

Installation and Maintenance
SERIES 1130
Deep Set Direct Coupled
Vertical Turbine Pumps

AURORA PUMP

A UNIT OF GENERAL SIGNAL

1000 W. 15th Street • Chicago, Illinois 60604 • (312) 348-1400

RECOMMENDATIONS FOR STORAGE AURORA VERTI-LINE PUMPS

Aurora Verti-Line 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 suction 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 not be construed to amend, to extend, or to modify in any way the AURORA Pump warranty.

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SECTION 1

A WORD TO THE OWNER

Efficient performance. Satisfactory operation. Dependable service.

We know these are the things you want from your Aurora Verti-Line deep well turbine pump and we've designed it accordingly. We've prepared this booklet to 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 Aurora service representative to supervise your installation and/or startup.

Because of variations in jobsite environments and installation requirements, we've had to be somewhat general. However, we have listed what we believe are 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 course of the work, we urge you to see your local Aurora representative immediately. Please be able to identify the unit by its serial number. We stamp the number on the nameplate that can be found on the discharge head and on the bowl assembly.

Figures 3 and 4 will show you 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 we've described in this book, omitting material not applicable to your particular pump. Study in detail the precautionary directions emphasized in Section 17.

Then, when you do start the work, 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 Aurora disassembly, assembly and troubleshooting manuals.

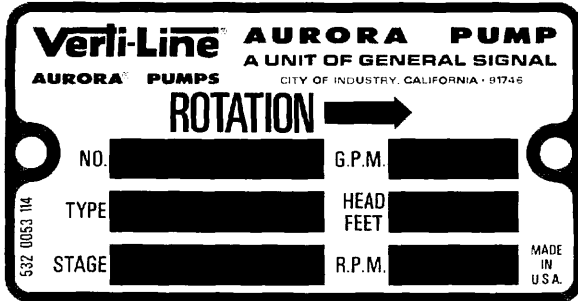


Figure 1. Discharge Head Nameplate

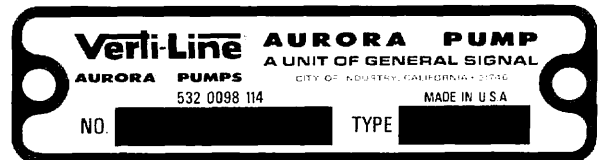


Figure 2. Bowl Assembly Nameplate

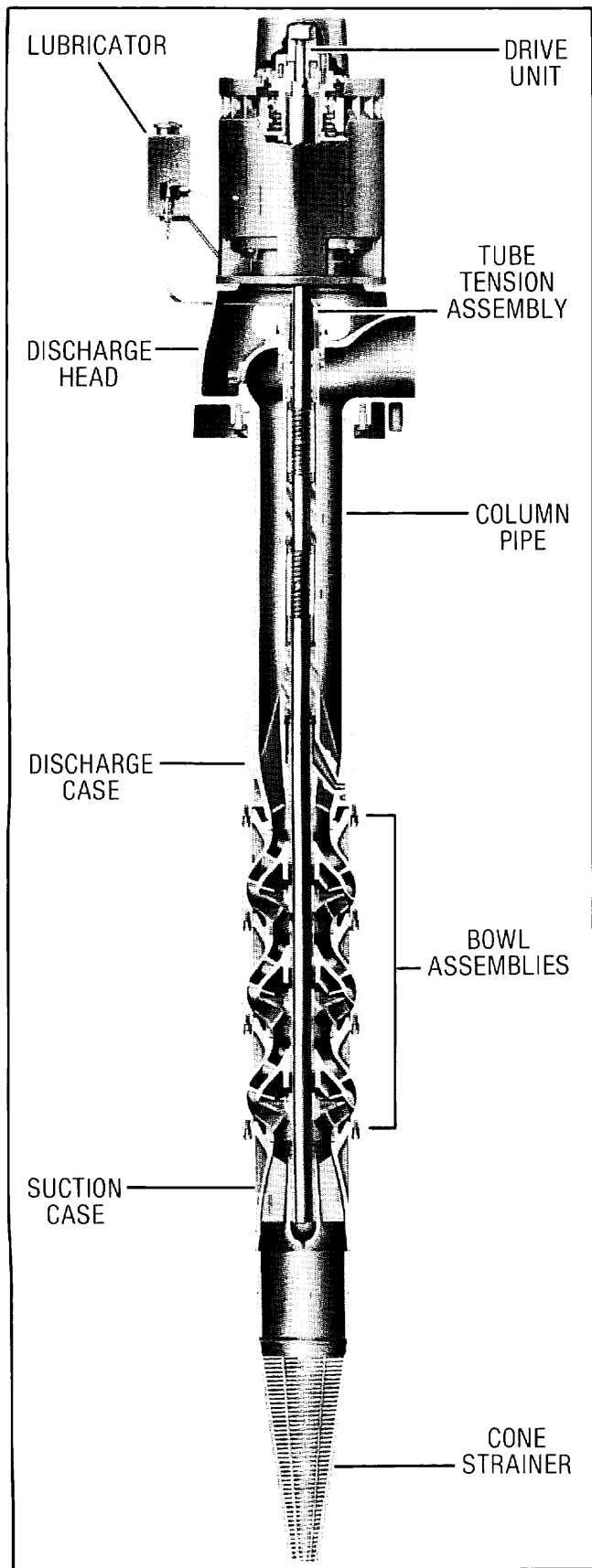


Figure 3. Deep Well Turbine Pump - Enclosed Lineshaft Configuration

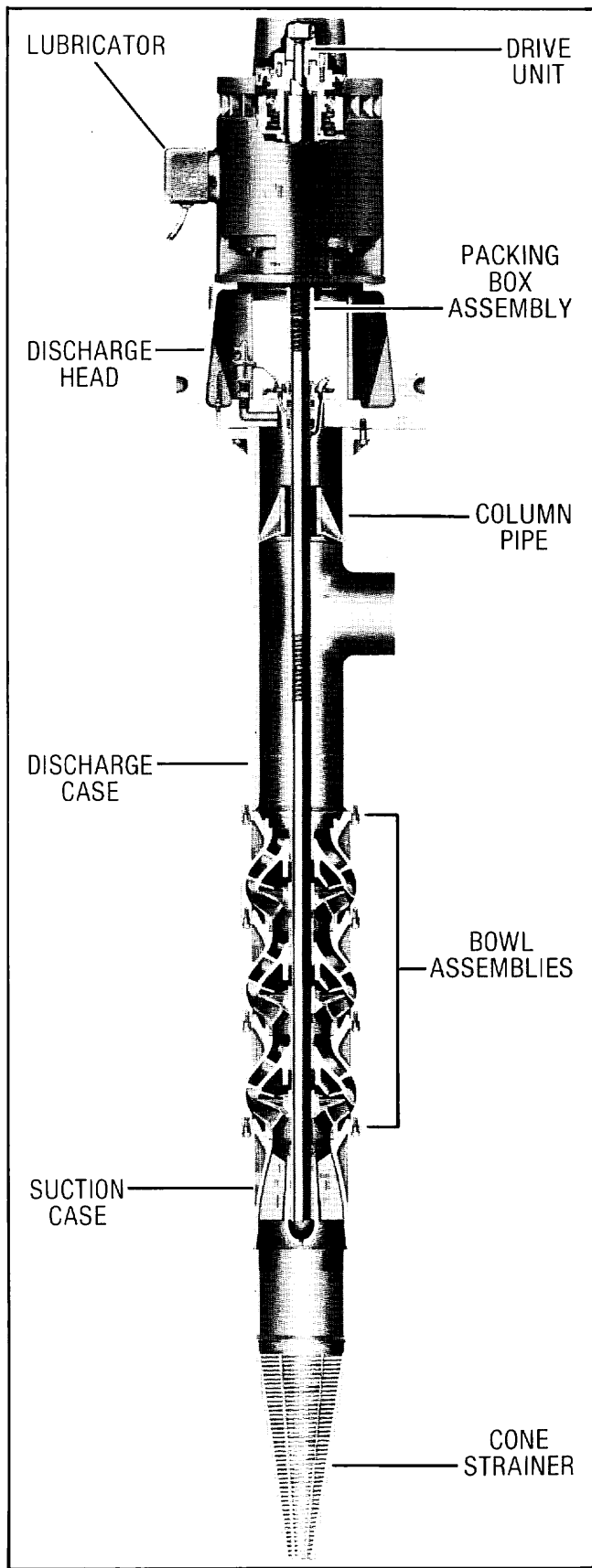


Figure 4. Deep Well Turbine Pump - Open Lineshaft Configuration

SECTION 2

THE WELL

Examine the well carefully before you start installation procedures. Be sure sand hasn't covered any of the perforated sections. Refer to Figure 5. If you don't

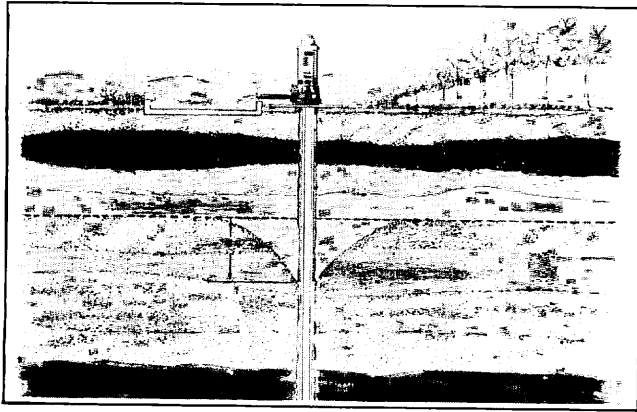


Figure 5. Typical Well Installation

already know, now is the time to determine that your well is of ample diameter and depth, and is straight enough to receive your pump. Allow at least four feet from the strainer to the bottom of the hole.

If you have any doubts at all about the straightness, we recommend caging and plotting. As an alternate procedure, you can lower a test section down the well to the eventual setting of the pump bowls. The test piece is usually a pipe as big around as the largest diameter on the bowl assembly and 1-1/2 times the length of the bowl unit.

Never start an installation until all of these questions are satisfied.

By the time you receive the pump at the jobsite, the well should have already been developed and tested. We cannot recommend the use of your new Aurora pump for this purpose since it can be classified as unusual abuse.

SECTION 3 THE FOUNDATION

Your pump requires a foundation suitable for the weight of the entire unit when full of water. While the preferred foundation material is solid concrete, you can use adequate beams or timbers within reason. Regardless of material, the foundation must be properly engineered, structurally sound and stable, able to withstand and prevent objectionable vibration. It must not exceed allowable soil loading for your specific site. If you intend to use beams to support a belt drive assembly, you must position the beams parallel to the drive -- never at right angles.

Most Aurora Verti-Line pump heads are designed so that there is no projection below the base to interfere with the foundation or well casing. However, once in a great while you may find a model with unusual size combination that will interfere if precautions are not taken. You can observe the bottom of the head for this at the same time you check for location of mounting bolt holes. If interference appears possible, merely construct the foundation so that the well casing terminates in a recess sufficient to clear the pump projection. The foundation must also permit the installation of an airline, Section 13, if one is furnished.

We suggest anchor bolts on any installation, but there are a few instances where we must insist on them.

These would include pumps furnished with belt drives, pumps with settings less than 50 feet, and pumps with discharge pressure exceeding 10 PSIG. We prefer the sleeve bolt design shown in Figure 4 and you probably will too since it is much easier to use. Alternate bolt designs are illustrated, however, for your information.

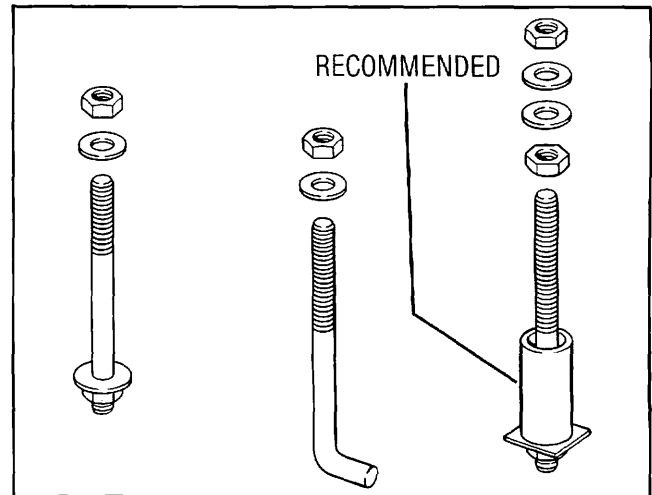


Figure 6. Foundation Anchor Bolts

SECTION 4 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 properly designed pump setting rig similar to that shown in Figure 7. With the rig in extended position, you must be able to erect the crown block so that the load hook will clear eighteen feet for ten foot column sections and twenty eight feet for twenty foot joints, whichever your pump components dictate. The hoisting equipment will depend on the type of tripod or rig you select but it must be of sufficient strength and power to provide a minimum safety factor of 6. Obviously, for heavier pumps and deeper settings, your installation equipment must be stronger and heavier in direct proportion.

Your load hook should be of the safety type with an easy working swivel and should be truly centered over the axis of the well. If your well is slightly out of plumb, you may have to compensate by shifting the crown block as the assembly becomes progressively longer during installation and displaces laterally with respect to the well head.

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

Lifting equipment (See Figure 7)

Steel beam clamps (See Figure 8)

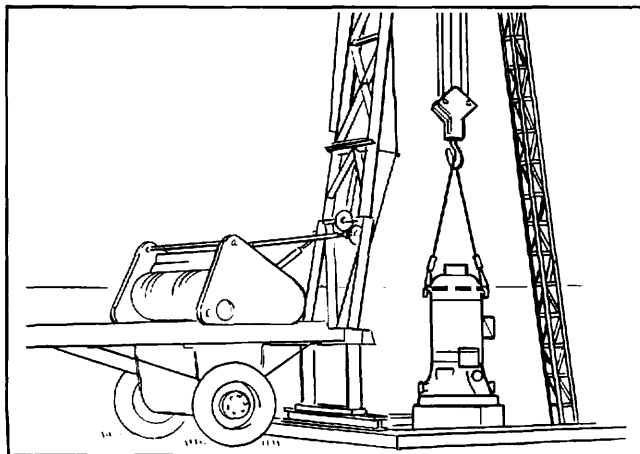


Figure 7. Pump Installation Rig

Steel lifting elevators of approved type and proper size (See Figure 9)

Cable sling about 10 feet long of adequate size for loads (See Figure 10)

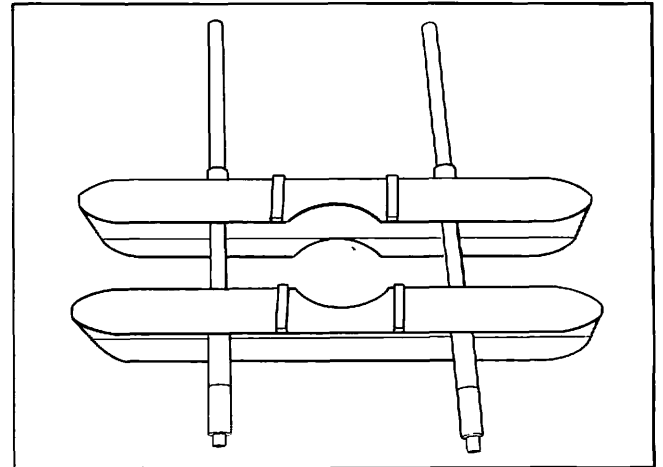


Figure 8. Steel Beam Clamps

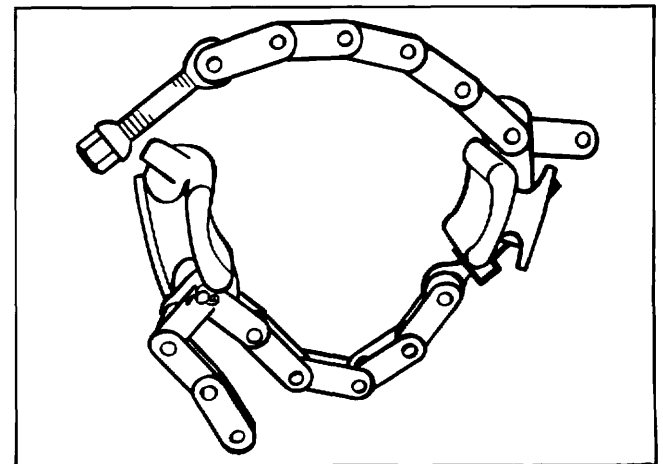


Figure 9. Elevators

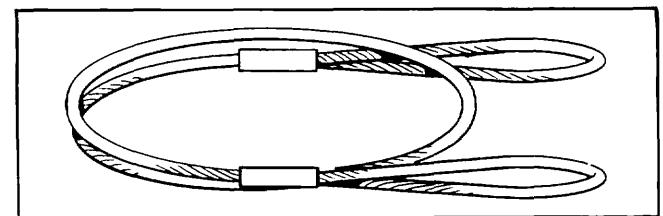


Figure 10. Cable Sling

Tube tension wrench (See Figure 30)
Chain tongs
Medium size pipe wrenches
Twelve foot length 3/4 inch rope
Ordinary set of mechanics tools (See Figure 11)
Pipe cutter or hacksaw
Wire brush
Assortment of files
Pliers and wire cutters
Pocket knife
Sacking or cover for bowl unit and column sections
Clean rags
Thread compound -- Use anti-galling type for stainless steel parts
Solvent -- Gasoline, distillate, or kerosene in recommended containers
Turbine oil -- One gallon for each 100 feet of column
Shims and wedges
Grouting material -- Non-shrink type

Note

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

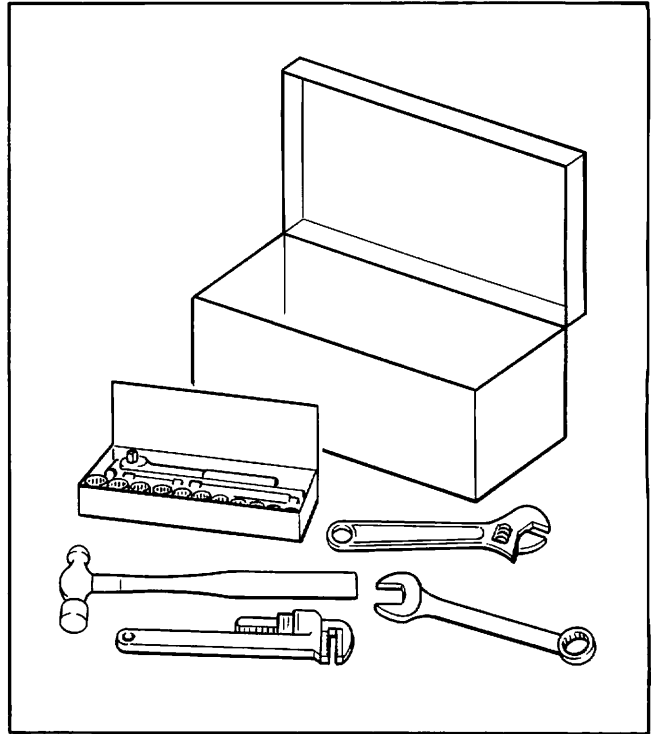


Figure 11. Ordinary Set of Mechanics Tools

SECTION 5

RECEIVING THE PUMP

Your Aurora Verti-Line pump was inspected on the carrier just prior to leaving the factory. When you receive it at your wellsite, look it over carefully for any visible damage to parts, skids, boxes, or dunnage. If shafting is crated, open the crate carefully to inspect and make a count but leave the shaft in the box for protection until each piece is ready for installation. Take

inventory on the truck or during the unloading process. We don't want you to sign for damaged or incomplete shipments unless you take the appropriate exceptions. Report such instances immediately to the Aurora sales office and to the transportation company involved giving full particulars and confirming all verbal understandings in writing.

SECTION 6

UNLOADING THE PUMP

We cannot urge you too strongly to exercise extreme care in handling and installing all parts, particularly the shaft and enclosing tube. All items are precision machined for proper alignment and, if dropped, banged, sprung, or mistreated in any way, misalignment and malfunction will undoubtedly result. Parts which are too heavy to be lifted from the transporting car or truck should be skidded slowly and carefully to the ground so as to prevent injury. We ask you never to unload by dropping parts directly from the carrier to the ground. Never use crates in which parts are shipped for skids.

If your pump is short enough, say a hundred foot setting or less, you might be able to install directly from the truck that brought it to you. If the truck driver has the time and if he can back his vehicle in close to the wellhead, the parts can be handled directly from the truck bed by the pump rig as the installation progresses, as shown in Figure 12.

For longer units, lay out column pipe and bowl assembly on suitable timbers or staging to keep all material out of the dirt. See Figure 13. Position coupling ends toward the wellhead. Inner column joints consisting of shafting and/or tubing with lineshaft bearings will have been preassembled for you at the Aurora factory into proper lengths to match the column pipe. Insert these assemblies into the matching pipe sections, with the projecting lineshaft bearing pointing toward the well. See Figure 14 for enclosed lineshaft and Figure 15 for open lineshaft.

Tube faces should be inspected to see that they are free from burrs or nicks and, in the process, should be wiped clean. Sections that have been assembled at the factory should be checked for tightness by your installer to insure none have loosened in transit. He should also check each joint for straightness as a bent tube cannot be used. Keep ends covered until each is ready for installation.

If the lineshaft was received 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. Keep ends covered until ready for 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.

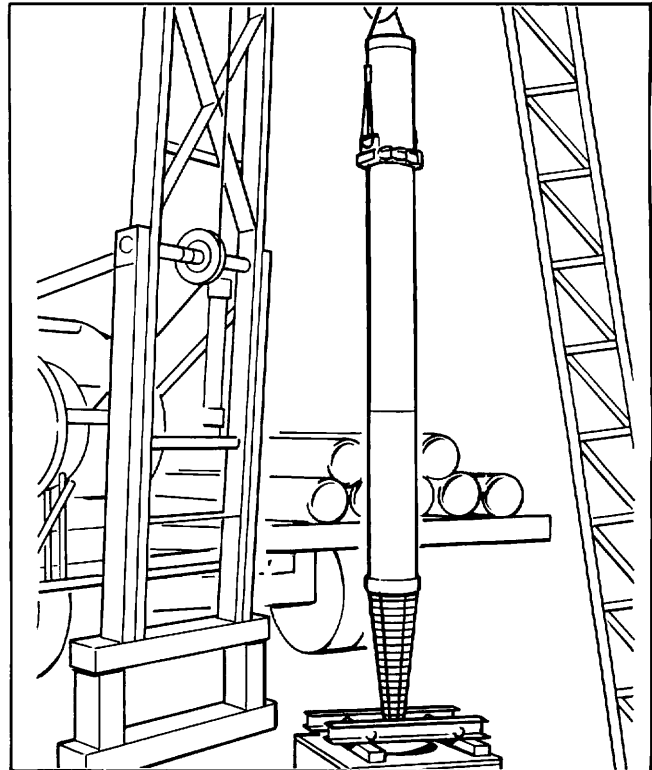


Figure 12. Installing Directly From Carrier

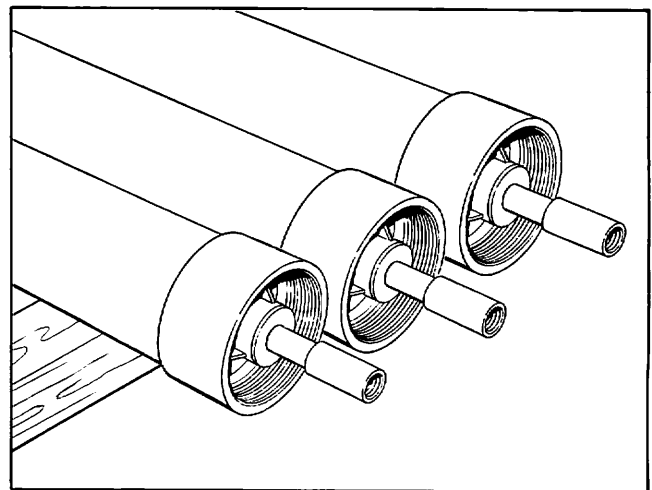


Figure 13. Readied for Installation

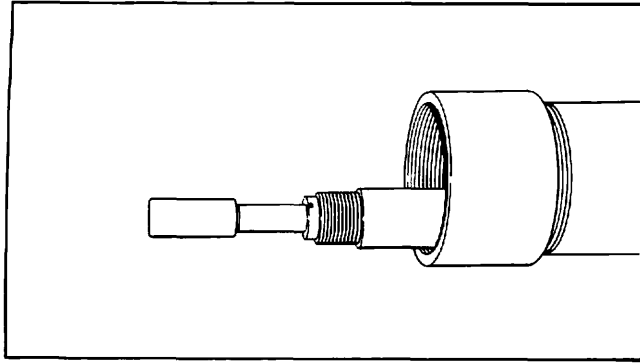


Figure 14. Enclosed Lineshaft

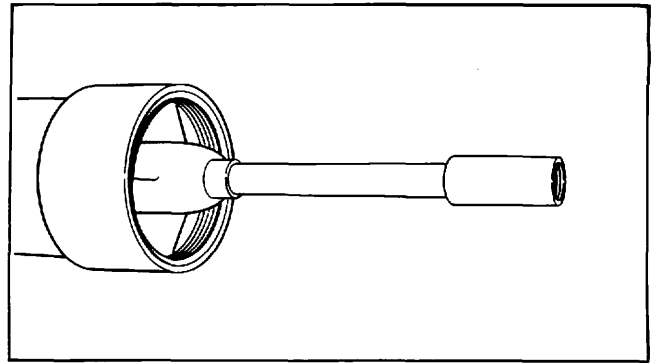


Figure 15. Open Lineshaft

SECTION 7

INSTALLATION - GETTING STARTED

Your're now ready to start actual installation. Clear the work area at and around the wellhead so installers can move freely and with safety. This will also decrease the chances for foreign material or objects to fall into the pump as it is lowered into the hole.

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 power is applied for tightening. Any harm resulting from cross threading or foreign material must be repaired with a file before applying force. Damage to end faces of threaded parts must be properly corrected before continuing. If not repairable, the part must be replaced. It's clearly worth your while to use care.

Set the beam clamp, shown in Figure 8, on the foundation over the well and open them wide enough for suction pipe and/or strainer to pass through. Seize the suction pipe with elevators, shown in Figure 9, two feet below the upper end so that pressure from the jaws will not distort the threads. Raise as shown in Figure 11, taking care not to damage the strainer, if furnished. Control and guide the bottom end of the pipe with a drag line. Position it directly over the well and lower it into the casing until the elevators rest on the beam clamps. Secure the clamps to hold the load as is. Paint the suction pipe threads with oil or thread compound.

If your pump is of the open lineshaft construction, skip the next few paragraphs and go on to Section 9. If you have the enclosed lineshaft design, continue right here with Section 8.

SECTION 8

INSTALLATION - ENCLOSED LINESHAFT

a. Column Assembly

Examine the bowl assembly to determine that the discharge case coupling, if used, is tightly butted in place and that all the stage connecting nuts or capscrews have been tightened securely. Inspect the bypass ports in the discharge case 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 16.

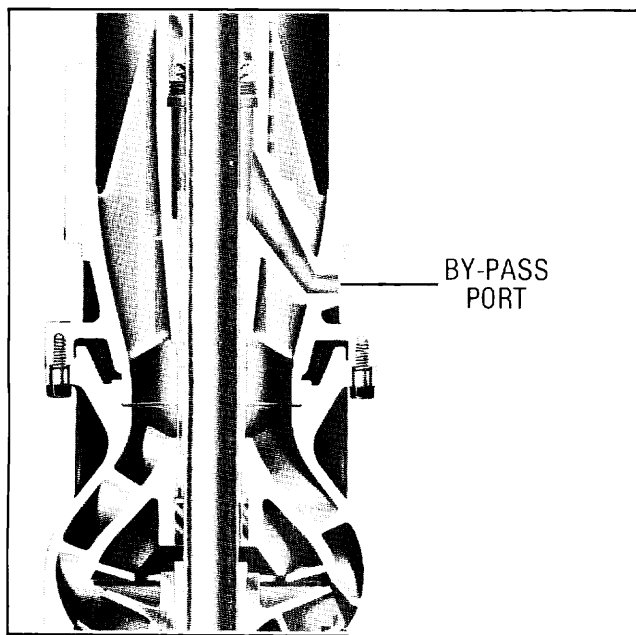


Figure 16 By-Pass Port

Determine the amount of bowlshaft endplay and record it. Push the shaft all the way into the bowls so impellers are firmly seated. Mark the shaft where it emerges from the top fitting. Pull the shaft out by hand as far as it will go and measure the distance your mark has travelled. This is endplay or bowl lateral. Check the lateral requirement of your pump for compatibility. If you're unsure, your Aurora representative can assist you.

Using elevators, secure the bowl assembly at a suitable point under the discharge case and raise as illustrated in Figure 17, controlling the lower end with a drag line. Suspend it directly over the well and screw onto the suction pipe, making a tight joint with the chain tongs. If you aren't using a suction pipe, you may want to assemble the strainer, if used, to the suction

case before lifting the bowl unit. If you do this, be careful not to harm the strainer while raising the bowl unit to the vertical posture.

Raise the load a few inches and back the beam clamps off from the suction pipe far enough to clear the bowls. Then lower the whole assembly so that the elevators at the top of the bowls can rest on the beams. Secure the clamps again. Clean and inspect all exposed threads and faces. Remove the shaft protector tube from the tube adapter at top of the bowl assembly but, please take note, under no circumstances may the pump be lifted or handled by the shaft.

If something is dropped into the pump at any point during the installation, you must retrieve it before going any farther. You might even have to return everything to the surface. 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 this purpose. Wrap a clean rag around the shaft just above the bearing. Remember to remove all this just before the pipe joint is made up.

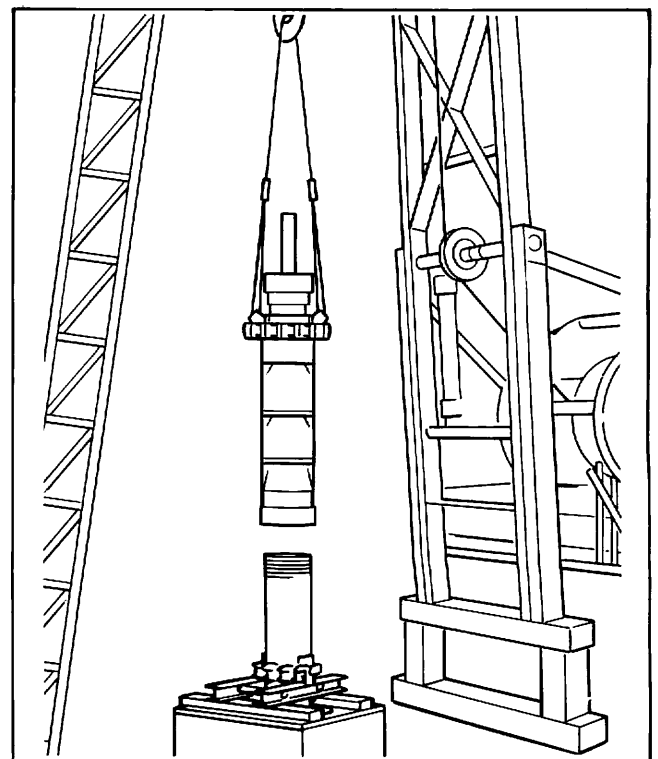


Figure 17. Raising Bowl Assemblies Over Well

Some installations will require a change in tube size due to fitting standards at the top of the bowl unit. Therefore, in selecting the first section of inner column, choose the joint with the tube that fits the discharge case tube adapter. You should already have nested this tube assembly within a length of column pipe.

Secure the elevators to this column assembly immediately below the pipe coupling. Using a hemp rope, secure a timber hitch knot around the pipe about one foot from the thread end away from the well. 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 18.

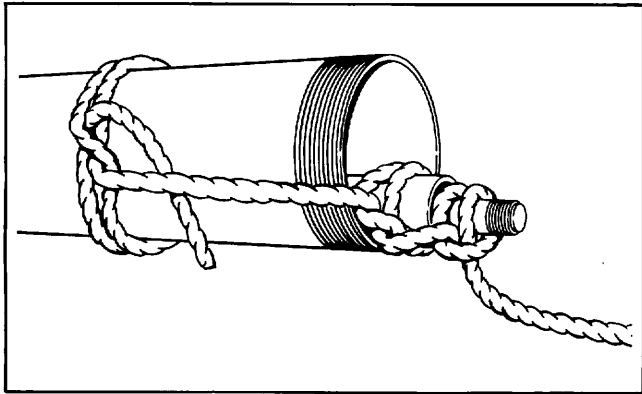


Figure 18. Securing Enclosing Tube

the exact center. If unusual power is required, stop and look for damaged or dirty threads since forcing may cause misalignment and eventual malfunction.

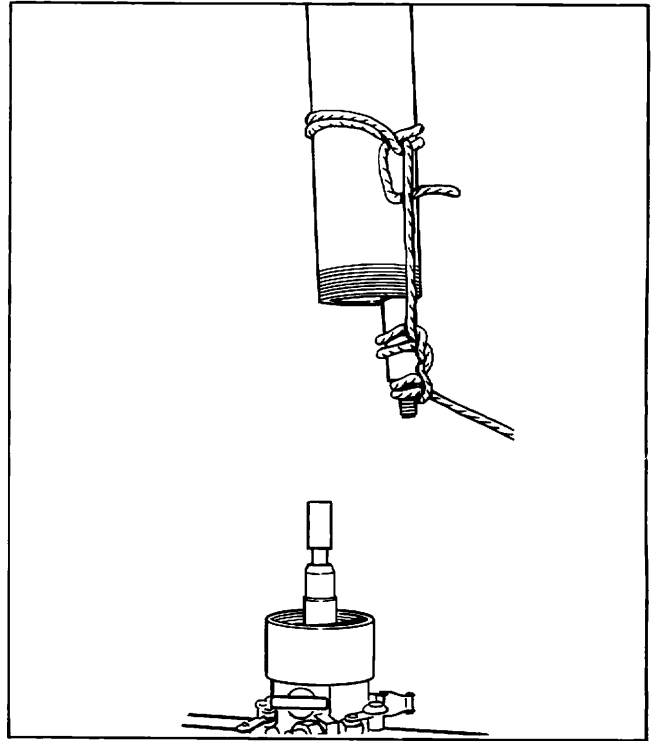


Figure 19. Column Section Hoisted Into Place

Hoist the column section into place above the well as shown in Figure 19. 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 threads will not be damaged as section is being raised. Clean all threads and inspect the shaft and enclosing tube faces once more to be sure there are no burrs, nicks, or dirt adhering to faces. Paint the shaft and tube thread with a 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. 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 do not use undue force. As shown in Figure 20, lock the 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 the threads or to any area of shafting that might run in a bearing or packing. Do not 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 the shaft butt is in

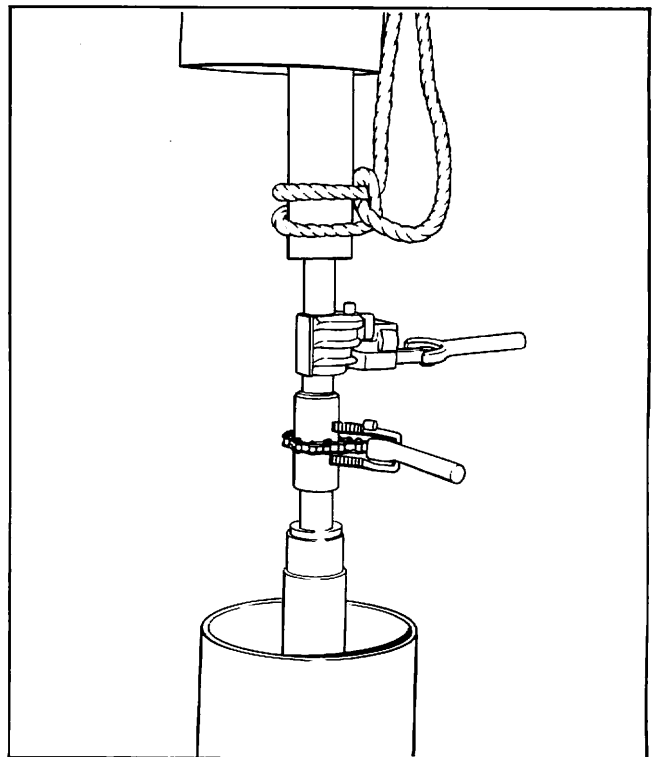


Figure 20. Connecting Shaft Ends

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

Now you can lower the column pipe. Clean the threads, apply lubricant, and start in by hand carefully to avoid cross threading remembering that these are right hand threads. In tightening the joints, place one set of chain tongs on the coupling and one set on the pipe. Do not depend on friction clamps to hold the lower section from turning. Make absolutely sure that the pipe ends butt solidly metal to metal. Never strike the coupling with a hammer during these operations as this can set up localized stresses that may later produce a crack with disastrous results. See Section 13 for air line attachment if one is furnished.

Raise the entire assembly sufficiently to allow access to loosen the holding clamp and remove the lower elevators. You may now let the whole assembly down slowly until the upper elevators rest on the clamp, which may now be secured again. Cover the opening as before to prevent anything from entering the pump.

Remove the lineshaft bearing from the projecting oil tube and pour one half cup (0.25 pint) approved turbine oil into the tube. Don't let any oil spill into the column or run down the outside of the tube as it can lead to deterioration of the rubber tube stabilizers. Replace the lineshaft bearing so that exactly half of it projects from the tube, noting that it should not be necessary to force the shaft over to permit positioning the bearing. No more than a light thumb pressure should suffice to center the shaft. Anything else indicates a misalignment or a bent part, either of which must be corrected before you continue.

Similarly, note the position of the tube in the column pipe. It should center with very light pressure. If all is in proper relationship at this time, the remaining column sections may be installed following the same procedures.

Before resuming the work, however, measure the tube and shaft projections with respect to the column pipe. Measure from the pipe rim, not the coupling. Write these figures down, keeping a log for each location on the way in, identifying the figures by location. If the measurements start to accrue a total deviation of one inch or more either way, stop and look for the reason. If none is obvious, call your Aurora representative or the Aurora factory. As long as projections remain reasonably constant, continue installing.

Your Aurora Verti-Line pump is furnished, as necessary with black widow type spiders, shown in Figure

21, as enclosing tube stabilizers, which are to be installed in the column. To assemble, wet the surface at the upper end of the tubing with water or soap suds and push the spider hub down over the tube, forcing the legs into the pipe so that the top of the stabilizer hub is just slightly below the rim of the pipe. Because of tolerance variations, you may find it necessary to drive the spider in with a mallet. Locate the first stabilizer about twenty feet up from the bowls and the last about twenty or so feet below the ground surface. In between, space them at staggered intervals from thirty to forty feet.

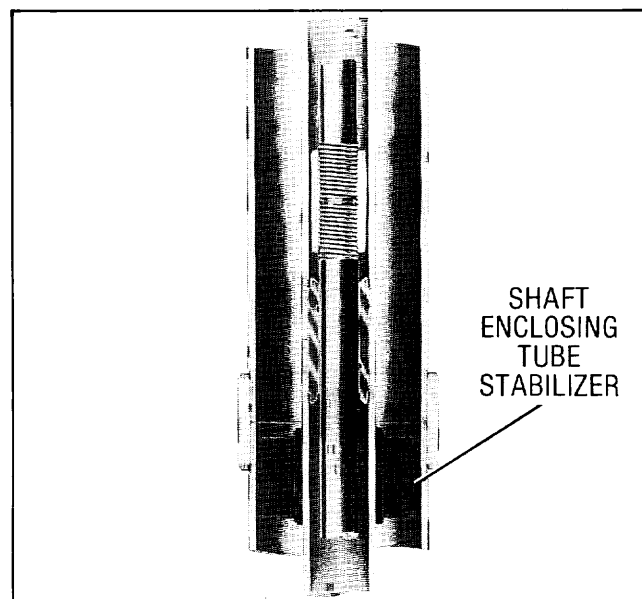


Figure 21. Shaft Enclosing Tube Stabilizer

The top column pipe section should be easily recognized since it is usually shipped without couplings and normally will be equipped with welded pads about twenty inches from the top end. These pads are to assist in installation work and are used for backup to elevators or clamps when lifting the pump.

The tube parcel to be assembled in the top column will usually consist of three sections, one of which is a standard five foot joint at the bottom end. The other two are shorter lengths but all will have been made up at the factory into a single section. There will be no upper lineshaft bearing to project from the top.

The top lineshaft may also be of a different length than the standard ten or twenty foot bars. It will have been designed to terminate at a predetermined point with respect to the top column flange.

b. Verification of Shaft and Tube Projection

Before attempting to install the top section, it is absolutely necessary to stop and make a final check of column lengths. Verification of shaft and tube projec-

tions is mandatory at this point if the remainder of the work is to go smoothly. If you've followed these instructions, you already have the figures for the joint that now hangs at the surface as well as all the others below it. Presumably they haven't varied appreciably one from the other or you would have stopped earlier to find a cause.

If there has been no reduction in tube size anywhere in the column, your measurements at this juncture should show approximately six inches for the tube and very close to fourteen inches for the shaft, measuring from the rim of the pipe. These are the A and B dimensions shown in Figure 22. If there has been a tube reduction, the nominal A dimension or tube projection will be seven inches. Projections should hit these nominals with a tolerance of plus or minus one and one half inches maximum. In the unlikely event they do not, the tube will not make up properly at the tension nut and the headshaft will not provide a proper connection with the driver.

To complete the jobsite check of the shaft relationship, your verification process must include the following review with respect to Figure 22.

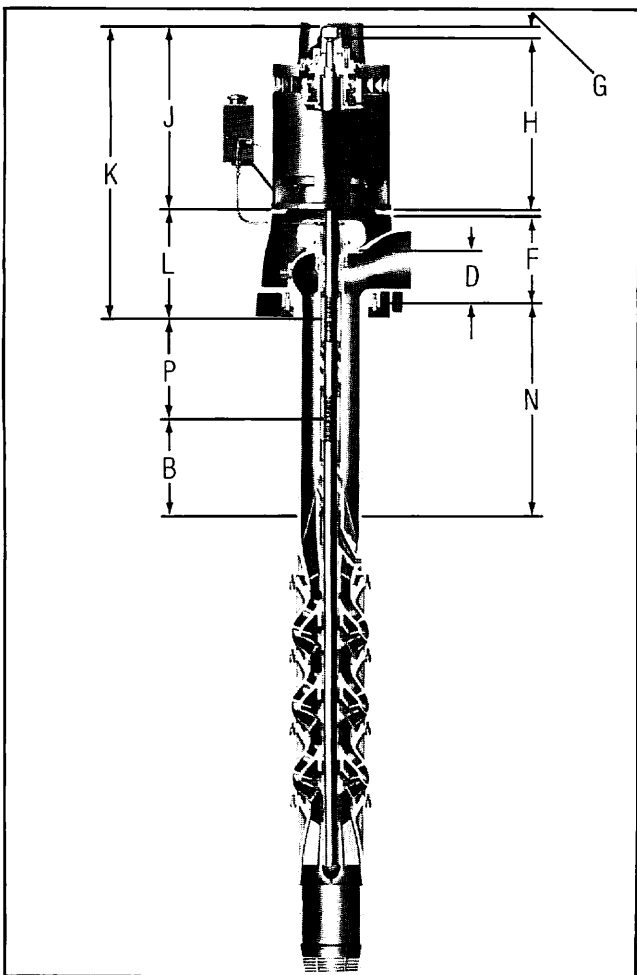


Figure 22. Shaft Relationship Verification - Enclosed Lineshaft

1. Measure and add the lengths K, P, and B.
2. Measure and add the lengths N, H, and F.
3. Subtract line 2 from line 1 and make sure the difference leaves sufficient thread for the adjusting nut G. Yet will not interfere with driver canopy.

If there is any doubt concerning verification of shaft and the tube makeup at this point, report the circumstances immediately to your local Aurora representative or to the Aurora sales office. Be prepared to give us the figures you logged during installation as well as the calculations you have just made, along with the pump serial number. We'll be glad to assist you to a quick solution, but we can do so only if you give us the information we've listed here.

c. Top Column Assembly

If you've verified the shaft and tube projections to be correct, you are now ready to install the top column section. Locate the headshaft. It is the piece with the keyway in one end. Connect it to the top lineshaft with a coupling, placing the keyway end up. Insert this shaft assembly into the top tube section with the headshaft protruding from the top. The long tube connector, Item 254 in Figure 31, may now be removed from its shipping location in the discharge head and made up as a tubing joint. If a lock collar, Item 258, is furnished, it must be in position on the connector before the connector is assembled. Lock collar setscrews, Item 259, should be left loose at this time.

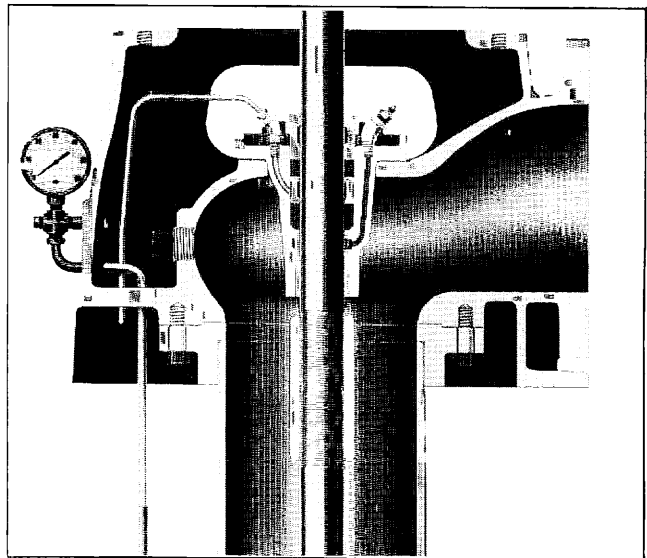


Figure 23. Discharge Head Assembly

Now insert the top inner column parcel in the top pipe joint and install as another section. Extreme caution must be used in this phase of the operation because of the vulnerability of the projecting tube and headshaft.

Do not spring them with the sling or bang them with the hook or block. At this point, the entire pump column should be in the well and resting securely on the beam clamps.

The top column flange, Item 371, is shipped loosely assembled to the discharge head, Figure 24. Remove the attaching nuts, Item 372, and the flange, Item 371, with its gasket, Item 370. Lay the gasket aside in a clean and safe place and thread the flange onto the pipe as the pump hangs in the well, making up this joint as you did all other column connections. However, you may find it easier to insert two long bolts through flange holes to enable you to use a bar for tightening as illustrated in Figure 25. Again, use care to avoid bumping the headshaft. As in any pipe joint, it is important that the flange shoulder make a tight butt against the pipe. Clean the face of flange and put a light even coating of grease on the machined surface. Place the gasket very carefully on this surface, around, but not projecting onto the register fit.

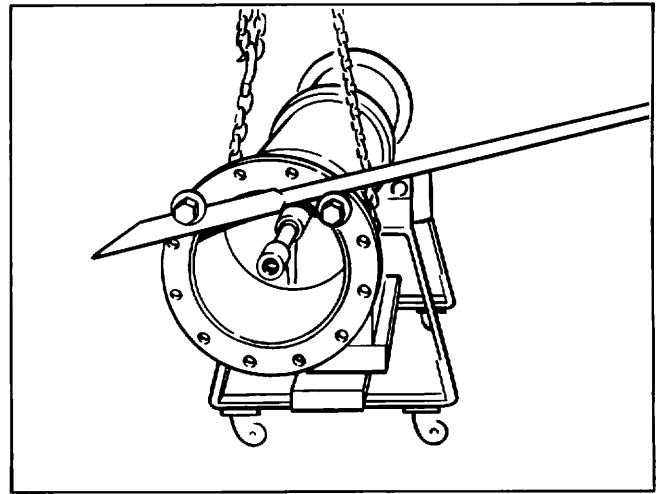


Figure 25. Tightening Flange

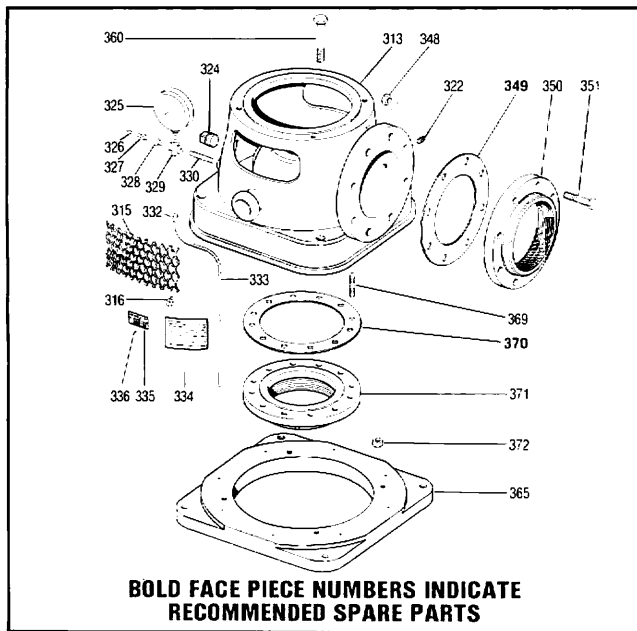


Figure 24. Discharge Head Assembly

d. Discharge Head

Clean the bottom face of discharge head and coat the machined surfaces with a light even film of grease. Remove the tension nut assembly and set it aside in a clean and protected place. Raise the head to clear and lower it carefully over the headshaft into position on top of the flange as shown in Figure 26, making sure centering register is fully engaged and that the flange face seats firmly, evenly, and with no cocking. Assemble and tighten the nuts uniformly on the studs. Refer to Figure 27. Continue to protect the headshaft to prevent its being bumped, scraped, or sprung.

As soon as the discharge head is secured, the pump should thereafter be handled with the lifting lugs on the

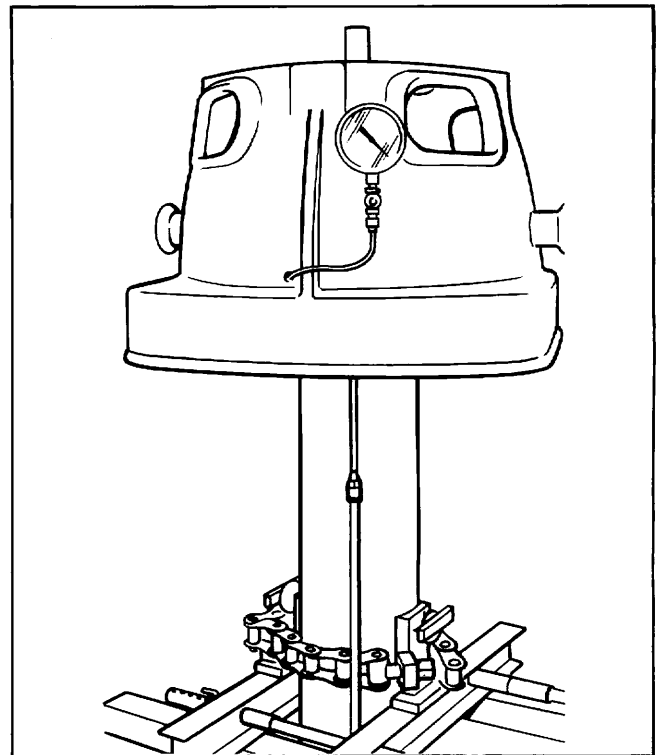


Figure 26. Lower Discharge Head Into Position

head. Never lift with eyebolts tapped into the holes for securing and driver. They're not intended to support the weight. Use lifting trunnions as shown in Figure 28.

If your pump has been designed for an unusually deep setting of heavy column, it may come to you furnished with a special steel baseplate and top column flange. If so, do not use the trunnions on the head; use only the lifting devices provided on the baseplate. Communicate with the factory for special handling instructions.

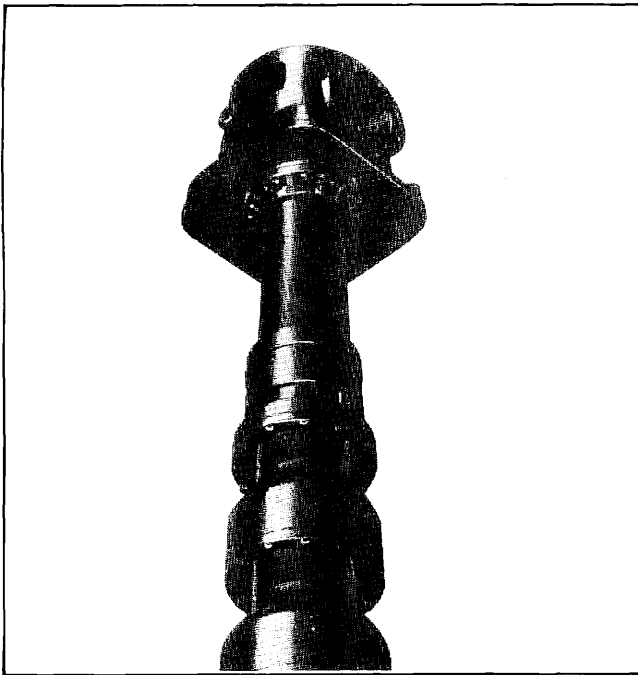


Figure 27. Discharge Head Flange

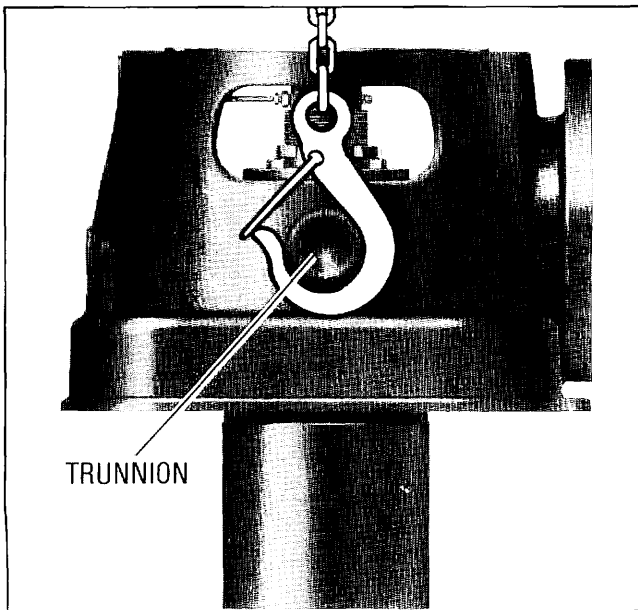


Figure 28. Lifting Trunnions

Raise the pump a few inches to remove the beam clamps and elevators. Let the pump down slowly and carefully, positioning the base with respect to the discharge piping system, if used, and engaging the anchor bolts, if any. Continue to lower until the skirt contacts the foundation and the weight of the pump is transferred to the mounting structure. Effect this transfer very gradually without a bump.

e. Tube Tension

The projecting tube connector and 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 the threads and flange surfaces of the tension nut, Item 251 in Figure 20. Inspect the mating face in the discharge head for any burrs, rough spots, or projections, especially at the location of the tapped holes. Correct any deficiencies with a file where necessary. Apply thread lubricant and grease the flange face. Thread the tube tension nut, Item 251, down over the connector, Item 254, and into position. Tighten by hand, engaging the register fit. You may have to remove the pipe bushing and plug, Item 253, from the ports at the top of the tube connector to do this. If so, lay them aside in a safe place for the time being. During this phase of work with the tubing, protect the protruding headshaft at all times.

Structurally, the tubing is an extremely long column of a relatively small diameter. As a result, it sags considerably from its own weight as it sits vertically, supported at the bottom by the discharge case. It must be pulled straight and tension must be applied and maintained by means of the tube tension nut. The best way to apply tension is based on the empirical rule that the proper tension equals the weight of the tube plus ten percent. See table, Figure 29. Multiply the weight per foot of your size tube times your pump setting times 1.1. This is the tension we recommend be applied to the tubing in your pump.

TUBE NOMINAL SIZE Inches	WEIGHT PER FOOT Pounds
1-1/4	2.99
1-1/2	3.63
2	5.02
2-1/2	7.66
3	10.25
3-1/2	12.50
4	14.98
5	20.78

Fig.29
Weight per Foot
Enclosing Tube

To implement this method, you'll need a dynamometer scale of sufficient range and a device to seize the tube. We suggest a short piece of steel tube threaded to accommodate the long tube connector and with welded lugs to permit use of the sling. With this fitting screwed

down over the connector as far as it will go, hook the fitting to the dynamometer scale and the scale to the load hook. Then very slowly raise the hook, picking up the tubing weight and stretching it the additional ten percent as indicated on the scale which should now read the load you calculated in the paragraph above. This will have pulled the tension nut flange off the seat. Reseat the flange by manually screwing it down into the register until the flange is in contact or within a few thousandths of its seat but properly oriented with the capscrew holes. Slowly release the load to zero and remove the scale and fitting. The tube is now stretched straight and is under the proper tension.

If your pump is set under five hundred feet, there is an alternate method in case a dynamometer scale is not available. This procedure is not as dependable as that described above but is acceptable if performed by experienced installers with sufficient care. Use a special tube tension wrench as shown in Figure 30. It may be obtained from your Aurora representative.

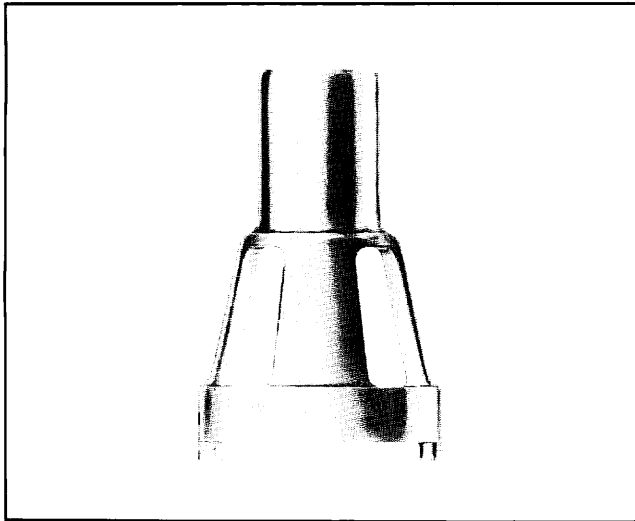


Figure 30. Special Tube Tension Wrench

Lower the wrench over the headshaft and over the tube connector so that the pins in the bottom of the wrench engage two of the boltholes in the tension nut flange, Item 251, Figure 31. Using chain tongs around the body of the wrench, screw the flange down, thus jacking up for two inch tubing and smaller, one and one half turns per hundred feet of setting is recommended. For two and a half inch tube and larger, one turn per hundred will be sufficient. Always move forward to match the holes; do not back off to a hole you've already passed. These are guidelines, of course, since feel and experience must play a part in this procedure. At all times, protect the headshaft.

When the tension nut flange is seated by either method, oil the capscrews, Items 249, and thread them firmly into position to secure the flange to the discharge head. If your pump is furnished with a tubing lock collar, Item 258, back it down the connector, Item 254, far enough to insert the packing ring, Item 257, working through the discharge opening in the head. Then screw the collar up on the connector until it butts against the tension nut, Item 251. Back the collar off very slightly until the setscrews, Items 259, line up with the first keyway on the connector. Tighten setscrews securely.

You may now place the packing ring, Item 250, in the chamfer in the top of the tension nut around the connector threads. Assemble the tubing locknut, Item 248, with its chamfered face down and tighten by hand very carefully so the packing ring remains properly seated as the nut is brought down against it. The final tightening of the nut may be done with a spanner wrench or by tapping the nut with a block of wood and a hammer. Never tap the nut with a metallic object.

Your tubing joint is now complete. You may reassemble the pipe bushing and plug, Item 249, in the oil ports in the position most convenient for the oil line from the reservoir. Skip Section 9 and go on to Section 10 for the next procedure. See also Section 12a for lubrication system.

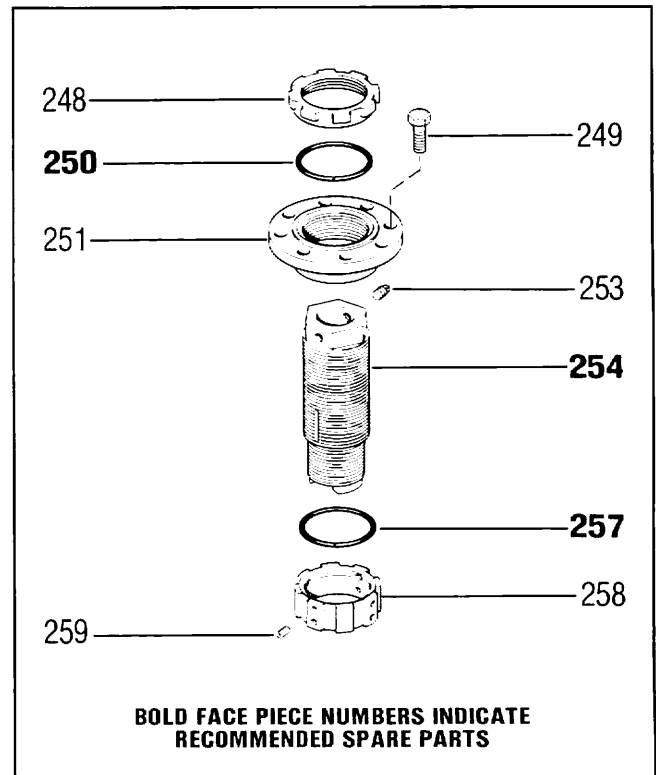


Figure 31. Tension Nut Assembly

SECTION 9

INSTALLATION - OPEN LINESHAFT

a. Column Assembly

Examine the bowl assembly to establish that the discharge case coupling, if used, is tightly butted in place and that all stage connecting nuts or capscrews have been tightened securely. Inspect bypass ports in the discharge case to determine that they have been properly plugged. Refer to Figure 16.

Establish the amount of bowlshaft endplay and record it. Push the shaft all the way into the bowls so the impellers are firmly seated. Mark the shaft where it emerges from the top fitting. Pull the shaft out by hand as far as it will go and measure the distance your mark has travelled. This is endplay or bowl lateral. Check the lateral requirement of your pump for compatibility. If you're unsure, your Aurora representative can assist you.

Using elevators, secure the bowl assembly at a suitable point below the discharge case and raise as shown in Figure 17, controlling the lower end with a drag line. Suspend it directly over the well position and screw onto the suction pipe, making a tight joint with the chain tongs. If you aren't using a suction pipe, you may want to assemble the strainer, if used, to the suction case before lifting the bowl unit. If you do this, be careful not to harm the strainer while raising the bowl unit to the vertical posture.

Raise the load a few inches and back the beam clamps off from the suction pipe far enough to clear the bowls. Then lower the whole assembly so that the elevators at the top of the bowls can rest on the beams. Secure the clamps again. Clean and inspect all exposed threads and faces. Please note, under no circumstances may the pump be lifted or handled by the shaft. Protect the projecting shaft at all times.

If something is dropped into the pump at any point during the installation, you must retrieve it before going any farther. You might even have to return everything to the surface. 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 this purpose. Wrap a clean rag around the shaft just above the bearing. Remember to remove all this just before the pipe joint is made up.

The bottom column pipe should be marked as such. It will be the one standard length joint with a full thread on one end and a shortened thread on the coupling end. The bottom shaft should be nested inside the pipe as described earlier. Secure the elevators to the pipe im-

mediately below the coupling. Using a hemp rope, secure a timber hitch knot around the pipe about one foot from the thread end away from the well. Place a double half hitch around the shaft over threads to prevent slipping. This is illustrated in Figure 32.

Hoist the column section into place above the well as shown in Figure 33. 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 threads will not be damaged as the section is being raised. Clean all threads and inspect pipe and shaft ends once more to be sure there are no burrs, nicks, or dirt adhering to the faces. Paint the threads with a thread lubricant. If parts are stainless steel, use only approved anti-galling compound.

Lower the parts until the shaft sits firmly on its coupling and start it in by hand, remembering the left hand threads. Remove the rope and continue threading the shaft in until it butts solidly. Make sure the ends are together, but do not use undue force. As shown in Figure 34, lock the shafts firmly with two small pipe wrenches, one on the coupling and the other on the shaft just above the thread. Keep the handles parallel to avoid pulling the shaft off center. Never apply

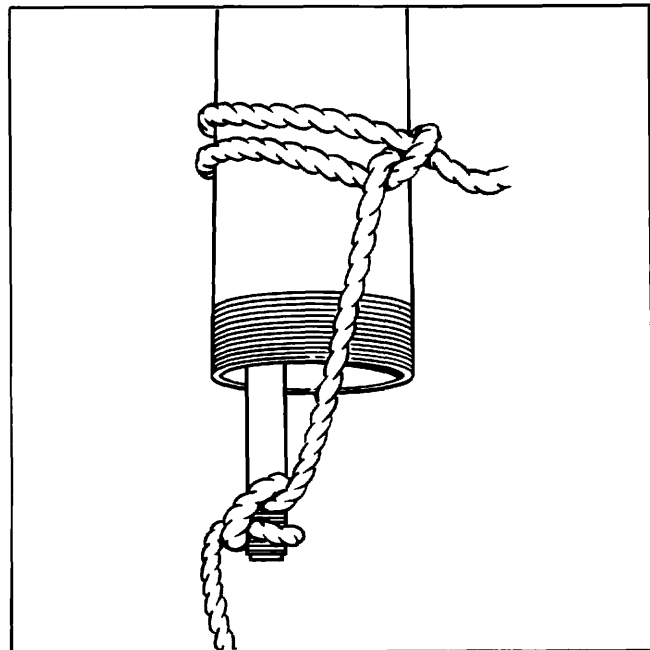


Figure 32. Securing Shaft Assembly

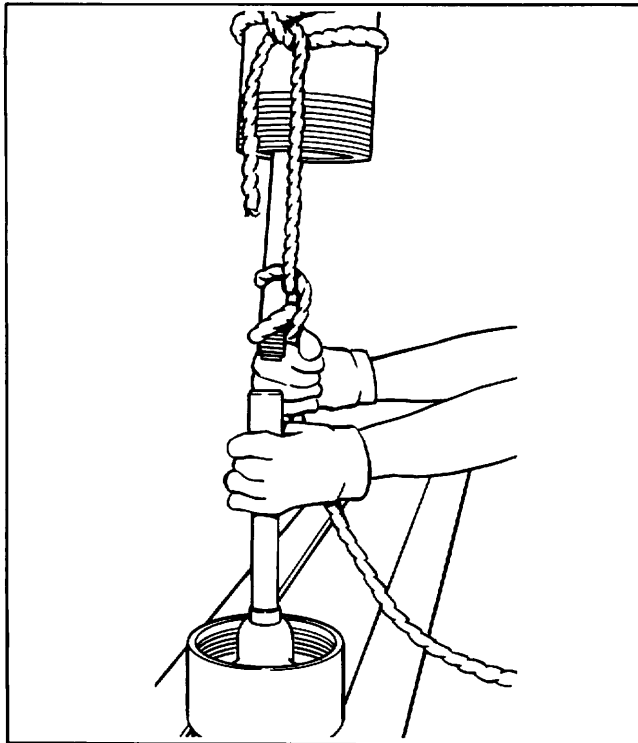


Figure 33. Column Section Hoisted Into Place

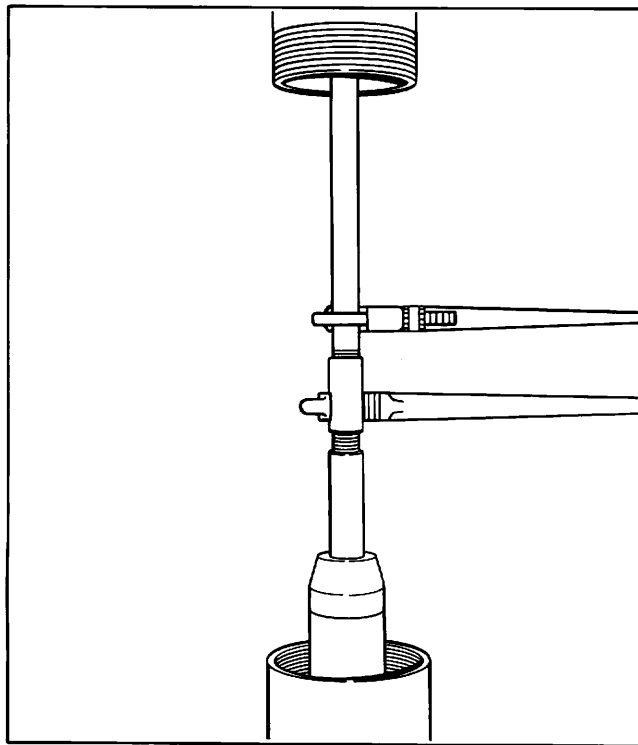


Figure 34. Connecting Shaft Ends

wrench jaws to the threads or to any area of shafting that might run in a bearing or packing. Do not allow the coupling to ride up on the 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. Forcing may cause misalignment and eventual malfunction.

Now you can lower the column pipe. Carefully start in by hand to prevent cross threading, remembering that these are right hand threads. In tightening the joints, place one set of chain tongs on the coupling and one set on the pipe. Do not depend on the beam clamps to hold the lower section from turning. Make absolutely sure that the pipe ends butt solidly metal to metal. Never strike the coupling with a hammer during these operations as this can set up localized stresses that may later produce a crack with disastrous results. See Section 13 for air line attachment if one is furnished.

Raise the entire assembly sufficiently to allow access to loosen the holding clamp and remove the lower elevators. You may now let the whole assembly down slowly until the upper elevators rest on the clamp, which may now be secured again. Wipe the upper end of the shaft clean of all oil to a point several inches below the sleeve journal. After this, on the way in, do not let oil run down the shaft or into the pipe as it will deteriorate the rubber lineshaft bearing.

Place a lineshaft bearing over the projecting end of the shaft as illustrated in Figure 35. Slide the bearing down until the spider rim enters the pipe coupling and then on down until the rim rests solidly on the face of the pipe below and the rubber bearing is located properly over the shaft journal. It should be possible to center the shaft so as to insert the spider into the coupling with little or no force. If the shaft bears heavily to one side, immediately investigate for cause before proceeding. Never continue with installation if shaft does not center freely at the bearing retainer as this indicates a misaligned column pipe or bent shaft, either of which will eventually cause trouble.

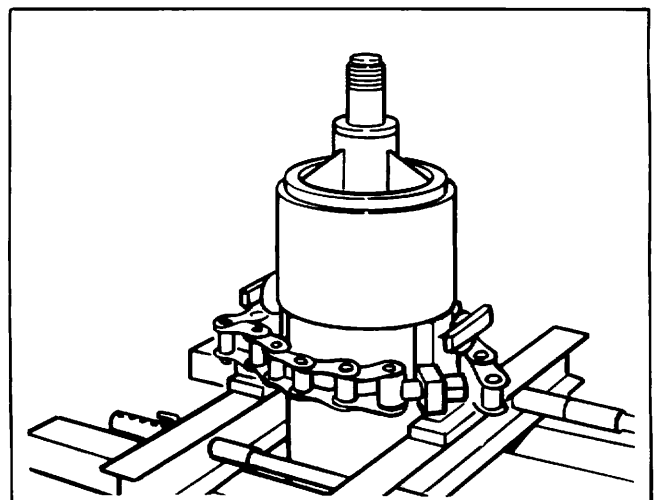


Figure 35. Installing Lineshaft Bearing

If all is centered properly at this time and journal location is acceptable, cover the open pipe end and proceed with the installation of the next column section. Repeat this installation procedure with all additional sections, remembering that pipes and shafts must butt solidly at each joint. Note that, in these subsequent joints, the pipe ends must clamp the bearing retainer rim securely.

As each length goes in the well, measure and record the projection of the shaft from the rim of the bearing retainer. If the measurements start to accrue a total deviation of one inch or more either way, stop and check for cause. If no cause is obvious, call your Aurora representative or the Aurora sales office. As long as projections remain reasonably constant, continue installing.

b. Verification of Shaft Projection

When you reach the top column pipe, however, and before it is installed, you must make a final check of shaft lengths. Presumably the projection remained fairly constant at about fourteen inches all the way in or you would not be at this point. To complete your verification, refer to Figure 36.

1. Measure and add the lengths K, P, and B.
2. Measure and add the lengths N, H, and F.
3. Subtract line 2 from line 1 and determine that the difference leaves sufficient thread for the adjusting nut G yet will not interfere with driver canopy.

If there is any doubt concerning verification of the shaft make-up, report the circumstances immediately to your local Aurora representative or to the Aurora sales office. Be prepared to give us the figures you logged during installation as well as the calculations you have just made, along with the pump serial number. We'll be glad to assist you to a quick solution, but we can do so only if you give us the information we've listed here.

c. Top Column Assembly

If you've verified the shaft makeup to be correct, you're now ready to install the top column assembly. Locate the headshaft. It is the piece with the keyway in one end. Connect it to the top lineshaft that already stands in the well. Place the keyway end up. From here on, care must be exercised to protect the headshaft from bumps or scrapes.

Place the discharge head on a clean wooden surface and remove the packing box, gasket, and capscrews. Set them aside in a safe area. Invert the head and set it carefully on its top. See Figure 24. The top column flange, Item 371, will be loosely assembled. Remove it,

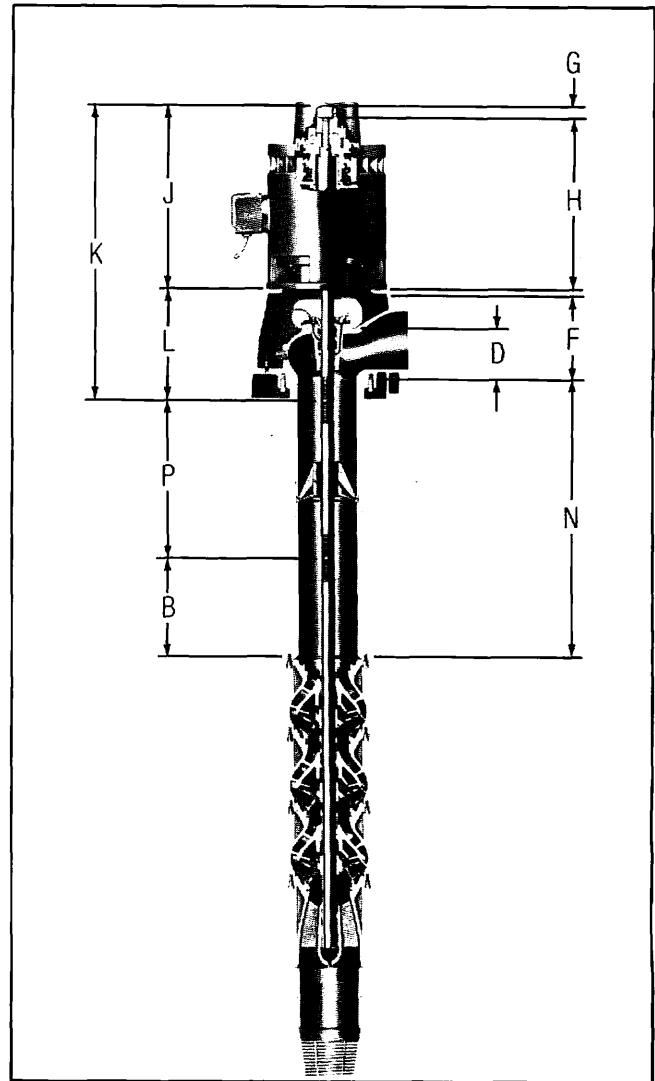


Figure 36. Shaft Relationship Verification - Open Lineshaft

the gasket, Item 370, and the attaching nuts, Item 372. Clean the flange face and the mating surface of the head, coating it with a very light film of grease. Place the gasket on the flange face, around, but not projecting onto the register fit and matching the holes. Reassemble the flange to the head with the register fully engaged and the flange seated firmly, evenly, and with no cocking. Secure the attaching nuts uniformly.

The top column pipe is easily recognized as a piece without couplings, shorter than standard, with a full thread on one end and a shortened thread on the other. Assemble it to the head much like any pipe joint, with the full thread end shouldered solidly in the flange. See Figure 37.

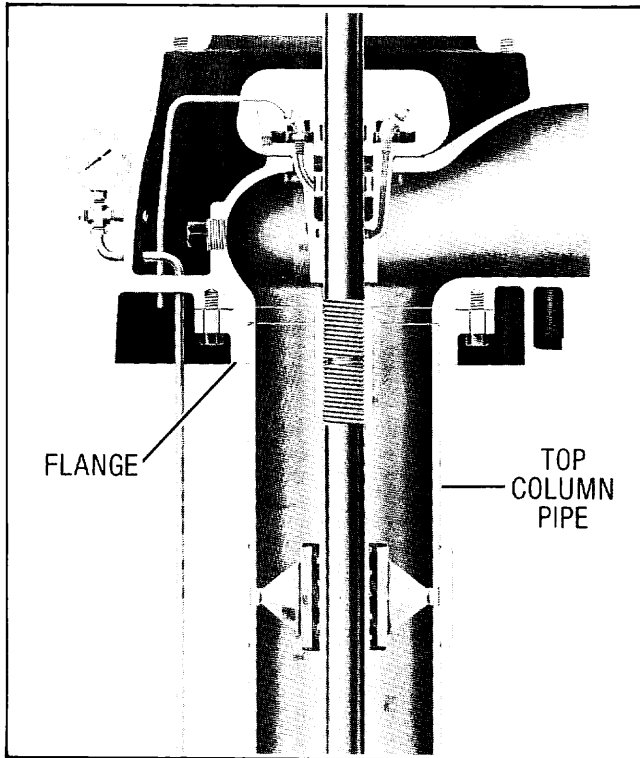


Figure 37. Discharge Head and Top Column Pipe Assembly

d. Discharge Head

Righting the head, raise it over the pump and then lower it very slowly and carefully over the headshaft. Again, exercise all the precaution necessary to protect the shaft from bumping or scraping. Make up the column connection at the wellhead in the usual manner. Refer to Figure 26. As soon as this joint is secured, the pump should thereafter be handled with the lifting lugs on the head. Never lift with eyebolts tapped into the holes for securing the driver. They're not intended to support the weight.

Raise the pump a few inches to remove the beam clamps and elevators. Then let the pump down slowly, positioning the base with respect to the discharge piping system, if used, and engaging the anchor bolts if any. Continue to lower until the skirt contacts the foundation and the weight of the pump is transferred to the mounting structure. Effect this transfer very gradually without a bump.

e. Packing Box

Retrieve the packing box and refer to Figure 38. Remove the gland, Item 224, lantern cage, Item 226, and packing rings, Items 225/227 from the assembly. Clean the packing cavity and check the drain port by probing a wire clear through the passage to determine that it is free from plugging obstructions. With a screwdriver in

the slot to spread the diameter, slip the lower slinger ring, Item 247, over the headshaft and down into the discharge elbow area. It must clear the bottom of the packing box by a sufficient amount so that, when the pump is adjusted, the ring will not interfere with the box.

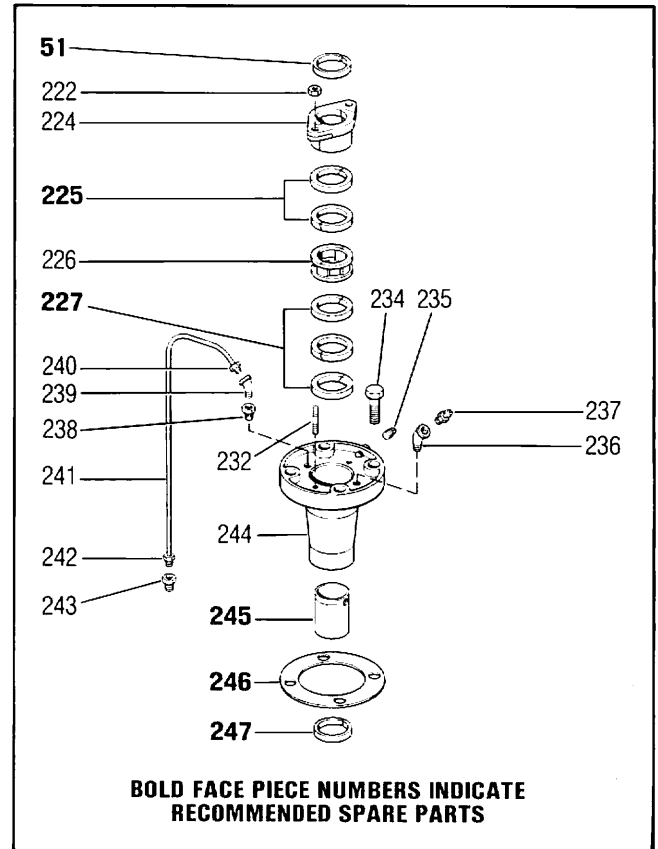


Figure 38. Packing Box Assembly

Clean the packing box flange face and the mating surface of the head, coating each with a light film of grease. Lay the gasket, Item 246, in place in the head and lower the box, Item 244, carefully over the headshaft into position, matching up the mounting holes. The box should enter the register easily and completely without forcing the shaft. Secure the cap-screw, Item 234.

To pack the stuffing box, insert three rings of packing, Item 227, into bottom of packing chamber, or whatever number is required to bring top of packing up to bottom of drain port. Put these rings in individually, one by one, staggering the cut joints. A short piece of small pipe may be passed carefully over the headshaft and down to press the rings in if desired.

You may now assemble the lantern ring, Item 226, to rest on the initial packing rings, Item 227, making sure the ring cage opens to the drain port. Then insert additional packing rings, Item 225, as necessary to achieve proper height of the gland, Item 224. Two or three rings at the very most should suffice. The gland, Item 224, may now be installed and the gland nuts, Item 222, assembled to studs, finger tight only. The gland should sit straight in the box, not cocked and not bearing against the shaft.

Spread upper slinger ring, Item 51, by wedging a screwdriver tip in the slot. Slip the ring over the headshaft and down to about two inches over the gland but at least one inch below top of head. Drain tube, Item 241, may now be connected to complete the box installation.

See the run-in procedure, Section 16, before attempting sustained pump operation.

SECTION 10

INSTALLATION - VERTICAL HOLLOWSHAFT DRIVER

Uncrate the driver, but leave it attached to the bottom skid on which it arrived. Move it to a location beside the pump head, keeping it vertical at all times. Set it down on firm and level footing. Remove the canopy cap-screws and the canopy itself. Refer to Figure 39. Remove the drive coupling and any other parts packed in the top for shipment. Cover all openings in the top to prevent anything from dropping into the driver. If this should happen, the object must be retrieved before continuing.

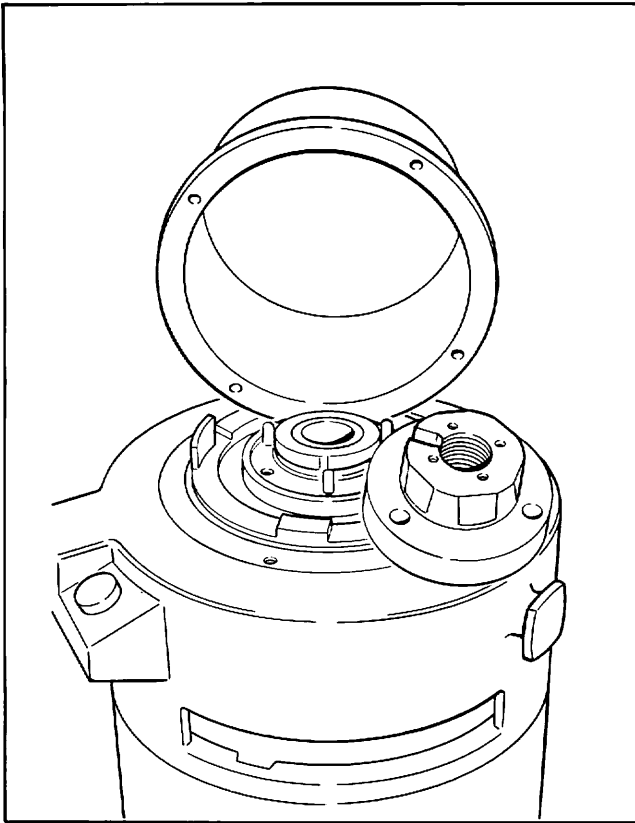


Figure 39. Remove Canopy

If your driver is an electric motor, as shown in Figure 40, 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 the proper connections be made to suit the voltage of your power source. Therefore, check the power characteristics and see the motor nameplate for correct wiring hookup.

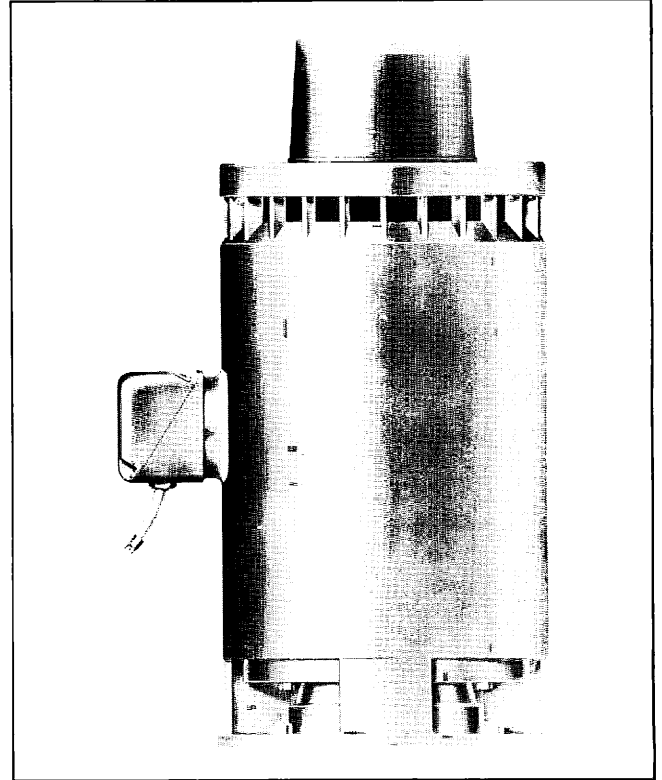


Figure 40. Electric Motor

While scanning the motor 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 may never be run at normal speeds without an appreciable thrust load. Therefore, 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.

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. The motor must turn counterclockwise when viewed from the top. If rotation is clockwise, interchange any two connections on three phase motors. With single phase machines, follow manufacturer's instructions. After reconnection, 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, and remove the temporary wiring.

If your pump is equipped with a right angle gear drive, as shown in Figure 41, instead of an electric motor, the rotation check must wait until later when the pump is completely installed and connected to the prime mover.

Now raise the driver off its skid to a convenient working height, lifting with the lugs provided on the frame. In the case of a gear drive, uncrate and follow the same procedure.

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 discharge head and inspect it, making any necessary repairs. Raise the driver and lower it over the headshaft very slowly and carefully so that you don't bump or scrape the shaft. Set the driver on the pump base with the register fit engaged but with the weight still on the hoist. Swing the motor around so the junction box is in the correct orientation. In the case of the gear drive, the positioning criteria is the horizontal input shaft. Align the mounting holes and start the capscrews in by hand. Transfer the weight gently from hoist to head and secure the capscrews, tightening them uniformly.

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

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 stands 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,

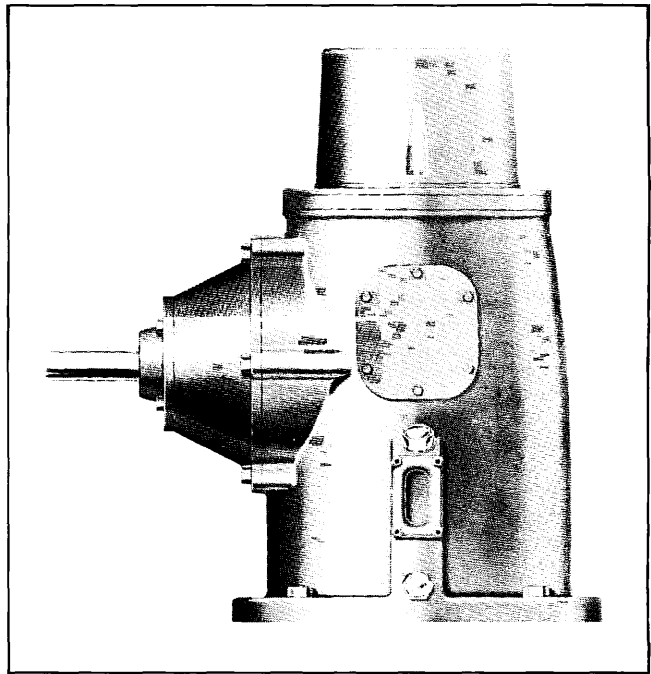


Figure 41. Right Angle Gear Drive

the mounting structure. Wherever it is, it must be rectified before proceeding. If in doubt, call your Aurora representative.

At this time, the permanent electrical connections may be made from the starter to the motor, following exactly the match marks you established for correct rotation. These connections must be made in accordance with all applicable electrical codes and regulations.

Similarly, a gear drive may now be connected to its prime mover, following manufacturer's instructions when installing universal shafts, couplings, prime mover, and related equipment. Provide all guards and safety devices as required for rotating machinery.

Replace the driver canopy with capscrews finger tight any time you aren't working at the area. Check the driver lubricant and follow directions from manufacturer. If the driver requires provisions for coolant flow, take proper measures as instructed. Do not run the equipment until all these considerations are satisfied.

SECTION 11

ALIGNING THE PUMP

When aligning your pump, you must line it up with the well. Do not use a plumb line or a spirit level. Adjust the height of each of the four corners of the discharge head with the leveling screws, if any, or by driving metal wedges under the skirt. Using these means, tilt the

head slightly one way and the other until the headshaft is concentric in the hollowshaft and doesn't drag in the quill. Then grout the head in place using non-shrinking grout mix and the method as established by construction industry standards.

SECTION 12

LUBRICATING THE PUMP

a. Gravity Oil Flow

If your pump is of the oil lubricated design, examine the oil reservoir and the oil feed line, making sure they are clean and without obstruction. Figure 42 will show you the parts involved. Attach the reservoir assembly, Item 204, to the driver pedestal by its bracket, using cap-screws, Item 218, and placing the dampener gasket, Item 219, between the bracket and the mounting surface. It may be necessary to interchange the sight gauge assembly with the oil line fittings to make the routing to the tube connector in the most convenient way.

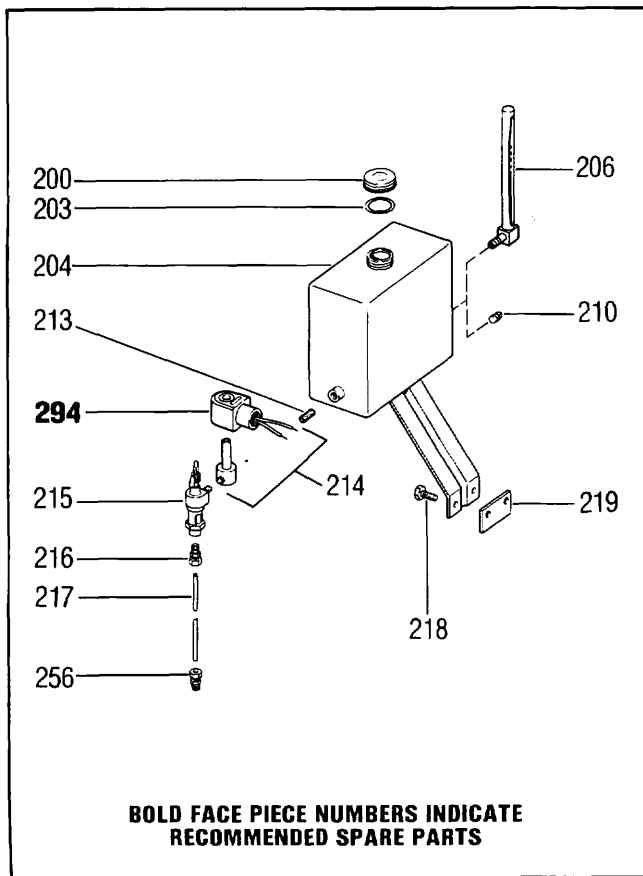


Figure 42. Oil Reservoir Assembly

If your lubrication system is automatic, you will have Item 294 as shown in Figure 42. If system is manual, this part is not needed. Keep the cover assembly on the reservoir at all times to prevent the entrance of foreign material.

Connect up the lubrication system as illustrated in Figure 43 using the parts depicted in Figure 42. Adjust lubricator valve, Item 215, to permit oil to drip at the rate of approximately one drop per second. With automatic lubricators, complete the electrical connections to the solenoid valve, Item 294, so it can be operated to allow the flow of oil to the lubricator valve, Item 215.

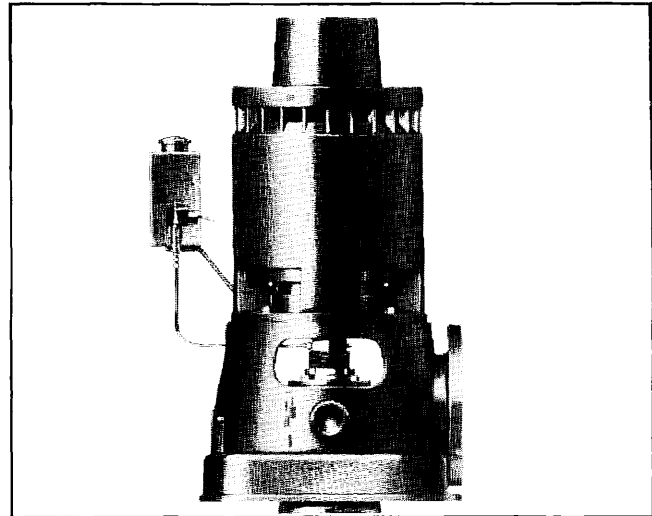


Figure 43. Lubrication System

If it isn't practical to energize the solenoid at this time, it will be necessary to prelubricate the pump manually. Remove the pipe plug in the top of the tube connector in the head and fill the upper cavity with turbine oil a number of times so that oil will run down into the enclosing tube.

Before first start, verify that the oil reservoir is full and that the lubricant can flow freely into the enclosing tube. If lubricant was introduced into the tubing during installation according to these instructions and if the pump has not been allowed to sit idle for more than a day or two, you may start the pump. Otherwise, you must allow the oil to drip for two hours before starting. Check all procedures through Section 16 before startup for operation.

Be sure 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 tubing 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 twenty operating hours. When a solenoid control is not furnished, shut off the manual lubricator during idle periods. After running about twenty hours, reduce the oil flow rate to about eight drops per minute for permanent operation.

b. Water

If your pump is set with more than fifty feet of column, it must be prelubricated with water before each startup. Connect a water supply to the port at the back

of the discharge elbow and valve water into the pump for a minimum of five minutes before each startup. If your pump is furnished with a prelubrication tank, empty the tank into the pump immediately before each startup. Keep the tank full at all times except when actually using for prelubrication.

When running, your pump is lubricated by the water being pumped. It needs no other lubrication as long as it is operating and the water is clear, cool, and without air, gas, or abrasives. The well must supply an adequate flow rate so the pump doesn't break suction or lubrication will be impaired.

SECTION 13

AIRLINE - INSTALLATION AND OPERATION

If your pump is equipped with an airline to determine depth to water, it must be installed with the bowls and pump column. The total length of the installed airline must be known.

While the suction pipe or bowl assembly is hanging upright in the hoist, secure the first section of airline to it, placing the lower open end at the desired position. Fasten the line in place with banding or heavy copper or galvanized wire, making it secure so it won't slip downward as additional sections are added. Protect the line with hose at each banding point. We recommend you mark the column pipe for the location of each end of the airline as it is installed so you'll be able to tell if the line starts to slip.

Add sections of airline in random lengths during the installation of column pipe sections as each joint is hanging in the hoist. Keep the airline outside of the elevators and fasten it to the column pipe after removing the elevators at foundation level. Each joint must be made air tight to be effective, so you should use a thread sealing compound here rather than a thread lubricant.

The last section of airline will have to be cut and fitted for length to match with the fittings connecting to the gauge and discharge head. Avoid hanging the weight of the line on a fitting having its threads in a horizontal direction. For example, if the line is to hang from an elbow, support the elbow instead of the horizontal nipple just behind the elbow.

Mount the gauge and air valve on the discharge head and connect the airline to it. Refer to Figure 44. It is good practice to remove the gauge glass and mark the airline length on the face of the dial for record purposes. Replace the glass when this is done. You'll also find it helpful to add the date of installation. If, at any subsequent time, you add an extension to the pump and to the airline too, you should correct the record on the gauge with the new length and date.

Your gauge may be one of two different types: altitude, and direct reading. Each use the same principles and values of pressure to indicate the depth. If you pump the airline full of air through the air valve, air pressure recorded at the surface of the ground is equal within small limits to the depth of water over the end of the airline. From this, you can see the length of installed airline is important to the system.

With an altitude gauge, the pressure is recorded directly on the gauge so that the depth to water is equal

to the length of the line minus the reading on the altitude gauge.

If you have a direct reading gauge, you may set the reference hand to a point on the dial equal to the length of the line. You must do this while there is no pressure on the gauge, so it's a good idea to remove the air valve core, make the adjustment, and replace the core. The indicator hand on the gauge will show the distance to water when the airline is pumped up. The hand will move away from the reference position a distance equal to the pressure in the airline.

If you record a periodic determination of water levels together with hours of pump operation, you'll have a vital record of well performance and deviations. Well performance will vary or even deteriorate over a period of time and your well log will be of invaluable aid in planning revisions in the pumping equipment made necessary by well change.

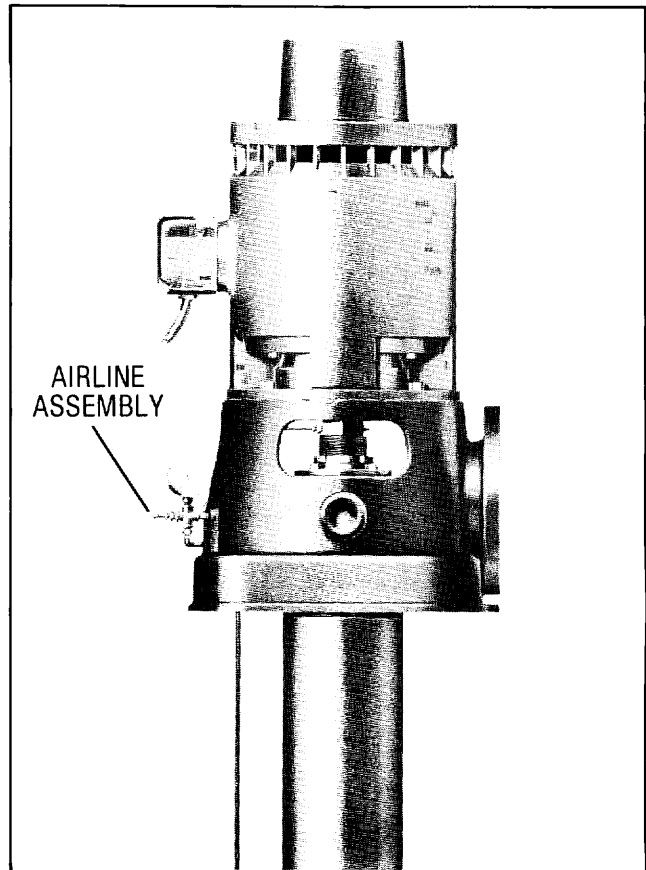


Figure 44. Airline Assembly

SECTION 14

IMPELLER ADJUSTMENT

Before attempting initial startup, pump impellers must be adjusted for the proper operating conditions. If your driver is an electric motor, as shown in Figure 45, deenergize the starter panel at the main breaker or pump disconnect switch. With either a motor or gear drive, remove the driver canopy and cover any openings into the top with clean rags or other suitable cover. If anything is dropped into the driver, it must be retrieved immediately.

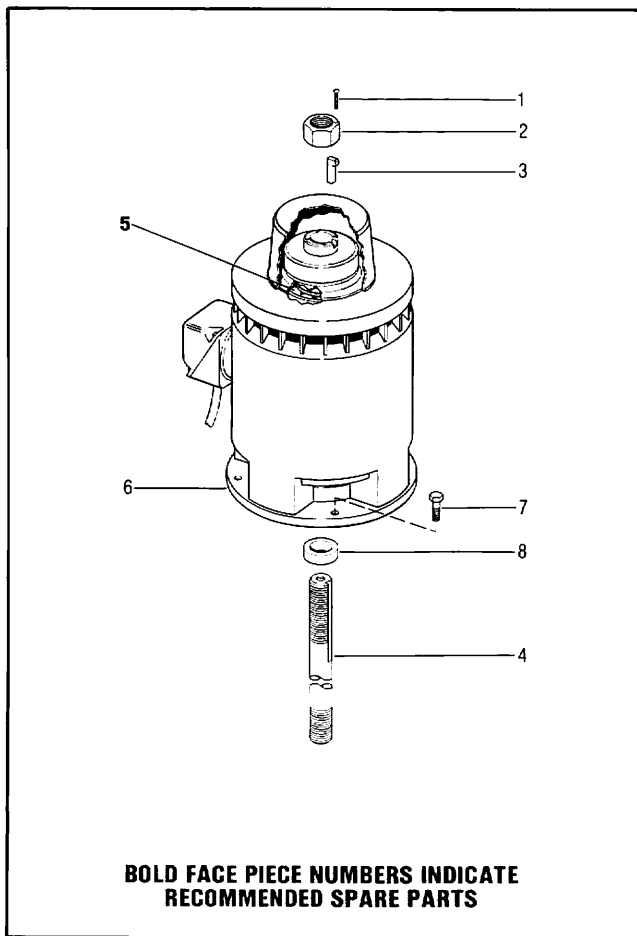


Figure 45. Electric Motor

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. Do not file the keyways. Slide the drive coupling over the headshaft, Item 4, into proper position onto its register. It must be firmly seated (perfectly

flat), without cocking. It should slide easily and smoothly without tendency to drag or hang up when lowered or rotated.

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, Item 2, seat when in place.

Thread the adjusting nut, Item 2, onto the headshaft, mindful of the left hand threads. Raise the headshaft until all its weight is on the nut. This is the breakfree point and may be recognized as that point at which the impellers can first be turned by hand. With a very slight lowering of the shaft, the impellers are felt to drag on the bowl seal rings. Mark the breakfree point, adjusting nut to the driver coupling.

Raise the impellers with the adjusting nut until they just contact the upper surface in the bowls. Count and record the number of turns from breakfree to upper limit. This should give you a dimension corresponding closely to the bowl lateral dimension you established in Section 8a or 9a. Lower the impellers to the halfway point and assemble the lock screw, Item 1, as shown in Figure 45.

If your pump is equipped with electric drive, energize the starter and just bump the switch very lightly. With an engine or other type of drive, you must go through the entire first startup procedure, then take the unit barely up to speed and immediately release the power. This will firm up all the shaft joints. However, keep in mind our warning regarding a spherical roller thrust bearing. If your driver came equipped with one, omit this step until you can apply the full thrust of the pump to the bearing.

De-energize the starter for electric drives. Remove the adjusting nut lock screw and lower the impellers to the original breakfree point as marked. Determine that this has not changed or, if it has, establish a new breakfree point, punch marking the nut and driver coupling for permanent reference.

Calculate the shaft stretch due to hydraulic thrust and raise the impellers accordingly. Your Aurora representative can help you with this if you're unsure. If your pump is set under three hundred feet, you may omit the calculation and raise the impellers one full turn of the adjusting nut for each hundred feet of head at the bowls. Secure the locknut with the setscrew, as illustrated in Figure 45 and reassemble the driver canopy.

SECTION 15

DISCHARGE CONNECTION

Some type of discharge system is usually provided, into which the pump is to deliver flow. It may be a sophisticated grid or a simple piece of pipe to direct the water into a ditch, but it will normally be connected to the pump at the discharge flange. Whatever your particular system is, it must be independently supported. It must not be allowed to impose stresses on the

discharge head due to weight, misalignment, thermal expansion, or any other condition.

When bolting the system flange to the pump head discharge flange, determine that the flanges fit face to face and hole to hole before inserting bolts. Do not draw the flanges together with the flange bolts.

SECTION 16

STARTING THE PUMP

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

- * Well water level must submerge bottom impeller.
- * Driver lubrication levels must be adequate.
- * Driver cooling system, if used, must be operative.
- * Driver wiring must have been carefully checked.
- * Driver connection to power source must be complete and adequately guarded.
- * Pump lubrication system is operative with adequate levels.
- * Pump has been through a proper prelubrication cycle as previously described.
- * All accessible connections are tight.
- * Pump is properly adjusted.
- * Pump rotation is counterclockwise when viewed from top.
- * Discharge system is in condition to 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.

If the tube leaks at the tension nut, check the locknut and packing ring at the top. If this isn't the cause, it may be necessary to apply more tension on the tube, assuming the initial tension was applied with a wrench. Stop the pump and move the tension nut flange around one or two more holes, working through the access openings in the discharge head.

With an open lineshaft pump, observe the packing box. The gland should be adjusted to allow a very slight leakage at the top for cooling purposes. The drain line should show a positive flow from the lantern ring. The shaft and the box should not exhibit excess heat. The packing will normally require a run in period of an hour or so for standard packing. Under normal operation, it is not necessary to use the grease fitting on the top of the box at all.

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. Refer to our Recommendations for Storage located on the inside front cover of this publication.

If you have any questions, Aurora Pump will be glad to help you. We wish you the best of service from your Aurora Verti-Line Deep Well Turbine Pump.

SECTION 17

PRECAUTIONARY INFORMATION

a. Responsibilities

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

Suitability of well for intended purpose

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

Aurora Pump cannot be responsible for damages, lost time, or injury resulting from failure to comply with these instructions. Aurora Pump'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 the pump in a sand locked condition or in a reverse rotation mode; neither do they cover performance when parts not furnished by Aurora are used in the pump.

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

b. General Cautionary Notes

Your Aurora Verti-Line pump is an engineered assembly of precision parts and must be treated appropriately, 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 twenty 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 Aurora representative for assistance.

Don't add oil to driver while running. Don't add grease to grease lubricated driver without removing 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 impellers 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. 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 without first checking with factory.

Don't start the pump without proper adjustment to the impellers.

Don't restart a sand locked pump. Call for help.

Don't pull discharge piping to pump discharge flange with bolts or capscrews. Install pipeline so that fasteners are used to prevent leakage only.

Don't hang weight of discharge line and fittings on discharge head alone. Support pipeline by blocking or concrete saddles according to best piping practice. Use dresser type couplings with thrust ties if necessary wherever 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 farther. If leakage water is too hot to put on 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.

And let us add one more DON'T for the benefit of your pump and your peace of mind:

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

c. Operation at Shutoff Head

In the usual application of Aurora Verti-Line deep well turbine pumps, no harm will result from operation under condition of static flow heads. However, not all installations are "usual" and for this reason consideration should be given to any unit which may be subjected to this usage. The following points should therefore be checked and resolved before putting the equipment into operation at or near shutoff heads.

Thrust bearing must be adequate.

Impeller adjustment must allow for greater shaft stretch due to higher head and resulting heavier thrust load.

If prolonged operation at no flow is contemplated, the problem of heat dissipation may become acute since the entire shutoff horsepower is converted to heat in the available liquid. In other words, the water in the well and aquifer may get hot.

For high pressure units, stresses at shutoff heads should be investigated. This information may be obtained from your Aurora representative upon request.

Certain impeller designs have critical horsepower characteristics at low flow rates. Shutoff horsepower requirements should be reviewed for possible driver overload.

You must remember that open lineshaft 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 O. 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 lineshaft 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 conditions or any variation in the system can create an undesirable reaction in the pump as the energizer of the system. If your pumping water level has increased, for example, check your impeller adjustment and your thrust bearing capacity for the new conditions.

We recommend you consult your Aurora 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 Aurora service engineer to guide you.

TERMS AND CONDITIONS OF SALE

NOT INTENDED FOR SALE OR USE FOR PERSONAL, FAMILY, OR HOUSEHOLD PURPOSES.

1-79 Printed in U.S.A.

All orders shall be made out to Aurora Pump at North Aurora, Illinois, and shall be subject to acceptance by us at North Aurora.

1. CONSTRUCTION AND LEGAL EFFECT. Our sale to you will be solely upon the terms and conditions set forth herein. They supersede and reject any conflicting terms and conditions of yours, any statement in yours to the contrary notwithstanding. Exceptions to any of our terms and conditions must be contained in a written or typed (not printed) statement received from you; we shall not be deemed to have waived any of our terms and conditions or to have assented to any modification or alteration of such terms and conditions unless such waiver or assent is in writing and signed by an authorized officer. No representation of any kind has been made by us except as set forth herein; this agreement conclusively supersedes all prior writings and negotiations with respect thereto and we will furnish only the quantities and items specifically listed on the face hereof; we assume no responsibility for furnishing other equipment or material shown in any plans and/or specifications for a project to which the goods ordered herein pertain. Any action for breach of contract must be commenced within one year after the cause of action has accrued. Our published or quoted prices, discounts, terms and conditions are subject to change without notice.

2. PRICES. Unless otherwise noted on the face hereof, prices are net F.O.B. our producing factory, and include standard catalogue literature only. Service time of a factory-trained service man is not included and may be charged extra. The amount of any applicable present or future tax or other government charge upon the production, sale, shipment or use of goods ordered or sold will be added to billing unless you provide us with an appropriate exemption certificate. We may adjust prices to our prices in effect at time of shipment. Purchased equipment such as motors, controls, gasoline engines, etc., will be invoiced at prices in effect at time of shipment in accordance with pricing policy of manufacturer.

3. DEFECTIVE EQUIPMENT. Providing Purchaser notifies us promptly, if within one year from date of shipment equipment or parts manufactured by us fail to function properly under normal, proper and rated use and service because of defects in material or workmanship demonstrated to our satisfaction to have existed at the time of delivery, the Company reserving the right to either inspect them in your hands or request their return to us will at our option repair or replace at our expense F.O.B. our producing factory, or give you proper credit for such equipment or parts determined by us to be defective, if returned transportation prepaid by Purchaser. The foregoing shall not apply to equipment that shall have been altered or repaired after shipment to you by anyone except our authorized employees, and the Company will not be liable in any event for alterations or repair except those made with its written consent. Purchaser shall be solely responsible for determining suitability for use and the Company shall in no event be liable in this respect. The equipment or parts manufactured by others but furnished by us will be repaired or replaced only to the extent of the original manufacturer's guarantee. Our obligations and liabilities hereunder shall not be enforceable until such equipment has been fully paid for. Purchaser agrees that if the products sold hereunder are resold by purchaser, he will include in the contract for resale, provisions which limit recoveries against us in accordance with this section. In case of our failure to fulfill any performance representation, it is agreed that we may at our option remove and reclaim the equipment covered by this agreement at our own expense and discharge all liability by repayment to the purchaser of all sums received on account of the purchase price. (THE FOREGOING OBLIGATIONS ARE IN LIEU OF ALL OTHER OBLIGATIONS AND LIABILITIES INCLUDING NEGLIGENCE AND ALL WARRANTIES, OF MERCHANTABILITY OR OTHERWISE, EXPRESS OR IMPLIED BY FACT OR BY LAW, AND STATE OUR ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR ANY CLAIM OF DAMAGES IN CONNECTION WITH THE SALE OR FURNISHING OF GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATION.) WE WILL IN NO EVENT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OR DELAY RESULTING FROM ANY DEFECT WHATSOEVER, AND OUR LIABILITY UNDER NO CIRCUMSTANCES WILL EXCEED THE CONTRACT PRICE FOR THE GOODS FOR WHICH LIABILITY IS CLAIMED.

4. DELIVERY. Delivery, shipment and installation dates are estimated dates only, and unless otherwise specified, are figured from date of receipt of complete technical data and approved drawings as such may be necessary. In estimating such dates, no allowance has been made, nor shall we be liable directly or indirectly for, delays of carriers or delays from labor difficulties, shortages, strikes or stoppages of any sort, fires, accidents, failure or delay in obtaining materials or manufacturing facilities, acts of government affecting us directly or indirectly, bad weather, or any causes beyond our control or causes designated Acts of God or force majeure by any court of law, and the estimated delivery date shall be extended accordingly. We will not be liable for any damages or penalties whatsoever, whether direct, indirect, special or consequential, resulting from our failure to perform or delay in performing unless otherwise agreed in writing by an authorized officer.

5. OPERATING CONDITIONS AND ACCEPTANCE. Recommendations and quotations are made upon the basis of operating conditions specified by the Purchaser. If actual conditions are different than those specified and performance of the equipment is adversely affected thereby, Purchaser will be responsible for the cost of all changes in the equipment required to accommodate such conditions, and we reserve the right to cancel this order and Purchaser shall reimburse us for all costs and expenses incurred in, and reasonable profit for, performance hereunder. We reserve the right to refuse any order based upon a quotation containing an error. The provisions in any specification or chart are descriptive only and are not warranties or representations; we will certify to a rated capacity in any particular product upon request. Capacity, head and efficiency certifications are based on shop tests and when handling clear, fresh water at a temperature of not over 85°F. Certifications are at this specified rating only and do not cover sustained performance over any period of time nor under conditions varying from these.

6. SHIPPING. Unless you specify otherwise in writing, (a) goods will be boxed or crated as we may deem proper for protection against normal handling, and extra charge will be made for preservation, waterproofing, export boxing and similar added protection of goods; (b) routing and manner of shipment will be at our discretion, and may be insured at your expense, value to be stated at order price. On all shipments F.O.B. our producing factory, delivery of goods to the initial carrier will constitute delivery to you and all goods will be shipped at your risk. A claim for loss or damage in transit must be entered with the carrier and prosecuted by you. Acceptance of material from a common carrier constitutes a waiver of any claims against us for delay or damage or loss.

7. PATENT INFRINGEMENT. We will not be liable for any claim of infringement unless due to infringement by goods manufactured by us in the form in which we supply such goods to you and without regard to their use by you. If you notify us promptly of any such claim of infringement and, if we so request, authorize us to defend or settle any suit or controversy involving such claim, we will indemnify you against the reasonable expenses of any such suit and will satisfy any judgment or settlement in which we acquiesce, but only to an amount not exceeding the price paid to us for the allegedly infringing goods. If an injunction is issued against the further use of allegedly infringing goods we shall have the option of procuring for you the right to use the goods, or replacing them with non-infringing goods, or modifying them so that they become non-infringing, or of removing them and refunding the purchase price. The foregoing expresses our entire and exclusive warranty and liability as to patents, and we will not be liable for any damages whatsoever, suffered by reason of any infringement claimed, except as provided herein. You will hold us harmless and indemnified against any and all claims, demands, liabilities, damages, costs and expenses resulting from or connected with any claim of patent infringement arising out of the manufacture by us of goods in accordance with a design or specifications which you furnish us.

8. CANCELLATION AND RETURNED EQUIPMENT. Orders may be cancelled only with our written consent and upon payment of reasonable and proper cancellation charges. Goods may be returned only when specifically authorized and you will be charged for placing returned goods in saleable condition, any sales expenses then incurred by us, plus a restocking charge and any outgoing and incoming transportation costs which we pay.

9. CREDIT AND PAYMENT. Payment for products shall be 30 days net. Pro-rata payments shall become due with partial shipments. A late charge of 1½ percent per month or the maximum permitted by law, whichever is less, will be imposed on all pastdue invoices. We reserve the right at any time to alter, suspend, credit, or to change credit terms provided herein, when in its sole opinion your financial condition so warrants. In such a case, in addition to any other remedies herein or by law provided, cash payment or satisfactory security from you may be required by us before shipment; or, the due date of payment by you under this contract may be accelerated by us. Failure to pay invoices at maturity date at our election makes all subsequent invoices immediately due and payable irrespective of terms, and we may withhold all subsequent deliveries until the full account is settled, and we may terminate this agreement. Acceptance by us of less than full payment shall not be a waiver of any of our rights. You represent by sending each purchase order to us that you are not insolvent as that term is defined in applicable state or federal statutes. In the event you become insolvent before delivery of any products purchased hereunder, you will notify us in writing. A failure to notify us of insolvency at the time of delivery shall be construed as a reaffirmation of your solvency at that time. Irrespective of whether the products purchased hereunder are delivered directly to you, or to a customer of yours, and irrespective of the size of the shipment, we shall have the right to stop delivery of the goods by a bailee if you become insolvent, repudiate, or fail to make a payment due before delivery, or if for any other reason we have a right to withhold or reclaim goods under the applicable state and federal statutes. Where you are responsible for any delay in shipment the date of completion of goods may be treated by us as the date of shipment for purposes of payment. Completed goods shall be held at your cost and risk and we shall have the right to bill you for reasonable storage and insurance expenses.

10. SPECIAL JIGS, FIXTURES AND PATTERNS. Any jigs, fixtures, patterns and like items which may be included in an order will remain our property without credit to you. We will assume the maintenance and replacement expenses of such items, but shall have the right to discard and scrap them after they have been inactive for one year without credit to you.

11. INSPECTION. Inspection of goods in our plant by you or your representative will be permitted insofar as this does not unduly interfere with our production workflow, provided that complete details of the inspection you desire are submitted to us in writing in advance.

12. RECORDS, AUDITS AND PROPRIETARY DATA. Unless otherwise specifically agreed in writing signed by an authorized officer, neither you nor any representative of yours, nor any other person, shall have any right to examine or audit our cost accounts, books or records of any kind or on any matter, or be entitled to, or have control over, any engineering or production prints, drawings or technical data which we, in our sole discretion, may consider in whole or in part proprietary to ourselves.