Deep Well Turbine Pumps

By RALPH NELSON
Hy-Bon Engineering Co., Inc.

VERTICAL TURBINE PUMPS

Vertical Turbine Pumps are engineered in three basic elements. Each element must be selected to perform a particular function and operate efficiently with each of the other two elements.

Bowl Assembly Fig. 1

This is the pumping element of the system and consists of a vertical rotating shaft, on which is mounted one or more impellers. The pump shaft and impellers rotate within an enclosed housing or bowl, and as fluid flows into the bottom of the bowl it is engaged by the rotating vanes of the impeller and forced into the guide vanes of the bowl. As the fluid is forced away from the center of the impeller, a partial vacuum is formed, which induces a flow of fluid into the bowl suction and continuous pumping with constant flow is accomplished.

Volume and head developed are dependent upon the diameter and rotational speed of the impeller: the total developed head of a multi-stage pumping unit is the sum of the head developed by individual stages. The bowl assembly requires compensation for the hydraulic downthrust developed in operation. To properly locate the impellers in relation to the perihedral seals in the bowls, the net column, shaft and tube elongation must be known. The minimum bowl lateral is engineered for all applications and will compensate for the encountered elongation during operation. In selection of the bowl assembly, the prime factors to consider are internal diameter of well casing, total head, volume of fluid and fluid specifications. The sizing of the bowl assembly is usually accomplished from a selection of several type bowls. Highest efficiency and head per stage will determine the most economical unit.

Column and Shaft Assembly Fig. 2

This element consists of the column pipe, line shaft and line shaft bearings. There are two type of assemblies, the open line shaft and enclosed line shaft column assembly. The open type line shaft is water lubricated from the pump discharge and normally used on pump units with a foot valve or short fluid lift. The line shaft is, of course, subjected to any corrosive properties of the fluid.

The enclosed line shaft unit is similar except for a tube isolating the line shaft from the discharged fluid. The line shaft enclosing tube is aligned in the discharge column by reinforced rubber spiders. The function of the tube is to isolate the line shaft from produced fluid, lubricate the entire length of line shaft with oil, and align the line shaft on deep settings with bushings not more than 5 feet apart.

Deep Pump Settings

The enclosed line shaft pump can be used with corrosive fluids, high lift wells and deep pump settings. The line shaft joints are in 10 foot lengths, turned and ground with minimum diameter for rotational speed and thrust, as per the American Standard Specifications of the American Water Works Association. The shaft enclosing tube is interchangeable sections of not more than 5 foot length. The discharge column pipe is sized to insure that the friction loss will not exceed 5 feet per 100 feet and it has a nominal length of 10 feet. Vertical alignment of the line shaft is of extreme importance due to the forces acting upon it. An important factor in the vertical alignment is the enclosing tube held in tension. This adjustment is accomplished on the surface. The weight of the line shaft will require compensation for the mechanical downthrust imposed in operation. Tables are available in which the shaft elongation is computed for specific operating conditions. This element of the pump unit is manufactured to precision tolerances and is undoubtedly the most important section.

Discharge Head and Driver Assembly Fig. 3

The pump discharge head assembly consists of the base on which the driver is mounted, discharge elbow which directs the fluid to surface piping, line shaft seal, and facilities for suspension of the discharge column and bowl assembly. The head can be adapted to standard casing flanges for an effective gas seal.

The driver is the mechanism mounted on the discharge head and transmits torque to the line shaft. It contains the means to adjust the vertical cylindrical seal of the impeller and to take the mechanical and hydraulic thrust in the appropriate bearing. The driver can be a vertical hollow shaft electric motor, right angle gear drive, coupled to a stationary prime mover and steam turbine.

CANNED TURBINE PUMP UNIT (Fig. 4)

Basically, the canned turbine pump unit is comprised of the standard elements of a deep well turbine with the exception of a suction annulus connected to a suction port in the special discharge head. The suction and discharge flange is above ground and the pumping element suspended in a shallow cellar. The simplicity of the unit allows for applications of staging two or more pumps in series or parallel when displacement and head variables are required, such as in water flood injection.

The canned pump unit is extremely versatile. With a variable speed prime mover, it can cover the range of variable displacement and head. Typical applications for the canned turbine are LPG, drilling mud or water booster, waterflood injection, transfer or process

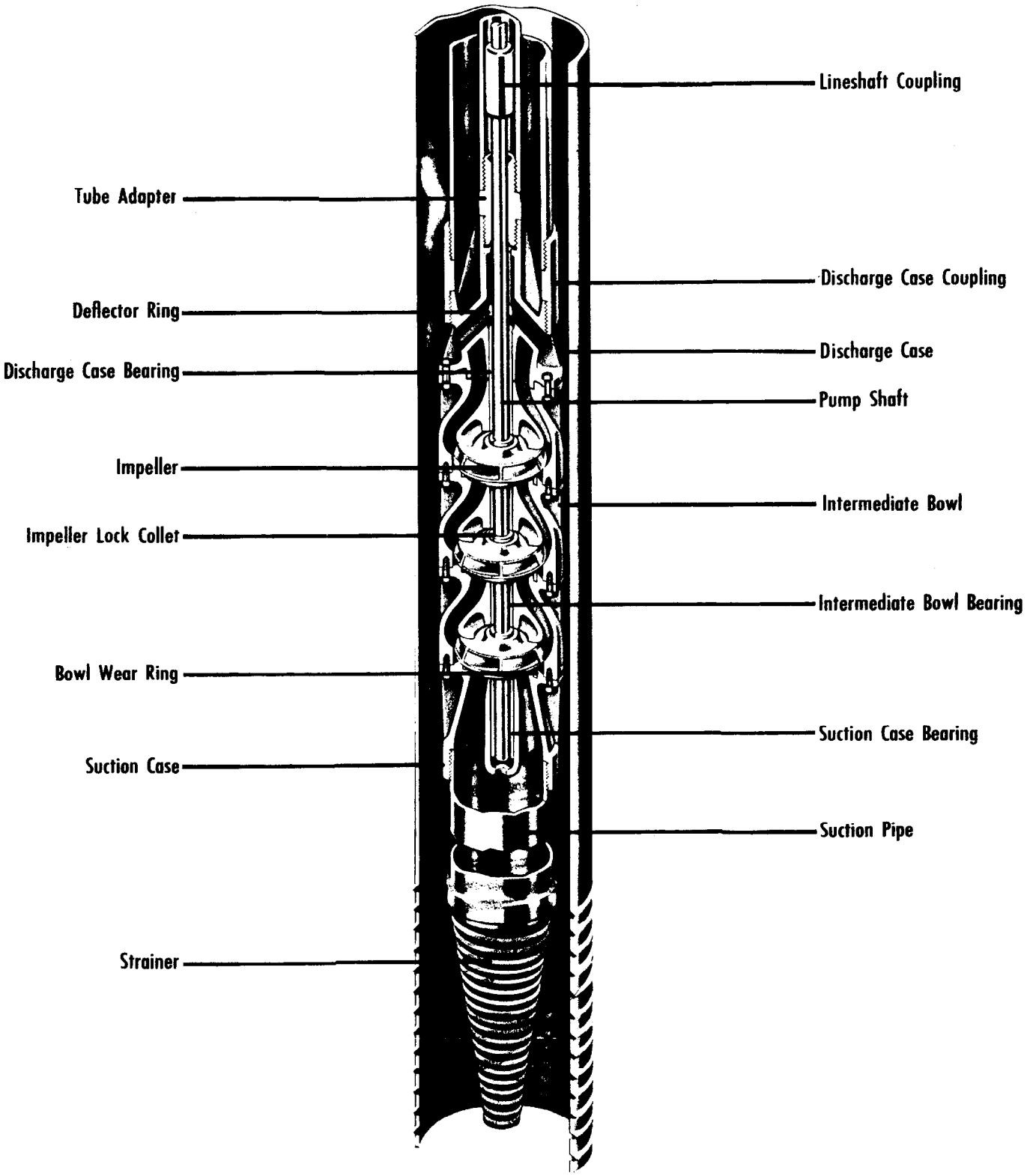
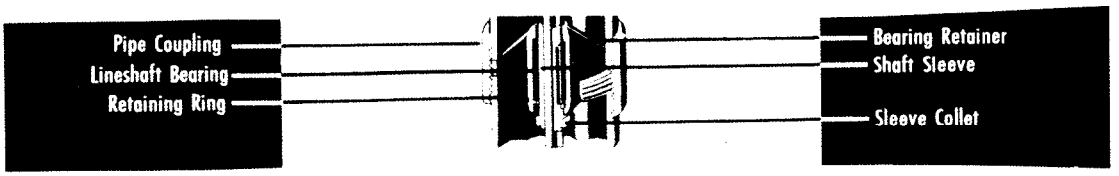


Fig. 1 BOWL ASSEMBLY



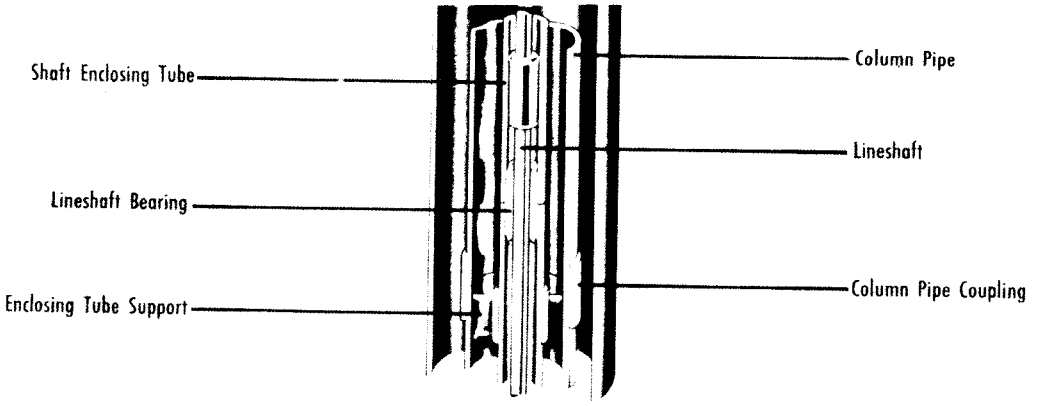


Fig. 2 ENCLOSED LINESHAFT

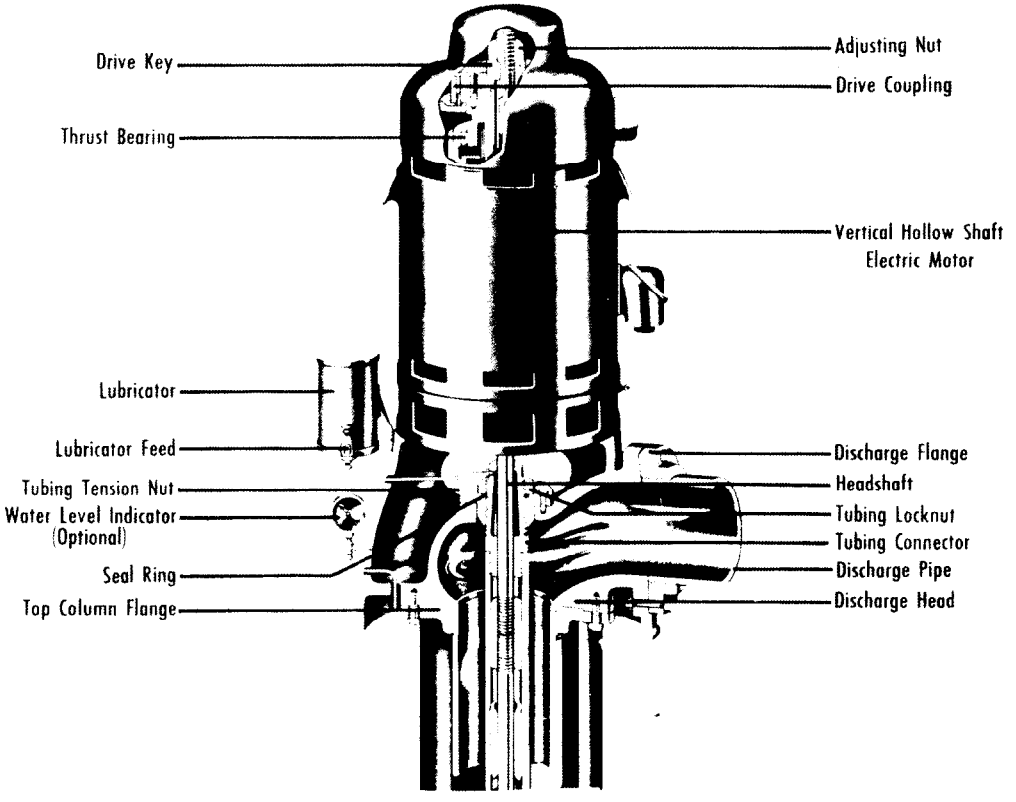


Fig. 3 DISCHARGE HEAD & DRIVER ASSEMBLY

service.

OIL FIELD APPLICATIONS

The main application for deep well turbine pumps is normally to furnish primary water supply for water flood injection or domestic use. Because of the variable depths of the water sand, increasingly deeper pump settings are required for saline water supply. Line shaft pump settings are operating from 1100 foot depth. However, it is possible to install deeper pump settings. Considerable engineering has been done and will be done for design of high head and low volume pumps. This covers most injection water supply problems.

Operating Conditions

There are a number of operating conditions in which the primary raw water supply pump is used to lift the water and also discharge it direct to storage with considerable surface friction loss. If a change in volume and head is encountered after the installation of a deep well turbine pump, it is economical to change stages of the pumping element to correspond. The efficiency of the deep well turbine pump is considered very high from an economic standpoint. Typical field efficiency of "wire to water," or over-all efficiency of 70% and greater, is common.

Correct installation of a deep well turbine pump is very important in order to obtain the best results in service. Experienced servicemen from the factory are expected to be present for supervision of the installation. The column, tube, and lineshaft are of precision machine work. Threading of joints, grinding and polishing the lineshaft and spacing the bushings are all done prior to direct shipment to the location. All this is available to the oil and gas industry and is backed by over 50 years experience in the manufacturing of turbine pumps. Versatility of the turbine pump with proper engineering results in economical cost per barrel of fluid lifted. The casing program can be planned after the desired pump is chosen; if deep pump settings are contemplated.

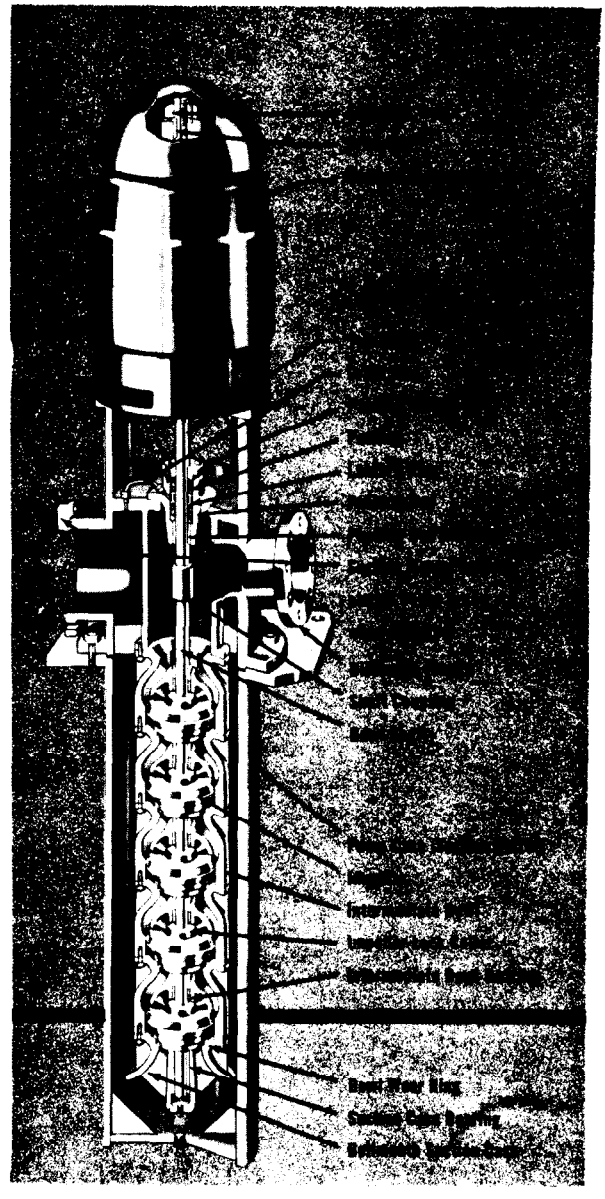


Fig. 4 SUCTION CASED TURBINE PUMP