$4.00

INSTALLATION AND OPERATING INSTRUCTIONS FOR LAYNE PUMPS

LAYNE DEEP WELL VERTICAL TURBINE LINESHAFT PUMP

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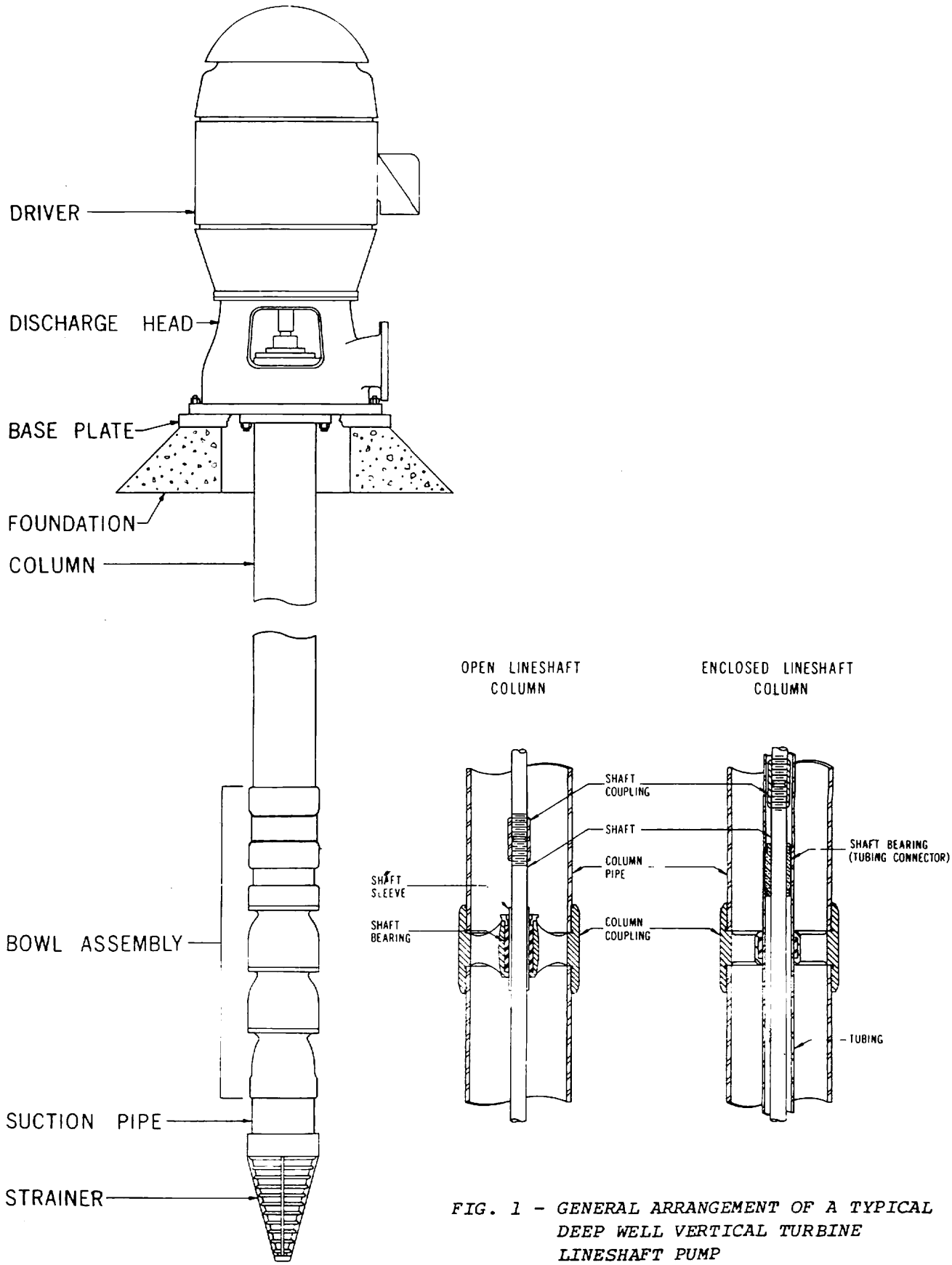


FIG. 1 - GENERAL ARRANGEMENT OF A TYPICAL DEEP WELL VERTICAL TURBINE LINESHAFT PUMP

I. INTRODUCTION

The purpose of this manual is to supply the information needed to properly install a standard Layne deep well, vertical turbine lineshaft pump. The pump installer should read and thoroughly understand this manual and the Installation Plan before proceeding with the installation. The Installation Plan is included in the Pump Record shipped with the pump. This manual is by necessity general in nature. Special installations will require special attention in areas where the information given here does not apply. Any special instructions required will be included in the Pump Record.

The satisfactory operation of a pump is dependent to a large extent on proper installation. The Layne warranty is voided if the pump is installed improperly. It is therefore imperative that the pump installer have a thorough working knowledge of the contents of this manual, general deep well pump installation practices, and the details of the specific installation and also that he exercise good practical judgment.

II. PREPARATIONS

A. RECEIPT INSPECTION AND HANDLING

Immediately upon receipt, check that the number of boxes and pieces received is the same as shown on the freight bills. Check for shipping damage. Note any shortages or damages on the carrier's copy of the freight bill prior to signing. Report these damages or shortages to the factory or your local Layne representative immediately.

If facilities are not available for lifting the materials off the carrier's vehicle, use skids for unloading rather than allowing the parts to drop to the ground. Even though a pump is made up of heavy steel parts, it is a piece of machinery and it is essential that its parts be handled with care. It is extremely easy to damage shafting, threaded parts, and mating surfaces of parts which must fit together. Even a minor bend in one piece of shafting can cause a pump to vibrate excessively; thus shortening the life of the pump drastically.

Uncrate and layout all equipment on clean boards in the order of their installation. Do not lay the shafting in a place where it is likely to be walked on, run over, or bent in any way. Check that all parts listed on the packing list were received. Also check that the parts received are all of the parts required for the installation. Report any shortages or errors to the factory or your local Layne representative immediately.

Follow the Manufacturer's instructions for handling and storing the driver and any other special equipment.

B. LIST OF REQUIRED EQUIPMENT

1. A derrick of sufficient strength, rigidity and hoist control to safely lift and lower the total weight of the pump. A conservative weight of the pump may be obtained from the freight bill. The minimum travel of the derrick hoist should be at least 6′ greater than the longest piece of pump equipment. The hoist must have a swivel hook.
2. One cable sling and friction clamp assembly of sufficient strength to lift entire pump and long enough to clear a 3′ shaft projection as shown in Fig. 2. This assembly is not required if a bailer, elevators, or other method is to be used to handle the column pipe sections.
3. A two part or four part sling for lifting entire pump from the discharge head. Figs. 17A, 17B, 17C, and 17D show the methods of rigging various heads. IF A STEEL PLATE SUCH AS SHOWN IN FIG. 17D IS PROVIDED, IT MUST BE USED AS SHOWN.
4. A sling adequate for lifting the driver.
5. A set of friction clamps or other means for lifting the pump bowl. See Fig. 8.
6. 4x4 timbers, H beams, or other equipment suitable for supporting the entire weight of the pump assembly from the friction clamp or other handling device described in 2 above. See Fig. 10.
7. Two chain tongs to handle threaded column pipe. See Fig. 11.
8. Two pipe wrenches to handle shaft couplings and shafting. See Fig. 10.

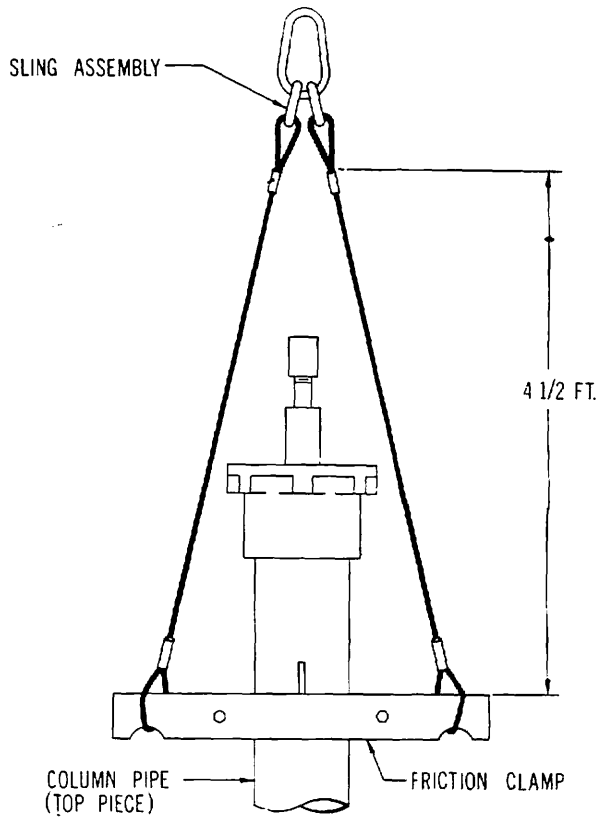


FIG. 2 - SLING AND CLAMP ARRANGEMENT

9. Two pipe wrenches or chain tongs to handle shaft enclosing tubing when applicable. See Fig. 14B.
10. Set of mechanic's tools including an assortment of socket wrenches, a pry bar and a heavy hammer.
11. Dial indicator calibrated in .001" divisions. A magnetic base type is preferred. See Figs. 5 and 23.
12. Two "V" blocks for checking shaft straightness. See Fig. 5.
13. Wire brush, 3 cornered file, flat file and emery cloth.
14. Steel tape measure and carpenter's square.
15. 15' of ¾" rope.
16. Set of inside and outside calipers.
17. Straight edge 3' to 4' long.
18. Sufficient quantity of metal wedges to shim under baseplate or head during alignment.
19. Sufficient quantity of top quality non-shrink grout.
20. Can of machine oil.
21. Solvent for cleaning parts. Assure that the solvent used is acceptable by local codes.
22. Laynecote thread compound (Permatex Form A, Gasket #2) for use on cast iron threaded couplings and pressure containing flange faces. A supply of Laynecote is furfurnished with each new Layne pump.
23. Anti-seize compound (Never Seeze, Blue Goop, Molykote "G", etc.) for use on steel column pipe threads, and stainless steel shafts and couplings.
24. Laynegrease (Shell Retinex P) for use in stuffing box. A supply of Laynegrease is furnished with each new Layne pump.
25. Putty knife for applying Laynecote and anti-seize compound.
26. A supply of lubricating oil for the driver. Follow the driver manufacturer's instructions as to the kind of oil to be used.
27. A supply of lubricating oil for the oil-lubricated lineshaft. The oil used should meet the following specifications:

Non-detergent	
Viscosity	95-105 S.S.U. at 100 deg. F. 35 S.S.U. at 210 deg. F.
Cold Pour Point	-20 deg. F.
A.P.I. Gravity	28-29.5

A local oil distributor can provide a specific brand of oil meeting these specifications. Also, a list of oils meeting these specifications is available from the factory on request.
28. For large column pipe and shafting or for deeper settings where a large number of column sections are required, it may be desirable to construct special column handling tools such as shown in Fig. 3 rather than to use the rope method described in these instructions.
29. Shaft lifting device (deep settings only). See Fig. 4.

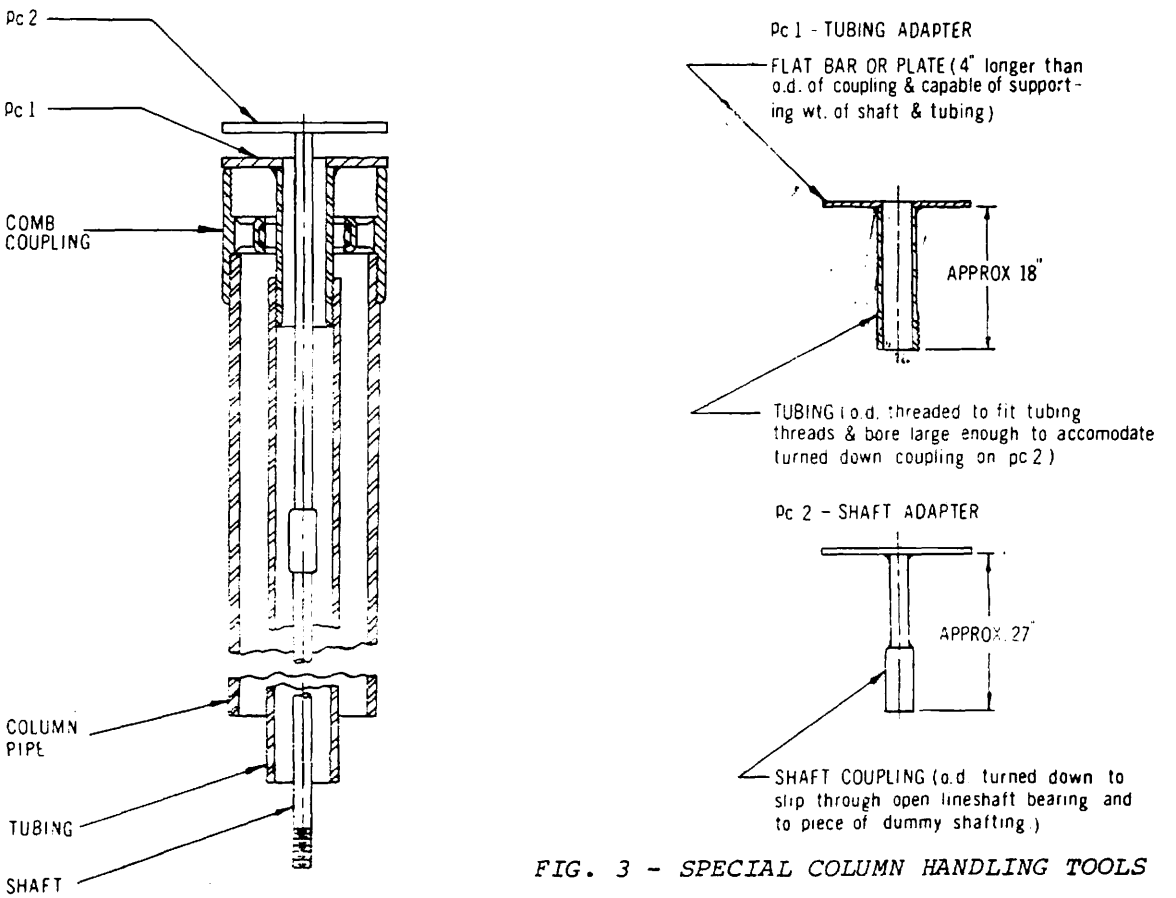


FIG. 3 - SPECIAL COLUMN HANDLING TOOLS

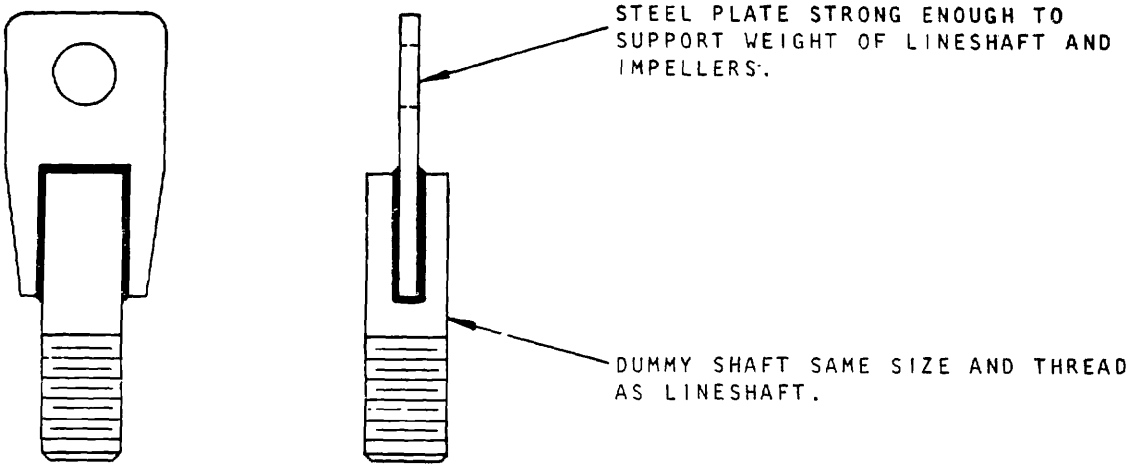


FIG. 4 - SHAFT LIFTING DEVICE

C. GENERAL PRECAUTIONS

1. Cleanliness is essential for a good installation. Threads and other mating surfaces will not function as required if they are not clean when assembled.
2. Make certain that no rags, wood scraps or other foreign material is lodged in any exposed openings.
3. Keep the well opening covered whenever possible to prevent dropping small parts, tools, or any other foreign material into the well.
4. Lift and handle the unit carefully to prevent damage caused by excessive strain being imposed on any part.
5. Do not allow pipe compound, solvent or any petroleum products to come in contact with rubber bearings.
6. *NEVER USE THREAD COMPOUND ON LINE SHAFT THREADS OR SHAFT COUPLINGS.* (Use anti-seize compound on stainless steel shaft and coupling threads.)
7. Always use anti-seize compound to prevent galling of the threads on steel column joints, stainless steel fasteners, and stainless steel shaft couplings.
8. Never use gaskets between flanges, column joints, flange-to-bowl connections or head connections.
9. Special care must be taken to prevent damage to the threads and *end faces* of shafting, column pipe and tubing.
10. Exercise special care when handling parts which have special coatings. If the coating is damaged (nicks, scrapes, wrench marks, etc.), the damaged spots should be repaired before the installation is completed.
11. If during installation the pump is observed to bind or will not rotate freely on the hook swivel, then either there is an obstruction in the well or the well is crooked. In either case, the well is not acceptable for a proper pump installation and continuing with the installation will void the warranty.

D. PARTS PREPARATION AND CLEANING

1. Prior to making up threaded column joints, remove the thread protectors and thoroughly clean threads with wire brush and solvent. If necessary, repair any damaged threads with a three cornered file and remove any burrs. THE PROTECTIVE COATINGS ON THE PARTS IS A RUST PREVENTATIVE AND IS NOT SUITABLE AS A THREAD LUBRICANT. THIS COATING MUST BE CLEANED OFF THREADS.
2. Clean all shafting and couplings using a rag soaked with solvent.
3. Make certain that all bearings are clean (do not use solvent on rubber).
4. Remove rust preventative from all flange faces with solvent and if necessary, smooth the flange face with a flat file.
5. If tubing is furnished, check the tube ends for nicks, burrs, etc. Sections of tubing which were assembled at the factory should be checked for tightness. Tubing torque requirements are given in Table I.
6. Check the shaft ends for nicks, burrs, etc. The shaft ends at each coupling must butt *squarely* against each other in order for the shaft to be aligned properly.
7. Check all loose shafting for straightness using "V" blocks and a dial indicator, as follows: (See Fig. 5).
   Do not attempt to check shaft straightness in direct sunlight.
   Place the shaft in "V" blocks as shown in Fig. 5. Rotate the shaft and observe the dial indicator. The dial indicator should not vary more than 0.001" times the number of feet to the nearest "V" block. Checks should be made at approximately 2 ft. intervals along the shaft.

If necessary, the shaft can be straightened by applying a load on the high side of the shaft at the point on the shaft having the greatest deviation from the allowable values.

The shaft must meet the above conditions after all straightening has been performed. Therefore, if straightening is required, the positions checked prior to the straightening operation must be rechecked.

8. Check the runout of the impeller shaft extension by placing a dial indicator toward the outer end of the shaft and turning the shaft slowly making certain that it stays to one side of the uppermost bowl bearing. The indicator reading should not vary by more than 0.002" as the shaft is turned (0.002 T.I.R.).
9. Measure and record the pump lateral (shaft end play). *This information will be required when making lateral adjustments outlined later.*
10. Remove the stuffing box from the pump head.
11. Check that the baseplate fits the foundation properly.

E. FOUNDATION

The foundation should be of sufficient strength and rigidity to support the weight of the pump assembly plus the weight of the water in the column and maintain the proper alignment of the pump head. The opening at the top must be of sufficient diameter and depth to clear the top column flange and fasteners. Fig. 6 is included only as a guide to be used if other information is not available. The pump manufacturer assumes no responsibility for the foundation.

F. WELL CHECK

Prior to attempting to install the pump in the well, check the inside diameter of the well casing and the maximum outside diameter of the pump bowl and column to determine that there is adequate clearance to install the pump assembly in the well casing. Also insure that the well is deep enough to receive the full length of pump. The well casing should be sufficiently straight and without obstructions so that the pump assembly can be installed without binding or being bent so as to cause misalignment. On deeper settings or where there is doubt about the size or straightness of the well, a well log should be run or a dummy sizer be made to the O.D. and length of the bowl and lowered into the well to the appropriate level. If the sizer will not go into the well, the pump cannot be installed properly and either the restriction in the well must be corrected or a smaller diameter pump must be considered. See also General Precaution 11.

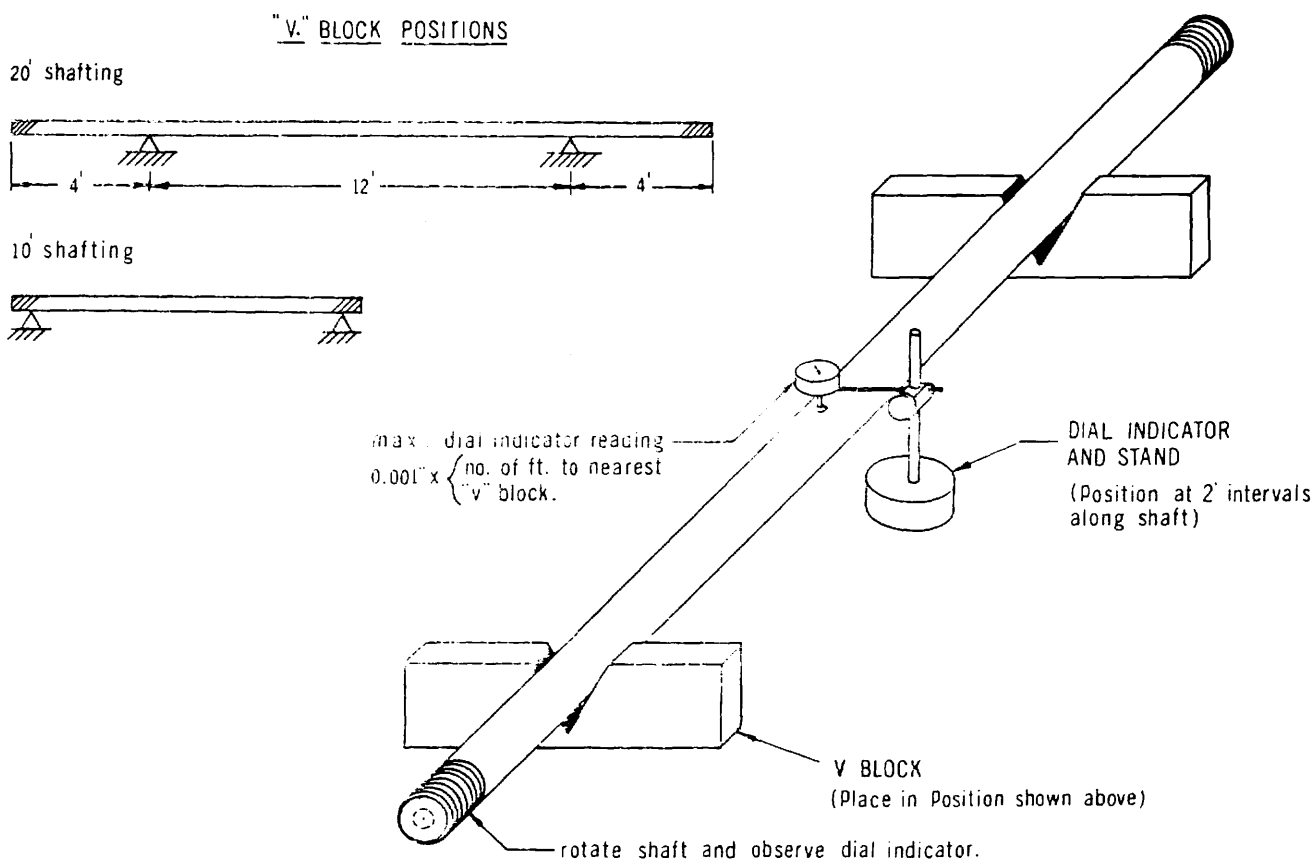
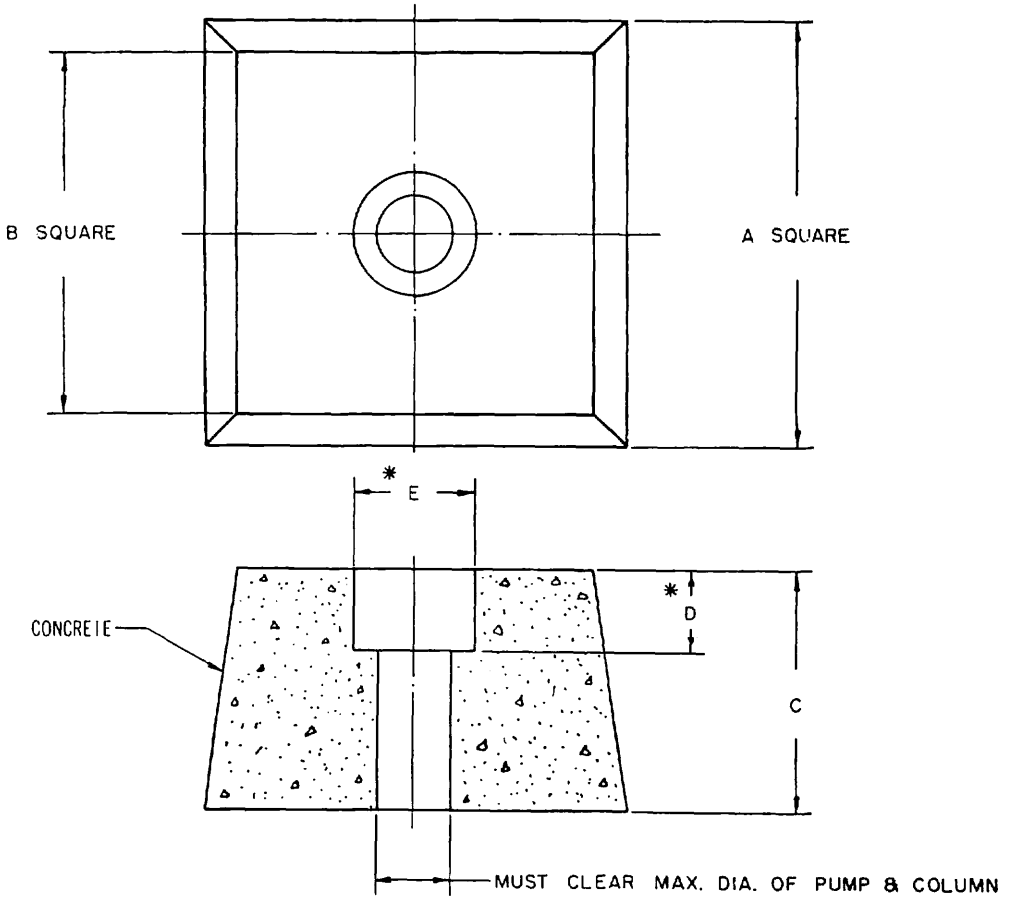


FIG. 5 - ARRANGEMENT FOR CHECKING SHAFT STRAIGHTNESS

FOUNDATION PLAN

TF, SDH, & LB HEADS

LAYNE & BOWLER INC. MEMPIS, TENN.



* DIMENSIONS D & E NOT REQUIRED FOR SDH SCREW TYPE HEAD

TYPE HEAD	A WITH BASE PLATE	B WITH BASE PLATE	A WITHOUT BASE PLATE	B WITHOUT BASE PLATE	C	D FLANGED HEAD	E FLANGED HEAD
SDH 3	1' - 10"	1' - 6"	1' - 10"	1' - 6"	2' - 0"	5"	7"
SDH 4	2' - 0"	1' - 8"	2' - 0"	1' - 8"	2' - 0"	5"	9"
SDH 6	2' - 5"	2' - 1"	2' - 5"	2' - 1"	2' - 0"	6"	11"
SDH 8	2' - 8"	2' - 4"	2' - 8"	2' - 4"	2' - 0"	6"	13"
SDH 10	3' - 0"	2' - 8"	3' - 0"	2' - 8"	2' - 0"	7"	16"
SDH 12	3' - 4"	3' - 0"	3' - 4"	3' - 0"	2' - 0"	7"	19"
TF 413	2' - 9"	2' - 3"	2' - 9"	2' - 3"	2' - 0"	12"	12"
TF 613	2' - 9"	2' - 3"	2' - 9"	2' - 3"	2' - 0"	12"	13"
TF 418	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	12"
TF 618	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	15"
TF 818	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	15"
TF 1018	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	18"
TF 1218	3' - 2"	2' - 8"	2' - 11"	2' - 5"	2' - 0"	12"	21"
TF 625	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	15"
TF 825	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	15"
TF 1025	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	18"
TF 1225	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	21"
TF 12251	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	23"
TF 1425	5' - 0"	4' - 0"	3' - 6"	3' - 0"	2' - 9"	12"	23"
TF 1227	5' - 0"	4' - 0"	4' - 0"	3' - 6"	2' - 9"	12"	21"
6LB10	2' - 0"	1' - 8"	2' - 0"	1' - 8"	2' - 0"	12"	13"
8LB17	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	15"
10LB17	3' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 0"	12"	18"
12LB20	3' - 2"	2' - 8"	2' - 11"	2' - 5"	2' - 0"	12"	21"

FIG. 6 - FOUNDATION PLAN

DRAWING NO PBO 125

The pump must be equipped with enough column pipe to assure that the bowls remain submerged during operation. THE FACTORY DOES NOT RECOMMEND OR GUARANTEE SATISFACTORY OPERATION WITH A SUCTION LIFT. It is desirable to determine the pumping level of the well prior to installation of the pump so that the pump can be provided with the proper amount of column.

The well should be developed and test pumped prior to installation of the permanent pump. Sand should not be pumped with the pump intended for permanent installation. PUMPING SAND OR OTHER ABRASIVES VOIDS THE WARRANTY.

III. INSTALLATION

A. BASEPLATE

If the pump is to be equipped with a baseplate, the baseplate can be installed separately or it can be installed as an integral part of the head. Installing the baseplate separately as outlined below is generally preferred since this method allows using the baseplate as a working surface for the friction clamps or elevators.

1. Assure that the strainer, bowl assembly and column assembly will pass through the opening in the baseplate. If these parts of the pump will not pass through the baseplate, then the baseplate must be installed as an integral part of the head.*
2. Remove the baseplate from the head or motor stand (if it is shipped attached to either) and place it on the foundation in an approximately level position.
3. If anchor bolts are to be used, temporarily install the nuts on the anchor bolts. Note that this is only a temporary installation. The baseplate cannot be installed permanently until after the discharge head has been aligned per Section III.H.
4. Place the two setting beams on the baseplate. See Fig. 10. Use plywood under the beams to protect the machined surface of the baseplate.

If the baseplate is to be installed as an integral part of the head, proceed as follows:

1. Same as step 1 above. See footnote also.
2. Place the setting beams directly on the foundation in an approximately level position. See Fig. 10.

**Note that if the strainer, bowl assembly, and column will not pass through the baseplate, this will complicate service and maintenance operations which require the pump to be pulled out of the well. Each time the pump is pulled, the baseplate will have to be removed and then realigned and re-grouted when the pump is reinstalled. If the strainer, bowl assembly and column will pass through the baseplate, then the baseplate (and therefore the alignment) need not be disturbed when the pump is pulled.*

B. SUCTION PIPE AND STRAINER

If the overall length of the assembled strainer, suction pipe and bowl assembly does not exceed the maximum hook height of the derrick or hoist, the suction pipe can be assembled to the bowl while they are on the ground. The bowls and suction pipe can then be installed as one unit per the instructions given in Section C. If the travel of the derrick or hoist being used is not sufficient, it will be necessary to install the suction pipe and bowl assembly separately, as follows:

1. Attach a pipe clamp to the upper end of the first piece of suction pipe (with strainer attached, if strainer is required), as shown in Fig. 7.
2. Attach a sling to the clamp and hoist the pipe and strainer assembly to the vertical position taking care not to damage the strainer. Push the bottom of the pipe away from the well opening and tap the side of the pipe to remove any loose matter.
3. If an airline is to be installed and is to extend below the bowl assembly, see Section III. K.6.

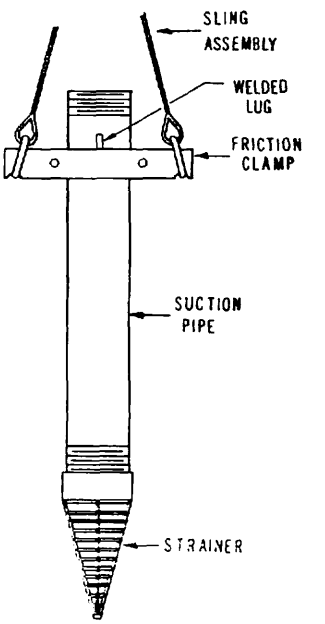


FIG. 7 - SUCTION PIPE AND STRAINER RIGGED FOR LIFTING

4. Center the suction pipe and strainer assembly over the well opening and carefully lower it until the clamp ears are resting squarely on the setting beams. Remove the sling.
5. Apply Laynecote to the exposed threads.
6. If there are no additional sections of suction pipe, proceed with the installation of the bowl assembly as described in Section III.C. If there are additional sections, install the clamps and sling to the next section to be installed, hoist it to the vertical

position, then slowly lower the hoist and screw the pipe into the coupling. Using chain tongs, tighten the pipe connection securely. Remove the chain tongs, raise the hoist slightly, remove the clamp from the lower piece of pipe, secure the airline (if required) to the upper piece of pipe, and slowly lower the assembly until the upper clamp is resting on the setting beams. Repeat the above until all of the suction pipe has been installed.

C. BOWL ASSEMBLY

CAUTION — DO NOT LIFT OR HANDLE PUMP BOWL BY THE SHAFT

1. Inspect the bowl assembly as follows:
   (a) Make sure no rags, wood or other foreign material is in the suction or discharge.
   (b) Rotate the impeller shaft to make sure it does not bind.
   (c) If the discharge nozzle has bleed ports (used if enclosed lineshaft type column is to be used), make sure that these ports are free of obstructions.
   (d) Measure and record the available pump lateral (impeller shaft end play) if not already done.
2. If not already installed, place the two setting beams on the foundation (or baseplate).
3. Install a friction clamp to the upper end of the bowl assembly beneath a convenient shoulder. Attach a cable sling to the friction clamp far enough out on the ears to allow removal of the sling after the friction clamp is resting on the setting beams. Also, make sure that the sling is long enough for the load hook to clear the shaft protector when the bowl assembly is uprighted. See Fig. 8. Leave the short piece of protective tubing (oil-lube pumps) or column pipe (water lube pumps) installed until after the bowl assembly has been hoisted to the vertical position.
4. Hoist the bowl assembly to a vertical position being careful not to damage the pump suction or strainer. Use a rope to tail in the bowl assembly preventing it from swinging into the suction pipe, foundation or derrick.
5. If the suction pipe was installed separately per Section B, apply thread compound to the threads of the suction pipe and then carefully lower the bowl assembly so that the suction pipe engages with the suction nozzle. Screw the bowl onto the suction pipe by hand, assuring that the connection is properly aligned and is not cross threaded. Use chain tongs to tighten the connection. After the connection is tightened, raise the pump slightly, remove the friction clamps from the suction pipe and lower the unit until the friction clamp around the bowl rests on the setting beams. Remove the sling.
6. If the suction pipe and bowl assembly are being installed as one unit, center the unit over the installation opening then carefully lower it until the clamp ears are resting on the setting beams. Remove the sling. If an airline is to be installed see Section III.K.6.
7. Remove the shaft protector (18″ piece of tubing on oil-lube pumps or 18″ piece of column pipe on water lube pumps.)
8. On oil lube pumps check that the exposed bearing box is tight. It should be tightened to the torque for the corresponding tubing size given in Table I.
9. Remove the shaft coupling, clean the shaft and coupling threads, the bowl assembly threads and butt face, and the main bearing box threads and face (if enclosing tubing is furnished). Lightly oil the shaft threads and screw the shaft coupling on half way. Place a rag over the coupling to prevent entrance of trash when installing the first section of column.

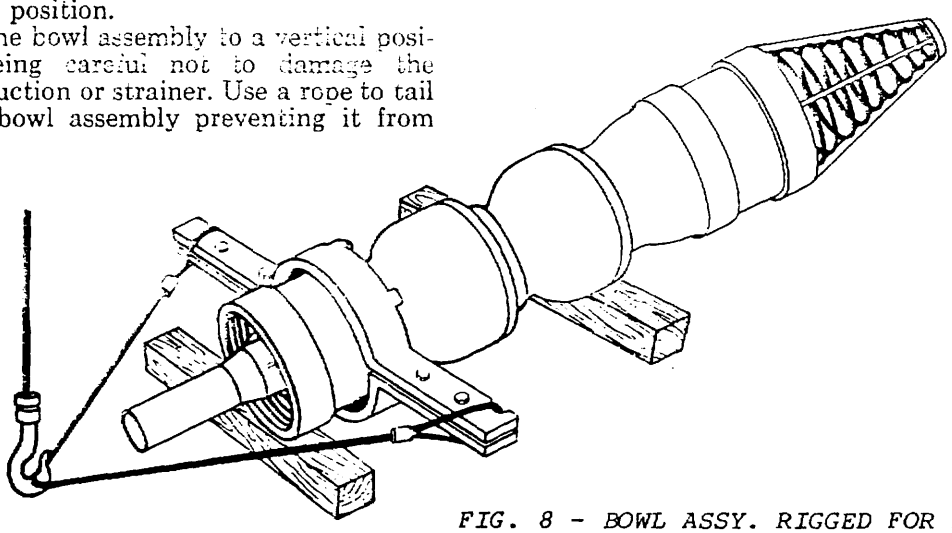


FIG. 8 - BOWL ASSY. RIGGED FOR LIFTING

D. COLUMN — OPEN LINE SHAFT

Assemble open line shaft column as follows. In addition, for "LB" type column observe the special precautions in Secction III.E.11.

1. Determine the correct sequence of installation of the column sections. Refer to the Installation Plan. The top and bottom sections may be special lengths and the top section has welded lugs approximately two feet from the top end.
2. Secure a friction clamp immediately beneath the column coupling (if column is flanged, secure the clamp about 6″ below the bottom of the flange) on the first section of column to be installed. See Fig. 9.
3. Screw a shaft coupling onto the upper end of the shaft to protect the shaft threads and face while sliding it into the column pipe (on smaller column sizes where there is not enough clearance to allow removal of the shaft coupling after the shaft is in the pipe, wrap a rag around the end of the shaft). Slide the shaft into the column pipe until it protrudes approximately 12″ past the bottom end of the pipe. Remove the coupling (or rag) installed above. Make certain that shaft sleeve, if furnished, is toward the upper end of the pipe. Tie a series of half hitches to the column pipe and to the shaft with a ¾″ rope, so as to prevent the shaft from sliding out of the column pipe when the assembly is hoisted to the vertical position. Attach a sling to the clamp ears. See Fig. 9. Screw a shaft coupling onto the lower end of the shaft to protect the shaft face and threads in case the shaft slips during handling.
4. Hoist the column assembly to the vertical position taking care not to strain the shaft or damage the shaft or pipe threads. The shaft should be supported by hand or with a pipe wrench to prevent it from slipping. Before centering the column assembly over the bowl, tap the side of the column pipe to remove any loose matter.
5. Swing the column assembly over the bowl, remove the extra shaft coupling from the lower end of the shaft being installed, align the shafts, remove the rag from the shaft coupling on the bowl and lower the column assembly until the shaft contacts the coupling, then remove the rope. Hold the coupling and turn the shaft by hand (left hand threads) until the shaft ends butt. DO NOT FORCE THE SHAFT INTO THE

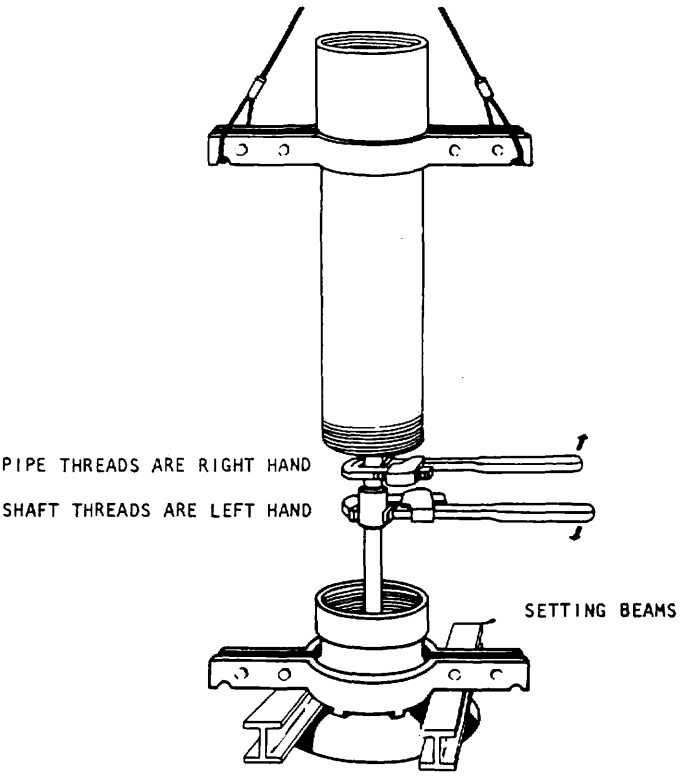


FIG. 10 - TIGHTENING SHAFT CONNECTION ON OPEN LINESHAFT COLUMN

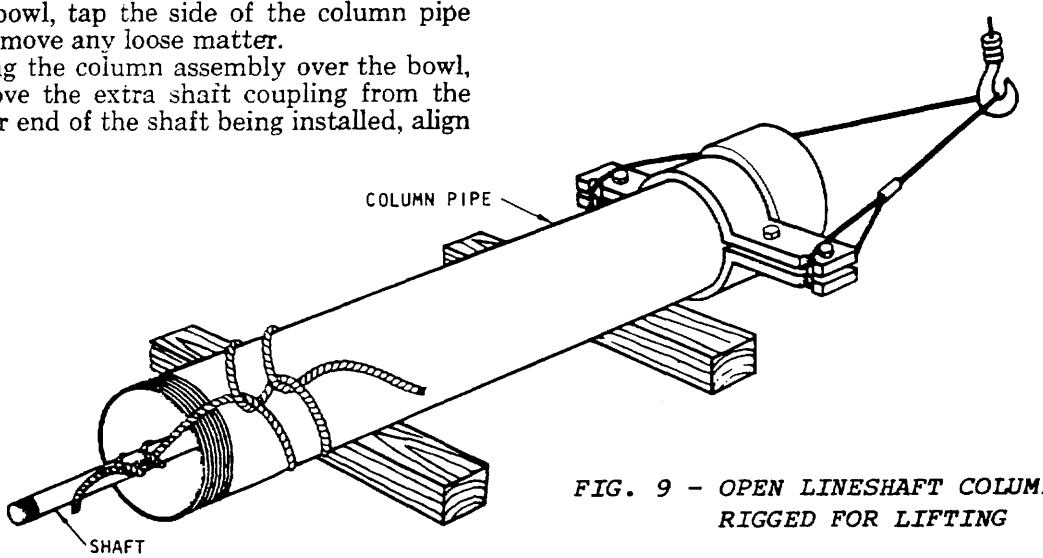


FIG. 9 - OPEN LINESHAFT COLUMN SECTION RIGGED FOR LIFTING

COUPLING. If the shaft will not screw into the coupling by hand, the threads are either damaged or dirty, or the shafts are not properly aligned. This problem must be corrected before proceeding. Place one pipe wrench on the coupling and one on the top piece shaft and tighten. Both wrenches should be handled by one man so that the push on one wrench will be balanced by the pull on the other wrench. See Fig. 10. The shafts should show equal amounts of threads above and below the coupling, indicating that the shaft butt is centered in the coupling. Remove any wrench marks from the shaft and the coupling with a flat file and emery cloth. Cover the opening with a rag to prevent the metal filings from falling on bearings below.

6. a. If the bowl to column connection is threaded, apply Laynecote thread compound to the bowl (pipe coupling on subsequent sections) assembly threads and butt face and to the pipe threads. Lower the column (making certain that on combination type couplings with integral spiders the shaft feeds smoothly through the bearing in the spider) until the column engages the bowl adapter. Using chain tongs, tighten the pipe into the bowl while slowly lowering the derrick hoist. Tighten the pipe into the bowl so that it seats securely against the mating shoulder in the bowl. See Fig. 11.

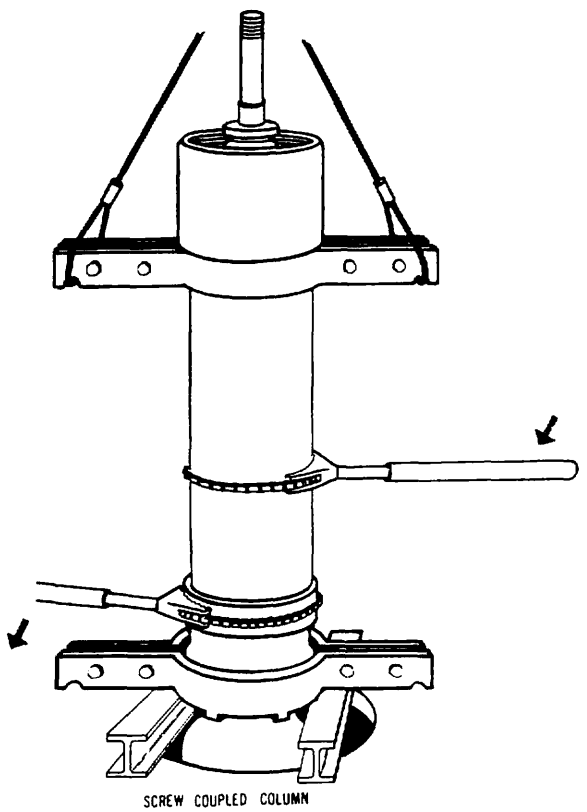


FIG. 11 - INSTALLATION OF COLUMN PIPE ON BOWL ASSEMBLY

   b. If the bowl to column connection is flanged, spread a thin even film of Laynecote on the bowl discharge flange. Lower the pipe, align the studs in the bowl with the holes in flanges, seat the column flange against the bowl flange, and then install and tighten the hex nuts evenly.
   c. If an airline is being installed, secure the line to the column pipe just above the column pipe joint just connected. See Section III.K.6.
7. Hoist the unit slightly, remove the bowl clamp and slide the setting beams out enough to allow passage of the unit.
8. If the bowl and column are coated with any special application, any required touch up work should be done before lowering the unit.
9. Lower the unit, slide the setting beams in close to the column and continue lowering the unit until the clamp ears rest on the setting beams. Remove the sling.
   If an airline is being installed, be careful not to crush or otherwise damage it as the unit is being lowered.
10a. If the column is threaded and a separate spider is used, slip the spider over the shaft, apply Laynecote thread compound to the spider threads and butt faces, then slip the spider into the coupling. See Fig. 12(A).
   b. If the column is flanged and a separate spider is used, clean the flange recess and the spider ring O.D. and faces thorough-

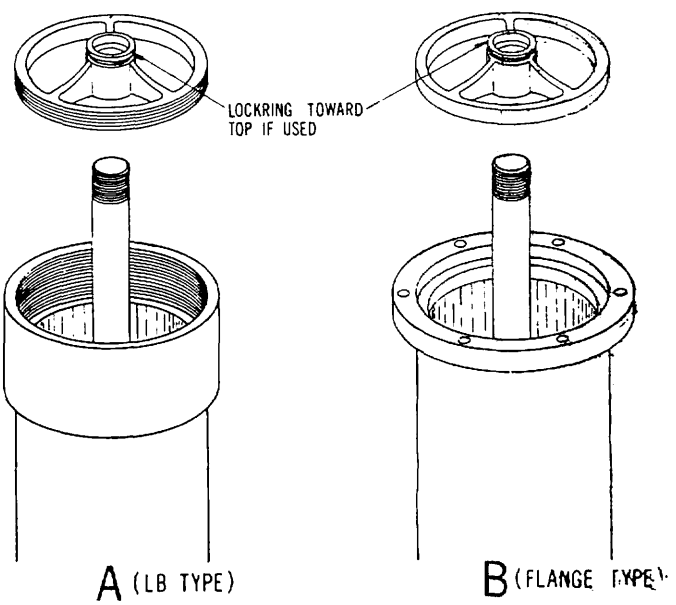


FIG. 12 - INSTALLATION OF SEPARATE SPIDERS (WHEN USED)

ly, slip the spider over the shaft and seat it in the flange recess. See Fig. 12 (B). Since Laynecote dries fairly quickly, wait until the next column section is in the vertical position and the shaft connection is made, then apply Laynecote to both flange faces and to the butt faces of the spider.

11. Check that the shaft sleeve is approximately centered in the bearing.
    Move the shaft around slightly so as to center it in its bearing. Only a slight amount of force should be required. If an excessive amount of force is required. the pipe or shaft may not be butted properly or the shaft may be bent. In any case, the trouble must be corrected prior to proceeding further.
12. Remove the exposed shaft coupling, clean the coupling threads and the shaft threads and face thoroughly. Thread the coupling on for half its length. Cover the coupling with a rag to prevent entrance of foreign matter.
13. Repeat the above outlined procedure for each additional section of column until all of the column has been assembled. Two welded lugs are provided on the O.D. of the top section of column pipe. The friction clamp should be installed immediately under these lugs. Clean the top column flange face (or end of pipe if head connection is threaded) and the shaft projection thoroughly. Do not assemble the shaft coupling to the top piece of shaft.

E. COLUMN — ENCLOSED LINE SHAFT

Assemble enclosed line shaft column as follows. In addition, for "LB". type column, observe the special precautions in Section III.E.11.

1. Determine the correct sequence of installation of the column sections. The top section of column has welded lugs approximately two feet from the top end. The top special tubing is tagged for identification by the factory. If this tag is lost, the top special tubing can still be identified by the smooth O.D. and chamfer on one end. This end also has longer threads inside the tube.
2. Secure a friction clamp immediately beneath the coupling on the first section of column to be installed. If the column is flanged, secure the clamp about 6″ below the bottom of the flange. See Fig. 13.
3. If the protective rubber cap has been removed from the end of the tubing to be inserted in the pipe, reinstall it. Slide the tubing and shaft assembly into the lower end of the pipe, allowing the tubing to protrude about 15″ past the lower end of the column pipe and allowing the shaft to protrude about 9″ past the end of the tubing. See Fig. 13. If the tubing is 5″ or larger, ensure that the end with the machined section goes toward the top. Tie a series of half hitches to the pipe tubing and shaft with a ¾″ rope so as to prevent the shaft and tubing from sliding out of the pipe when the assembly is hoisted to the vertical position. Attach a sling to the clamp ears. See Fig. 13.
4. Hoist the column to the vertical position taking care not to strain or damage the shaft. The shaft and tubing should be supported by hand or with two pipe wrenches to prevent slippage. Before centering the

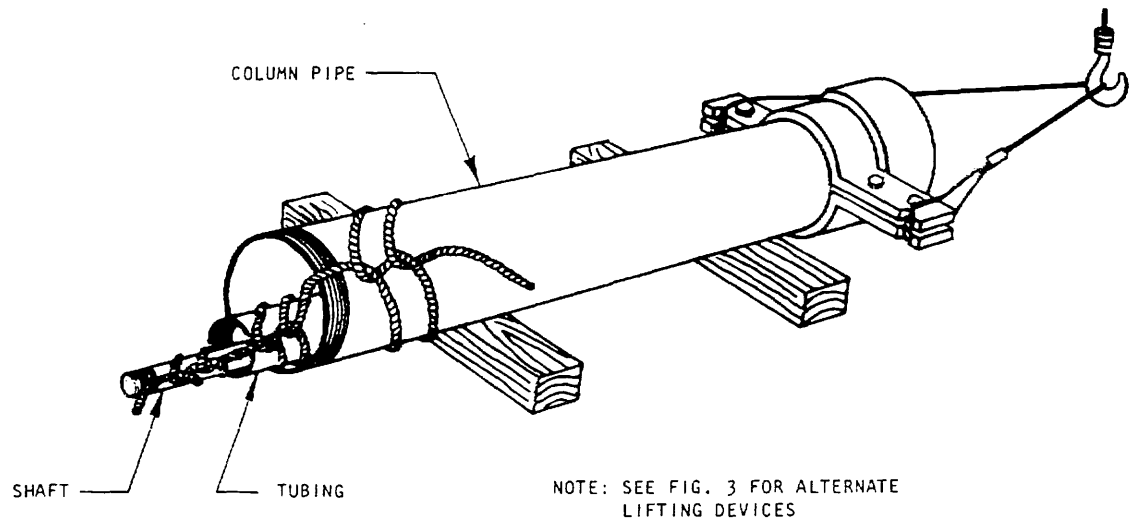


FIG. 13 - ENCLOSED LINESHAFT COLUMN SECTION RIGGED FOR LIFTING

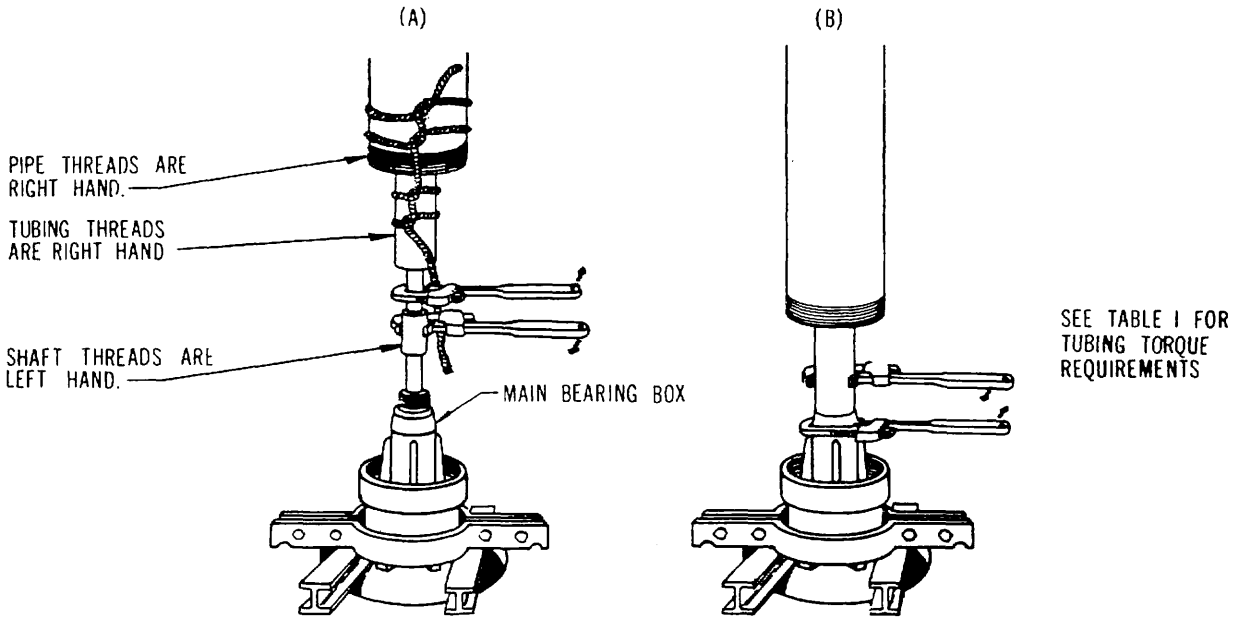


FIG. 14 - ASSEMBLING SHAFT AND TUBING ON ENCLOSED LINESHAFT COLUMN

column over the bowl, tap the side of the column to remove any loose matter from the pipe.

5. Make up the shaft joint as described in Section D.5. See Fig. 14-A.
6. Lower the assembly until the tubing contacts the main bearing box (lineshaft bearing on subsequent sections) and then remove the rope. Apply a small amount of Laynecote thread compound to the outside diameter of the exposed bearing threads. Place one pipe wrench on the main bearing box shoulder (place wrench on lower piece of tubing on succeeding column joints) and the second wrench on the tubing and tighten firmly. See Fig. 14 B. Table 1 gives the torque requirements for assembling tubing joints. If the tubing is coated with any special application, any touch up required resulting from using the pipe wrench should be done now.

TABLE 1—OIL LINE TUBING ASSEMBLY TORQUE REQUIREMENTS

Tubing Size	Assembly Torque (ft. -lbs.)	
	Minimum	Maximum
1¼	80	110
1½	120	150
2	280	350
2½	440	560
3	850	1100
3½	1150	1350
4	1300	1600
5	1300	2500
6	1300	4000

7. Make up the pipe connection as described in Section D.6 through D.9.
8. After each piece of column has been lowered and is resting on the setting beams, remove the exposed lineshaft bearing, pour oil into the tubing and reinstall the bearing. This is not necessary if the unit is to be force water lubricated. The amount of oil to be poured is given in the table below.

TABLE 2 — AMOUNT OF OIL TO BE POURED INTO OIL-LINE TUBING AT ASSEMBLY

TUBE SIZE	AMT. OF OIL PER SECTION	
	10′ Sections	20′ Sections
1¼, 1½, 2	½ Cup	1 Cup
2½, 3, 3½	1 Cup	½ Qt.
4 and larger	½ Qt.	1 Qt.

The oil used should meet the specifications given in Section II.B.27.

9a. If the column is threaded and utilizes "LB" construction (steel coupling and separate rubber spider), clean the tubing O.D., slip the spider over the tubing, and force it approximately 2″ into the pipe. The spiders should be located approximately 20′ from the bowl and from the head and at 40′ intervals along the tubing. The spiders should fit snugly in the column pipe or on the tubing (or both places), otherwise they will slide to the bottom of the well.

b. If the column is flanged, clean the flange recess and the bronze spider faces and O.D. with a file to remove any foreign matter, nicks and burrs. Slide the bronze spider over the tubing and seat the spider in the flange recess. See Fig. 12. Since Laynecote dries fairly quickly, wait until the next column section is in the vertical

position and the tubing connection has been made, then apply Laynecote to both flange faces and to the butt surfaces of the spider.

10. Repeat the procedure outlined above for each additional section of column until all of the column has been assembled.
11. **Special precautions for "LB" type column.** Because of the tendency of the threads to gall when steel pipe is screwed into steel couplings, the following special precautions should be taken when assembling "LB" column.
    a. Inspect and thoroughly clean the coupling threads (on the section set in the well) and repair any damaged threads as required. Liberally coat the threads with Anti-Seize compound (NOT thread compound).
    b. Before centering the column assembly over the installation opening, clean, inspect and repair any damaged threads.
    c. Recheck pipe threads for cleanliness or damage after pipe is hoisted to vertical position, and then apply a liberal coat of anti-seize compound to the threads.

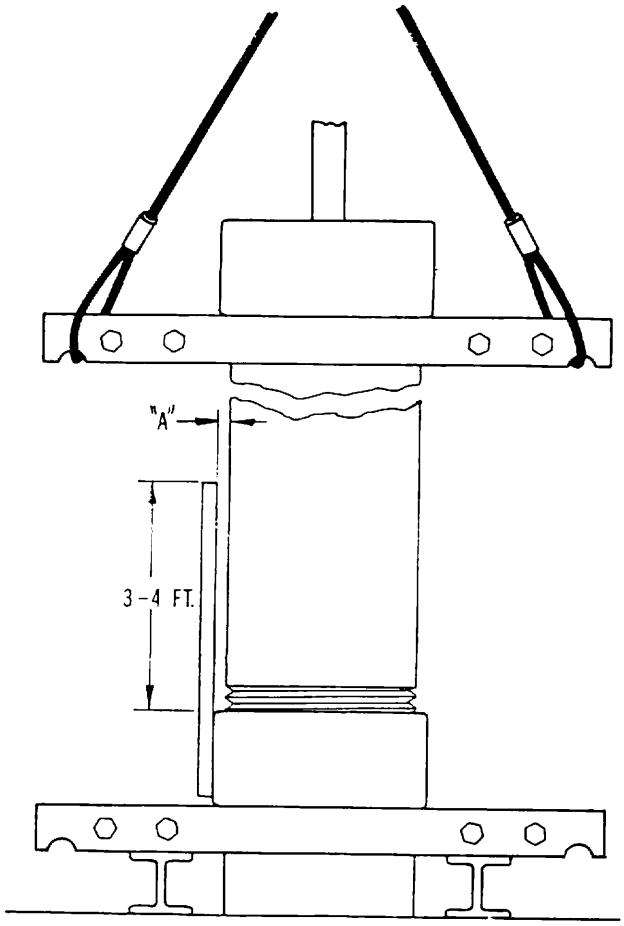


FIG. 15 - ALIGNMENT OF PIPE AND COUPLING FOR LB TYPE COLUMN

    d. When lowering the pipe into the coupling, do not back thread the pipe.
    e. Align the coupling and pipe threads using a straight edge about 3 to 4 feet long. Lay the straight edge vertically against the coupling O.D. See Fig. 15. Align the pipe so that the distance between the pipe and the straight edge is equal along the full length of the straight edge in two positions 90° apart (i.e. until the pipe is parallel to the straight edge).
    f. Carefully screw the pipe into the coupling as far as possible by hand. Do not use a power driven mechanism to spin the connection together. If at any time the threads are suspected of galling, unscrew the pipe and inspect, clean and repair as necessary the pipe and coupling threads. Apply a fresh coat of anti-seize compound and repeat the above assembly procedure exercising special care in aligning the pipe with the coupling.

F. DISCHARGE HEAD

1. If a steel plate is provided for use under the discharge head and this plate is not already attached to the head, attached the plate as described below.
    (A) Simple Lifting Plate: See Fig. 16A
        1. Clean the mating surfaces of the head and the lift plate.
        2. Place the head on the plate. Orient the head so that the holes (including any auxiliary holes) in the head line up with the holes in the plate.
        3. Bolt the head to the plate by installing two bolts in diagonally opposite holes in the base of the head.
    (B) Full Lifting Plate: See Fig. 16B .
        1. Install studs in the threaded holes near the large hole in the plate. Drive the studs into the plate as deep as the threads will allow. Also assure that the stud protrudes from the same side of the lifting plate as the male register.
        2. Clean the mating surfaces of the head and the lifting plate and install the "O" ring.
        3. Place the discharge head on the lifting plate. Orient the head to the desired position, making sure that the auxiliary holes in the head line up with the auxiliary holes in the plate.
        4. Install the socket head capscrews provided to secure the plate to the head.
2. If a top column flange is to be used and it is not already installed, install it on the top section of column pipe as follows:
    (A) Butt type flange
        1. Clean the pipe and flange threads and butt surfaces and apply a thin coat of Laynecote.

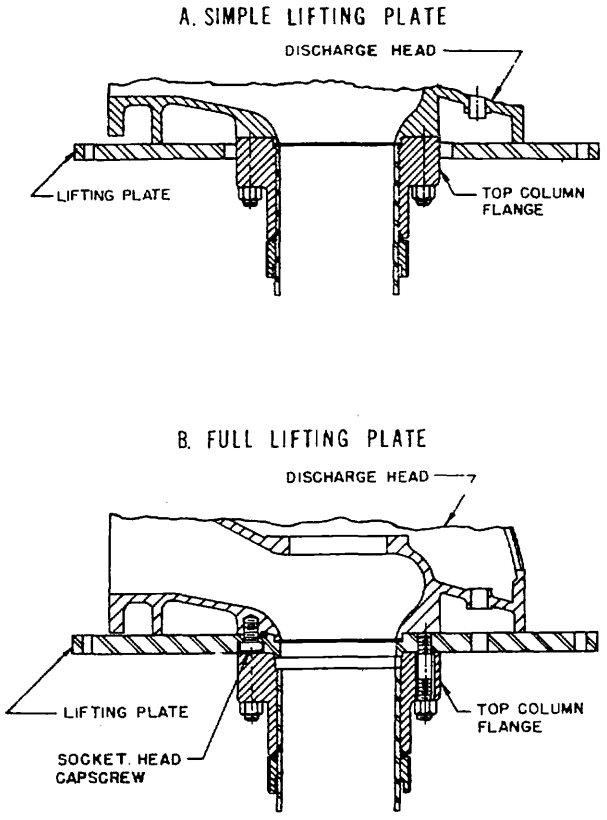


FIG. 16 - ARRANGEMENT OF DISCHARGE HEAD WITH SPECIAL LIFTING PLATES

2. Screw the flange onto the pipe and tighten securely.

(B) Adjustable type flange

1. Clean the threads on the column pipe, the flange and the packing ring.
2. Screw the packing ring onto the pipe. Make sure that the chamfer is on top.
3. Screw the flange onto the pipe.

3. Attach slings to the head for lifting as shown in Fig. 17A, 17B, 17C, 17D, whichever is applicable. WHEN A STEEL PLATE SUCH AS SHOWN IN FIG. 17D IS PROVIDED, THIS PLATE MUST BE USED AS SHOWN FOR LIFTING THE PUMP ASSEMBLY.
4. Lift the head (and lifting plate if used), remove the hex nuts from the studs (if flanged head-to-column connection), and clean the mating surfaces on the bottom. of the head (or lifting plate) and on the column pipe. Apply a thin coat of Laynecote to all of the head-to-column mating surfaces.
5. (A) If the head-to-column pipe connection is flanged, align the head studs with flange holes, lower the head until it is seated squarely on the flange, and then install and tigthen the hex nuts. If a butt type flange is used, orient the head so that its outlet is as close as possible to its final position.

(B) If the head-to-column pipe connection is threaded, lower the head until it contacts the pipe, apply a set of chain tongs to the pipe and turn the head until the pipe seats. To tighten the head further, place a long pipe through the head windows or into the discharge (being careful not to damage the shaft).

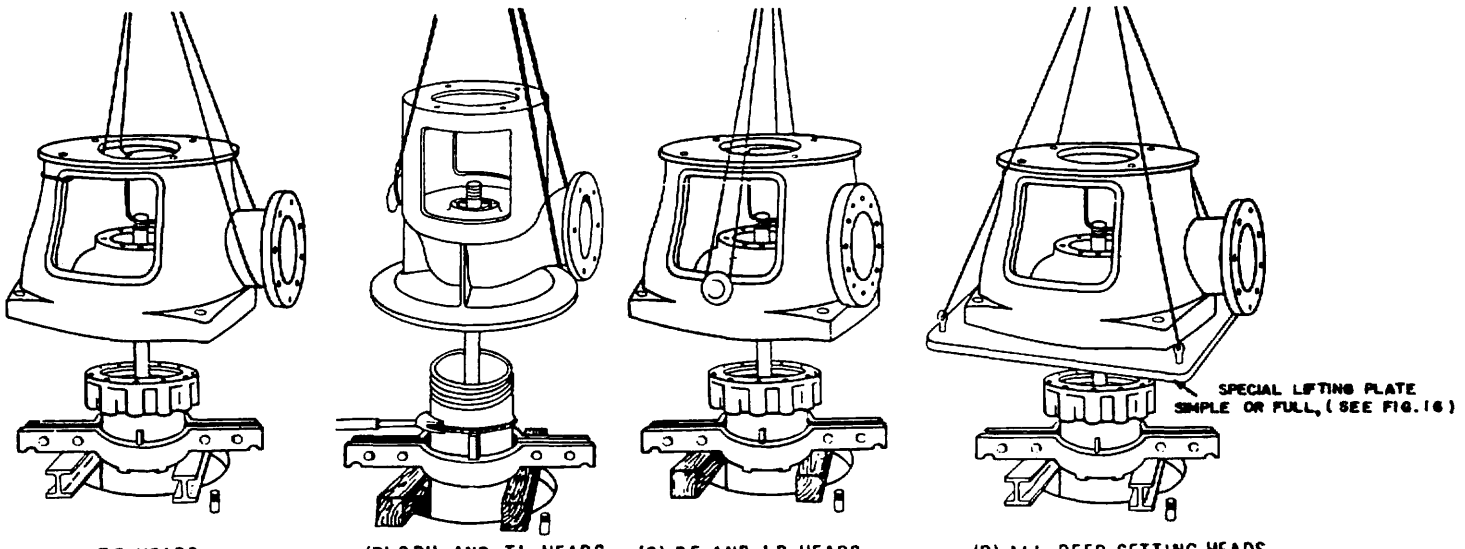


FIG. 17 - METHODS OF RIGGING HEADS FOR LIFTING

G. DISCHARGE HEAD SHAFT AND TUBING PROJECTIONS—TOP COLUMN FLANGE ADJUSTMENT

Adjustable top column flange, enclosed tubeline, and style 60 stuffing box (See Fig. 18)

1. Rotate the packing ring clockwise (when viewed from above) as far as possible. The packing ring should now be at the bottom of the threaded area on the top column pipe.
   Rotate the head until its male register either butts or is even with the end of the column pipe (see insert on Fig. 18).
2. Measure and record distance "T". Mark the lug used for this measurement so that the same lug can be identified and used for measurements to be taken later.
3. Adjust the head until *all* of the conditions listed below are met.
   - X≥* (½L + bowl lateral + shaft pullup + shaft rise + ⅜")
     where: L = coupling length
     bowl lateral = value recorded in para II.D.9 or III.C.1(d)
     shaft pullup = value from Table 3
     shaft rise = value from Table 3
   - Y is between Y min. and Y max. from Table 4.
   - D≥* (S+½L — shaft rise)
     where: S=the stuffing box protrusion (see fig. 18)
   - T is less than the value recorded in step 2 above plus the max. allowable increase per Table 5.

   If the above conditions cannot be met on settings of less than 500'; then the problem is probably due to the shafting, tubing, or column pipe not being butted properly. The problem should be corrected before proceeding.
   On settings greater than 500'; it may be necessary to change the requirements for "X" to:
   X≥* (½L + bowl lateral + shaft pullup + shaft rise + ⅛" — B)
   where B is the distance from the driver mounting face to the bottom of the driver quill (hollow shaft). See Fig. 21
   The deviation from the original requirements should be kept to a minimum.
   The above limitations are based on the following:

X—There must be enough room for the shaft to rise the required amount without the driveshaft-to-lineshaft coupling hitting the bottom of the driver when the pump lateral is set.

Y min.—There must be enough threads exposed on the stuffing box tension nut to allow taking the required amount of tube tension.

Y max.—The tube must protrude through the "O" ring in the stuffing box prior to taking tube tension.

D—The shaft must protrude sufficiently to allow proper installation of the head-shaft-to-lineshaft coupling after the tube tension has been taken.

T—The column pipe must have enough threads engaged in the top column flange to prevent the threads from stripping when the load is applied.

4. Install the packing ring and packing as follows:
   (A) Fill the chamfer on the lower end of the top column flange with lampwick packing that has been coated with Laynecote thread compound. Use a generous amount of packing. Wind the packing around the column pipe in a clockwise direction so that when the packing ring is tightened, the packing is forced into the chamfer on the flange.
   (B) Screw the packing ring up against the flange and tighten securely.
5. Using slings attached to the head as shown in Fig. 17A, 17B, 17C or 17D. Lift the entire pump assembly slightly, remove the elevators from the top section of column, remove the setting beams, clean the surface of the base plate or foundation, and loosen or remove the anchor bolt nuts if they have been installed. (Required airline connections should be made up prior to lifting the head and removing the elevators).
6. If the baseplate is not already bolted to the head, orient the discharge outlet to the desired position and lower the unit just enough to install the head-to-baseplate mounting bolts. Raise the unit until the baseplate clears the foundation and then tighten the mounting bolts securely and clean the foundation.
7. Slowly lower the unit until one corner of the baseplate (head base flange if no baseplate is used) just touches the foundation. Stop lowering at this point and insert wedges (two per side) underneath the edges of the baseplate that are not touching the foundation. Tap the wedges lightly to tighten them.
8. Lower the hoist until the full weight of the unit is resting on the foundation and the wedges.

Butt type top column flange, enclosed tubeline, and style 60 stuffing box. (See Fig. 18)

The butt type flange cannot be adjusted. However, check that distances "X", "Y", and "D" are within the limits given in the section above (Adjustable Top Column Flange, Enclosed Tubeline and Style 60 Stuffing Box). If "X", "Y", and "D" are not within these limits, the

* equal to or greater than

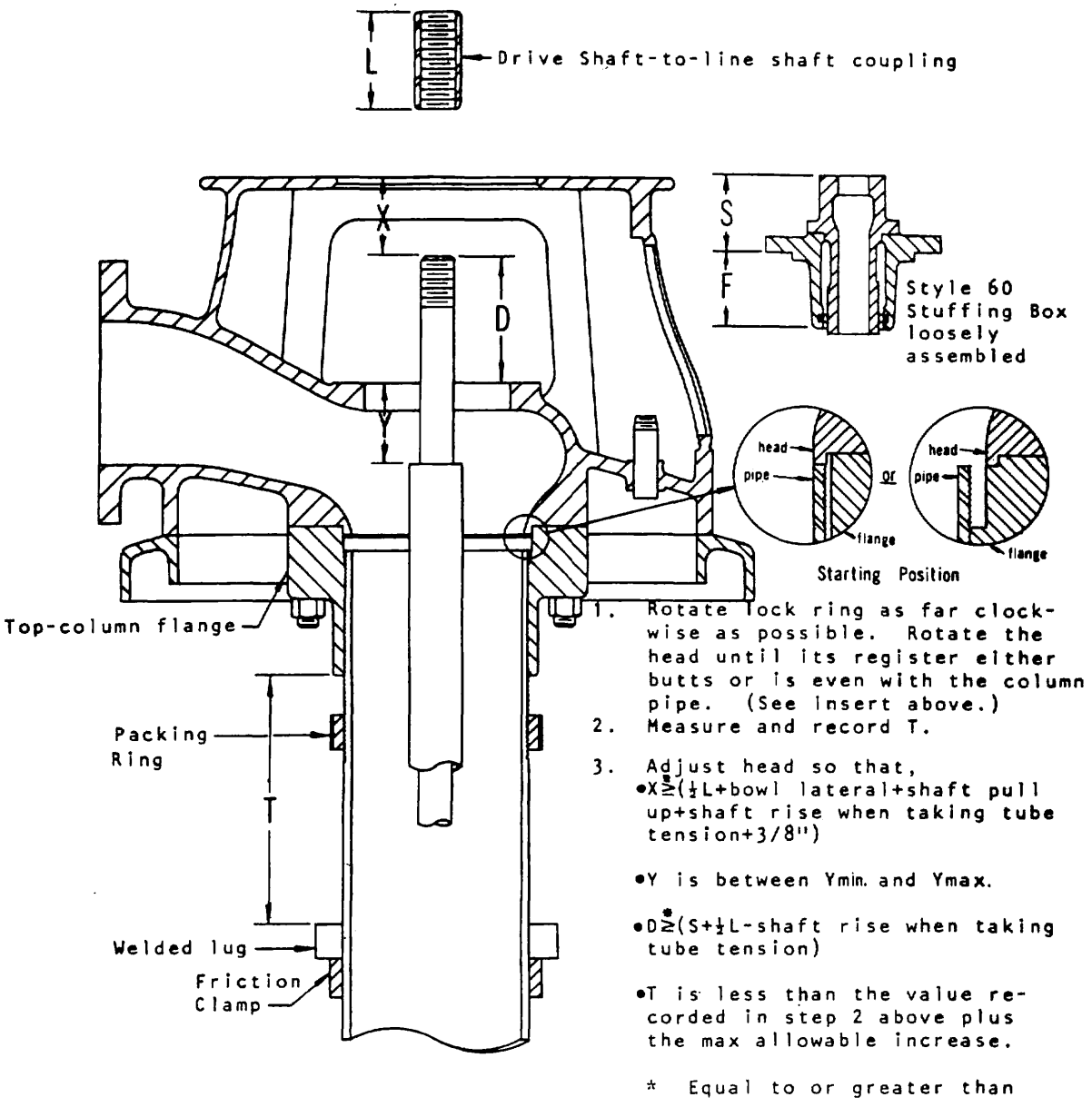


FIG. 18 - ADJUSTMENT OF TOP COLUMN FLANGE (ENCLOSED LINESHAFT COLUMN)

TABLE 3—TUBE TENSION, SHAFT RISE, AND SHAFT PULL-UP

Column Size (in.)	Shaft and Tube Size (in.)	SETTING (Ft)														
		100			200			300			400			500		
		Tube Tension (in.)	Shaft Rise (in.)	Shaft Pull-up (in.)	Tube Tension (in.)	Shaft Rise (in.)	Shaft Pull-up (in.)	Tube Tension (in.)	Shaft Rise (in.)	Shaft Pull-up (in.)	Tube Tension (in.)	Shaft Rise (in.)	Shaft Pull-up (in.)	Tube Tension (in.)	Shaft Rise (in.)	Shaft Pull-up (in.)
3" (0.187)	1-1/4" x 7/8	0.03	<0.01	0.02	0.10	0.04	0.07	0.23	0.10	0.15	0.40	0.17	0.27	0.63	0.27	0.43
	1-1/2 x 1	0.03		0.02	0.11	0.06	0.07	0.25	0.12	0.16	0.45	0.22	0.28	0.70	0.35	0.44
4" (0.237) Sch. 40	1-1/4" x 7/8	0.02		0.02	0.08	0.03	0.06	0.19	0.06	0.14	0.33	0.11	0.26	0.52	0.17	0.40
	1-1/2 x 1	0.02		0.02	0.09	0.03	0.07	0.20	0.08	0.15	0.36	0.14	0.27	0.57	0.21	0.42
	2 x 1-3/16	0.03		0.02	0.10	0.05	0.07	0.24	0.11	0.16	0.42	0.19	0.28	0.66	0.30	0.44
5" (0.258) Sch. 40	1-1/4" x 7/8	0.02		0.02	0.08	0.02	0.06	0.17	0.05	0.14	0.30	0.08	0.25	0.48	0.13	0.39
	1-1/2 x 1	0.02		0.02	0.08	0.03	0.06	0.18	0.06	0.14	0.32	0.10	0.26	0.51	0.16	0.40
	2 x 1-3/16	0.02		0.02	0.09	0.04	0.07	0.21	0.08	0.15	0.37	0.14	0.28	0.58	0.22	0.42
6" (0.280) Sch. 40	1-1/4" x 7/8	0.02		0.02	0.07	0.02	0.06	0.16	0.03	0.14	0.29	0.06	0.24	0.45	0.10	0.38
	1-1/2 x 1	0.02		0.02	0.08	0.02	0.06	0.17	0.04	0.14	0.30	0.08	0.25	0.47	0.12	0.39
	2 x 1-3/16	0.02		0.02	0.08	0.03	0.06	0.19	0.06	0.15	0.34	0.11	0.26	0.53	0.17	0.41
	2-1/2 x 1-1/2	0.02	0.01	0.02	0.10	0.04	0.07	0.22	0.10	0.15	0.40	0.17	0.28	0.62	0.27	0.43
	2-1/2 x 1-11/16	0.02	0.01	0.02	0.10	0.05	0.07	0.23	0.11	0.16	0.41	0.19	0.29	0.65	0.30	0.45
	3 x 1-15/16	0.03	0.02	0.02	0.12	0.07	0.08	0.27	0.15	0.17	0.49	0.26	0.30	0.76	0.41	0.47
7" (0.301) & 8" (0.322)	2 x 1-3/16	0.02	0.01	0.02	0.08	0.02	0.06	0.17	0.05	0.14	0.31	0.08	0.25	0.49	0.13	0.40
	2-1/2 x 1-1/2	0.02	0.01	0.02	0.09	0.03	0.07	0.20	0.07	0.15	0.36	0.13	0.27	0.56	0.21	0.42
	2-1/2 x 1-11/16	0.02	0.01	0.02	0.09	0.04	0.07	0.21	0.08	0.16	0.37	0.15	0.28	0.58	0.23	0.43
	3 x 1-15/16	0.03	0.01	0.02	0.11	0.05	0.07	0.24	0.11	0.16	0.43	0.20	0.29	0.67	0.31	0.45
	3-1/2 x 2-3/16	0.03	0.02	0.02	0.12	0.06	0.08	0.27	0.14	0.17	0.48	0.25	0.30	0.75	0.40	0.47
	3-1/2 x 2-7/16	0.03	0.02	0.02	0.13	0.07	0.08	0.28	0.16	0.18	0.50	0.28	0.32	0.79	0.44	0.50
9" (0.312) & 10" (0.279)	2 x 1-3/16	0.02	0.01	0.02	0.07	0.02	0.06	0.16	0.04	0.14	0.29	0.07	0.25	0.46	0.11	0.39
	2-1/2 x 1-1/2	0.02	0.01	0.02	0.08	0.03	0.06	0.18	0.06	0.15	0.33	0.10	0.26	0.51	0.16	0.41
	2-1/2 x 1-11/16	0.02	0.01	0.02	0.09	0.03	0.07	0.19	0.06	0.15	0.34	0.12	0.27	0.53	0.18	0.42
	3 x 1-15/16	0.02	0.01	0.02	0.10	0.04	0.07	0.22	0.09	0.16	0.38	0.16	0.28	0.60	0.25	0.44
	3-1/2 x 2-3/16	0.03	0.01	0.02	0.11	0.05	0.07	0.24	0.11	0.16	0.43	0.20	0.29	0.67	0.32	0.45
	3-1/2 x 2-7/16	0.03	0.01	0.02	0.11	0.06	0.08	0.25	0.12	0.17	0.45	0.22	0.31	0.70	0.35	0.48
	4 x 2-11/16	0.03	0.02	0.02	0.12	0.06	0.08	0.27	0.14	0.18	0.47	0.25	0.32	0.74	0.39	0.50
12"	2-1/2 x 1-1/2	0.02	0.01	0.02	0.07	0.02	0.06	0.17	0.04	0.14	0.30	0.07	0.25	0.47	0.12	0.39
	2-1/2 x 1-11/16	0.02	0.01	0.02	0.08	0.02	0.06	0.17	0.05	0.14	0.31	0.08	0.26	0.48	0.13	0.40
	3 x 1-15/16	0.02	0.01	0.02	0.08	0.03	0.07	0.19	0.06	0.15	0.34	0.11	0.27	0.53	0.18	0.42
	3-1/2 x 2-3/16	0.02	0.01	0.02	0.09	0.04	0.07	0.21	0.08	0.15	0.37	0.14	0.28	0.58	0.23	0.43
	3-1/2 x 2-7/16	0.02	0.01	0.02	0.10	0.04	0.07	0.22	0.09	0.16	0.38	0.16	0.29	0.60	0.25	0.45
	4 x 2-11/16	0.03	0.01	0.02	0.10	0.04	0.07	0.23	0.10	0.17	0.40	0.18	0.30	0.63	0.28	0.47

NOTES:

1. TUBE TENSION — the distance that the top end of the tubing must be pulled up to put the tubing in the proper amount of tension.
   SHAFT RISE — the distance that the lineshaft will rise when taking tube tension
   SHAFT PULL-UP — the distance that the top end of the lineshaft must be pulled up in to just lift the impellers off the bowl.

TABLE 4
LIMITS OF DIMENSION "Y" SHOWN ON FIG. 18

Shaft Size	Y Max.	Y Min.
7/8" & 1"	1¾"	Tube tension (per Table 3) Minus ¼"
1-3/16" & up st. length**	2¾"	Tube tension (per Table 3) Minus ⅜"
1-3/16" & up extra length**	4¾"	Same as above

**dimension "F" on Fig. 18 is approximately 3½" for std. length and approximately 5½" for extra long.

TABLE 5
MAX. ALLOWABLE INCREASE OF DIMENSION "T" SHOWN ON FIGS. 18 and 19

Column Size	Max. Allowable Increase*
4	3⅞
5, 6, 7	4⅜
8, 9	4⅛
10	3
12	3¼

*Values given are for cast iron top column flange which has an overall length of approximately 6½". On deeper settings using a welded steel top column flange with an overall length of approximately 8½", the values can be increased by 2".

problem is probably due to the tubing, shafting, or column pipe not being butted properly. This problem must be corrected before proceeding. If "X", "Y", and "D" are within the specified limits, proceed with lowering the pump into the well as described in steps 5 through 8 above.

Adjustable top column flange and open lineshaft column. (See Fig. 19)

1. Rotate the packing ring clockwise (when viewed from above) as far as possible. The packing ring should now be at the bottom of the threaded area on the column pipe. Rotate the head until its male register either butts or is even with the end of the column pipe. (See insert on Fig. 19.)
2. Measure and record distance "T". Mark the lug used for this measurement so that the same lug can be identified and used for measurements to be taken later.
3. Adjust the head until *all* of the conditions listed below are met.

- $X \geq^*$ ($\frac{1}{2}$L + bowl lateral + shaft pullup + $\frac{3}{8}$")

  where: L = coupling length
  bowl lateral = value recorded per para II.D.9 or III.C.1 (d)
  shaft pullup = value from Table 3
- $D \geq^*$ ($\frac{1}{2}$ + 2$\frac{7}{8}$")
  (This condition does not apply for shaft size larger than 2 11/16")
- T is less than the value recorded in Step 2 above plus the max. allowable increase per Table 5.

Keeping distance "X" as short as allowed by the formula above will provide maximum clearance for access to the stuffing box. This will be beneficial when stuffing box requires repacking.

If the above conditions cannot be met, the problem is probably due to the shafting or column pipe not being butted properly.

The above limitations are based on the following:

X — There must be enough room for the shaft to rise the required amount without the driveshaft-to-line-shaft shaft coupling hitting the bottom of the driver when setting the pump lateral.

D — The shaft must protrude sufficiently to remove the stuffing box internals without removing the driver.

T — The column pipe must have enough threads engaged in the top column flange to prevent the threads from stripping when the load is applied.

4. Install the packing ring and lower the pump into the well as described in steps 4 through 8 above.

Butt type top column flange and open lineshaft column. (See Fig. 19)

The butt type flange cannot be adjusted. However, check that distances "X" and "D" are written the limits specified in the preceeding section (Adjustable Top Column Flange and Open Lineshaft Column). If "X" and "D" are not within these limits the problem is probably due to the shafting or column pipe not being butted properly. This problem must be corrected before proceeding. If "X" and "D" are within the specified limits, proceed with lowering the pump into the well as described in steps 5 through 8 above.

H. ALIGNMENT

In order to prevent undue bearing loads and excessive vibration, the pump head and lineshaft must be aligned properly and must remain aligned during operation. The pump head should be placed at the approximate elevation desired by shimming equally under the wedges installed in Section III.G.7 if necessary, and the discharge flange should be oriented properly (this is limited if anchor bolts are used) prior to commencement of the head alignment. Once the head has been aligned, any connections made must be fitted so that no strain is placed on the pump head when the connections are tightened. DO NOT ATTEMPT TO ALIGN THE HEAD WITH THE DISCHARGE PIPING CONNECTED.

When properly aligned the lineshaft will be in the center of the head and will be perpendicular to the driver mounting flange on the head. The alignment should be performed as described below. See Fig. 20.

1. Remove the stuffing box (if installed). Using calipers check the distance "R" between the shaft O.D. and the stuffing box bore of the head in four places approximately 90° apart. If these distances are all equal, the shaft is properly centered. If not, the shaft must be centered by shimming between the foundation and the baseplate until these distances are equal. This is done by loosening the anchor bolts driving in the wedges or inserting shims under the side where the shaft is fartherest from the bore and withdrawing the wedges or removing shims from the side where the shaft is closest to the bore. Tighten the anchor bolts and check to see that the shaft remains centered.
2. Install the drive shaft or a short dummy shaft. Using a carpenter's square, determine whether or not the shaft is perpendicular to the motor mounting flange. Check four places 90° apart. If the shaft is not

* greater than or equal to

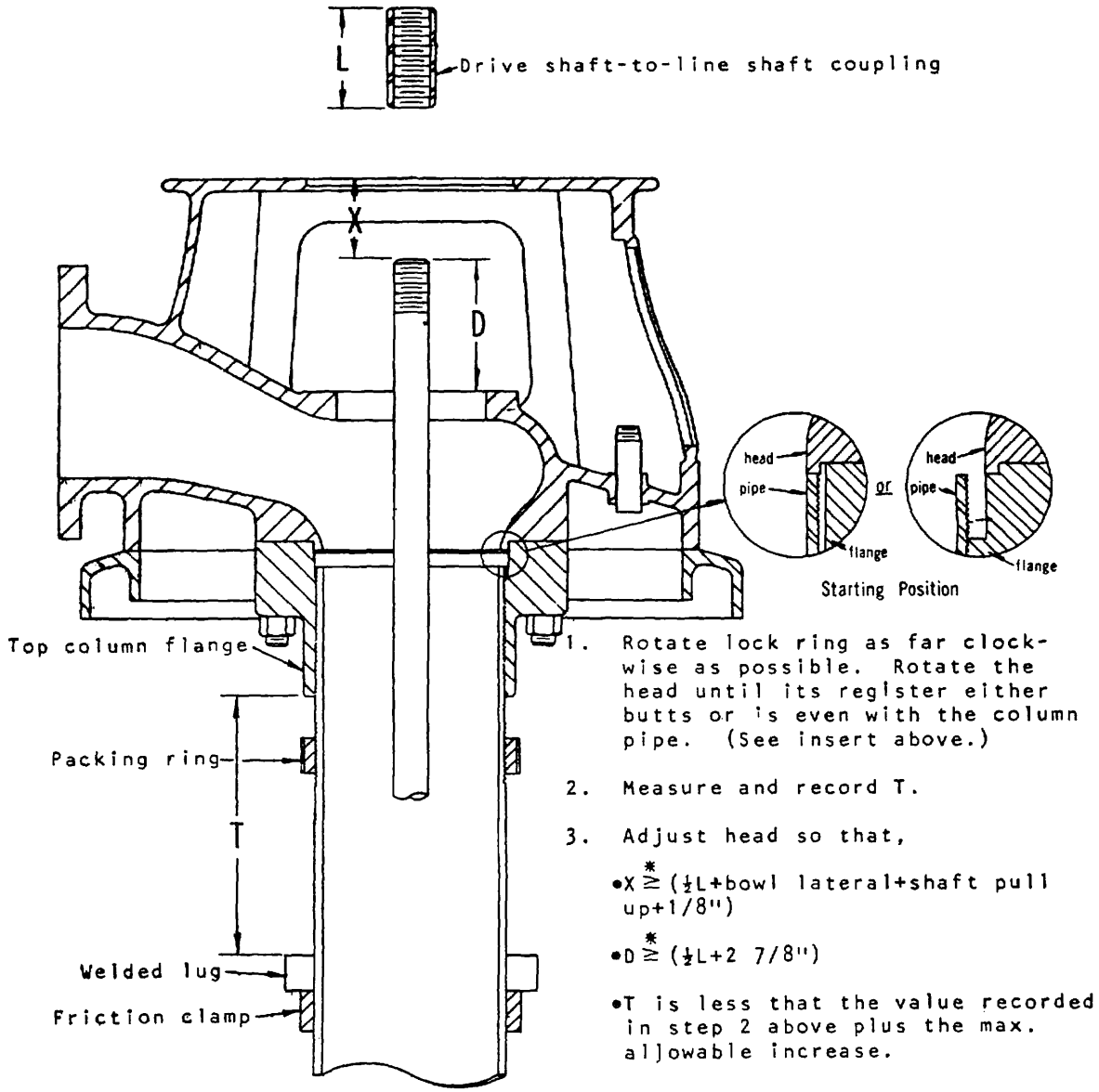
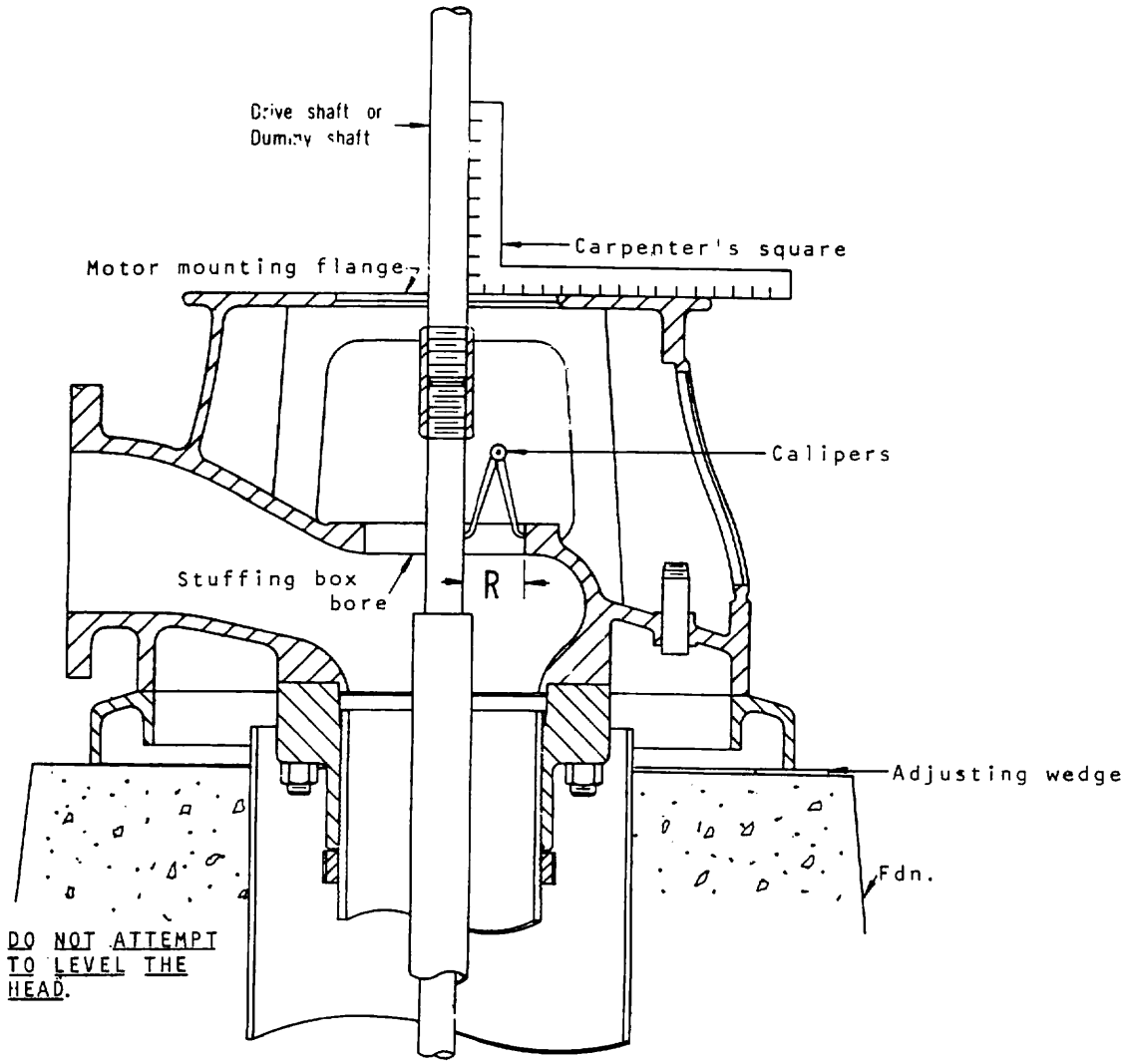


FIG. 19 - ADJUSTMENT OF TOP COLUMN FLANGE (OPEN LINESHAFT COLUMN)



1. The shaft must be centered in the stuffing box bore. Check that R is equal in four positions 90° apart.

2. The shaft must be perpendicular to the motor mounting flange. Check with carpenter's square in two positions 90° apart.

3. Conditions in 1 and 2 above must exist for two positions of the shaft, 90° apart.

FIG. 20 - DISCHARGE HEAD TO LINESHAFT ALIGNMENT (OPEN AND ENCLOSED LINESHAFT)

perpendicular, adjust the wedges as described above. (A bent carpenters square will give a false indication. If the direction of indicated out-of-perpendicularity changes as the square is shifted between positions 180° apart, then the square is bent). After adjusting the wedges, check that the shaft is still in the center of the stuffing box bore.

3. Rotate the shaft approximately 90° and repeat steps 1 and 2 above.

NOTE: The shaft can be turned on shallow settings by temporarily installing the stuffing box (without packing rings, etc.) connecting a dummy shaft (not necessary if line shaft to head shaft connection is below the stuffing box) and turning the shaft with a wrench. Remove the stuffing box prior to doing any alignment checks.

NOTE: On deeper settings it will be necessary to connect a lifting device such as shown in Fig. 4 to the upper end of the shaft and then carefully raise the shaft and impellers using the hoist on the derrick. A wrench can then be used to turn the shaft. Lower the hoist and remove the lifting device prior to doing any alignment checks.

NOTE: When a wrench is to be used on a shaft that is a permanent part of the installation, wrap the shaft for protection.

If the shaft did not remain in the center of the stuffing box or did not remain perpendicular to the motor mounting flange, then it is likely that either the top shaft is bent or the first shaft joint below the head is not installed properly (not butted, trash or burrs on butt faces, etc.).

In order for the alignment to be acceptable the shaft must remain in the center of the stuffing box bore and remain perpendicular to the motor mounting flange for two shaft positions 90° apart.

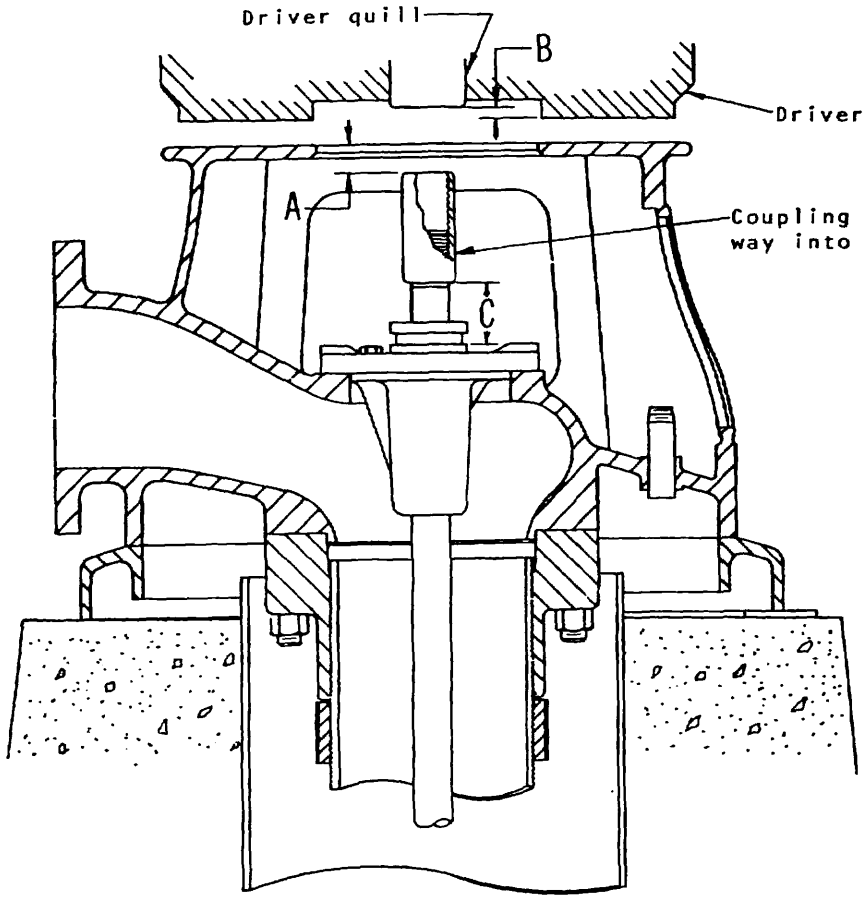
Note that the discharge head may not be exactly level when the alignment is completed. This is normal and NO ATTEMPT SHOULD BE MADE TO *LEVEL* THE DISCHARGE HEAD. The head is aligned so that the shaft will run true in the stuffing box bearing (i.e. head is aligned perpendicular to the shaft). If the well is drilled at a slight angle then the pump may lay against one side of the casing, resulting in the column pipe and shaft laying at a slight angle away from vertical. When the head is aligned to this shaft it also will sit at this same angle.

I. STUFFING BOX

1. Open line shaft
   (a) Remove any paint and burrs from the underside of the machined flange of the stuffing box and from its mating surface on the pump head. Remove the lantern ring and separator rings which are shipped in the bottom of the stuffing box cavity.
   (b) Determine whether the stuffing box has normal or reverse porting. If it has normal porting, the longest bulge on the body of the stuffing box will be underneath the "G" port (i.e. the "G" port is connected to the lowest point). Reverse-ported stuffing boxes will have the long bulge under the "R" port.
   (c) Slide the stuffing box over the shaft and orient it so that its ports are in the position desired. Hold the stuffing box off its mating surface on the head and apply a liberal amount of Laynecoat to the head. Lower the stuffing box into position and bolt it down firmly in place with capscrews. If it is necessary to push the shaft sideways in order to get the stuffing box register to go into the bore, then the head is not properly aligned. See section III G. above.
   (d) Complete assembly of the stuffing box per the "Stuffing Box Assembly" instructions shipped with the unit. Retain these instructions for reference when repacking the stuffing box.
2. Enclosed line shaft using Style 60 stuffing box.
   (a) If an adjustable top column flange is utilized, adjustment of flange must have been made per Section III.G above.
   (b) Complete assembly of the stuffing box per the "Stuffing Box Assembly" instructions (PBS-276) shipped with the unit.

J. DRIVER AND DRIVE COUPLING

1. Check that the stuffing box installation is complete. If a style 60 stuffing box is being used, insure that the tubing tension adjustment has been made.
2. Inspect, clean and oil lightly the face and threads on the exposed portion of the shaft. Thread the coupling onto the shaft for half of its length. (If the coupling won't screw on as far as required, see Step 3 below). Place rag in and over the top of the coupling to prevent foreign material from getting into the coupling.
3. If an adjustable top column flange is being used, check that the shaft projection in the head is within the required limits. This is done as follows: (See Fig. 21).
   1. Screw the shaft coupling half way onto the shaft.



Check that:

1. (A+B) $\overset{*}{\geq}$ (bowl lateral+shaft pull up+1/8")
2. C $\overset{*}{\geq}$ 1 3/4" (open lineshaft only)
3. The coupling will screw on half-way without hitting the top of the Style 60 stuffing box (enclosed lineshaft only).

*equal to or greater than

FIG. 21 - SHAFT PROJECTION REQUIREMENTS

2. Check that
   - $(A + B) \geq^* \left(\begin{matrix} \text{bowl} \\ \text{lateral} \end{matrix} + \begin{matrix} \text{shaft} \\ \text{pull up} \end{matrix} + \frac{1}{8}'' \right)$
   - $C \geq^* 1\frac{3}{4}''$ (open line shaft only)
   - The coupling does not hit the stuffing box (enclosed lineshaft only)

   The above limitations assure that there is adequate room for the shaft to rise as far as will be required when adjusting the impellers, and that there is sufficient room to repack the stuffing box without disturbing the shaft connection. Distance C can be less than $1\frac{3}{4}''$ but this will require that the coupling be removed in order to have adequate clearance to repack the stuffing box.

   If the above conditions are not met, the top column flange is not adjusted properly. The unit must be lifted, supported from the welded lugs and the top column flange adjusted per Section III.F.6.
4. Unbolt the driver from its shipping skid and place it near the head on its wooden base. Remove the top cap from the driver. Unbolt and remove the top clutch plate. See Fig. 22.
5. Attach slings to the driver lifting lugs and hoist the driver sufficiently to allow easy access to its mounting base.
6. Run a fine flat file over the mating surface on the driver base and the driver mounting surface on the head to remove any nicks or burrs. Thoroughly clean these surfaces with solvent and wipe a thin layer of light oil over them. This will help prevent rust and will also facilitate shifting the driver during alignment of the driver with the pump shaft.
7. Swing the driver over the pump centerline and slowly lower the driver until it rests on the pump head. For heads on which the driver coupling is located below the stuffing box, be extremely careful not to bend or damage the exposed headshaft when lowering the driver over the headshaft. Align the mounting holes and install BUT DO NOT TIGHTEN the driver mounting capscrews and cut washers. If the driver-to-head connection is a register fit, ensure that the registers are properly engaged.
8. Clean the drive plate thoroughly and dress the drive shaft threads and keyway with a 3 cornered file, if necessary. Lift the drive shaft and carefully lower it through the driver bore (end with keyway goes toward the top) until it comes in contact with the head coupling. Remove the rags from the coupling just before the drive shaft comes in contact with the coupling. Hold the head coupling and screw the drive shaft into the coupling until the shaft faces butt.
9. If the driver-to head connection is not a register fit, align the driver to the pump centerline (drive shaft) as follows: (See Fig. 23).
   (a) Mount a dial indicator base on the drive plate of the driver so that it measures the relative movement of the drive shaft O.D.
   (b) Slowly turn the driver. If the dial indicator reading varies by more than 0.003", loosen the driver mounting bolts, shift the driver and retighten the mounting bolts until the reading does not vary by more than 0.003. Do not place shims between the motor base and top ring of the head under any circumstances.
10. Temporarily make any necessary connections, so that the driver starter can be bumped to determine its direction of rotation. It should rotate counter-clockwise when viewed from above. *If power is not available to make a rotational check, do not make the driver-to-drive-shaft connection (Step 11 and 12 below) until power is available and correct rotation is determined.* (Incorrect rotation of the driver, with the pump connected, can unscrew the shaft connections and damage the pump). If the driver is an electric motor and the leads are to be disconnected after the rotation check, mark the leads and the motor terminals

* greater than or equal to

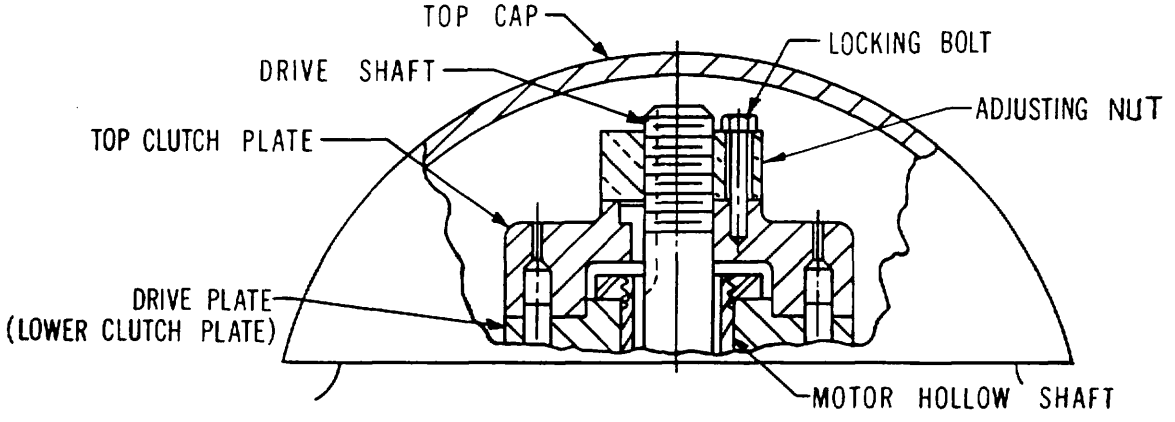


FIG. 22 - GENERAL ARRANGEMENT OF CLUTCH ASSEMBLY IN A HOLLOW SHAFT DRIVER

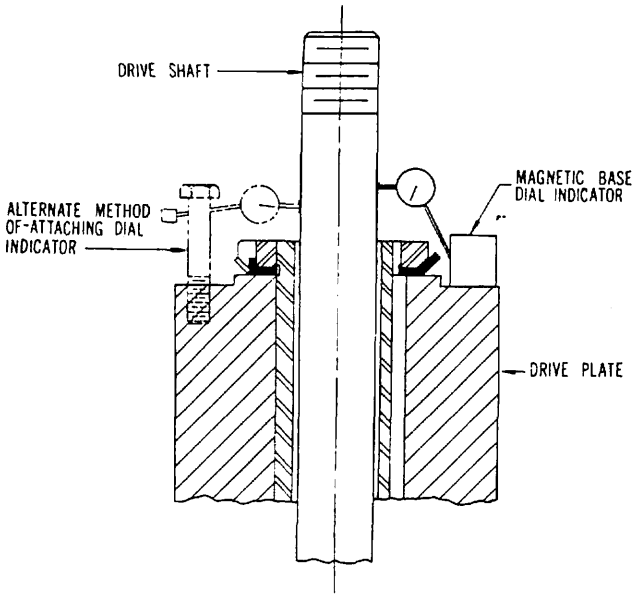


FIG. 23 - DIAL INDICATOR SETUP FOR ALIGNING DRIVER TO PUMP CENTERLINE

so that the motor leads will be reconnected to the same positions as they were for the rotation check.

If the pump is to operate in conjunction with automatic control equipment, this equipment should be aligned (sequenced properly, trip points and timers adjusted, etc.) and an operational check performed prior to making the driver-to-driveshaft connection. This allows the driver to be started and stopped as necessary to perform a complete checkout of the control system, without operating the pump itself.

11. Remove the bolt from drive plate (if installed), slide the clutch top plate down over drive shaft and install and tighten bolts (if bolted type). The clearance between the drive shaft O.D. and the clutch bore should be from 0.001″ to 0.003″.
12. Turn driver until the keyway in the clutch aligns with the keyway in the shaft. Install and seat the gib key. The key should fit snugly but should not be a drive fit.
13. Unless special instructions are provided by the factory, adjust the pump shaft lateral, as follows: See Fig. 24 and 25. Screw the adjusting nut onto the drive shaft (left hand thread for all adjusting nuts except the ¾″ nut which is right hand thread) until it seats on the clutch. Continue tightening the nut (lifting the shaft) until the impellers are free from the bowl. This is the point at which the shaft can be rotated with much less effort than was required before. On most settings, the shaft should rotate free by hand; however, on very deep settings with large shafting, it may be necessary to use a wrench to rotate the shaft. Measure the protrusion of the drive shaft past the adjusting nut as shown in Fig. 24. Continue tightening the adjusting nut (raising the shaft), counting the number of complete turns, of the adjusting nut until the impellers come in contact with the top of the bowl. This is the point at which the shaft no longer turns freely. CAUTION: DO NOT CONTINUE TIGHTENING THE ADJUSTING NUT PAST THIS POINT. FURTHER TIGHTENING WILL RESULT IN THE IMPELLERS BEING PULLED FREE FROM THE PUMP SHAFT. Measure the protrusion of the drive shaft past the adjusting nut. The total lateral movement (difference in shaft protrusion measurements) should equal that recorded previously (Section II.D.9 or Section III.C. 1 (D). If the lateral as measured above is less than that recorded previously, check the drive shaft to make sure that the adjusting nut has not run out of threads on the drive shaft and that the keyway is long enough. Also, check the shaft coupling or water slinger (on water lubricated pumps) to make sure that neither one is being

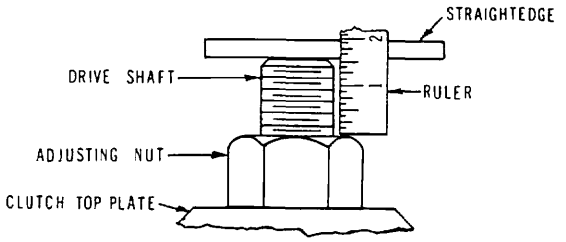


FIG. 24 - MEASURING PROTRUSION OF DRIVE SHAFT PAST ADJUSTING NUT

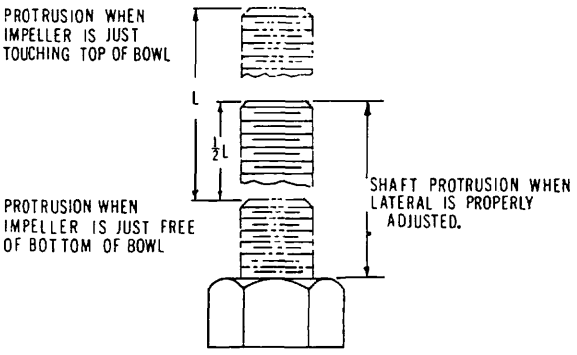


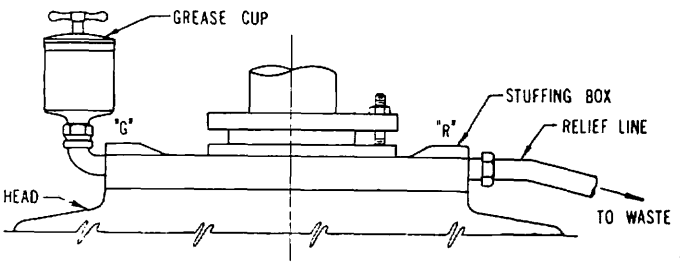
FIG. 25
SHAFT PROTRUSION WHEN NO SPECIAL INSTRUCTIONS ARE PROVIDED BY FACTORY

pulled up against the bottom of the driver base. If either of the above occurs, the problem must be corrected before proceeding. Back off the adjusting nut half the total number of turns counted above. Measure the protrusion of the drive shaft past the adjusting nut. The shaft protrusion as measured here should fall approximately half way between the two extremes measured previously. See Fig. 25.
Lock the nut to the clutch with the adjusting nut locking bolt or key the nut to the shaft with a gib key, whichever design is applicable.

14. Reinstall the top cover on the driver.

K. MISCELLANEOUS EQUIPMENT

1. LUBRICATING DEVICES.
   (a) Oil Lube Pumps
   Install the lubricator and bracket to the discharge head. Refer to the lubricator assembly drawing. Connect the ¼" copper line from the lubricator to the stuffing box inlet port.
   (b) Water Lube Pumps. See Fig. 26
      1. Connect the grease cup or fitting to the stuffing box port marked "G".
      2. Connect the relief line (cooper tubing) to the stuffing box port marked "R". High pressure stuffing boxes have a valve installed in the "R" port. In this case the relief line should be connected to the valve outlet. Route the relief line so that it will not interfere with normal maintenance operations.
      3. Connect the line from the prelube system to the prelube connection on the stuffing box. (SDH heads have a prelube connection at the back of the head).
      The following items should be taken in consideration for the prelube system.
         (a) Do not use pipe that is smaller than the prelube connection furnished in the stuffing box.
         (b) If the system is to be subjected to low temperatures, adequate precautions must be taken to prevent freezing.
         (c) The prelube system should supply a flow of water for approximately 15 seconds plus 15 sec. per 100' of column above the static water level. Pumps operating at a static water level of greater than 100 ft. and which are not equipped with a non-reverse mechanism must be post-lubricated during the time that the pump is spinning backward after it is shut down. The post lubrication should start immediately when the pump is shut down and should continue for as long as the shaft is turning. It is desirable that the post-lube be initiated automatically, so that loss of power to an unattended pump will not result in damage due to lack of post-lubrication.
         (d) If automatic controls are used on the prelube system, the control system should be designed so that it provides maximum assurance that prelube (and post lube if required) is supplied when the pump needs it. Special consideration should be given to such situations as loss of electric power to the prelube control system without an accompanying loss of power to the driver itself. One of the most foolproof systems is a continuous running system taking its supply from a pressurized header or a large reservoir. If a tank type prelube system is used precautions must be taken to assure that an adequate supply of water is always available to provide the required lubrication.
         (e) The minimum prelube tank capacities are given in Table 6.



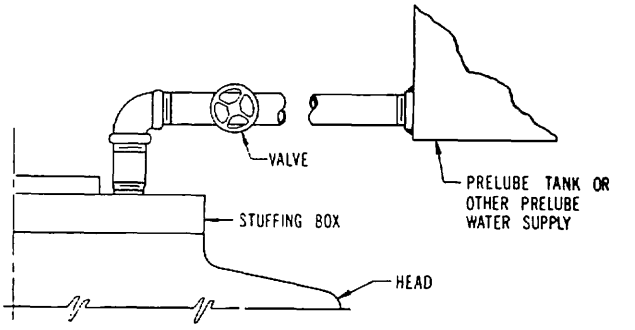


FIG. 26 - STUFFING BOX CONNECTIONS

TABLE 6 PRELUBE TANK CAPACITIES

Column Size	Reqd. Capacity
3	10 gal. per 100′ depth to static water level
4, 5, 6	25 gal. per 100′ depth to static water level
8, 10, 12, 14	50 gal. per 100′ depth to static water level

Note: Use 1½ times the above capacity if post lube is required.

2. DISCHARGE PIPING

(a) The head and discharge pipe flange faces should be clean and free of nicks and burrs. If a grooved type flange is used, make certain that the groove is clean and free of obstructions.

(b) Do not attempt to use a flat gasket on discharge head outlet flanges which are not machined. These flanges are grooved to accept the square packing furnished with the head. Since these flange faces are not flat, tightening the bolts in an attempt to seal a flat gasket will usually result in a broken discharge flange.

(c) The discharge piping should be installed and supported in such a manner as to eliminate the possibility of the head (discharge ell) being placed in a strain. The pump head can easily be thrown out of alignment by "drawing up" the bolts in a discharge flange connection that is not "fitted up" properly.

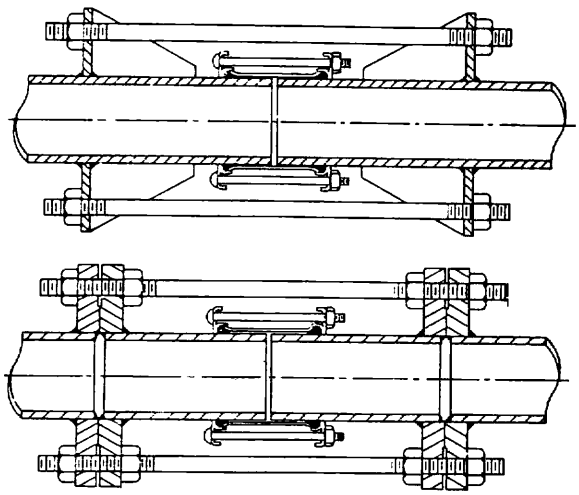


FIG. 27 - SUGGESTED HARNESS DESIGNS FOR FLEXIBLE COUPLING JOINTS

(d) If a flexible connection such as a Dresser coupling is to be used, a joint harness such as shown in Fig. 27 should be installed across this connection. The tie bolts for such a harness should be designed so that they do not elongate more than 0.005" when restraining the hydraulic force which tries to separate the joint. This force is equal to the discharge pressure in psi times the cross sectional area of the bore of the pipe in square inches. The tie bolts should be snugged up carefully by applying approximately the same amount of torque to each bolt, otherwise, the purpose of the coupling will be defeated.

3. AIR RELEASE VALVE (See Fig. 28)

(a) Install the air release valve, piping and manual valve (if furnished), to

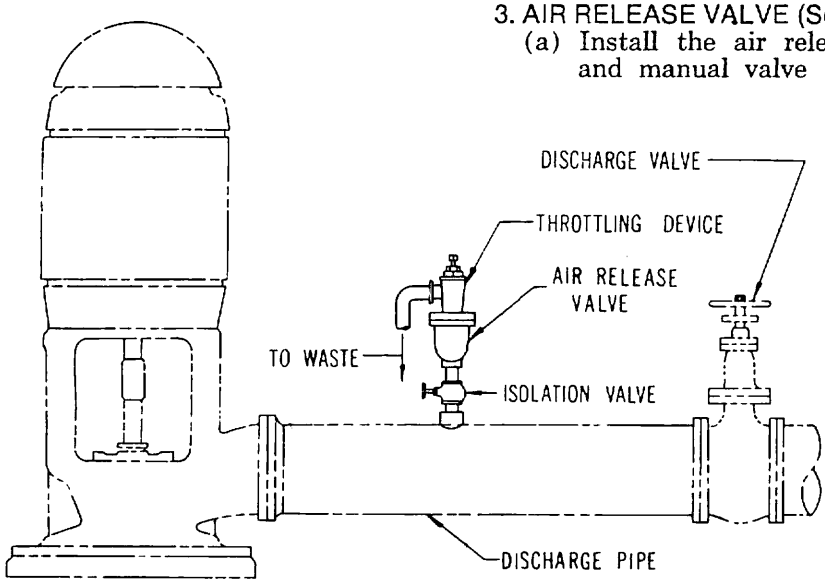


FIG. 28 - TYPICAL ARRANGEMENT OF AIR RELEASE SYSTEM

the pump head or just beyond the head flange on the discharge piping. It is recommended that a throttling device be used on the discharge side of the air release valve to restrict the discharge of air ensuring that a cushion of air is available in the discharge head during start up. Exhausting the air too quickly can cause damage to the head.

(b) An air release valve is imperative on water lubricated pumps with underground outlets. It eliminates trapped air in the column above the underground outlet which would cause the bearings and stuffing box to run dry.

4. MISCELLANEOUS ACCESSORIES
Connect the pressure gauge, and/or gauge cock, if furnished to the tapped hole at the top of the discharge flange on the head. Position the dial face to facilitate reading.

5. ELECTRICAL CONNECTIONS
(a) All connections to the motor such as main leads, space heater leads, thermocouple leads, etc. should be made in accordance with motor manufacturer's recommendations and local codes.
(b) Make necessary connections to lubricator solenoid if oil lubricated. Ensure that the solenoid is supplied with the proper voltage.

6. AIR LINE
(a) Connect the air line piping and equipment as shown in Fig. 29.
(b) When required, the water level in the well can be determined by attaching a bicycle tire pump to the air valve and forcing air into the air line until the pressure gauge reading is constant. This reading (converted to ft. of water*) indicates the number of feet of submergence of the end of the air line. The water level in the well is determined by subtracting the amount of submergence from the known length of the air line. (The air line length was recorded during installation).
*PSI x 2.31 = ft. of water

IV. INITIAL START UP, NORMAL OPERATION AND ROUTINE MAINTENANCE

A. INITIAL START UP

1. Ensure that all of the pump installation as described in preceding sections of this manual is complete.
2. Ensure that auxiliary equipment has

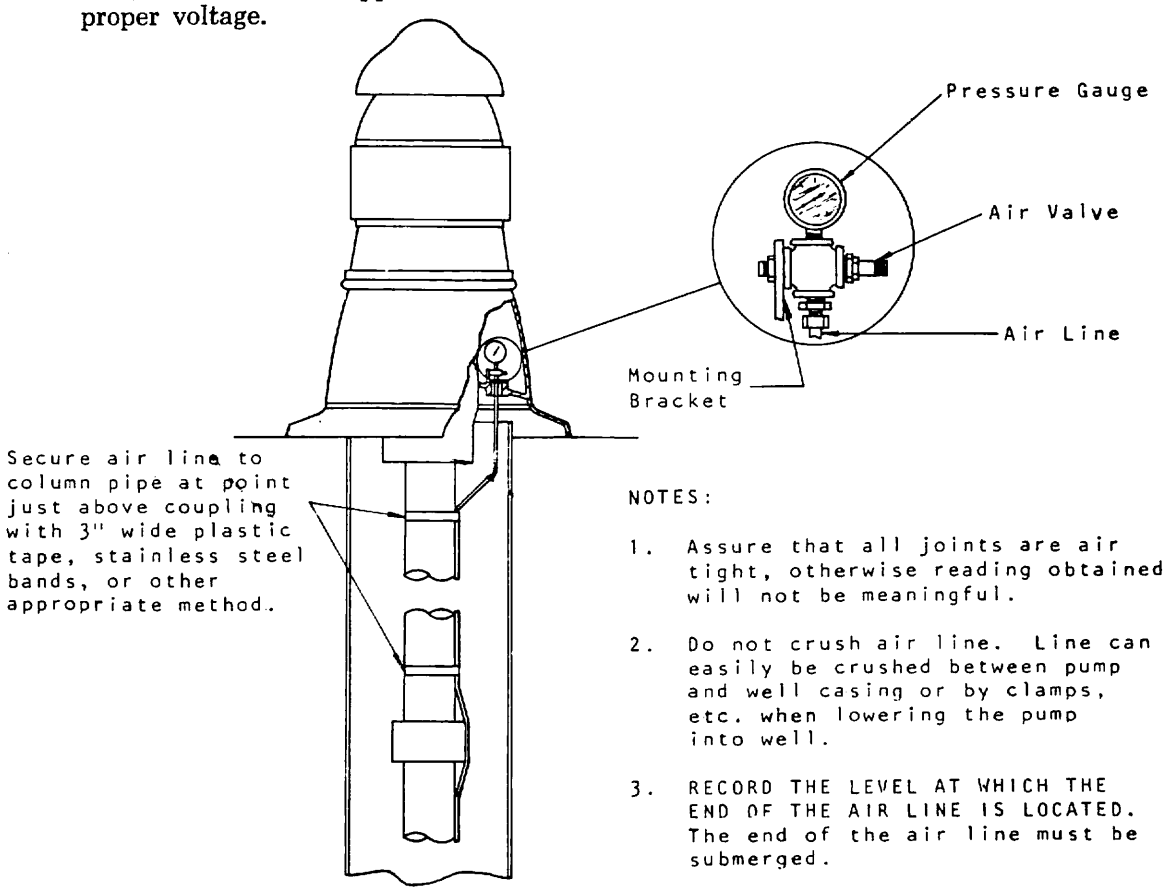


FIG. 29 - TYPICAL AIR LINE INSTALLATION

been installed, serviced, and is ready for operation. Automatic control systems should have been checked per Section III.J.10 prior to making the driver-to-driveshaft connection. Automatic controls that do not function properly can cause serious damage to the pump.

3. Service the driver as recommended by the manufacturer.
4. Open the air release system isolation valve. Adjust the air release system throttling device so that it is partially open. It should not be closed or fully open. Not exhausting the air or exhausting it too quickly can damage the pump.
5. On oil lubricated units, clean and fill the lubricator tank with oil meeting the specifications given in Section II.B.27. Manually open the lubricator valve and allow oil to run into the tubeline for at least 20 minutes for each 100 feet of setting prior to start-up. Assure that the oil is in fact flowing into the tubing before timing is commenced and that the flow rate is at least as much as given in Table 7.
   On systems equipped with a solenoid operated lubricator valve that cannot be energized independently, it will be necessary to remove the valve stem (See Fig. 30) to allow the oil to flow. Replace the valve stem before starting the pump. The pump should be started shortly after allowing the oil to flow into the tubeline. If the start up is delayed, the lubrication procedure must be repeated just prior to the actual start up.
6. Ensure that the system to which the pump is connected is ready to receive flow from the pump. For most well pumps the position of the discharge valve at start up is not critical and the general practice is to start the pump with the valve in a partially open position. Special consideration must be given to the following conditions:
   A. If the pump is to discharge into a system that is already pressurized, ensure that the system pressure will not cause reverse flow through the pump during start-up. This can be accomplished by installing a check valve between the pump and the system, or by starting the pump with the discharge valve shut and then opening the valve after all of the air is exhausted and the pump is developing a discharge pressure equal to or greater than the system pressure. Also see para. C below.
   B. A pump is designed to run at specific head and flow conditions. Operating at conditions other than design can damage the pump.

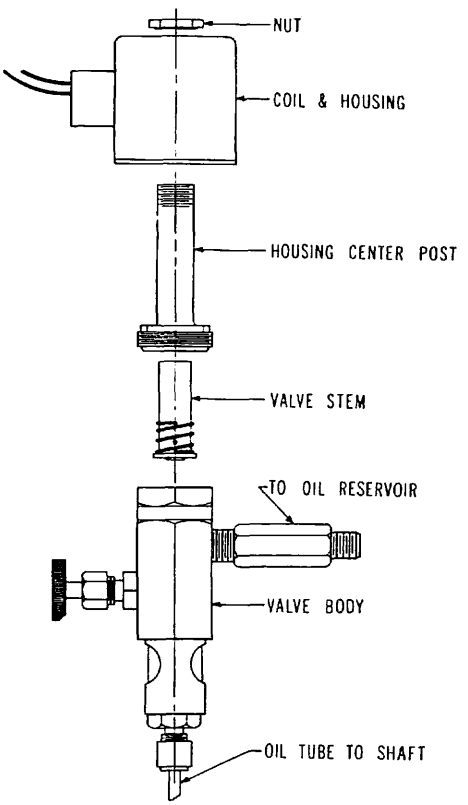


FIG. 30 - SOLENOID LUBRICATOR VALVE

(1) Operating at low head and high flow conditions can cause the impellers on some pumps to "float". This can occur if a pump which is designed to operate at system pressure is used to fill the system without throttling the discharge valve to create head (back pressure) on the pump.
(2) Operating some pumps at high head and low flow conditions will cause the pump shaft to stretch sufficiently to allow the impellers to drag on the bowl.

C. The water hammer created when starting a shallow setting high pressure pump can damage the pump. Special consideration must be given to the rate of releasing the air from these pumps and to the operation of the discharge valve.
   If the pump is discharging into a pressurized system it may be necessary to install an automatically operated discharge valve that opens at approxi-

mately the same time that the pump develops a discharge head equal to that of the system.

7. On open line shaft units equipped with prelube systems supplied from a pressurized header, open the supply valve and allow the prelube water to flow for 15 seconds plus 15 seconds per 100′ of pump setting. The prelube system should be left running until after the pump has been started (unless the discharge pressure of the pump will damage the prelube system).
   On open lineshaft units equipped with a tank type prelube system, clean the tank and fill it with clean water. Open the valve between the prelube tank and the pump and allow approximately half of the water in the tank to run into the well. The pump should be started immediately (per Step 8 below) and the prelube valve should remain open during the start up.
8. Upon completion of the above preparations, energize the starter. If any abnormal noises, jerking or vibration is noted, stop the pump immediately, determine the cause of the abnormalities and correct them.
9. After the pump has come up to speed, and all of the air has been exhausted, regulate the discharge valve to achieve the desired discharge pressure.
10. If the air release valve is manually operated, close it.
11. On oil lubricated units adjust the lubricator valve for the flow given in Table 7 below.

TABLE 7 RECOMMENDED OIL LUBRICATION FLOW

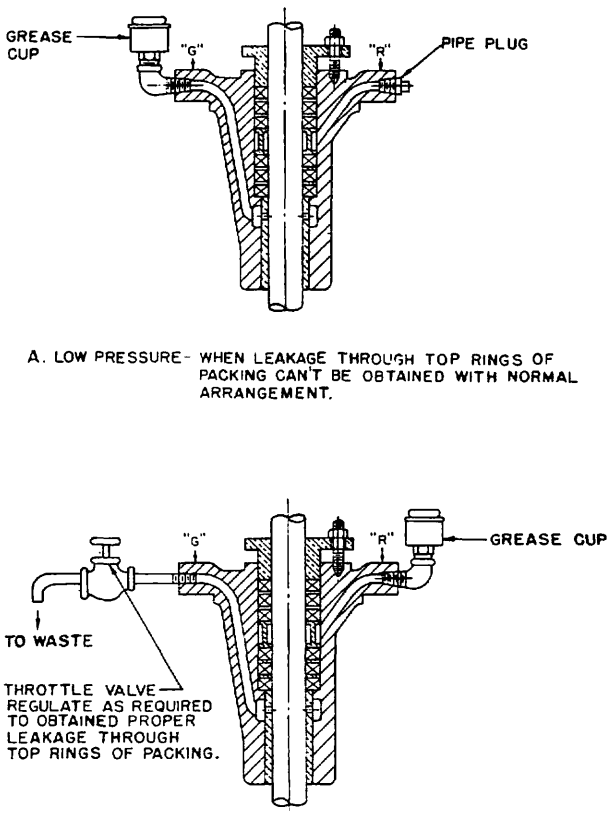
Shaft Size	"A" Basic Setting In Drops/Min.	"B" Additional Drops/Min. Per Ea. 100′ Setting
7/8—1-3/16	5	2
1-1/2—1-11/16	7	3
1-15/16—2-7/16	10	4
2-11/16	12	5

$$\text{Total Drops/Min.} = \text{"A"} + \frac{(\text{Setting} \times \text{"B"})}{100}$$

Example: 500 Feet of 11/16″ x 2-1/2″

$$\text{Total Drops/Min.} = 7 + \frac{500 \times 3}{100} = 22$$

12. On open lineshaft pumps equipped with a stuffing box, adjust the stuffing box packing gland to allow a liberal amount of leakage past the packing. A small trickle is desirable.
    On units where the pressure at the stuffing box is very low, it may be necessary to plug the "R" port on the stuffing box as shown in Fig. 31A in order to obtain leakage through the top rings of packing. On high pressure units where leakage through the gland is excessive, it may be necessary to move the grease cup to the R port and install a throttle valve in the "G" port as shown in Fig. 31B. The pressure on the gland can then be regulated using the throttle valve. Do not reverse the ports if a reverse ported stuffing box was supplied by the factory. (See Section III.I.1.(b)
    During the first four or five hours of operation, periodically observe the leakage and feel of the gland. If necessary, loosen the gland to restore the leakage to the desired rate or to prevent the gland from overheating. The water leaking past the packing should not be allowed to become hot enough to steam. If the packing is allowed to overheat, it will score the shaft, requiring replacement of the packing and the shaft. After five or six hours of operation gradually tighten the gland (do not tighten the gland follower nuts more than 1/6 turn in ten minutes) to reduce the leakage. DO NOT COMPLETELY STOP THE LEAKAGE PAST THE PACKING and DO NOT ALLOW THE GLAND TO



A. LOW PRESSURE - WHEN LEAKAGE THROUGH TOP RINGS OF PACKING CAN'T BE OBTAINED WITH NORMAL ARRANGEMENT.

B. HIGH PRESSURE - WHEN LEAKAGE IS EXCESSIVE WITH NORMAL ARRANGEMENT.

FIG. 31 - ALTERNATE STUFFING BOX CONNECTIONS

OVERHEAT. Check periodically to see that the gland is not leaking excessively and that it is not overheating.

13. If the unit is equipped with a prelube water tank and a manual valve, close the valve to the tank after the tank has filled with water.
14. Assure that the driver and auxiliary equipment is operating satisfactorily by performing the checks recommended by the manufacturer.
15. Check all fittings and joints for leakage.
16. Check the pumping level of the well to assure that the pump bowl remains submerged when it is operating.
17. If no trouble is encountered the pump should be allowed to run until the water from the well is clear and free of all solids. Short ON-OFF cycles at initial startup or at startup on a pump which has been idle for an extended period can cause "sand-locking" of the pump if the pump is not allowed to run long enough to obtain clear water.
18. On open lineshaft pumps requiring post-lube; assure that post-lube is provided when the pump is stopped. (Post lube is required on open lineshaft pumps which operate at a static water level of greater than 100 ft. and which are not equipped with a non-reverse mechanism).
19. After the pump is shut down for the first time, repeat the impeller adjustment procedure given in Section III.J.13. This is necessary because some of the shaft joints may have tightened during initial start up, thus changing the initial adjustment.

B. NORMAL OPERATION AND ROUTINE MAINTENANCE

1. Subsequent normal start ups are essentially the same as the initial start up described above, consisting of:
   (a) Checking that the driver, the auxiliary equipment and the system into which the pump is discharging are ready for operation.
   (b) Prelubing the pump as recommended.
   (c) Pressing the "Start" button.
   (d) Checking or adjusting system for desired flow.
   (e) Check for proper oil drip rate or stuffing box leakage whichever is applicable.
   (f) Initiate post-lube (if required) when the pump is shut down.
2. On oil lubricated units, periodically check the oil level in the lubricator tank. Refill the tank if it is less than ¼ full.
3. On water lubricated units, periodically check the packing for overheating or excess flow. The amount of adjusting done on the packing gland should be held to a minimum.

Apply grease to the stuffing box at the rate of one turn of the grease cup handle for each 24 hours of operation. Refill the grease cup as necessary, using Laynegrease or any other standard water pump grease.

Usually up to two additional rings of packing can be installed in the stuffing box to compensate for wear and compression of the packing. However, if difficulty is encountered in adjusting the packing gland after the packing ring has been added, then all of the packing should be removed and the stuffing box completely repacked.

To repack the stuffing box, remove all the old packing, separator rings and lantern ring. The packing can be removed using packing hooks which are designed for this purpose. The separator rings and lantern ring can be removed by forming a small hook at the end of a piece of small stiff wire and inserting this hook into the holes provided in the lantern ring and separator rings. A mirror will be useful for looking into the stuffing box cavity since the amount of working space is minimal. Also, some soft wire or string can be used to tie the separator rings and lantern rings up out of the way. Clean the stuffing box cavity, inspect the shaft for scoring and install the new packing using the instructions given on the "Stuffing Box Assembly" sheet originally supplied with the pump. Adjust the packing gland per the instructions given in Section IV.A.12 above.

C. TROUBLESHOOTING

When properly installed and operating in non-abrasive, non-corrosive water a pump is a relatively long lived piece of machinery, requiring a minimum of attention. However, machinery is subject to wear. The most common causes of improper operation are given below. These include problems created by wear and other adverse conditions. Note that most of these problems require removal of the pump from the well in order to correct the problem. Contact the factory or your Layne representative for this type service.

1. Low capacity or low pressure
   a. Impeller clogged or loose on shaft
   b. Air or gas in water
   c. Driver speed slow
   d. Clogged suction
   e. Incorrect rotation
   f. Excessively worn impeller skirts or wear rings
   g. Insufficient submergence
2. Excessive Power Consumption
   a. Speed too high

b. Improper lateral adjustment
c. Bad driver thrust bearing
d. Pump out of alignment
e. Shafting bent
f. Head coupling mis-aligned
g. Pumping foreign matter

3. Vibration
   a. Bad driver thrust bearing
   b. Pump out of alignment
   c. Driver coupling mis-aligned or out of balance
   d. Shafting bent
   e. Bearings badly worn or broken
   f. Improper foundation
4. Water in Oil Tubing
   a. Discharge nozzle relief ports plugged
   b. Tubing joint leaking
   c. Shaft seals damaged
   d. Crack or hole in tubing or leaking at tension box "O" ring.
   e. Excessively worn top intermediate and discharge nozzle bearings.

WARRANTY

Products manufactured by Seller and sold under this agreement are warranted free from defects in materials and workmanship for one year from the date of shipment to the Buyer. Goods manufactured by other than Seller and sold under this agreement are warranted only to the extent that the manufacturer warranted them to Seller. Seller's obligation is limited to repair or replacement f.o.b. seller's plant, when examination of such products shall disclose them, to Seller's satisfaction, to have been defective and Buyer shall have notified Seller promptly of the discovery of any such defect. At the Seller's option such products shall be returned to Seller transportation charges prepaid. This warranty does not apply to any products which have been opened, disassembled, repaired or altered by anyone other than Seller or subjected to misuse or abuse. In addition to the foregoing, all products furnished hereunder are warranted with respect to (a) title, and (b) in the case of standard commercial products, non-infringement; in each case to the extent provided by the Uniform Commercial Code. Unless otherwise specifically agreed in writing by Seller, the obligation of Seller is limited, in the case of a material breach of the warranties set forth in (a) and (b) above, to the return of Buyer's purchase price or, at Seller's option in the case of infringement, to the prompt replacement of the products with non-infringing conforming products. Except as above specifically provided, Seller's liability to Buyer shall not exceed the cost of correcting defects in the goods sold and Seller shall not in any event be liable to Buyer or third parties for any delays or special, indirect or consequential damages. The foregoing warranties are in lieu of all other warranties, express or implied, including, without limitation, warranties of merchantability, fitness for any particular purpose and non-infringement.