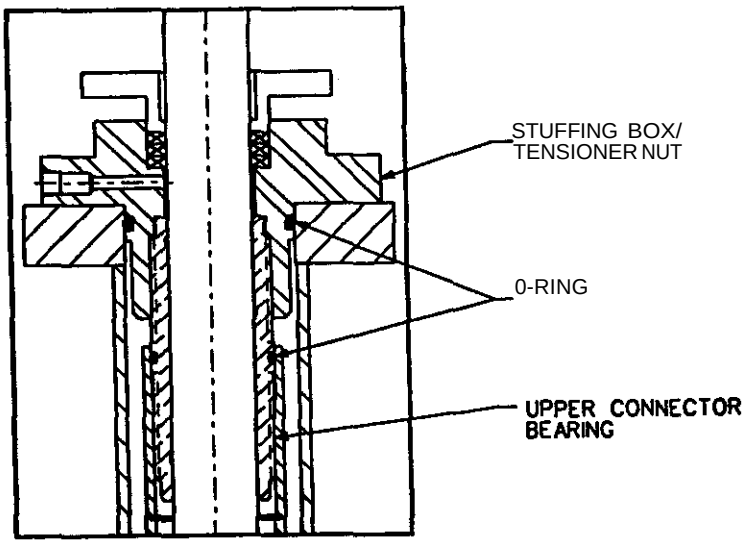


Figure 7-E

1. Clean all o-rings sealing surfaces and oil lightly.

2. Thread upper connector bearing (103A) into packing box (83) by hand until seated firmly.

3. Install a-rings (73A, 73) in connector bearing and lower part of packing box.

4. After assembling discharge head to column, slide stuffing box (83) over the shaft and thread (right hand threads) the connector bearing (103A) into the upper enclosing tube (85A) until it is snug. The upper enclosing tube has the threads recessed in about 1" from the upper end.

5. Tighten packing box / tensioner until the holes in the tensioner line up with the first tapped hole in the discharge head (1/8 to 1/4 turn maximum past contact).

CAUTION!! It is necessary that the enclosing tube have a tension on it which is accomplished by tightening the tensioner, however, excess tightening will distort or break the tensioner. Do no tighten more than 1/4 tum past contact on close coupled pumps.

6. Installlockscrew(s) and tighten.

7. Proceed with remainder of installation.

> BOWL DISASSEMBLY, INSPECTION, REPAIR, AND REASSEMBLY:

Bowl Disassembly:

1. Match mark all flange butts. A punch mark on each flange will help.

2. With the bowl laying on a horizontal surface, remove the rubber bearing protector and unbolt and remove discharge case from top of assembly.

3. Remove the three stainless steel capscrews and two setscrews from the impeller bushing. Reinsert the capscrews into the two threaded holes in the bushing.

4. Tighten down the screws in the bushing being careful not to strip the threads, and gently tap the impeller with a non-metallic hammer to loosen it-from the bushing.

5. Slide the impeller and bushing off the shaft as a unit.

6. Unbolt and remove the top bowl making sure it is numbered and match marked.

7. Repeat Steps 3-6 until the entire bowl assembly is disassembled.

Inspection:

After disassembly, all the components of the bowl assembly should be thoroughly cleaned and examined for physical defects. The following components should be inspected for wear, corrosion and damage.

1. Impeller – check water passageways for signs of damage from abrasion or corrosion, check impeller skirts against "as new" clearance.

2. Shaft – check shaft for pitting and wear. Check for straightness – shaft must be straight within .005 total indicator reading.

3. Bowls – check water passageways for signs of damage from abrasion or corrosion, check impeller seat against "as new" clearance.

4. Bearings – check all bearings for total clearance over the shaft diameter. It is recommended that all bearings indicating wear be replaced. The chart below lists the most common observations, and corrective action required.

TROUBLE CHART

OBSERVATION	PROBABLE CAUSE	CORRECTIVE ACTION REQUIRED
Crooked shaft	Bent in handling	Replace shaft or have it straightened
Misalignment of tubing bearings and adapters	Improperly assembled	Reassemble and check. If still out of alignment, replace the parts.
Wear on shaft at seals	Natural wear, corrosive action	Replace shaft
Uneven wear on bearings	Misalignment on shaft	Replace bearings and straighten or replace shaft
Wear on bearings	Abrasive action	Replace bearings
Lateral seal ring wear	Abrasive action	Replace seal rings
Wear on side seal and impeller skirt	Abrasive action	Apply wear rings to impeller skirt and side seal if damage to bowl and impeller not too great.
Wear on bowl vanes and outside wall	Abrasive action	Replace bowls if wear is excessive
Wear on impeller vanes and shroud	Abrasive action	Replace impellers if wear is excessive

Figure 7-F

Repairs:

Parts showing signs of damage, cracks or excessive wear should be replaced. Use only genuine Patterson Pump parts for replacements. Order replacement parts as indicated in Section 8.

CAUTION!! When repairing a bowl assembly that has been in service for several years, the physical condition or strength of all parts such as capscrews, bowls and bowl threads must be carefully checked.

CAUTION!! When attempting to rework any part extreme care must be taken to maintain alignment of mating parts and "as new" tolerance.

1. Replacing Bearings:

Replacement bearings are furnished "to size" for press frtting into their respective bores with a .001" to .003" interference fit. If the bearing bore is heavily scarred or corroded the part should be replaced or reworked to provide a true bore for the bearing.

2. Replacing Shaft:

Shaft damage is usually best corrected by replacing the shaft. Due to the possibility of interim damage, replacement shafts should always be checked for straightness before installing.

3. Repairing Enclosed Impeller and Bowl Seal Surface:

Enclosed impeller skirt and bowl seal surface wear can be corrected by installing wear rings if the damage is not excessive. This is usually accomplished by turning the impeller skirt to obtain a smooth surface and then boring the bowl and installing wear rings on either, or both, surfaces. If the original unit was furnished with either bowl or impeller I(or both} wear rings, these should be removed completely and replaced.

When wear rings are installed on the impeller it is recommended that a shrink fit be utilized -the interference should be heavy to prevent slippage, 0.010" on the smaller units and up to 0.015" to 0.020" on the larger sizes. Sufficient heat is then applied to the wear ring to expand it and allow the wear ring to drop over the impeller.

When wear rings are installed in bowl a .003" to .005" press fit should be used. The wear ring can be installed by carefully tapping into place. A wooden block should be used to protect the wear ring.

Lubrication:

Repack suction bearing with insoluble grease such as those shown in the table on the next page. Lubricate all bearings and impeller skirts with clean grease or oil. Thoroughly clean all bolts, nuts, threaded connections, and flanges and paint with white lead and oil, or pipe joint compound.

MANUFACTURER	For General Service (may be water resisting) Minus 20 degrees F to plus 250 degrees F	For Maximum Water Resisting Service Minus 20 degrees F to plus 250 degrees F
American Oil Company and Standard Oil Division of American Oil Company	Amolith Grease No. 2	Amolith Grease No. 2
The Atlantic Refining Company	Atlantic Lubricant 54	Atlantic Lubricant 54
Cato Oil and Grease Company	5335 Lith-flex C No. 2	5484 Mystic JT-6
Cities Service Oil Company	Trojan Grease H-2	Trojan Grease H-2
Continental Oil Company	Conoco Super Lube	Conoco Super Lube
*Gulf Oil Corporation	Gulfcrown No. 2 or EP-2	Gulfcrown No. 2 or EP-2
Exxon	Nebula EP-1	Nebula EP-2
*E.F. Houghton & Company	Cosmolube No. 2 Grease	Cosmolube No. 2 Grease
*Imperial Oil 7 Grease	BRB-572	BRB-572
*Jesco Lubricants Company	Jesco 822 Grease	Jesco 822 Grease
Keystone Lubricating Company	Grease Nos. 81XLTor 51XLT	Grease Nos. 81XLTor 51XLT
*Mobile Oil Company	Mobilux EP #2	Mobilux EP #2
*The Pennzoil Company	Pennzoil 705 HOW	Pennzoil 705 HOW
Phillips Petroleum Company	Philube Multi-Purpose L-2	Philube Multi-Purpose L-2
*Quaker State Refining Corporation	Quaker State Multi-Purpose Lubricant	Quaker State Multi-Purpose Lubricant
*Shell Oil Company, Inc.	Shell Alvania Grease 2	Shell Alvania Grease 2
Signal Oil Company	Signal Industrial Grease Med	Signal Industrial Grease Med
Atlantic Richfield	Litholine HEP 2	Litholine HEP 2
*Standard Oil Company of California	Chevron Industrial Grease Med	Chevron Industrial Grease Med
Sunay DX Oil Company	No. 646 DX All Purpose Grease	No. 646 DX All Purpose Grease
Sun Oil Company	Sun 72 XMP Grease or Prestige 42	Sun 72 XMP Grease or Prestige 42
*Texaco, Inc.	995 Multifax EP2	995 Multifax EP2
*Tidewater Oil Company	Veedol All Purpose Grease	Veedol All Purpose Grease
*Union Oil Company of California	Unoba A-1 Grease	Unoba F-1 Grease

- Internationally & Nationally Distributed

Figure 7-G Recommended Grease

> **REASSEMBLY:**

Assembly of the unit is essentially the reverse of disassembly. Before proceeding with assembly, clean thoroughly and check all threads, registers and mating faces for burrs. Cleanup with file where required. Lubricate as outlined in Lubrication paragraph.

CAUTION!! Cleanliness and proper lubrication are very important since one small chip, burr or one dry bearing can be cause for redoing the whole job.

1. Place the bowl shaft on a horizontal surface.

2. Check shaft closely for nicks or burrs- smooth with emery cloth as required.

3. Check shaft for straightness – shaft must be straight within .005" total indicator reading. If the shaft is not straight it must be straightened or replaced. If the deflection is gradual over a considerable length the shaft can usually be straightened by supporting on two blocks straddling the crooked section and applying pressure to the high side to deflect the shaft in the opposite direction. If the shaft has a sharp crook (dog-leg) it is recommended that the shaft be replaced since the shaft will not always remain straight even if satisfactorily straightened.

4. Slide the sand collar onto the shaft 2-3" from bottom end (unthreaded end).

5. Pack the bottom bearing with grease as shown in the table on the previous page and slide the suction bell onto the bottom end of the shaft.

6. Thread the end of the threaded rod or capscrew on the tiedown bolt assembly into the end of the shaft until it bottoms out.

7. Thread the plug portion of the tiedown bolt in the suction bell. Tighten the plug.

8. Rotate the shaft (RH) so as to thread the shaft down tight against the plug.

9. Back the shaft off two full turns.

10. Slide the sand collar down the shaft until it touches the suction bell bearing.

11. Slide the first stage impeller down the shaft until it seats firmly in the suction bell.

12. Slide the bushing down the shaft and insert it into the impeller taking care that the three untapped holes in the bushing line up with the three tapped holes in the impeller. Inserting the capscrews at this time will assure alignment.

13. Drive the bushing tightly into the impeller with the bushing driver supplied with the pump. Install the three capscrews and secure the bushing to the impeller. Reinstall the two setscrews. (Loc-tite on these threads is recommended).

14. Slide the first stage diffuser onto the shaft. taking care not to damage the shaft threads. Position it above the suction bell, aligning the match marks made at disassembly. Bolt into place. It is a good idea to only tighten 3 or 4 bolts at each bowl during assembly, to facilitate disassembly should that become necessary later in the assembly process.

15. Check the shaft for lateral movement as follows:
    With the tiedown bolt removed push the shaft toward the bottom of the pump as far as it will go.
    Scribe a mark on the shaft at the point where it enters the bowl hub.
    Then pull the shaft in the opposite direction as far as it will go.
    The distance from the top of the bowl hub to the scribed mark on the shaft should remain constant during assembly.
    Be sure that the shaft is free to rotate in the bowl.
    Check for free shaft lateral after each bowl is assembled.

16. Before placing the next impeller, pull the impeller(s) already installed down till they bottom out using the tiedown bolt. Do not over tighten, as this can cause the impeller to shift on the shaft.

17. Repeat Steps 11-16 for each consecutive stage.

18. After the last bowl is installed, locate the discharge case and bolt it into place.

19. Remove the tiedown bolt – replenish grease as necessary being careful not to over pack the bearing. The shaft should not raise when the plug is installed.

20. Grasp shaft and rotate by hand to check for binding, also check end play by pulling all the way up and measuring distance traveled. Check this against end play recorded in Step 15.

21. Install the suction bell plug.

22. Screw column adapter in place if required.

23. Screw shaft coupling onto shaft.

24. If the lateral movement is correct (same as that checked with one stage installed} install and tighten the rest of the bowl bolts. See Figure 7-D for torque values.

Dimensions and Clearances:

Listed below are the allowable clearances for bearings. If the measured clearance exceeds the high tolerance clearance shown below the part should be replaced. The clearance shown for wear rings are factory tolerances. If the pump shows more than a 5% deterioration in performance these should be replaced.

BOWL SIZE	**12**	13	**14**	**17**	**18**	**19**	**21**
SHAFT SIZE	1-1/2	1-11/16	1-11/16	2-3/16	2-3/16	2-3/16	2-7/16
BEARING HIGH REPLACE	.016	.020	.020	.020	.020	.020	.023
CLEARANCE LOW	.006	.006	.006	.010	.010	.010	.013
WEAR RING FACTORY DIAMETRAL CLEARANCE	.020 .014	.018 .013	.018 .013	.020 .016	.026 .020	.021 .016	.024 .016
BOWL WEAR RING I.D.	5.392 5.394	7.954 7.956	7.954 7.956	9.016 9.018	10.890 10.896	12.016 12.018	12.016 12.021

Figure 7-H

Before replacing wear rings, be sure and check other surfaces and leading edges in the bowl for excessive wear. If the vanes or walls are not in satisfactory condition, the entire part should be replaced.

In the event that wear rings are replaced it is recommended that the bowl bearings also be replaced to avoid rubbing of the wear ring surfaces.

The wear rings are pressed into the bowl side seal. After installation the I.D. of the ring should be machined to the dimension shown in the chart above.

SECTION 8
PARTS LIST

> **ORDERING PARTS:**

When ordering spare parts or replacement parts the pump serial number and size and type of pump must be given. This can be found on the nameplate furnished with the unit. Give the complete name and reference number of each part as indicated on the applicable sectional drawing (Figures 8-A or 8-B) and the quantity required.

> **STOCKING SPARE PARTS:**

Spare parts to be kept in inventory will vary according to service, field maintenance anticipated, allowable down time and number of units. A minimum inventory of one complete set of bearings, gaskets, o-rings, and packing or mechanical seal and one spare of each moving part is suggested.

1> **RETURNING PARTS:**

All materials returned to the factory must be accompanied by a Returned Goods Authorization (RGA) form. The RGA forms can be obtained directly from the factory or through your local Patterson Pump representative. The RGA form must be filled in completely and forwarded as directed thereon. Parts being returned under warranty claim must have a complete written report submitted with the RGA form.

CAUTION!! Returned material must be carefully packaged to prevent transit damage. The factory cannot assume any responsibility for parts damaged in transit.

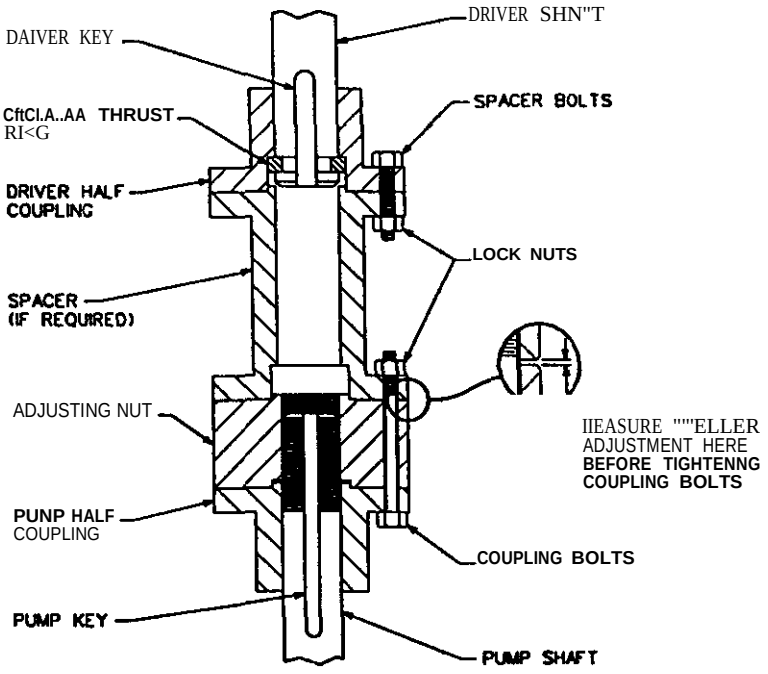


Figure 8-A

PARTS LIST FOR STANDARD VERTICAL TURBUNE

<OPEN LINESHAFT, HOLLOW SHAFT DRIVER>

ITEM	DESCRIPTION
2	IMPELLER
6	BOWL SHAFT
10	MOTOR SHAFT
12	LINE SHAFT
12A	HEAD SHAFT
13	PACKING
17	PACKING GLAND
39	SUCTION BELL BEARING
39A	DIFFUSER BEARING
46	GIB KEY
55	SUCTION BELL
63	STUFFING BOX BEARING
64	SAND CAP
66	ADJUSTING NUT
70	LINE SHAFT COUPLING
73	0-RING, STUFFING BOX
73A	0-RING,DIFFUSER
73B	D-RING, TOP COLUMN
83	STUFFING BOX
84	TAPER BUSHING
101	COLUMN PIPE
187	DISCHARGE HEAD
193	SPIDER BEARING
199	DIFFUSER
209	SUCTION STRAINER

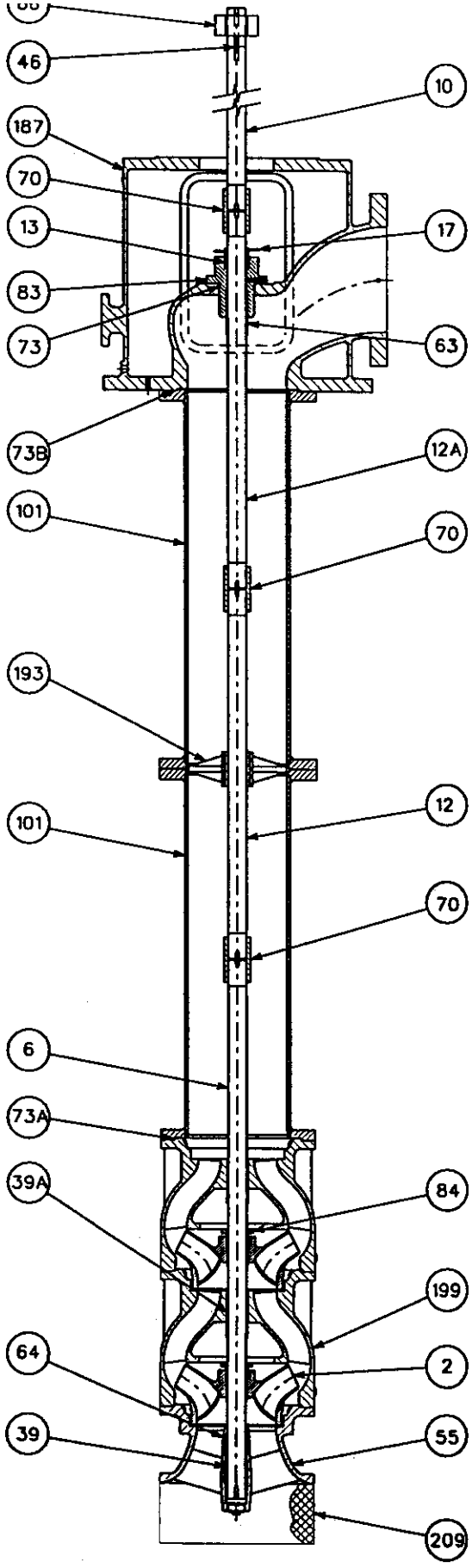


Figure 8-A