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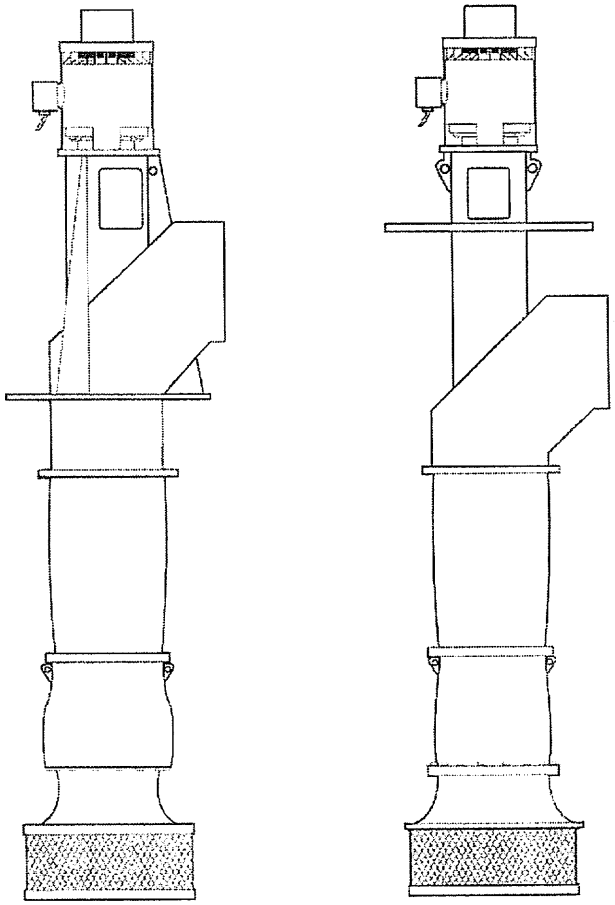

AURORA® LAYNE VERTI-LINE SERIES
MIXED FLOW AND PROPELLER PUMPS
INSTALLATION AND MAINTENANCE MANUAL

NOTE! To the installer: Please make sure you provide this manual to the owner of the equipment or to the responsible party who maintains the system.

Part # LV-03-800 | © 2013 Pentair Ltd. | 09/05/13

These instructions are not intended to cover all details or variations in equipment nor to provide for every possible contingency to be met in conjunction with installation, operation, and maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the factory.

⚠ WARNING ⚠

High voltage, rotating parts, or falling parts can cause serious or fatal injury. The installation, operation, and maintenance of this equipment should be performed only by qualified personnel familiar with the contents of this manual, the contents of the pump motor manual, the National Electrical Code, local electrical codes, local plumbing codes, local water well codes, and sound practices for electrical and mechanical equipment. Among the many considerations are:

- **Observe good safety practices at all times.**
- **Use proper procedures when handling, lifting, installing, operating, or maintaining the equipment.**
- **Avoid contact with electrically energized circuits.**
- **Before initiating maintenance procedures, be sure that all power has been removed from the pump and its accessories.**
- **Avoid removing, by-passing, or rendering inoperative any safeguards or protective devices.**
- **Be sure the unit is properly grounded per the instructions in the motor manual and per applicable electrical codes.**
- **Be sure the equipment is properly enclosed to prevent access by unauthorized personnel who could injure themselves or damage the equipment.**
- **When making electrical tests, use rubber gloves and rubber soled shoes for protection from possible electrical shock. Perform the tests in a dry location.**

⚠ WARNING ⚠

CALIFORNIA PROPOSITION 65 WARNING:

This product and related accessories contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

TABLE OF CONTENTS

SECTION 1
INTRODUCTION

Efficient performance. Satisfactory operation. Dependable service.

These are the things you want from your pump and it has been designed accordingly. This booklet will help you assure continuance of these features by implementing a careful and proper installation and maintenance program. If you want further assistance, you might consider contracting for the services of an experienced factory service representative to supervise your installation and/or startup.

Because of variations in jobsite environments and installation requirements, the instructions are somewhat general. However, the manual includes the most important guidelines. Your installer must still use sound judgement to adapt the methods we've outlined to the specific site circumstances and pump design features in each particular installation. It is in your interest that he does, since failure to comply with recommended procedures may void your warranty.

If any question should arise during the installation, contact your local factory representative immediately. Be ready to identify the unit by its serial number. The serial number is stamped on the nameplate on the discharge head.

Figures 1 and 2 illustrate the relationship of all the parts after installation is complete. The nomenclature we've used here will identify the items throughout the instructions. Before starting the installation procedure, please read through the entire process described in this book, omitting material not applicable to your particular pump. Study, in detail, the precautionary information emphasized in Section 15.

When you begin the installation, refer to the instructions for each individual step. After the equipment is in operation, we suggest you keep a manual available at the site for future use in maintenance programs. It can be used in conjunction with the disassembly, assembly and troubleshooting manual.

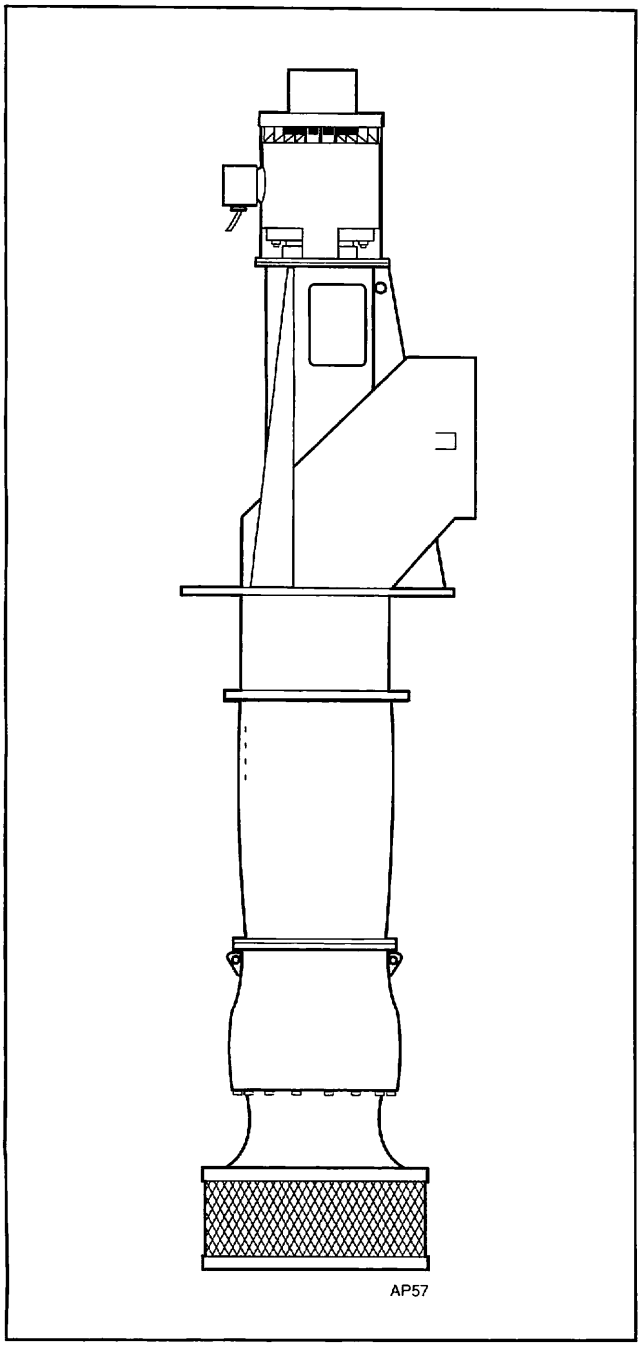

Figure 1A. Mixed Flow Low Lift Pump with Above Surface Discharge

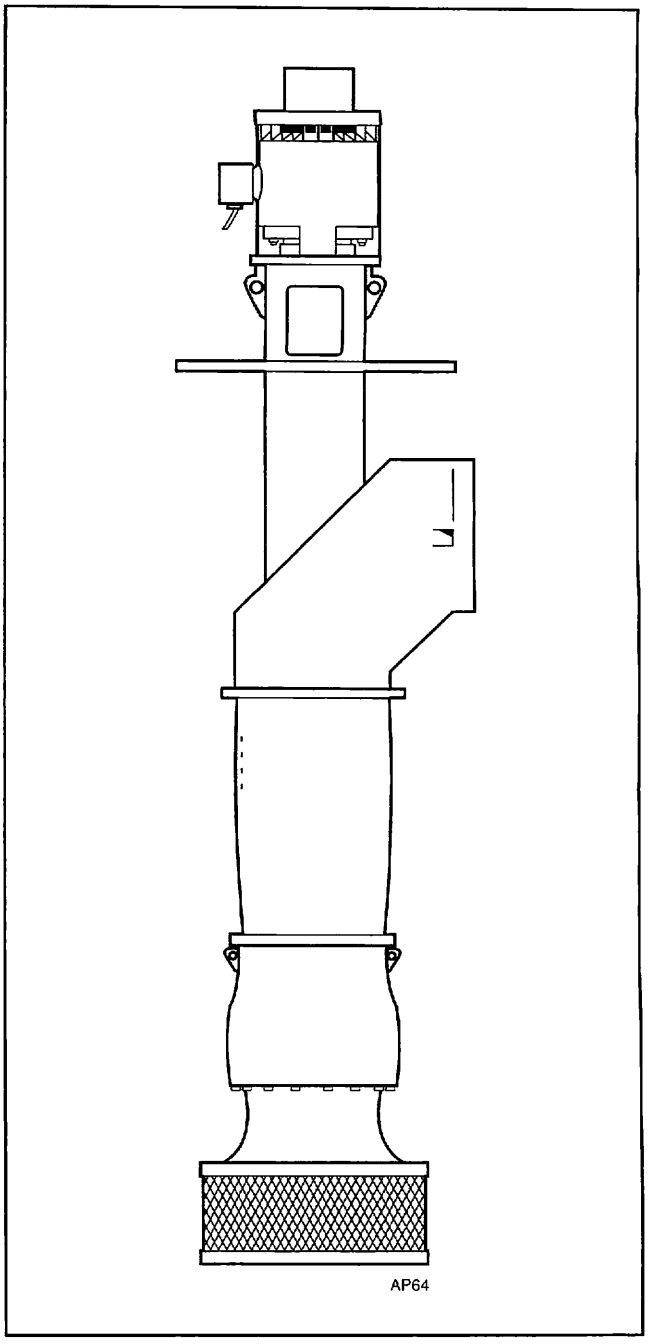

Figure 1B. Mixed Flow Low Lift Pump with Below Surface Discharge

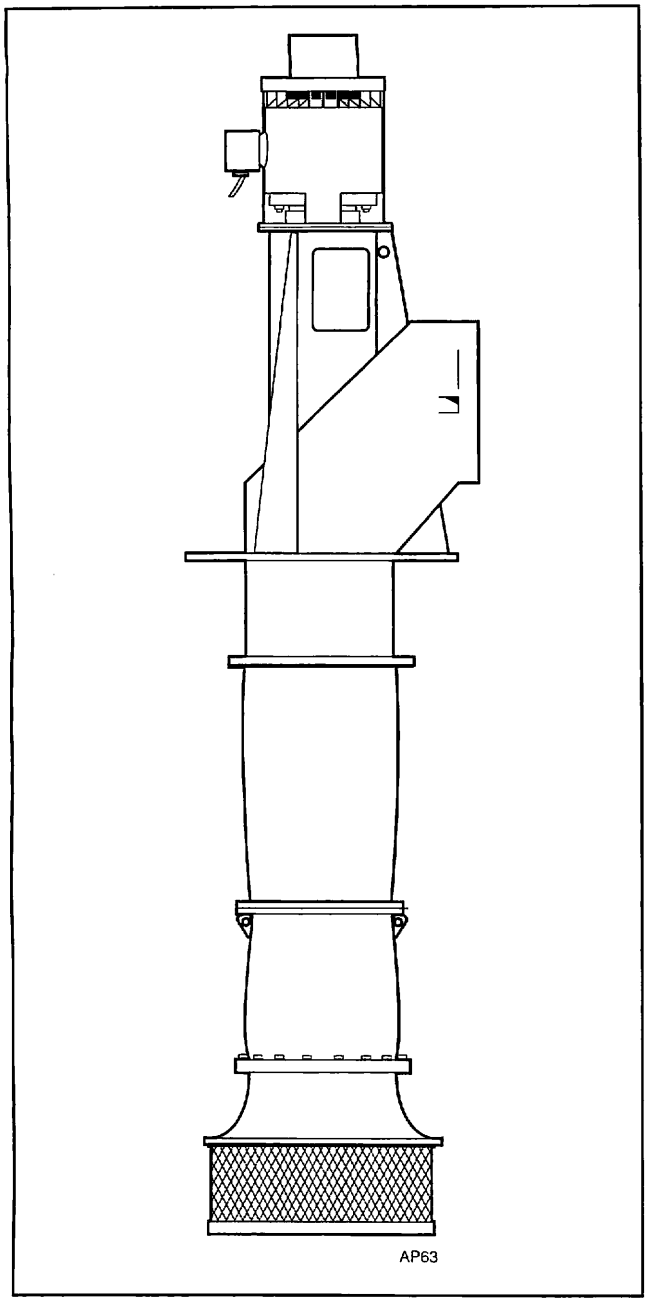

Figure 2A. Propeller Low Lift Pump with Above Surface Discharge

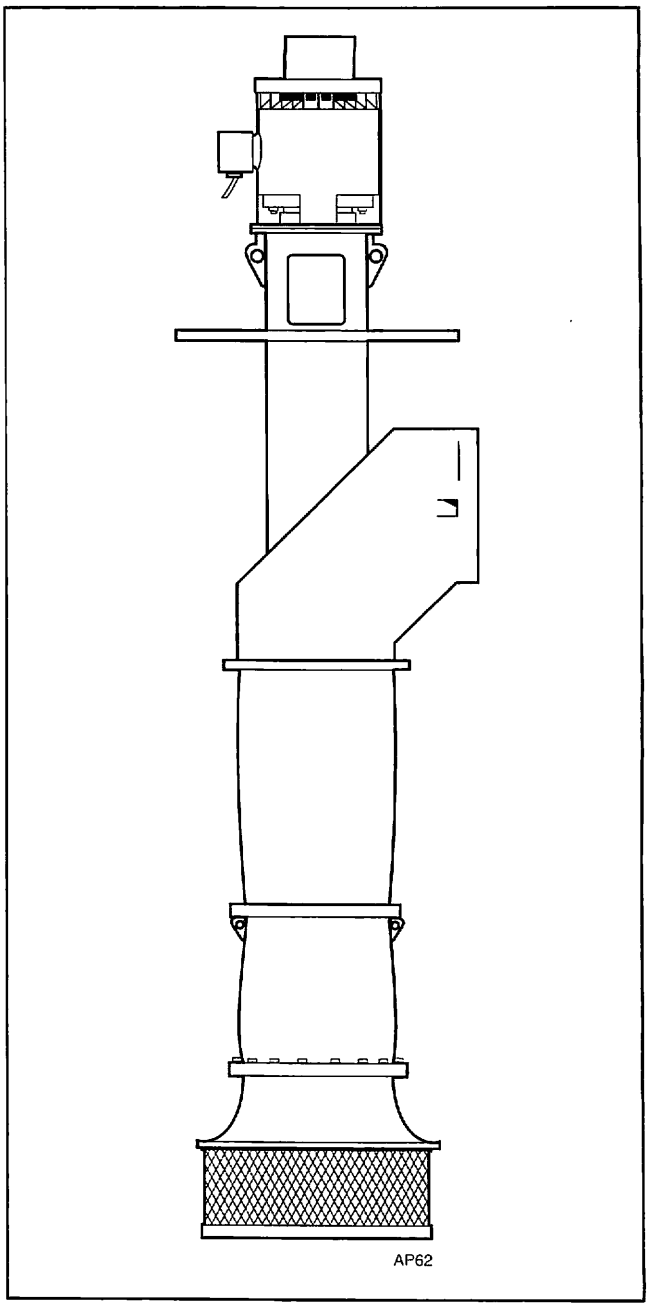

Figure 2B. Propeller Low Lift Pump with Below Surface Discharge

SECTION 2
THE EQUIPMENT

The material and equipment you'll need for installation may vary with the size of pump and the type of job. We'll offer the following suggestions as a guide but you will want to remember the primary tool to be used at all times is SAFETY FIRST.

You can use a portable derrick or tripod, but we recommend a boom crane of adequate capacity or a properly designed pump setting rig similar to that shown in Figure 3. Whatever you choose, your lifting device must allow the load hook to be raised at least two feet higher than the total length of your assembled pump. Your hook should be of the safety type with a good easy working swivel and you must have sufficient reach to center it over the installation position.

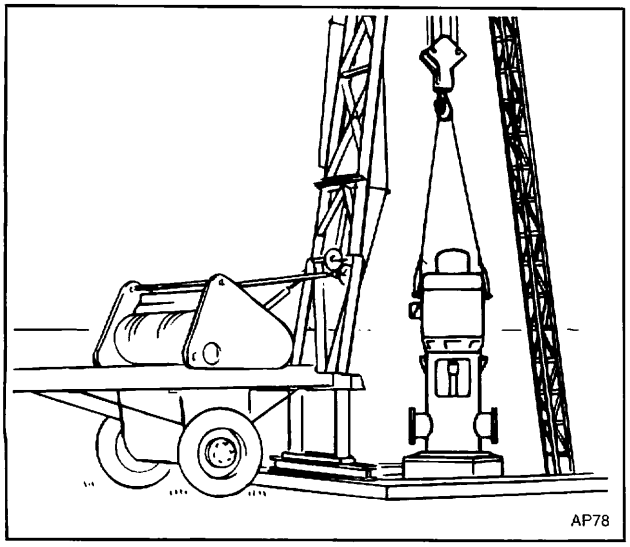

Figure 3. Pump Installation Rig

In most cases, your pump will be delivered to you in an assembled condition, ready to lower in place and to accept the driver plus some miscellaneous parts. We've described this situation in Section 7. If you've elected to receive it unassembled due to its size, job-site headroom limitation, or some other compelling reason, we've provided this information in Section 8.

For the usual installation, we suggest the following miscellaneous tools and material but you may want to vary them to suit the peculiarities of your individual project:

- Lifting equipment. See Figure 3.
- *Steel beam clamps. See Figure 4.
- Chain or cable sling about 10 feet long of adequate size for job. See Figure 5.

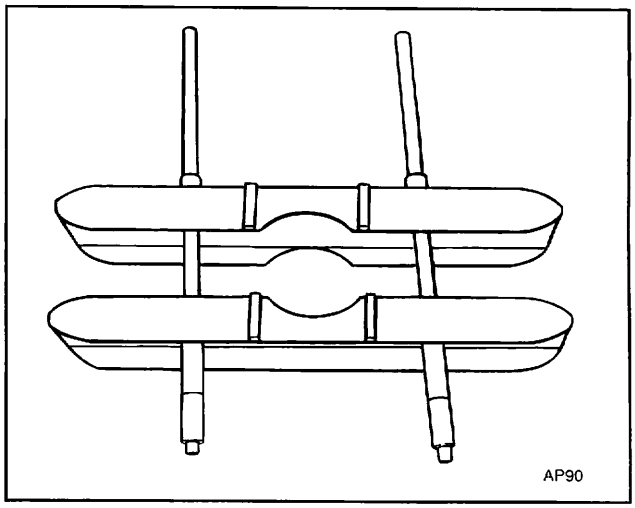

Figure 4. Beam Clamps

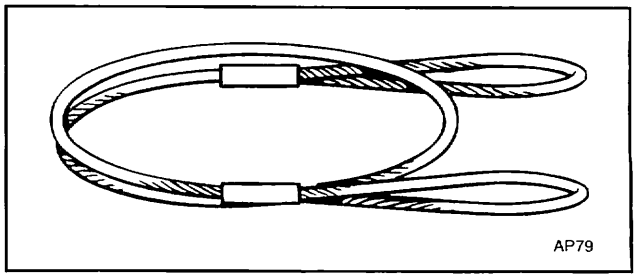

Figure 5. Cable Sling

- Chain tongs
- Medium size pipe wrenches
- 12 foot length 3/4 inch rope
- Ordinary set of mechanics tools. See Figure 6.
- Large crescent wrench
- Wire brush
- Assortment of files
- *Cover for bowl unit and column sections
- Clean rags

* Required only for installation of unassembled pumps

- Thread compound -- Use anti-galling type for stainless steel parts
- Solvent -- in recommended containers
- Special lubricants as required
- Shims and wedges
- Non-shrink grouting material

⚠ WARNING ⚠

All combustible materials must be kept in approved safety containers and handled carefully, away from any flame, sparks, exhaust, or any other possible source of ignition.

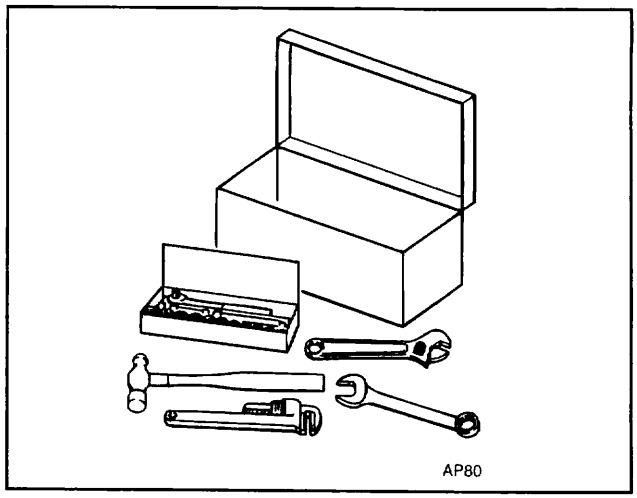

Figure 6. Ordinary Set of Mechanics Tools

SECTION 3
RECEIVING THE PUMP

Your pump was inspected on the carrier just prior to leaving the factory. When you receive it at your jobsite, look it over carefully for any visible damage to parts, skids, boxes, or dunnage. If shaft is crated, open the crate carefully to inspect and make a count but leave the shaft in the box for protection until ready for installation. Take inventory on the truck or during the unloading process. Do not sign for damaged or incomplete shipments unless you take the appropriate exceptions. Report such instances immediately to the factory sales office and to the transportation company involved giving full particulars and confirming all verbal understandings in writing.

SECTION 4
UNLOADING THE PUMP

It is important to exercise extreme care in handling and installing all parts. All items are precision machined for proper alignment and, if dropped, banged, sprung, or mistreated in any way, misalignment and malfunction will result. Parts which are too heavy to be lifted from the transporting car or truck, as shown in Figure 7, should be skidded slowly and carefully to the ground to prevent harm. Never unload by dropping parts directly from the carrier to the ground. Never use shipping crates for skids.

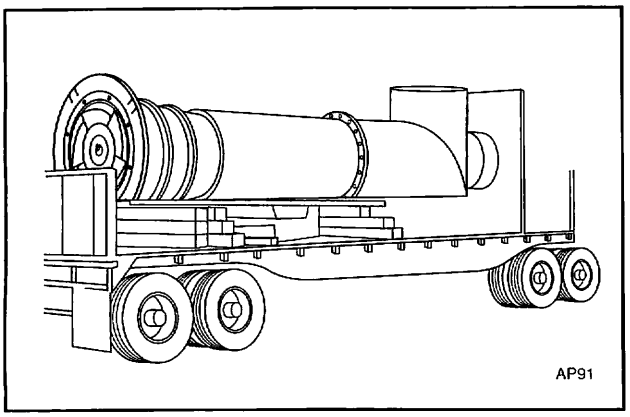

Figure 7. Transported via Truck Carrier

If you can't begin installation within a very few days after delivery, it's a good idea to segregate and identify all components comprising your shipment so you won't lose them in the midst of other equipment arriving at the jobsite. Under these conditions, refer to the Recommendations for Pump Storage, see Section 16. Read and follow the instructions carefully because care of the pump during storage can be as important as maintenance after operation has begun.

If jobsite conditions permit, you may be able to install directly from the truck that brought the pump to you. If not, and if you've received your pump unassembled, lay out the column pipe and bowl assembly on suitable timbers or staging to keep all material out of the dirt. Figure 8 illustrates an acceptable method of laying out a pump. Inner column joints consisting of shafting and tubing with couplings and line shaft bearings will have been preassembled for you at the factory into proper lengths to match the column pipe. Insert these assemblies into the mating pipe sections with the projecting line shaft coupling and bearing if any pointing toward the installation position. See Figure 9 for enclosed line shaft and Figure 10 for open line shaft.

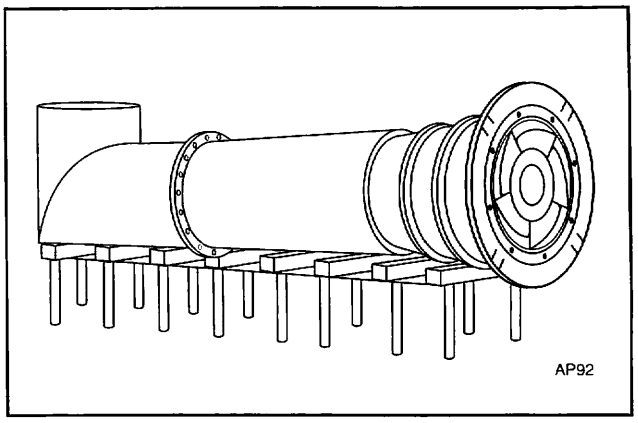

Figure 8. Properly Laid Out Pump

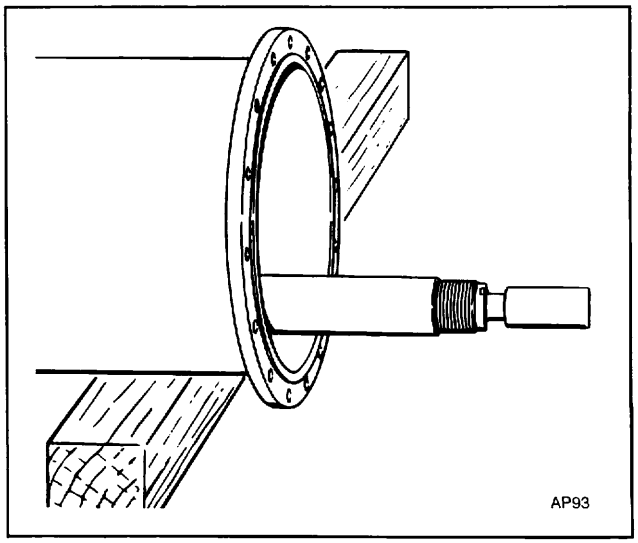

Figure 9. Enclosed Line Shaft

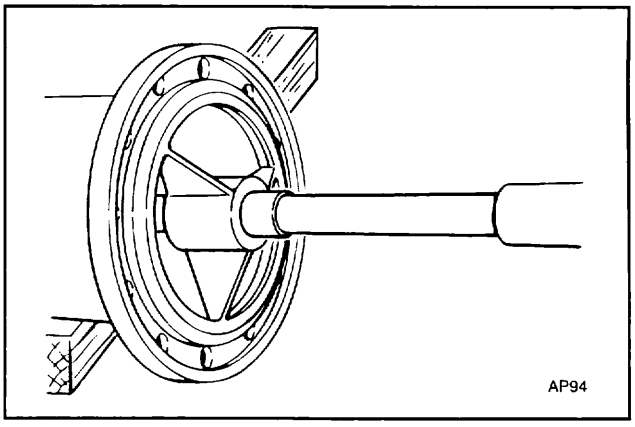

Figure 10. Open Line Shaft

Examine the tube faces to see that they are free from burrs or nicks and, in the process, wipe them clean. Your installer should check for tightness those sections that were assembled at the factory to insure none have loosened in transit. He should also inspect each joint for straightness as a bent tube cannot be used. Keep ends covered until each piece is ready for installation.

If your line shaft was shipped to you in a crate, we suggest you handle it directly from the crate. If not, place each length on timbers and clean with solvent to remove rust preventive, oil, or slushing compound. In either case, inspect each joint to make sure the faces are undamaged and that the piece is absolutely straight. Each was straightened before shipment from the factory and, if any were bent in transit, they cannot be used. Insert each piece into the proper pipe section and keep ends covered until installation.

All other parts should be cleaned and laid out on a suitable surface in the order in which you'll want to use them. Again, check against your packing list to be sure none are missing. It's much better to find out now than during the actual installation.

If you received your pump in the assembled condition, go right on to Section 7. If unassembled, skip Section 7 and follow directions in Section 8.

SECTION 5
THE SUMP

The sump you provide can influence both the mechanical and hydraulic performance of your pump. The intake configuration should be designed to deliver an evenly distributed flow of water to the pump suction since uneven flow patterns tend to create vortices. Vortexing can be submerged and completely invisible or it can appear on the surface. It can introduce air into the pump, can increase or decrease power consumption, can influence submergence requirement, and can produce objectionable noise and vibration, among other things.

It's easy to be misled by low calculated average velocities across an intake channel, but keep in mind these figures can often mean absolutely nothing. It's the localized velocities that start the vortex. Actually, vortices are more easily sustained in flows of lower average velocities where a calm slowly moving surface does nothing to interfere with a gradual buildup in vortex size. A more turbulent surface can tend to break up these disturbances before they grow large enough to cause harm.

The Standards of the Hydraulic Institute offers certain guidelines for good pit design and we subscribe to these general principles. However, we recommend you put your sump design questions in the hands of an experienced sump design engineer who can match intake configuration with pump requirements in the plant design phase and make it possible for you to realize optimum performance from each.

Before starting installation, inspect the completed sump carefully. You'll want to make sure it's dimensionally adequate to receive the pump. You'll also want to see that it has been cleared of all trash and debris. Your inspection should include any pipelines or conduits feeding into the pit. It's a good idea to have the basin screened to prevent future entrance of foreign material which can damage or clog the pump, possibly even rendering it inoperative.

SECTION 6

THE MOUNTING BASE

Your pump requires a foundation suitable for the weight of the entire pump when full of water. While the preferred material is solid reinforced concrete, you can use adequate fabricated steel framework as long as you keep deflections to an absolute minimum. Regardless of material, the supporting base must be properly engineered, structurally sound and stable, able to withstand and prevent objectionable vibration.

Most mixed flow and propeller pump designs feature relatively large suction bell diameters. The opening in the foundation through which you'll install the unit must allow working clearance. If you've elected to use a below base discharge configuration, the opening must also accommodate passage of the discharge elbow. We advise you to verify these clearances before starting installation.

You'll undoubtedly want to provide anchor bolts to secure the discharge head to the mounting base. We prefer the sleeve bolt design shown in Figure 11 and you probably will too since it's easy to use. Alternate bolts are illustrated, however, for your consideration.

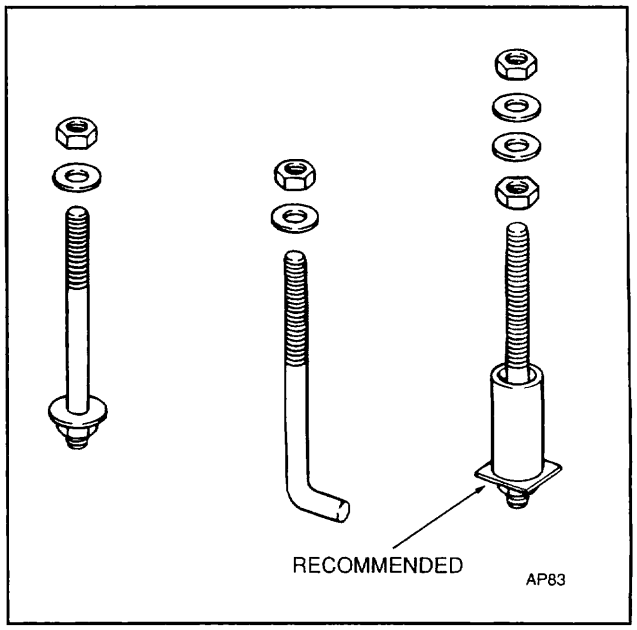

Figure 11. Foundation Anchor Bolts

SECTION 7
INSTALLING THE PUMP - FACTORY ASSEMBLED UNIT

You're now ready to start actual installation. Clear the work area at and around the mounting position so installers can move freely and with maximum safety. This will also decrease the chances for foreign material or objects to enter the pump as it is lowered into position and secured.

During the course of the work, you must never lose sight of the fact that you are handling precision components no matter how awkward they may be to manipulate. All threads should be engaged by hand and checked before tightening. Damage resulting from cross threading or dirt must be repaired with a file before applying force. If not repairable, the part must be replaced so it's clearly worth your while to use the utmost care.

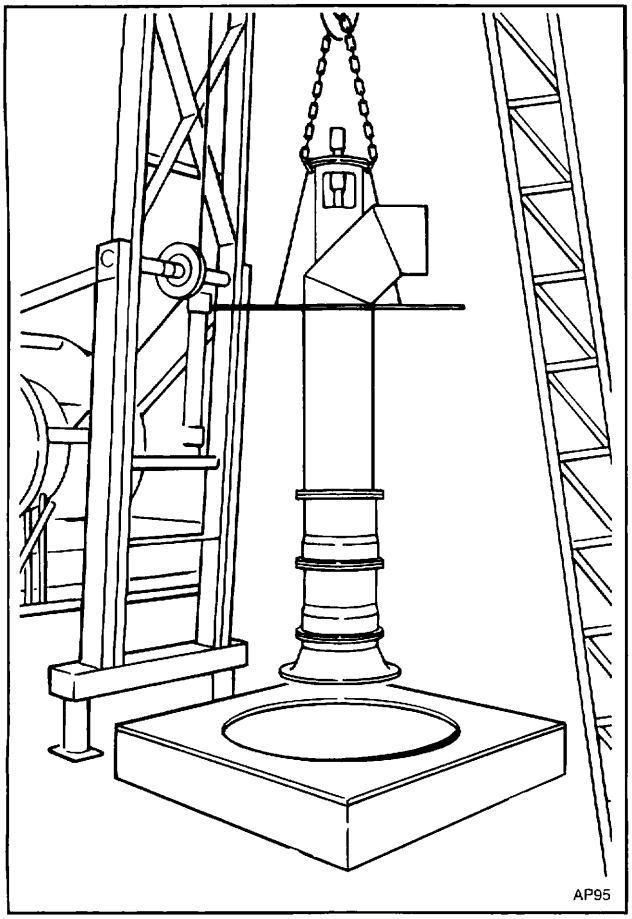

Figure 12. Raising Unit Over Mounting Position

Using the lifting lugs on the discharge head only, raise the unit as shipped to a vertical position over its mounting base, Figure 12. Take care to avoid putting any strain on the column or any exposed shafting. Also be careful not to damage the strainer, if used, during the lifting operation. Clean the bottom of the pump base and, if the base is to be grouted, apply a heavy coat of grease. Lower the assembly gently into place in its operating position with full contact, base to mounting surface. Assemble anchor bolt nuts very loosely.

If your pump has been constructed with a shaft enclosing tube, you will find the tubing terminates in a tension nut assembly in the discharge head. Since this part is assembled at the factory where the proper tension has already been applied to the tube, there is nothing for you to do here except to connect the lubricating system. Refer to Section 9.

If there is ever any reason for you to relieve the tension on the tube, be sure to mark the position of the nut flange with respect to its mounting surface in the head. With this as an indicator, you can reload the tubing to the same tension when you reassemble.

If your pump is of open line shaft construction, it will be furnished with a packing box, instead of a tension nut. Before first startup, see Section 13 for run-in procedure and directions for maintenance and repacking when necessary.

Examine the position of the pump. The suction bell must hang the proper distance from the sump bottom and be unobstructed. Piping connections must be in the right orientation with respect to jobsite plumbing. The whole unit must hang plumb and true; if not, use wedges and/or shims until it does.

When you're satisfied with the position of the equipment, skip Section 8 and go on to the appropriate portion of Section 9.

SECTION 8
INSTALLING THE PUMP - UNASSEMBLED UNIT

You're now ready to start actual installation. Clear the work area at and around the mounting position so installers can move freely and with maximum safety. This will also decrease the chances for foreign material or objects to enter the pump as it is lowered into position and secured.

During the course of the work, you must never lose sight of the fact that you are handling precision components no matter how awkward they may be to manipulate. All threads should be engaged by hand and checked before tightening. Damage resulting from cross threading or dirt must be repaired with a file before applying force. If not repairable, the part must be replaced so it's clearly worth your while to use utmost care.

A. ENCLOSED LINE SHAFT CONSTRUCTION

Examine the bowl assembly to determine that all stage connecting nuts or capscrews have been taken up securely. Inspect the bypass ports in discharge bowl to make sure they are open clear through to the shaft and not plugged in any way. This may be done by probing a wire into the port and through the passage. See Figure 13A or Figure 13B.

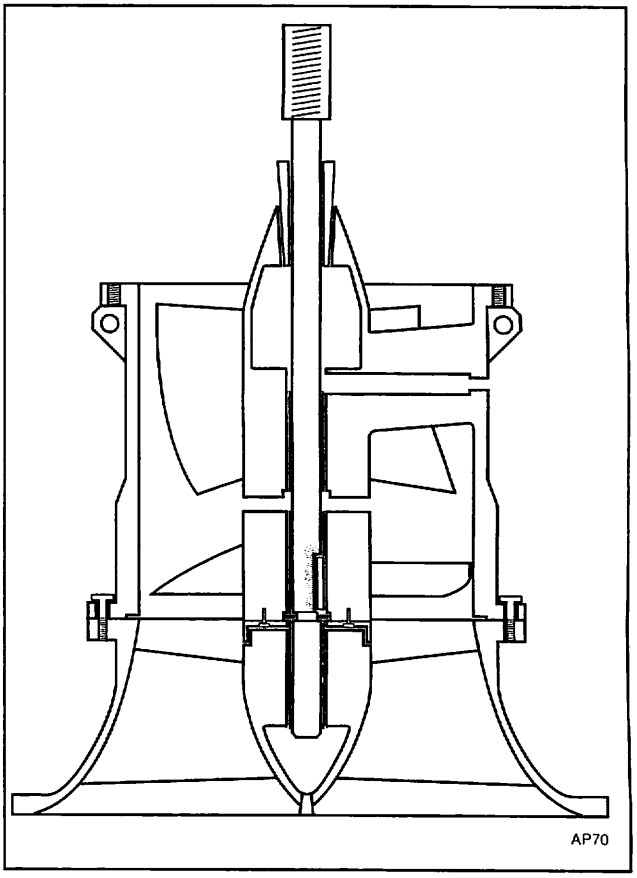

Figure 13A. Inspecting By-Pass Port - Propeller Pump

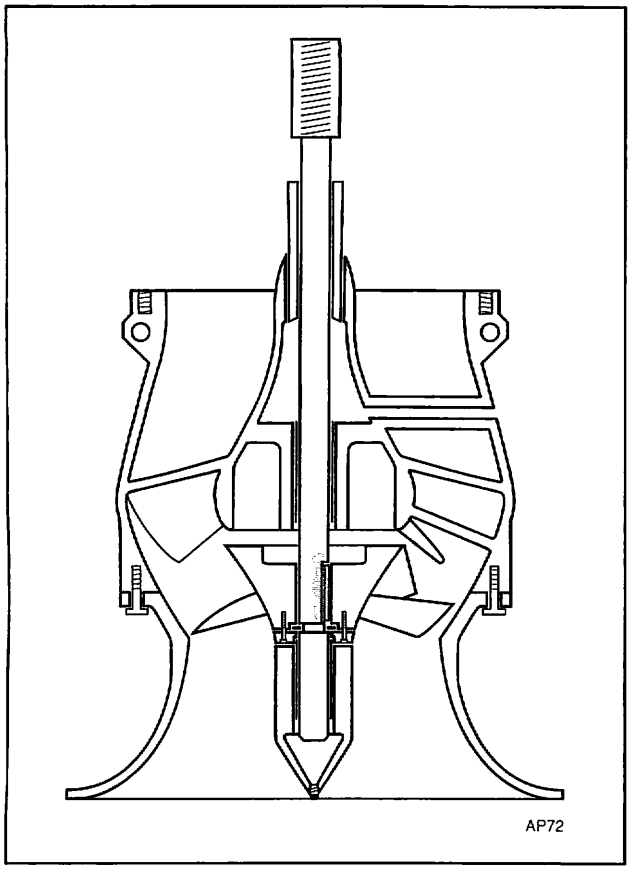

Figure13B. Inspecting By-Pass Port - Mixed Flow Pump

Determine the amount of bowl shaft end play and record it. You can do this by pushing the shaft all the way into the bowls and mark it where it emerges from the top fitting. Then pull the shaft out manually as far as it will go and measure the distance your mark has travelled. This is end play or bowl lateral. We'll want to check your record later.

Using elevators under the top flange or properly sized eyebolts through the flange, raise the bowl assembly as illustrated in Figure 14, controlling the lower end with a rope drag line. If you have a strainer, this is the time to attach it to the suction bell. Suspend the load directly over the mounting position and lower until the elevators or the flange rest securely on the beam clamps, as shown in Figure 15. Never lift the assembly with the cast lugs, if any, on the individual bowl casings. These are adequate only for handling the disassembled part by itself.

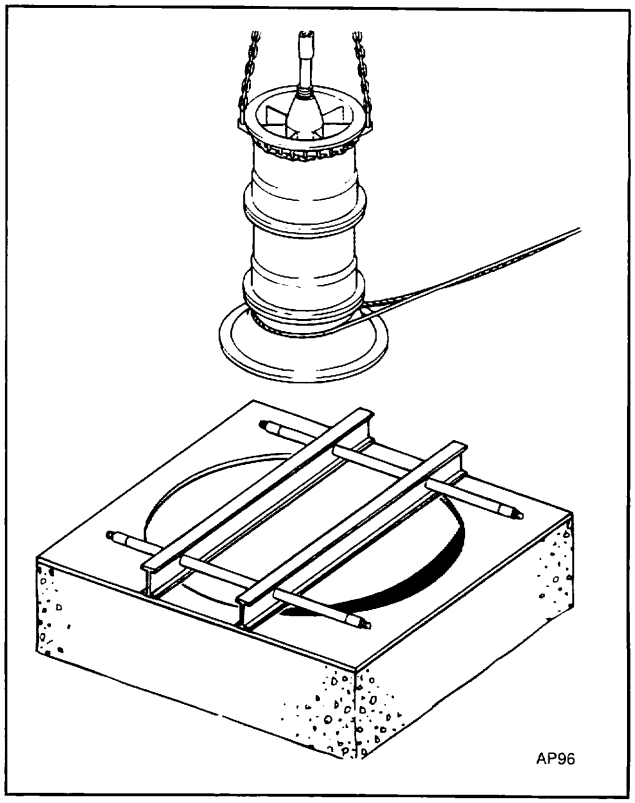

Figure 14. Raising Bowl Assembly Over Well

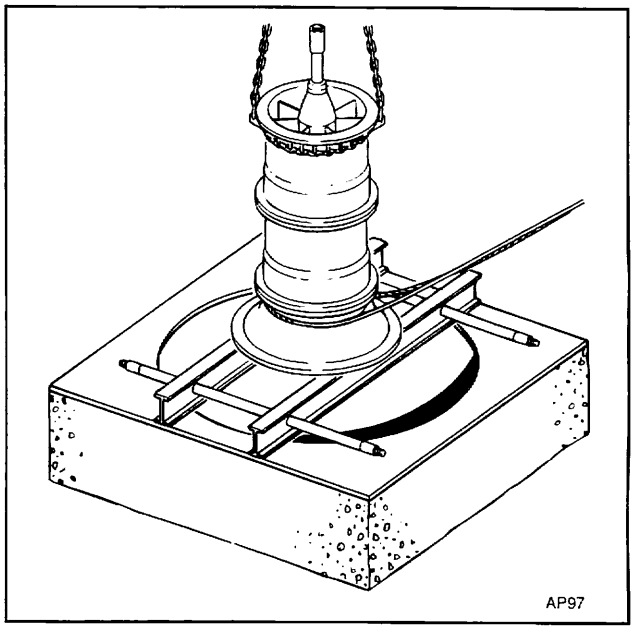

Figure 15. Bowl Assembly Resting on Beam Clamps

Remove the shaft protector tube, if used, shown in Figure 16, from the top of the bowl assembly. Clean and inspect all exposed threads and faces. The tube adapter should project exactly half its length from the discharge bowl hub unless it has a shoulder to butt solidly against the hub. Do not attempt to handle the assembly by the shaft, now or at any other time.

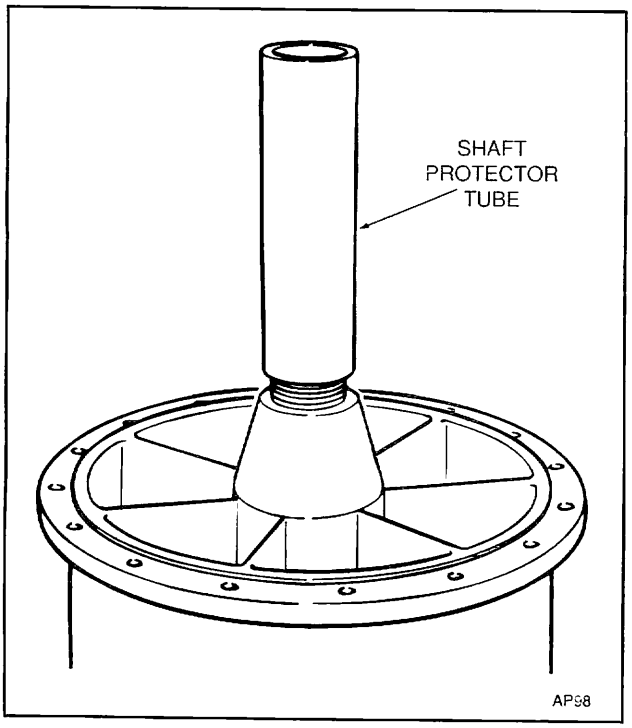

Figure 16. Shaft Protector Tube

If something is dropped into the pump at any time during the installation, you must retrieve it before going any farther. You might even have to return everything to the surface to do this. This is why we caution you to keep the open end of the pump covered at all times. Stuff sacking into the opening or use a cover designed specifically for the purpose. Stuff a clean rag into the open end of the shaft coupling. Remember of course to remove all this as the joint is made up.

Secure the elevators to the bottom column assembly below the flange. Again you may use proper eyebolts through the flange if you prefer. Using a hemp rope, secure a timber hitch knot around the pipe about one foot from the end away from the mounting position. Place a double half hitch knot around the tubing, and a reverse double half hitch knot around the shaft and over the threads to prevent slipping. This is illustrated in Figure 17.

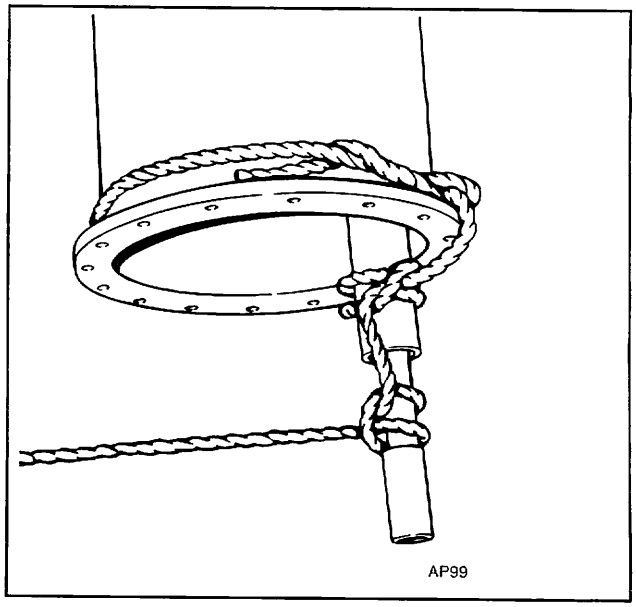

Figure 17. Securing Enclosed Line Shaft Assembly

Hoist the column assembly into place above the mounting position as shown in Figure 18. You must keep the free end of the tail rope taut at all times to prevent dropping the shaft. A soft board or pipe dolly should be laid out for the end of the pipe to slide in on, restrained by the tail rope, so that the flange face will not be damaged as the section is being raised. Clean all the threads and inspect the faces of the pipe, shaft, and tube to be sure there are no burrs, nicks, or dirt. Paint the shaft and tube threads with thread lubricant. If parts are stainless steel, use only an approved anti-galling compound.

Lower the parts until the shaft sits firmly on its coupling and start threading it in by hand. Remove the rope from shaft only and continue threading the shaft in until it butts solidly, remembering the threads are left hand. Make sure the shaft ends are together but don't use undue force. As shown in Figure 18, lock shafts firmly with two small pipe wrenches, using one wrench on the coupling and the other on the shaft just above the thread with the wrench handles parallel to avoid pulling shaft off center. Never apply wrench jaws to threads or to any area that might run in a bearing or packing. Do not allow coupling to ride up on last scratch or imperfect thread. Both shafts should expose an equal length of thread above and below the coupling, indicating that the shaft butt is in the exact center. If unusual power is required, stop and look for damaged or dirty threads since forcing may cause misalignment and eventual malfunction.

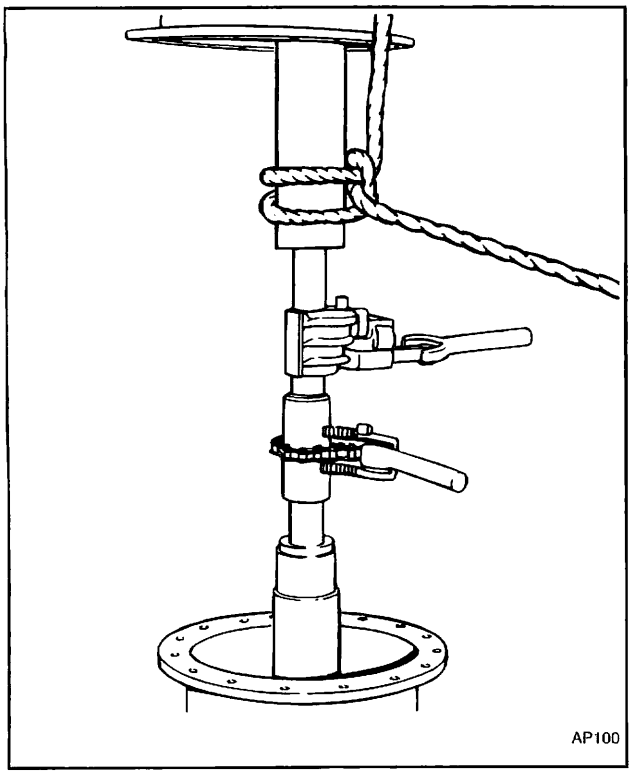

Figure 18. Connecting Enclosed Line Shaft Assembly

Lower the enclosing tube to the tube adapter and start the threads on by hand. Remove the rope and continue threading the enclosing tube on with a small pipe wrench or chain tong, remembering these are right hand threads. On the following tube sections, two wrenches or tongs should be used. One is to hold the lower tube stationary while the other tightens the upper section into place onto the projecting line shaft bearing. Keep the wrench handles parallel. Remove the cover material.

Now you can lower the column pipe, engaging the registers and seating the flange faces firmly. Insert all bolts not obstructed by the elevators or eyebolts and tighten the nuts uniformly. When you have enough bolts to carry the weight of the assembly safely, remove the lower elevators and assemble the rest of the bolts, making sure all holes are filled and that all nuts are secure. Lower the pump until it again rests on the beam clamps.

You may repeat this procedure for each succeeding column section. In working with flanged column pipe and pieces with similar configuration, be particularly conscious of the pulloff effect where the chains or sling bear against the flange rim. Scoring or chafing will reduce the strength of your sling considerably and must be avoided.

Slide the top inner column assembly into the elbow/mounting base section and join the bottom end to the pump column in the manner described for all column joints. From this point on, the pump must be handled with the lifting lugs on the discharge head, as depicted in Figure 12. Never lift with eyebolts tapped into the holes for securing the driver. They're inadequate to support the weight.

Clean the bottom face of the mounting plate and, if the pump is to be grouted, apply a heavy coat of grease to the underside. Raise the load a few inches to remove the beam clamps and elevators, then let it down slowly and carefully, positioning the base with respect to the discharge piping system, if any, and engaging the anchor bolts, if used. Continue to lower until the base contacts the foundation and the weight of the pump is transferred to the mounting structure. Effect this transfer very gradually without a bump. Be sure the pump is in a plumb vertical position with full contact base to mounting surface. Assemble the nuts loosely to anchor bolts.

The projecting headshaft will probably have sagged to one side of the opening through the head. Make sure you can center them easily by hand. Examine and clean threads. Inspect the mating face in the discharge head for any burrs, rough spots, or projections, especially at the location of the tapped holes. Clean with a file where necessary. Apply thread lubricant and grease flange face.

INSTALL STUFFING BOX PER:

- Style 60 - Enclosed Line Shaft.
  Refer to Style 60 sectional drawing for complete assembly instructions.

- Style 60 - Enclosed Line Shaft - Force Water Lube.
  Refer to Style 60, force water lube, drawing for complete assembly instructions.

You have also completed this phase of the installation. Skip Section 8B and go on to Section 9 for the next procedure.

B. OPEN LINE SHAFT CONSTRUCTION

Examine the bowl assembly to determine that all stage connecting nuts or capscrews have been tightened securely. Inspect bypass ports in discharge bowl to make sure they are closed. Refer to Figure 19A or Figure 19B.

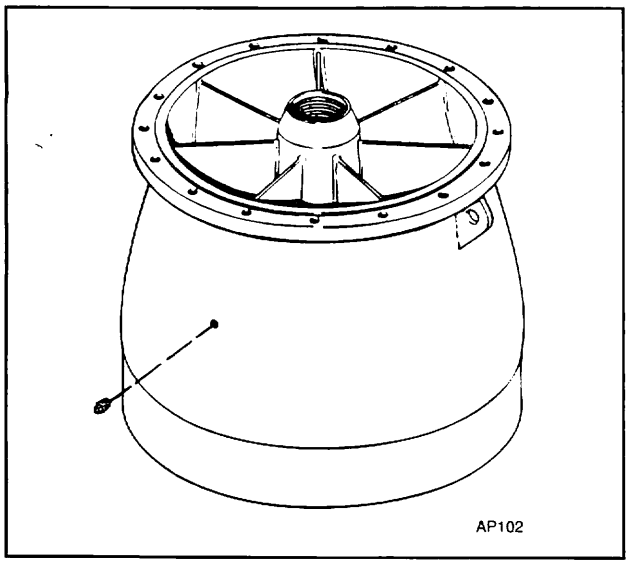

Figure 19A. Propeller Bowl Assembly - Mixed Flow Pump

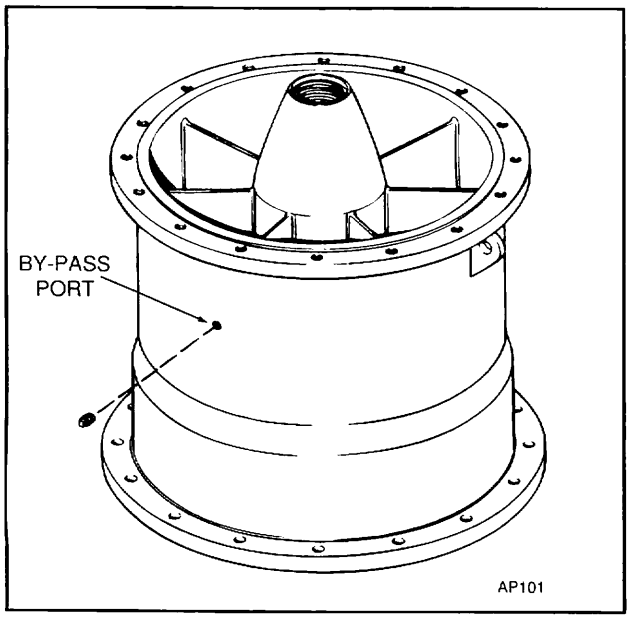

Figure 19B. Propeller Bowl Assembly - Propeller Pump

Establish the amount of bowl shaft end play and record it. You can do this by pushing the shaft all the way into the bowls and mark it where it emerges from the top fitting. Then pull the shaft out manually as far as it will go and measure the distance your mark has travelled. This is end play or bowl lateral. We'll want to refer to your record later.

Using elevators under the top flange or properly sized eyebolts through the flange, raise the bowl assembly as illustrated in Figure 20, controlling the lower end with a rope drag line. If you have a strainer, this is the time to attach it to the suction bell. Suspend the load directly over the mounting position and lower until the elevators or the flange rest securely on the beam clamps. See Figure 15. Never lift the assembly by using the cast lugs, if any, on the individual bowl casings. These are adequate only for handling the disassembled part by itself.

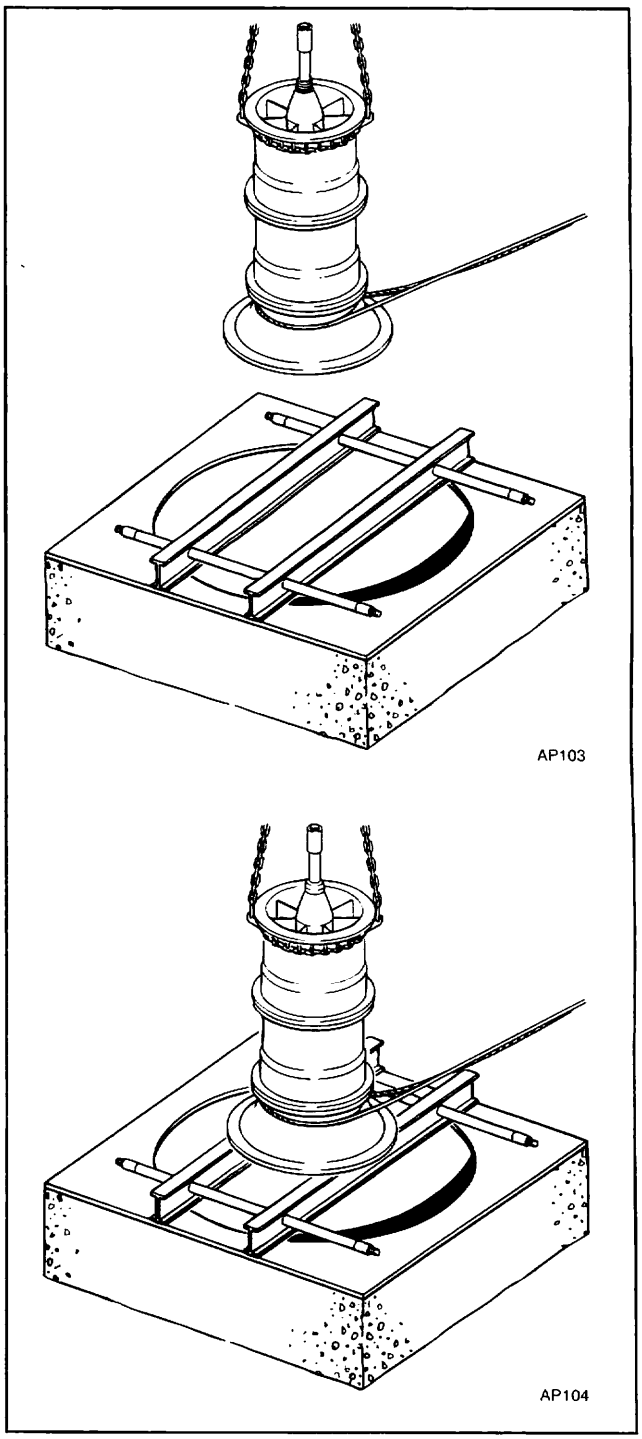

Figure 20. Positioning Bowl Assembly

If something is dropped into the pump at any time during the installation, you must retrieve it before going any farther. You might even have to return everything to the surface to do this. That's why we caution you to keep the open top of the pump covered at all times. Stuff sacking in the opening or use a cover specifically designed for the purpose. Stuff a clean rag into the open top of the shaft coupling. Remember of course to remove all this just before the joints are made up.

Secure the elevators to the bottom column assembly, below the flange. Again you may use proper eyebolts through the flange if you prefer. Using a hemp rope, secure a timber hitch knot around the pipe about one foot from the end, away from the mounting position and a reverse double half hitch knot around the shaft over the threads to prevent slipping. This is illustrated in Figure 21.

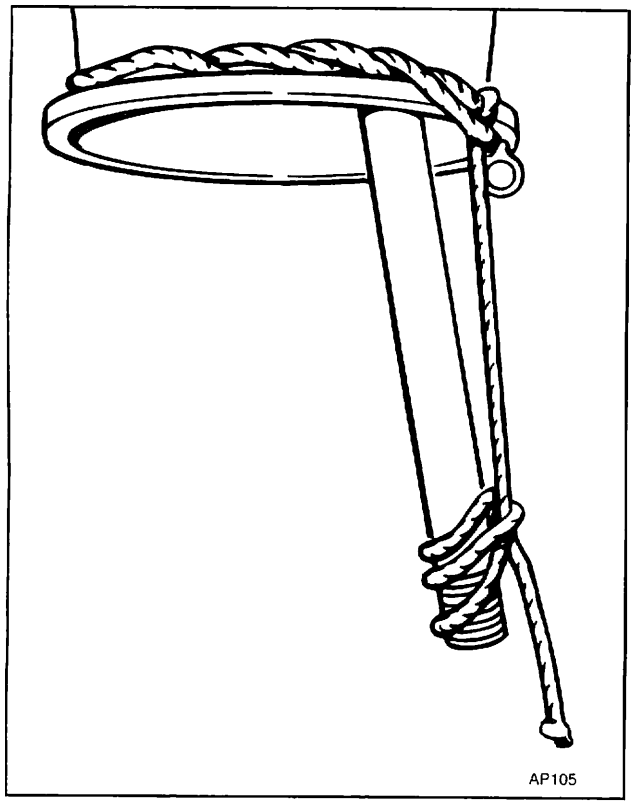

Figure 21. Securing Open Line Shaft Assembly

Hoist the column assembly into place above the installation position. You must keep the free end of the tail rope taut at all times or you'll drop the shaft. A soft board or pipe dolly should be laid out for the end of the pipe to slide in on, restrained by the tail rope, so that the flange face will not be damaged as the section is being raised. Clean the shaft threads and inspect the faces of shaft and pipe flanges to be sure there are no burrs, nicks, or dirt. Paint the shaft threads with a thread lubricant. If parts are stainless steel, use only an approved antigalling compound.

Lower the parts until the shaft sits firmly on its coupling, as shown in Figure 22. Start the threads in by hand, keeping in mind they are left hand. Remove the rope and continue threading the shaft in until it butts solidly. Make sure the ends are firmly together but don't use undue force. As in Figure 23, lock the shafts securely with two small pipe wrenches, one on the coupling and the other on the shaft just above the thread, with the handles parallel to avoid pulling shaft off center. Never apply wrench jaws to the threads or to any area of shafting that might run in a bearing or packing. Don't allow the coupling to ride up on last scratch or imperfect thread. Both shafts should expose an equal length of thread above and below the coupling, indicating that you have the shaft butt in the exact center. If unusual power is required, stop and look for damaged or dirty threads since forcing may cause misalignment and eventual malfunction.

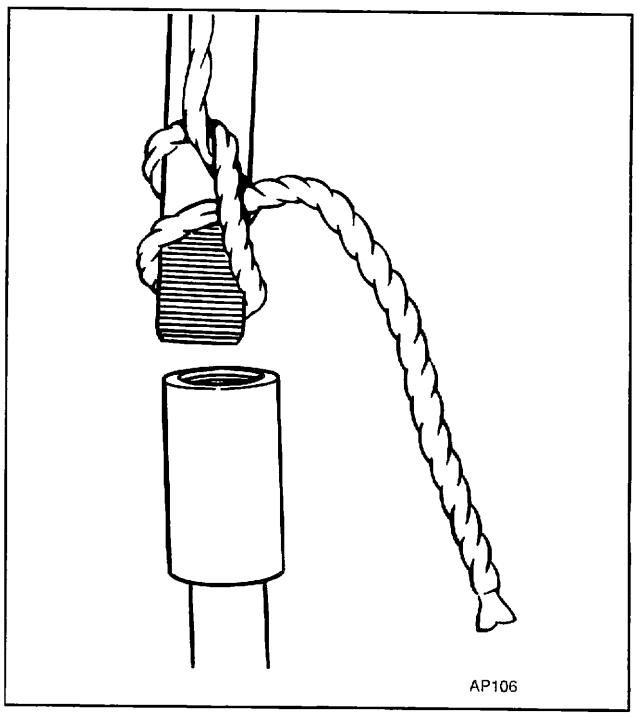

Figure 22. Joining Open Line Shaft

Now you can lower the column pipe, engaging the registers and seating the flange faces evenly. Insert all bolts not obstructed by elevators or eyebolts and tighten the nuts uniformly. When you have enough bolts to carry the weight of the assembly safely remove the lower elevators and assemble the rest of the bolts, making sure all holes are filled and that all nuts are secure. Lower the assembly until again it rests on the beam clamps.

Wipe the upper end of the shaft clean of oil to a point several inches below the journal. After this point on the way in, don't let oil run down the shaft or into the pipe as it will deteriorate the rubber line shaft bearing. If the

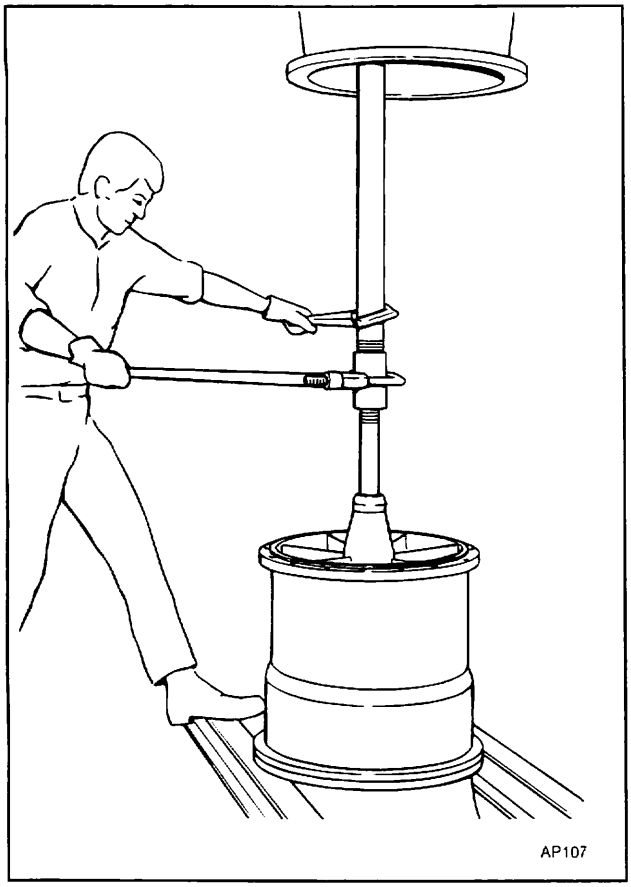

Figure 23. Connecting Open Line Shaft Assembly

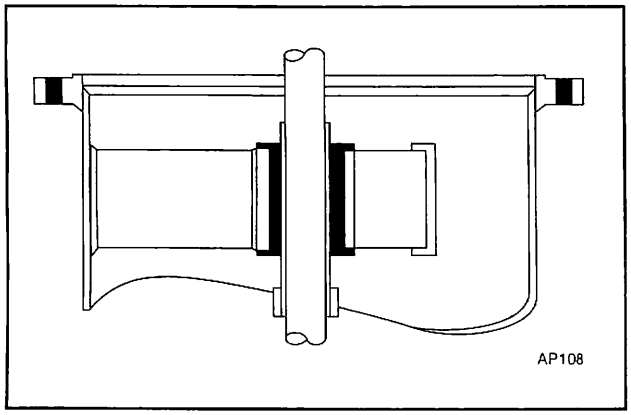

Figure 24. Open Line Shaft Bearing, Welded Configuration

line shaft bearings in your pump are secured in a hub fastened to the column pipe by welded ribs, Figure 24, the bearings will install as part of the pipe assembly.

However, if your line shaft bearings are assemblies separate from the pipe, Figure 25, you must install them in the top of each pipe joint. Place a line shaft bearing over the projecting end of the shaft. Slide the parcel down until the retainer rim seats solidly in the column flange register. Check to see that the rubber bearing is located properly over the shaft journal. It

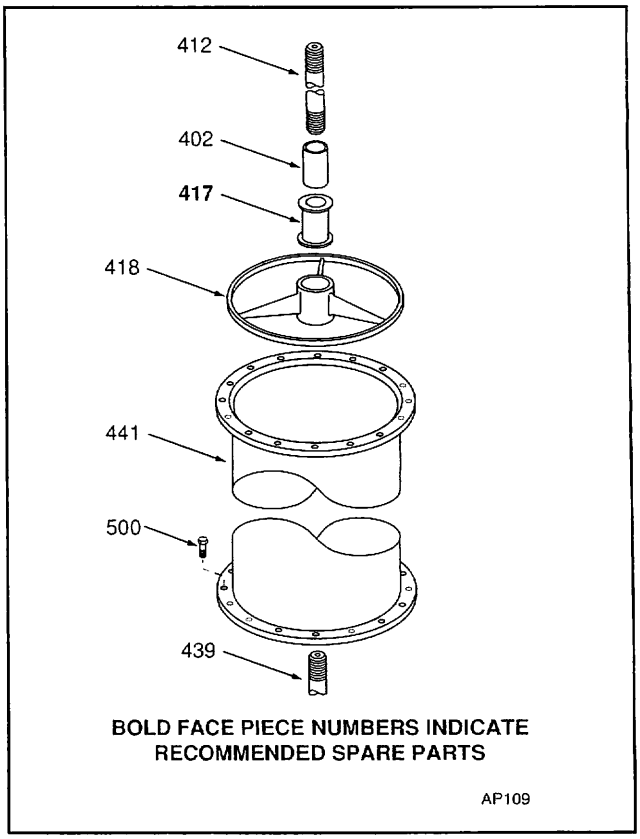

Figure 25. Open Line Shaft Bearing, Separate Configuration

should be possible to center the shaft so as to insert the spider rim into the register with little or no force. If the shaft bears heavily to one side, investigate immediately for cause before proceeding. Never continue with installation if shaft does not center freely at bearing retainer as this indicates a misaligned column pipe or bent shaft, either of which will eventually cause trouble.

When all components are centered properly and the journal location is acceptable, cover the open pipe end and proceed with installation of the next column section. Repeat the same procedures with all additional sections.

The discharge elbow/mounting base section is usually sent to you with the packing box installed. Remove this assembly complete with its gasket and capscrews and store in a clean safe place. Insert the top line shaft into the elbow/base section and join the bottom end of the resulting assembly to the pump column in the manner described for all column joints. From this point on, the pump must be handled by the lifting lugs on the discharge head shown in Figure 12. Never lift with eyebolts tapped into the holes for securing the driver. They're inadequate to support the weight. Clean the bottom face of the mounting plate and, if pump is to be grouted, apply a heavy coat of grease to the underside.

Raise the unit a few inches to remove the beam clamps and elevators, then let down slowly and carefully, positioning the base with respect to the discharge piping system, if any, and engaging the anchor bolts if used. Continue to lower until the base contacts the foundation and the weight of the pump is transferred to the mounting structure. Effect this transfer very gradually without a bump. Be sure the pump is in a plumb vertical position with full contact base to mounting surface.

Retrieve the packing box assembly. Place the gasket in position on the mounting flange in the discharge elbow. Loosen the gland by backing off the gland nuts slightly. Slip the box very slowly and cautiously down over the shaft and into place in the elbow with the flange seated firmly and evenly. The shaft should center and allow the box to enter the register without forcing. Oil the capscrews and use them to secure the flange evenly.

Refer to stuffing box sectional drawing for packing instructions.

Before first startup, study the run in procedure described in Section 13. Again check the installation to make sure the pump hangs plumb and that the shaft is easily centered without force. It should be possible to correct deviation in either of these areas by proper use of wedges and/or shims under the base.

When all is satisfactory, go on to Section 9 for the next procedure.

SECTION 9
LUBRICATING THE PUMP

A. GRAVITY FLOW OIL

If your pump is designed for gravity oil lubrication with an enclosing tube around the line shaft, examine the oil reservoir and the oil feed line, making sure they are clean and without obstruction. Figure 26 will show you the parts involved. Attach the reservoir assembly, to the driver pedestal by its bracket.

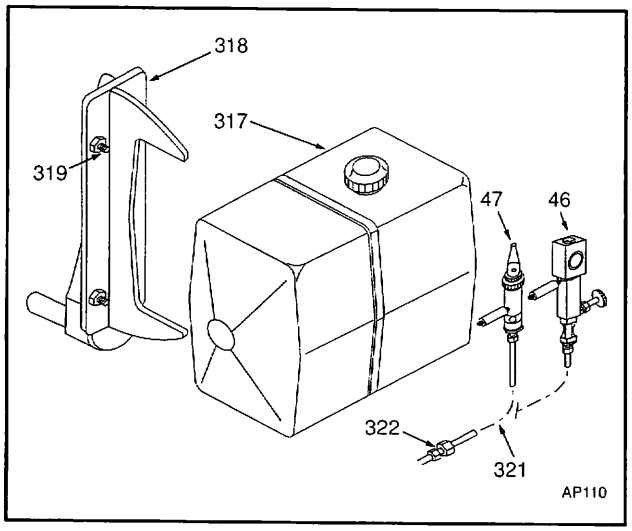

Figure 26. Lubricator

If your lubrication system is automatic, you will have Item 46, as shown in Figure 26. If system is manual, this part is not needed. Keep the cover assembly on the reservoir at all times to prevent entrance of foreign material.

Connect up lubrication system as illustrated in Figure 27 using the parts depicted in Figure 26. Adjust the lubricator valve, Item 47 to permit oil to drip at the rate of approximately one drop per second. With automatic lubricators, you'll have to complete the electrical connections to the solenoid valve, Item 47, so it can be operated to allow flow of oil to the tension bearing.

If it isn't practical to energize the solenoid at this time, you'll have to prelubricate the pump manually. Remove the pipe plug in the top of the tube connector and fill the upper cavity with approved turbine oil at least three times so the oil will run down into the enclosing tube.

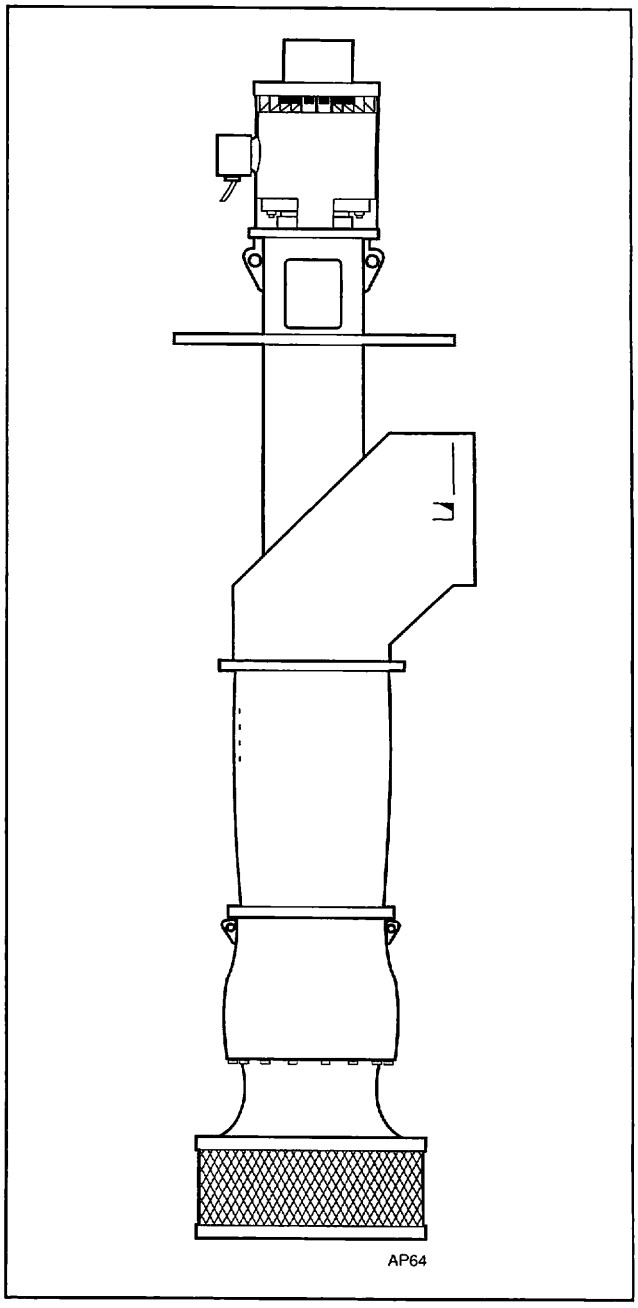

Figure 27. Lubricator Location

Before first start, verify that the oil reservoir is full and that the lubricant can flow freely into the enclosing tube. Allow oil to drip for fifteen minutes while checking all related procedures to be sure all is ready for startup. After starting, be sure the oil continues to drip into the pump during operation. You may find it necessary to apply a small amount of oil from a can to the point where the shaft emerges from the tensioning nut in the

discharge head. This should only be required during the first few minutes of operation.

After logging about one half hour running time, adjust the flow on the manual lubricator to about thirty drops per minute and run at this rate for the first ten operating hours. When a solenoid control is not furnished, shut off manual lubricator during idle periods. After running successfully for about ten hours, reduce oil flow rate to eight drops per minute maximum for permanent operation.

B. PUMPED LIQUID

If your unit is designed to be lubricated by the pumped liquid, there is little if anything for you to do since the pump is, in effect, self lubricating. All it requires is an adequate supply of cool, non-aerated liquid, free from suspended solids or gases in solution. All you need do before installation is to make sure the bypass ports in the discharge bowl are closed as described in Subsection 8B.

If your pump must be idle for any prolonged period, the shaft should be rotated by hand once a week. If you prefer, you can instead spin the shaft under power once a week provided you have adequate liquid over the pump suction.

Your packing box has a grease fitting in the top. It is not often necessary to use this fitting and you can usually ignore it. If you use it to lube the box bearing at all, apply the grease sparingly. Too much will interfere with cooling water flow through the box.

If the fluid you are to handle is something other than water, or if you expect temperature to be higher than normal, we will have furnished bearings suited specifically to that kind of service provided we knew about it. However, if your pump has been designed for a given application, we can't recommend your switching it to a different environment without first checking with the factory representative.

C. EXTERNAL SOURCE PRESSURE LUBRICATION

You may have ordered your pump equipped for connection to an external source of pressurized lubricating liquid. In our description here, we'll deal with water as the lubricant, though any suitable lubricating fluid will do so long as it's compatible with your bearing material. Be sure to use the lubricant for which your pump was originally designed.

This construction usually features a shaft enclosing tube terminating in a tension nut assembly in the discharge head. Like a similar part described in subsection 8A, this assembly is usually installed at the factory where the proper tension has already been applied to the tube for you. However, the tension bearing has a packing chamber ported to receive the lubricating water and direct it down the tube to the line shaft bearings. Rings of packing in sufficient number to prevent excessive leakage are supplied.

As a tension nut, this assembly is treated the same as we suggested in subsection 8B. If there is ever any reason for you to relieve the tension on the tube, be sure to mark the position of the nut, Item 251, with respect to its mounting surface in the head. With this, you can reload the tubing to the same tension magnitude when you reassemble. As a packing box, the connector will respond to the same general treatment we'll describe in Section 13.

If your external lubrication system is of the low pressure variety, make sure the bypass ports in the discharge bowl are open before you install the pump. For most applications, you'll need to furnish three to five gallons per minute of lubricating water at 40 to 50 PSIG source pressure to lubricate and cool the line shaft bearings. This flow is injected into a port on the side of the tension bearing. A pressure gauge on your source will only indicate system backpressure so it may not show the forty pound value we've mentioned. We recommend you have this much available should you need it. To check flow, a flow indicator must be used.

If your system is a high pressure design, the bypass ports in the discharge bowl will be plugged. You should verify this before installation of the pump. In this design, lubricating water must be admitted to the tubing under heads greater than that generated in the bowl assembly. Higher pressures will of course necessitate more frequent maintenance of packing. Do not exceed 125 PSIG injection pressure without first checking with the factory.

In either the low or the high pressure systems, we recommend you incorporate a positive indicating flowmeter and an alarm arrangement to warn of any interruption in flow of lubricating water. If flow stops, the pump must be shut down immediately until the malfunction is cleared. Otherwise, serious damage will result.

D. FRESH WATER FLUSH

If you're going to pump fluids containing abrasive particles, you'd be well advised to inject clean liquid directly into the journal areas to provide lubrication and cooling as well as to prevent entrance of abrading material into bearing zones. If you ordered your pump equipped for this service, we will have provided means for you to flush bearings continuously with clean or filtered water.

As in subsection 9C, we recommend very strongly you incorporate a positive indicating flowmeter and an alarm arrangement to warn of any interruption in flow anywhere in the lubricating system. If flow to any journal area stops, the pump must be shut down immediately until the malfunction is cleared. Otherwise serious damage may result.

Although this option is referred to as a fresh water flush system, you can use any approved lubricant that is compatible with the pumped liquid and with your bearing material, and so long as flow and pressure conditions permit. In general, for water, you should be prepared to furnish about one gallon per minute for each journal to be served up through one inch shaft diameter; you'll need two GPM for each journal from one through two inch, nearly 5 GPM per journal through three inch. Above these sizes, it's best to consult the factory.

Figure 28 will give you an idea what to expect in the way of external piping for this system. Figure 28 also illustrates the bowl assembly in which the suction case is provided with a port in the bottom of the hub through which flush, water may be injected. Assembled units are usually shipped with the piping in place but occasionally it may be required for you to install at the jobsite. When you handle these units with external piping, take care to avoid damage to pipe or tubing. Pinching or perforating a line could render the lubrication system inoperative.

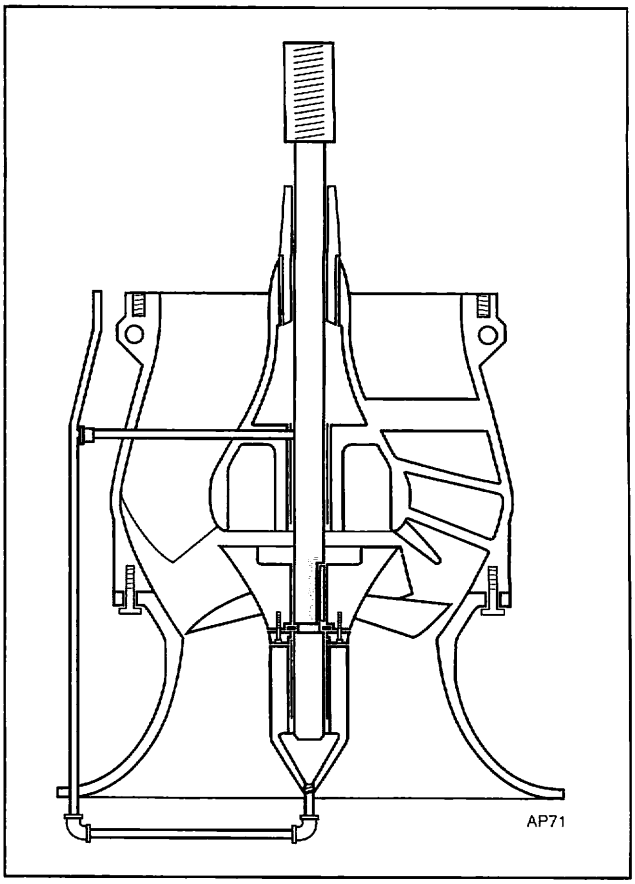

Figure 28. Bowl Assembly Lubrication
(Mixed Flow Pump Illustrated)

The flushing liquid must be free from abrasives and other foreign particles, must have adequate lubricating properties to do the job, and should be kept below 85° F in temperature. The liquid must be injected at a pressure in excess of that existing across the journal area to which it is ported A. This usually means something greater than the total discharge head against the pump.

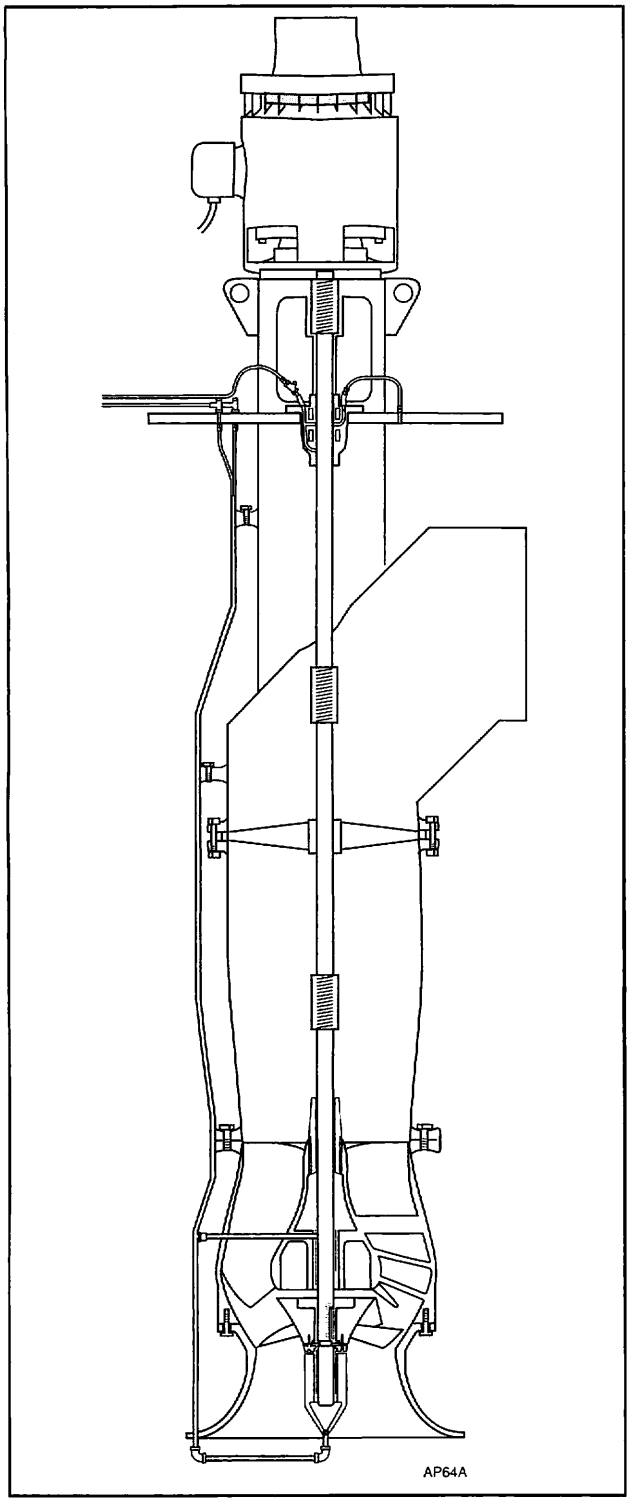

Figure 29. Complete Pump Lubrication - Open Line Shaft

Flushing at the packing box may be accomplished in a manner as depicted in Figure 30. You can make similar arrangements for mechanical seals, Figure 31. Occasionally, you may want to use a water flush design in connection with tube enclosed construction and you may accomplish this by an extension of the system described in subsection 9C.

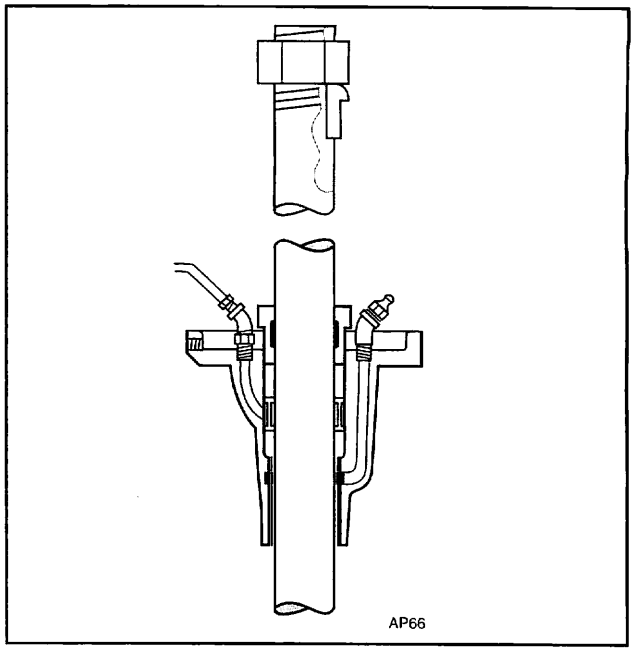

Figure 30. Packing Box Flush Provision

If you choose oil as your lubricant, you can reduce the recommended capacities or flow rates slightly. If you use this type of system to feed grease to your bearings, it is only necessary to keep the piping full and under adequate pressure at all times during operation. Here again, an alarm system may save you much trouble.

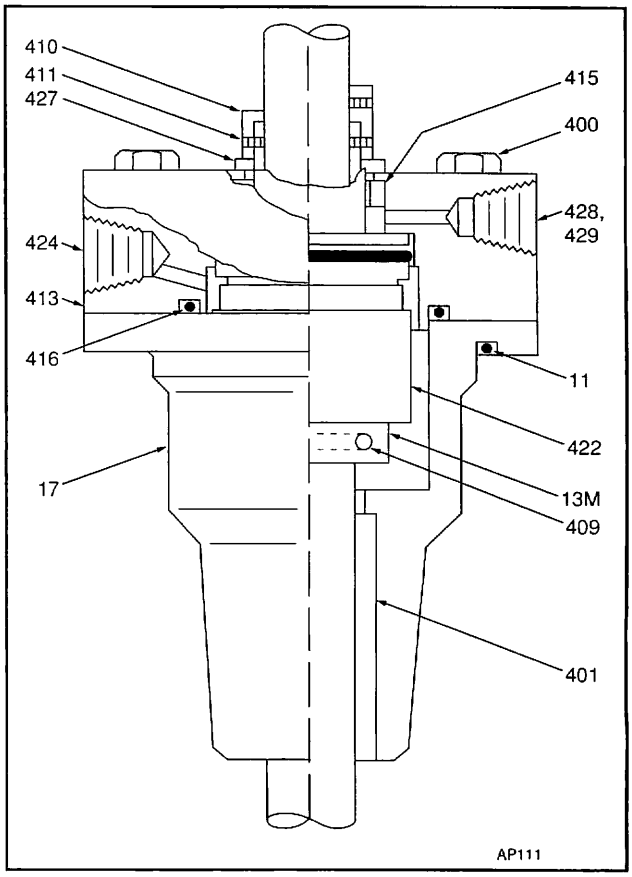

Figure 31. Typical Mechanical Seal - Ported for Flush System

SECTION 10
INSTALLING THE DRIVER

Uncrate the driver but leave it attached to the bottom skid on which it arrived. Move it to a convenient location beside the pump head, keeping it vertical at all times. Set down on firm and level footing.

When ready for installation, raise the driver off its skid to a comfortable working height, lifting it with the lugs provided on the frame.

⚠ WARNING ⚠

Stand beside the load as it hangs in the sling, never under it. Inspect and clean the mounting flange and register. If you find any burrs or nicks, set the driver on two beam supports and repair with a file.

⚠ WARNING ⚠

Don't work under the load while it's hanging from the hoist. Clean the top of the pump head and inspect it also, making any necessary repairs.

If your pump is equipped with a vertical hollow shaft driver, illustrated in Figure 32, continue right on here with subsection 10A. If you have a solid shaft driver as in Figure 33, skip this portion and be guided by subsection 10B.

A. VERTICAL HOLLOW SHAFT

Remove the driver cover capscrews and the canopy itself. See Figure 34. Remove the drive coupling and any other parts packed in the top for shipment. Match mark coupling orientation for proper reinstallation later. Place them in a clean safe place for later use. Cover all openings in the top to prevent anything from dropping into the driver. If this should happen, the object must be retrieved before proceeding.

Lower the driver slowly to the head until the register fit is engaged but with the weight still on the hoist. In the case of an electric motor, swing it around so the junction box is in the desired orientation. If you have a gear drive, as shown in Figure 35, your positioning criterion is the horizontal input shaft. Align the mounting holes and start the attaching capscrews in by hand. Transfer the weight gently from hoist to head and secure the capscrews, tightening them uniformly.

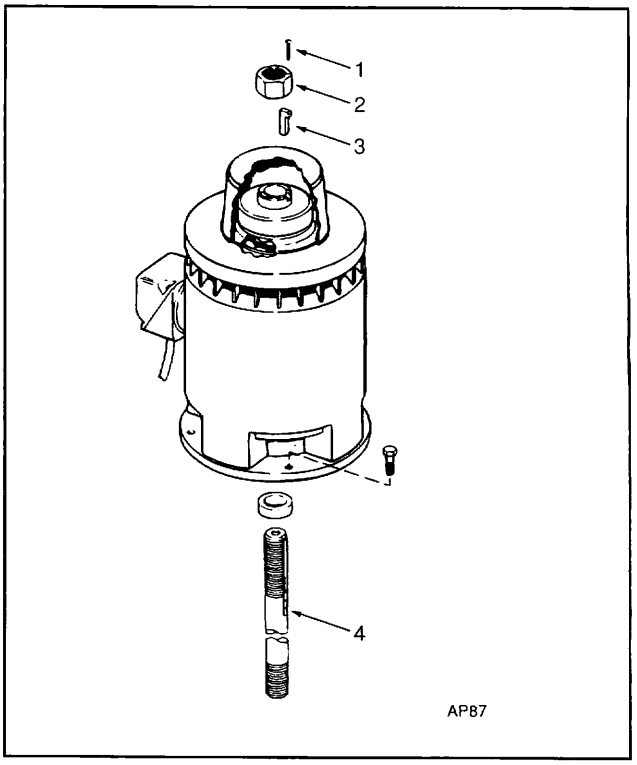

Figure 32. Vertical Hollow Shaft Driver

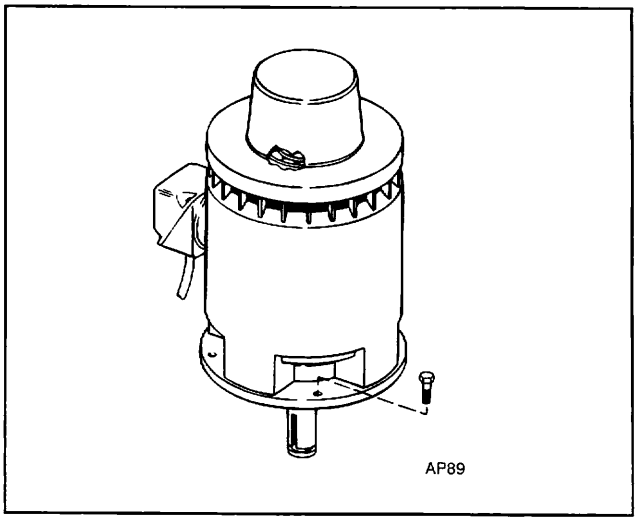

Figure 33. Vertical Solid Shaft Driver

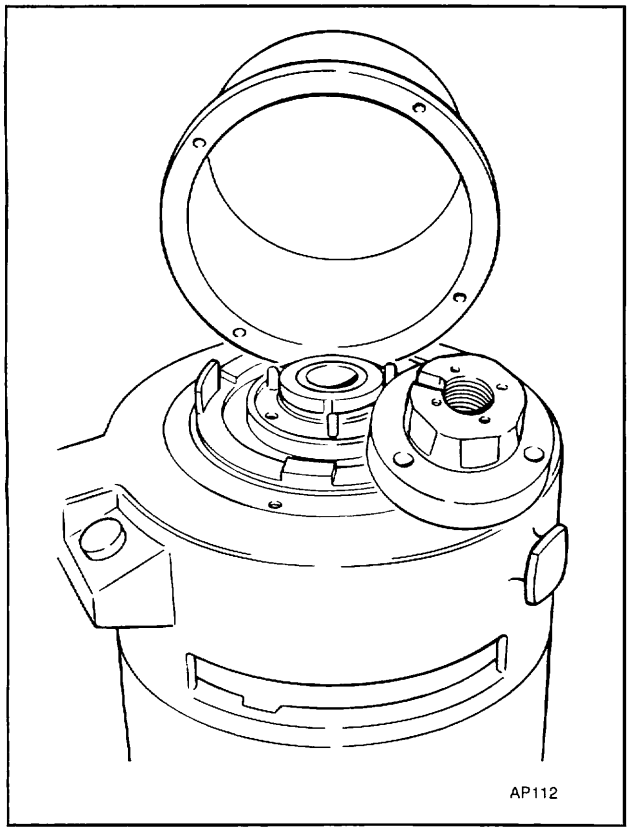

Figure 34 . Removing Driver Canopy

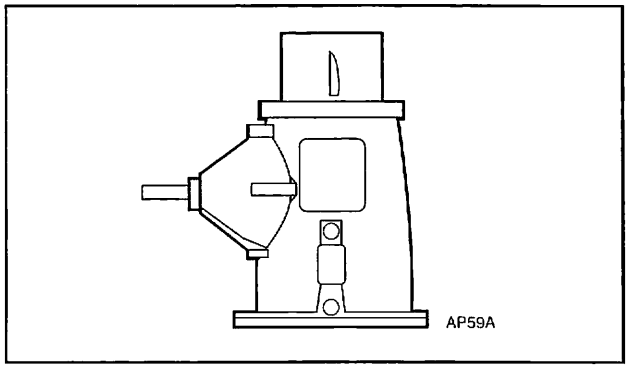

Figure 35. Right Angle Gear Drive

Please note that the lifting lugs on the driver are for handling the driver only. Never attempt to use these lugs to hoist the pump. The pump must be handled with its own lifting trunnions.

If you have a VHS electric motor, depicted in Figure 32, to deal with, open the main breaker or pump disconnect switch and make a temporary connection between the motor terminals and the leads from the starter panel. Since many electric motors are built as dual voltage machines, it is important that proper connections be made to suit the voltage of your power source. Therefore, you must check both power characteristic and motor rating for compatibility, then see the motor nameplate for correct wiring hookup.

While scanning the nameplate, determine the type of thrust bearing with which you've been furnished. If it's a spherical roller bearing, proceed with utmost caution as it must never be run at normal speed without an appreciable thrust load. For this reason, when establishing rotation as we're about to do, be very careful to just bump or tap the switch. Never close it fully until the pump is completely operational.

Otherwise, you may now energize the starter panel and buzz start the motor by switching it very quickly on and off, observing for direction of rotation and watching to see that it spins freely and is in apparent balance. Driver shaft must turn counterclockwise when viewed from the top. If rotation is clockwise, kill the power to the starter panel and interchange any two leads on three phase motors. With single phase machines, follow manufacturer's instructions.

After reconnection, energize the starter and again buzz start the motor. When you're sure you have counterclockwise rotation, mark the motor terminals and the leads from the starter box to match. De-energize the starter at the main breaker or pump disconnect switch and make the permanent power connections. Naturally, these connections must be made in accordance with all applicable electrical codes and regulations.

If your pump is equipped with a right angle gear drive, as shown in Figure 35, instead of an electric motor, the rotation check must wait until later when the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner similar to that just described with allowances for the type of power equipment. Match up the rotation arrows on the gear and the prime mover to determine compatibility, at least as far as the nameplates are concerned.

Your headshaft was probably shipped to you in a separate box. Find it and clean it thoroughly throughout its length, threads, keyway, and end faces. Now slide it down through the driver hollow shaft without bumping or scraping, keyway end up. If you were furnished with a slinger ring, assemble it to the shaft as the shaft bottom end emerges from the bottom of the driver. With the coupling already assembled to the top line shaft, join the headshaft to the line shaft, snapping the two to a firm butt.

Looking down on the driver, check to see that the headshaft stands in the center of the hollowshaft and that the driver shaft rotates freely by hand. If the shaft stand to one side of the quill, rotate the shaft from below. If the top of the bar moves around the quill, you have a bent shaft or a bad coupling joint. If, however, the shaft remains in the same off center spot during rotation, the problem is with one of the stationary parts, perhaps the

column or head assembly or, just as likely, the mounting structure. Whatever it is, it must be rectified before proceeding. If in doubt, call your factory representative.

When all is well, retrieve the drive coupling and other parts you set aside, together with the pump parts shown in Figure 32. Try the drive key, Item 3, in both headshaft and drive coupling keyways. They should produce a sliding fit. If necessary, dress the key until a free but not loose fit is obtained. Don't file the keyways. Slide the drive coupling over the headshaft, Item 4, into proper position onto its register, firmly seated perfectly flat without cocking. It should slide easily and smoothly without tendency to drag or hang up when lowered or rotated. Make sure you align match marks made at disassembly of driver coupling.

Insert the drive key, Item 3. Again it should be a free, but not loose, fit. If necessary dress the key but never the keyways. The top of the key must be below the adjusting nut seat when in place.

Thread the adjusting nut, Item 2, onto headshaft keeping in mind the left hand threads, and raise the shaft until all its weight is on the nut. This is the break-free point. With a very slight lowering, the propeller hub is felt to drag on the bowl. Mark the breakfree point, adjusting nut to driver coupling.

FOR PROPELLER PUMPS

Turn the nut counterclockwise to raise the shaft, counting the turns, until the top of the propeller hub is felt to contact the bowl. Measure the distance the shaft moved out of the nut. This dimension should correspond to the end play dimension you recorded in Section 8. Now back the nut off clockwise until the propeller is located halfway between the two extreme positions. Assemble the lockscrew, Item 1, Figure 32. The top of your driver now looks like Figure 36.

FOR MIXED FLOW PUMPS

Now turn the nut counterclockwise to raise the shaft, counting the turns, until the top of the propeller hub is felt to contact the bowl. Measure the distance the shaft moved out of the nut. This dimension should correspond to the end play dimension you recorded in Section 8. Now back the nut off clockwise until the propeller is located halfway between the two extreme positions. Assemble the lockscrew, Item 1, Figure 32. The top of your driver now looks like Figure 36.

Replace the driver canopy and secure the capscrews. Keep it that way all the time you aren't actually working under the cover. Check your driver lubricant and follow manufacturer's directions. If your driver requires provision for coolant flow, take necessary measures as instructed. Don't run equipment until all these conditions have been satisfied. Leave the power circuit open to the starter panel while performing remaining work except when you require pump operation.

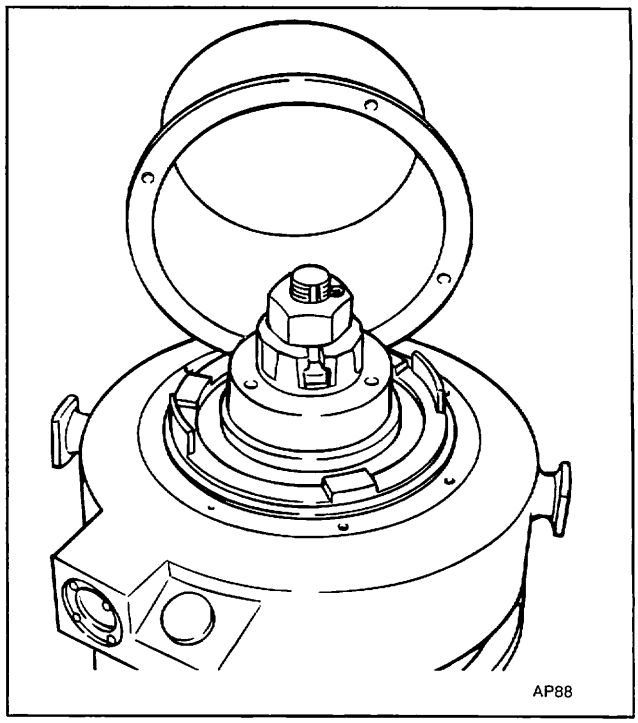

Figure 36. Driver Top

B. VERTICAL SOLID SHAFT

Lower your vertical solid shaft driver to a firm and stable position atop a pair of beams or blocks placed on the discharge head to provide ample clearance between driver shaft and pump shaft. If you have an electric motor to deal with, secure it firmly against reactive torque with chain or cable restraints. Open the main breaker or pump disconnect switch and make a temporary connection between the motor terminals and the leads from the starter panel. Since many electric motors are built as dual voltage machines, it is important that proper connections be made to suit the voltage of your power source. You must check both power characteristic and motor rating for compatibility, then see the motor nameplate for correct wiring hookup.

While scanning the nameplate, determine the type of thrust bearing with which you've been furnished. If it's a spherical roller bearing, proceed with utmost caution as it must never be run at normal speed without an appreciable thrust load. For this reason, when establishing rotation as we're about to do, be very careful to just bump or tap the switch. Never close it fully until the pump is completely operational.

You may now energize the starter panel and buzz start the motor by switching it very quickly on and off, observing for direction of rotation and watching to see that it spins freely and is in apparent balance. Driver shaft must turn counterclockwise when viewed from the top. If rotation is clockwise, kill the power to the starter panel and interchange any two leads on three phase motors. With single phase machines, follow manufacturer's instructions.

After reconnection, energize the starter and again buzz start the motor. When you're sure you have counterclockwise rotation, mark the motor terminals and the leads from the starter box to match. De-energize the starter at the main breaker or pump disconnect switch and remove the temporary power connections from the motor.

If your pump is equipped with a right angle gear drive, as shown in Figure 37, instead of an electric motor, the rotation check must wait until later when the pump is completely installed and connected to the prime mover. At that time, rotation is verified in a manner similar to that just described with allowances for the type of power equipment involved. Match up the rotation arrows on the gear and the prime mover to determine compatibility, at least as far as the nameplates are concerned.

While the driver is sitting on the blocks, examine the protruding drive shaft for any nicks or burrs. If necessary, repair very cautiously with a small file. Clean the shaft and oil it very lightly. Find the shaft coupling parts and clean them all thoroughly.

Try the drive shaft key in both driver shaft and upper coupling half keyways. You should find a very close sliding fit. If necessary, dress the key but not the keyways until you obtain a free but not loose fit. Now try the thrust collar in the shaft groove. It too should be a very close fit and may be dressed to obtain this if necessary. Try the top half coupling on the shaft.

When you have the proper fits and while the driver still sits on the blocks, insert the key in the motor keyway and slide the coupling half up on the shaft with the flange face down. With the flange above the drive shaft ring groove, assemble both halves of the thrust collar in the groove and slide the coupling back down until it rests firmly on the thrust collar, retaining the collar halves in place in the coupling recess.

If your coupling is furnished with a spacer spool assemble the spacer to the driver coupling half. If parts are matchmarked, install them accordingly. Use only the nuts and bolts shipped with the pump as some couplings are balanced as assemblies. Tighten all flange bolts securely and uniformly throughout the coupling.

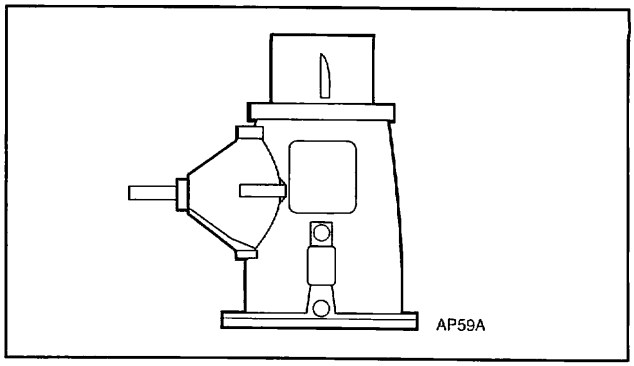

Figure 37. Right Angle Gear Drive

Inspect and clean pump shaft threads, painting lightly with good thread lubricant. If parts are stainless steel, be sure to use an approved anti-galling thread compound. After trying keys and parts as described above, insert key in pump shaft keyway and slip pump shaft coupling half well down over shaft, flange face up, leaving shaft threads projecting above coupling. Screw adjusting nut onto pump shaft with the rimmed end up, turning counterclockwise until pump shaft protrudes through threaded portion of nut by at least two threads. Remove the capscrews securing the packing box or tension nut flange.

Raise the driver just enough to remove the blocks, then lower it slowly to the head until the register fit is engaged but keeping the weight on the hoist. In the case of an electric motor, swing it around so the junction box is in the desired orientation. If you have a gear drive, Figure 37, your positioning criterion is the horizontal input shaft. Align the mounting holes and start the attaching capscrews in by hand. Transfer the weight gently from hoist to head and secure the capscrews, tightening them uniformly.

Please note the lifting lugs on the driver are for handling the driver only. Never attempt to use these lugs to hoist the pump. The pump must be handled with its own lifting trunnions.

With the pumpshaft all the way down, screw the adjusting nut up by turning clockwise until its outer shoulder is approximately one tenth of an inch below the face of the driver coupling flange or spacer lower flange, if you have a spacer spool. Pull the pump coupling up and insert flange bolts through both flanges. Assemble nuts and run up by hand until they are snug, using a light machine oil on the bolt threads.

Check for shaft alignment at the outer edges of all the flanges. They must meet evenly both at the faces and at the outer circumferences. True alignment can be further verified by using dial indicators on both the driver and the pump shafts. If you cannot obtain alignment within 0.003 inches T.I.R., call your local factory representative.

When satisfactory alignment is achieved, put all bolts under uniform tension, using a torque wrench if available. Five hundred inch pounds should be sufficient torque; i.e., a fifty pound pull on a ten inch wrench or the equivalent.

Now replace the packing box or tension nut flange capscrews. Tighten them uniformly and securely.

Make the permanent power connections to the electric motor, if equipped, checking to see that the power circuit to the starter panel is still open. These connections must be made in accordance with all applicable codes and regulations.

Check the driver lubricant and follow manufacturer's directions. If your driver requires provision for coolant flow, take the necessary measures as instructed. Do not attempt to run the equipment until all these considerations have been satisfied. Leave the power circuit open to the starter panel while performing remaining work except when the procedure requires pump operation.

SECTION 11
OPTIONAL EQUIPMENT

A. BELOW BASE DISCHARGE

Mixed flow pumps are constructed so that the discharge elbow may be either above or below the mounting base. Up to now in this manual, we've dealt primarily with an above base discharge configuration. We're including this subsection covering the below base arrangement, as shown in Figure 38, in case that's the way you ordered your pump.

In most cases, the discharge elbow, mounting base, and motor pedestal are all combined to make a one piece section from which any additional column may be suspended. This is true regardless of whether the discharge is above or below base. Essentially, the installation procedures are identical, even when the elbow is in a separate piece of column farther down, well below the mounting plate. There are, however, several considerations worthy of your attention and we'll discuss them here.

Because your column pipe in effect dead-ends above your discharge, it's possible to entrap air in the upper cavity. Therefore we furnish all arrangements of this type with a port from which the air may be released. The port may be in the pedestal or in the column itself, depending on details of construction. We recommend you make provisions for either automatic or manual exhaust. Release should occur continuously during operation but at least at each startup.

Another point of difference: since the discharge is somewhat removed from the base and the tie down bolts, the moment imposed on the column by the discharge pressure can be appreciable, even in low head pumps like yours. When this becomes a factor, restraints are required to oppose the horizontal thrust forces acting at the tee. Such forces must not be allowed to produce misalignment in the column.

As shown in Figure 38, the elbow must pass through the foundation. Because of the large size of the discharge, this sometimes complicates the structural design of the mounting base.

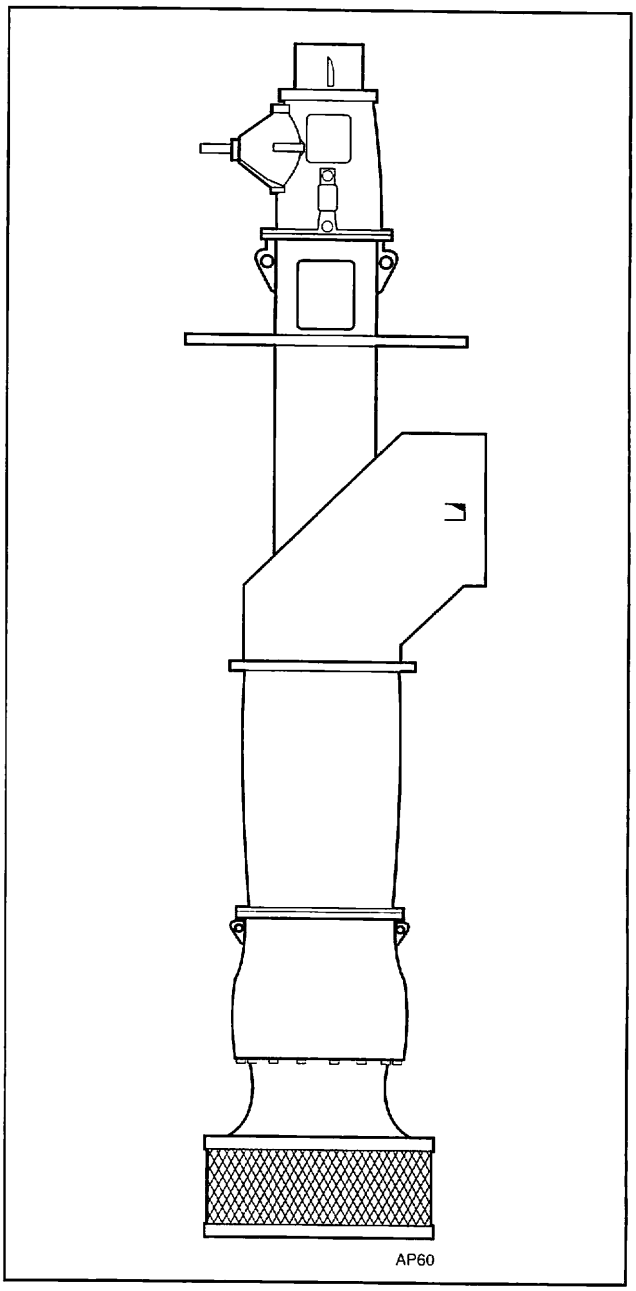

Figure 38. Below Base Discharge

B. SUCTION UMBRELLA

When indicated by submergence or inflow conditions, you may want to order your low lift pump equipped with a suction umbrella. These parts are of unusually large diameter, probably too large to pass through the hole in the foundation where you'll install the rest of the pump. The umbrella is usually, therefore, assembled after the pump is installed.

If clearances will permit its entry into the sump, you can use a single piece umbrella as illustrated in Figure 39. If the pump is large, the umbrella will be large and you may want to go to a two piece split design as shown in Figure 40. In either case, the parts are taken into the sump below the pump and installed from there, using the clips, Item 734, washers, Item 735, and nuts, Item 736, in connection with the studs on the umbrella itself. With the split arrangement, the two pieces, Items 730 and 731 must also be joined, using washers, Items 732 and nuts 733. For the big parts, it is best to block the items up under the suction bell so they don't have to be muscled up from the sump floor.

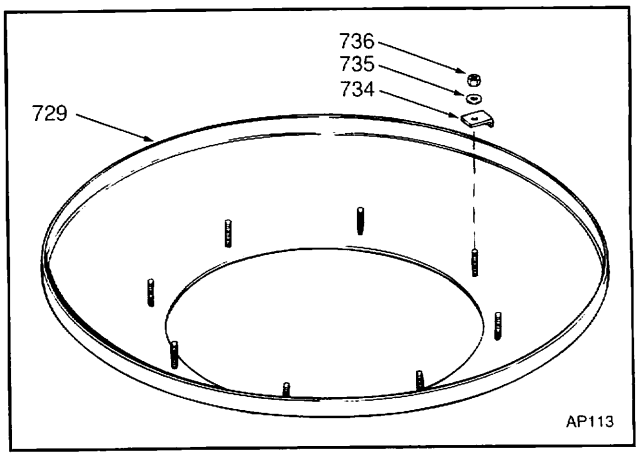

Figure 39. Suction Umbrella, Single Piece Design

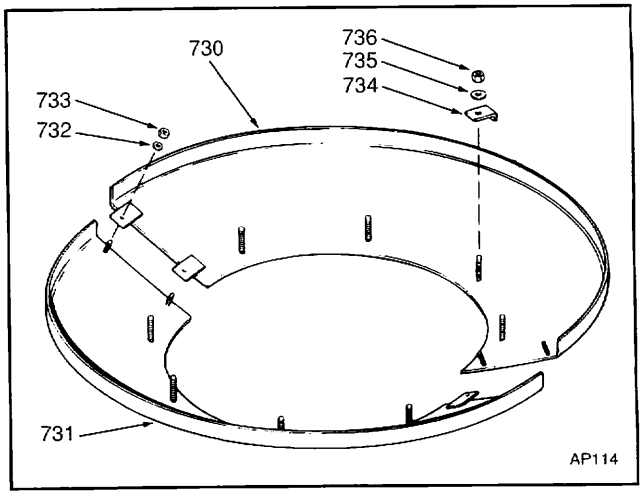

Figure 40. Suction Umbrella, Two Piece Split Design

SECTION 12
CONNECTING THE PIPING

You will be connecting your pump to your piping of course, since the pump is there to energize your system. Whatever your particular piping system is, it must be independently supported. It must not be allowed to impose stress on the pump due to weight, thermal expansion, misalignment, or any other condition.

When bolting system flanges to the pump flanges, determine that the flanges fit face to face and hole to hole before inserting bolts. Don't draw the flanges together with the flange bolts.

One way you can avoid stressing the pump parts with the system piping is to incorporate couplings designed to absorb some misalignment and vibration. Dresser type, as shown in Figure 41 and, to a lesser extent, victaulic type couplings, as shown in Figure 42, will give you a little more tolerance in fashioning your piping grids. Keep in mind, however, that there is a thrust load across such couplings that may require restraining ties. You may have some small pipes or tubes to accommodate if you are supplying coolant to the driver, for example. In such cases, it is well to protect the small lines from vibration by using hose connections at strategic locations.

If it is your intent to grout the pump base in place and you haven't already done it, this is the time to do so. After the grout has cured sufficiently, secure the anchor bolt nuts firmly and proceed with Section 13.

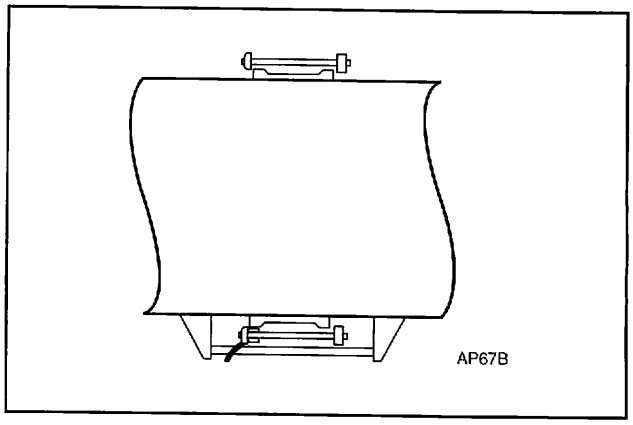

Figure 41. Dresser Type Coupling

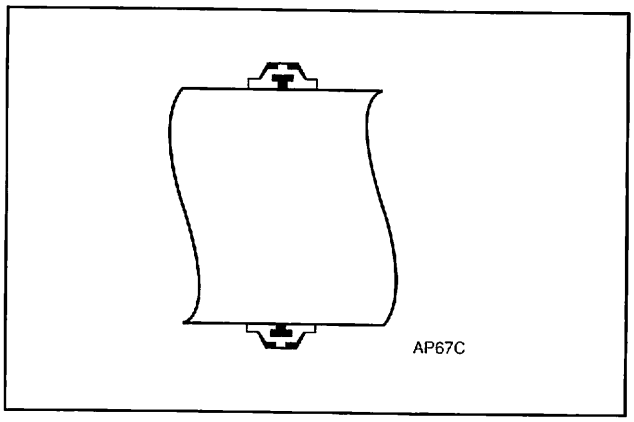

Figure 42. Victaulic Type Coupling

SECTION 13
STARTING THE PUMP

Before starting a new pump for the first time, you must establish the status of the following items:

- Driver lubrication levels must be adequate.
- Driver cooling system, if used, must be operative.
- Driver wiring has been carefully checked.
- Driver connection to power source is complete and adequately guarded.
- Pump lubrication system is operative with adequate levels.
- Pump has been through a proper prelubrication cycle.
- All accessible connections are tight.
- Pump is properly adjusted according to Section 10.
- Pump rotation is counterclockwise when viewed from top.
- Suction bell is properly submerged.
- System is in condition to deliver and accept full flow.
- All covers and guards are in place.
- All personnel are clear of equipment.

When all these conditions are satisfied, start the pump and observe the operation closely. If there is excessive vibration, unusual or excessive noise, or if the driver draws noticeably more power than expected, stop the pump. Research the cause and correct the problem before attempting a restart.

With an open line shaft pump, give your attention to the packing box. Let the pump run for ten to fifteen minutes while you allow the packing gland to leak at least one hundred drops per minute. If the leakage rate slows during this period, loosen the gland nuts to maintain constant flow. Gland temperature should level off and then drop slightly toward the end of the run. You may then draw up the nuts about one sixth of a turn every five minutes until leakage is minimized. If, during this procedure, the gland heats up so that it will vaporize water, back off the nuts and repeat the run in process as described until the temperature stays down after the gland is finally adjusted.

During the first four hours of operation, you may find it necessary to tighten the gland gradually as the packing rings are broken in and formed to fill the chamber. You must always allow a small trickle to flow through the top of the gland. During this time, check frequently to see that the box is not overheating. Should this occur, slacking off on the gland nuts may be all you need do. If excess heat continues, inspect the bypass line from the drain port and make sure there is substantial flow through it.

The grease fitting channels into the throttle bearing. Only a very small amount of standard water pump grease should be injected for startups only, otherwise not at all. Too much grease can actually interfere with heat transfer in the journal area, producing excessive temperature in the box. It's better to use no grease than too much.

As you repeatedly tighten the gland over long periods of operation, the packing rings will be compressed in the chamber, lowering the gland into the box. Additional rings are often added as required to compensate but you must never add more than two above the lantern ring since you will block the drain port. After adding any packing, probe the drain port with a wire to see that it has not become plugged.

When you eventually find it necessary to repack the box, you must first remove the remains of the old packing with packing hooks, cleaning the chamber thoroughly. The lantern cage is provided with holes in the face so that you can lift it out using appropriate machine screws or similar means. You'll find the gland, easy to remove because of its split design. You can secure the lantern ring up out of the way during repacking by tying a couple turns of string around the shaft.

At the time of repacking, always check the shaft alignment and surface finish. The finish should be smooth without burrs, grooves, or scratches. Avoid shaft runouts over 0.005 inch. You may use butt or diagonal cut packing, but we recommend the latter. We also recommend you use die cut rings for repacking, of the same size and material as the original. If you cut and fit the rings at the jobsite, be sure to cut them so the ends just barely meet when formed around the shaft. The ring joints should be located 90° to 180° from the cut in rings immediately above and below.

If your pump has been repaired or if it has been shut down for several days or more, follow the same procedures for restarting as above.

If you have any questions, please contact your factory representative.

SECTION 14

ADJUSTING THE MIXED FLOW PUMP

In Section 10, when connecting the driver to the pump shaft, you adjusted your impeller(s) about one turn up off the bowl seat(s). The pump may be operated this way, and often is, at least for an initial period if not longer. However, since your mixed flow impellers are of the semi-open variety, as shown in Figure 43, you'll want to achieve a precision adjustment if you intend to develop optimum hydraulic performance.

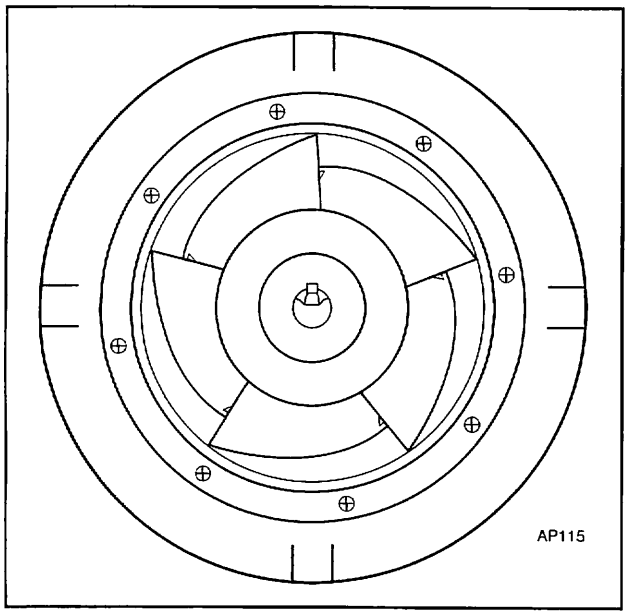

Figure 43. Mixed Flow Impeller

You'll need an ammeter to indicate power behavior. Assuming your power readings were within reason during first operation discussed in Section 13, stop the pump, remove the adjusting nut lockscrew, and back the adjusting nut down to the next lockscrew hole by turning the nut clockwise. Secure the lockscrew and start the pump, observing power behavior on the ammeter. Repeat this, backing up one lockscrew hole at a time until the ammeter first displays fluctuating power requirement. This tells you the impellers have contacted the bowl seats.

If the fluctuations are very slight and the power magnitude is acceptable, you've got the optimum setting. After some running time, the fluctuations should disappear as the impellers seat themselves.

If the power deviations are wide and the power peaks too high, the impellers are dragging too heavily. Raise the shaft slightly by turning the adjusting nut counterclockwise one lockscrew hole. Secure the lockscrew and run the pump. This is your proper setting.

If the performance of your pump gradually falls off over a period of time and you're unable to find the explanation in the system, readjust the pump as described. If adjustment is the problem, you'll restore your original performance unless other changes have taken place. It's always a good idea to check the adjustment and readjust if necessary before running a performance test on the unit. This will give you a standard of comparison for the life of the equipment.

SECTION 15
PRECAUTIONARY INFORMATION

A. RESPONSIBILITIES

There are certain areas in which the factory has no control and can therefore accept no liability. For instance, unless supervised by a factory service engineer, responsibility for installation, start up and maintenance rightfully belongs to the Owner and his authorized agents. Similarly, the following shall be the Owner's obligation and responsibility:

Suitability of foundation or mounting structure

Suitability of power characteristics

Security and safety of jobsite and site conditions

Placement and maintenance of all appropriate guards and safety devices

Suitability and performance of system to which pump is applied

The factory cannot be responsible for damages, lost time, or injury resulting from failure to comply with these instructions. The factory's obligations do not cover damage to the pump due to abrasives, gas, or corrosives in the water. They do not cover harm due to starting pump in a reverse rotation mode; neither do they cover performance when parts not furnished by the factory are used in the pump.

If you have any question, please call your factory representative.

B. GENERAL PRECAUTIONARY NOTES

Your pump is an engineered assembly of precision parts and must be treated accordingly even though sometimes the components are heavy and awkward to manipulate. Also, because they may be heavy, they must never be handled carelessly. Normal rules of safety and approved methods of practice as associated with the erection of heavy equipment must be observed in any activity related to your pump.

In addition to general acceptable industrial practice, we emphasize the following precautions:

Don't work on pumps, wiring, or any pump or system components without opening energizing circuits such as at main breaker or pump disconnect switch. This will prevent damage or injury due to "surprise" starts actuated by automatic control systems. It will also help prevent other possibilities of injury.

Don't work under a suspended load. Rest the load on positive supports when it's necessary to be underneath.

Don't run a spherical roller thrust bearing except under full thrust load. It can fly apart and cause damage to equipment and injury to personnel.

Don't forget that this equipment contains rotating parts. Use CAUTION when working near such parts to avoid injury. Always replace all guards, covers, shields, and other safety devices before startup.

Don't permit smoking in the vicinity of petroleum base solvents. Store solvents in approved containers.

Don't use lubricants that can contaminate your system and cause damage or injury.

Don't start pump while it is still rotating in reverse direction after having shut down. It is advisable to install a time delay relay on electric drives to prevent this. Non-reverse protection in the driver could also be a solution.

Don't put heavier than recommended heaters in your starter if the pump load begins to trip those furnished originally. These are protective devices. Call your factory representative for assistance.

Don't add oil to driver while running; check levels only when idle. Don't add grease to grease lubricated driver without removing the relief plug.

Don't drop parts into pump during installation or disassembly. Don't drop parts into driver when canopy is off and top is open. Parts must be recovered immediately.

Don't run pump backward. Clockwise operation (looking down at top of pump) under power can unscrew threaded shaft joints. Power requirements of some designs increase when driven backward and can thus create undesirable overloads. In certain areas of the country prone to phase reversal problems, consider phase protection in your power circuit. Note: these problems do not apply to pumps coasting backward due to return flow from system; overspeed is the circumstance to question then.

Don't allow oil, grease, or thread lubricant to contact rubber bearings or tube stabilizers.

Don't pump anything but water unless your pump has been designed for it.

Don't start the pump without proper adjustment.

Don't start a pump in which the shaft appears frozen or locked up. Free the shaft and rotate by hand first.

Don't pull system piping to pump flanges with bolts or capscrews. Install pipelines so that fasteners are used to prevent leakage only.

Don't hang the weight of suction or discharge lines and fittings on pump. Support pipe runs with blocking or concrete saddles according to best piping practice. Use dresser type couplings with thrust ties if necessary whenever possible to eliminate piping strains imposed on pump.

Don't throttle or obstruct the suction of any pump.

Don't tighten shaft packing except in increments. For example, take gland nuts up part of a turn and let pump run five or ten minutes before tightening further. If leakage water is too hot to put on your hand, back gland nuts off a little until water cools, then tighten again. Gland nuts must be adjusted evenly so as to prevent gland from cocking and forcing against shaft.

Don't change pump speed without first checking effect on power, internal pressure, and other conditions.

Don't forget that your pump is guaranteed for design conditions only as purchased.

Don't hesitate to call your factory representative or the factory when you need help or have a question.

C. OPERATION AT SHUTOFF HEAD

In the usual application of propeller or mixed flow pumps, no harm will result from operation at condition of static flow heads as long as you've prepared for that contingency. The following points should be checked and resolved before putting your equipment into operation at or near shutoff heads. Impeller adjustment must be made at shutoff head.

Thrust bearing must be adequate.

If prolonged operation at no flow is contemplated, the problem of heat dissipation may become acute since most of the shutoff horsepower is converted to heat in the available liquid. This can be reduced with an adequate recirculation system.

Propellers or mixed flow impellers usually have critical power characteristics at low flow rates. Shutoff horsepower requirements should be reviewed for possible driver overload. If your pump will start against a closed valve, you'd better review and compare the speed torque curves of your pump and your driver for complete compatibility.

You must remember that open line shaft units depend upon pumped liquid for lubrication. Fluid temperatures, if raised excessively due to lack of flow, may impair lubrication efficiency even to the point of destroying the pump.

To summarize, normal designs will easily accommodate most of the considerations listed above. However, to obtain the best possible application, you must notify the factory at the time of purchase if operation at static flow heads will be a possibility. This precaution must be observed to validate any warranty.

D. MAINTENANCE HINTS

For pump oil lubrication, use a light turbine oil equivalent to Standard Oil 0. C. Turbine Oil #32 or a good grade of mineral oil with proper additives having a viscosity equal to SAE #10. Always be sure your lubrication system has plenty of oil and is operating any time the pump is running.

Remove the old oil from your driver at least once a year or according to the driver manufacturer's instructions. Flush with kerosene and refill. Follow manufacturer's directions carefully as to method and type of lubricant. Replace self lubricated driver ball bearings in about five years. It is generally less expensive to replace these before they fail.

Replace all shaft packing on open line shaft pumps after maintenance has required the addition of no more than two rings. Always let packing box leak slightly at top of gland to protect the shaft and add life to your packing.

Be aware of changing conditions in your system. Any change from the original condition or any variation in the system can create an undesirable reaction in the pump as the energizer of the system. If your system head has increased, for example, check your performance curve, your thrust bearing capacity, and other details for the new conditions.

We recommend you consult your factory representative before attempting to remove or repair your pump. If it becomes necessary to work on your equipment, be sure to review all instructions for operation and maintenance. You may want to consider contracting for the services of a trained factory service engineer to guide you.

SECTION 16

RECOMMENDATIONS FOR PUMP STORAGE

Our Pumps are carefully prepared for shipment from the factory. Skids and boxes are intended to resist mechanical damage from normal handling and preservatives are used to protect critical surfaces from routine conditions of weather and corrosion in transit. Effective life of factory-applied protection, however, can vary widely under different circumstances and should be considered adequate only to secure the equipment during shipment and installation. If installation and operation cannot be effected within a reasonably short time after delivery to jobsite, the product is assumed to be in storage and subject to precautionary procedures as described below.

With common sense as the best guide, store the equipment off the ground in an indoor location where it will not be exposed to excess moisture or humidity, extreme weather conditions, blowing dust corrosive fumes, or other harmful factors. If storage must be outdoors, provide at least a roof shelter and cover all pieces securely with six mil polyethylene sheet or equivalent.

Inspect pump periodically to assure that factory-applied preventives remain intact. With the first sign of deterioration, renew the protective measure in question. If rust spots appear on machined surfaces, clean with fine emery cloth and apply approved rust preventive.

If pump is assembled, it should remain on skids just as delivered. Packing rings and/or mechanical seals if assembled in place should be removed from the pump and stored in a box. If pump is unassembled, inner column joints should be nested inside eduction column pipe to save space as well as to provide greater protection. All threads must be covered with wrapping and tape or with suitable caps. Never stack anything on top of column joints.

Electric motors and right angle gear drives must be handled vertically at all times. See individual manufacturer's storage instructions for motors, gears, IC engines, universal shafts, other appurtenances and accessories.

For long term storage, but not to exceed 36 months, the following additional precautions should be observed:

- Air dry hydraulic portion of pump to remove any residual liquid.
- Cover and seal with pressure sensitive waterproof tape all openings into flowstream areas.
- Wrap shaft extension with pressure sensitive waterproof tape.
- Coat rabbet fit on driver and pump head with heavy grease, along with any other exposed machined surfaces.
- Completely cover upper part of motor and seal with tape. Consider providing space heaters for motors if stored under damp or humid conditions.
- Fill any external lubrication piping or flush lines with rust preventive.
- Store all parts in a clean dry area with ambient temperature reasonably constant between 40 and 100 degrees F.

Upon removing a pump from any type of storage, proceed as follows:

- Consider contracting with the pump manufacturer for the services of a factory trained field service engineer or technician.
- Remove all covers and tape from openings, drivers, and threads.
- Remove grease and rust preventive from mating fits and running surfaces.
- Clean all threads and mating fits thoroughly.
- Assemble packing and/or mechanical seal if applicable, using appropriate instructions.
- Flush any external lubrication piping to remove rust preventive.
- Follow individual manufacturer's instructions regarding driver and other appurtenances.
- Inspect all visible parts.
- Install pump and start up in accordance with applicable instruction manual.

Occasionally, a pump is stored in its installed position for protracted periods while related equipment is made ready or perhaps simply in seasonal shutdown. In this event, pump and driver shaft must be rotated manually once a week or the unit may be power run every two weeks, using proper startup procedures at each start.

These procedures are offered as a guide to assist users and may be construed to amend, to extend, or to modify in any way the pump warranty.