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ANTI GAS-LOCK CONSTRUCTION FOR TURBINE PUMP

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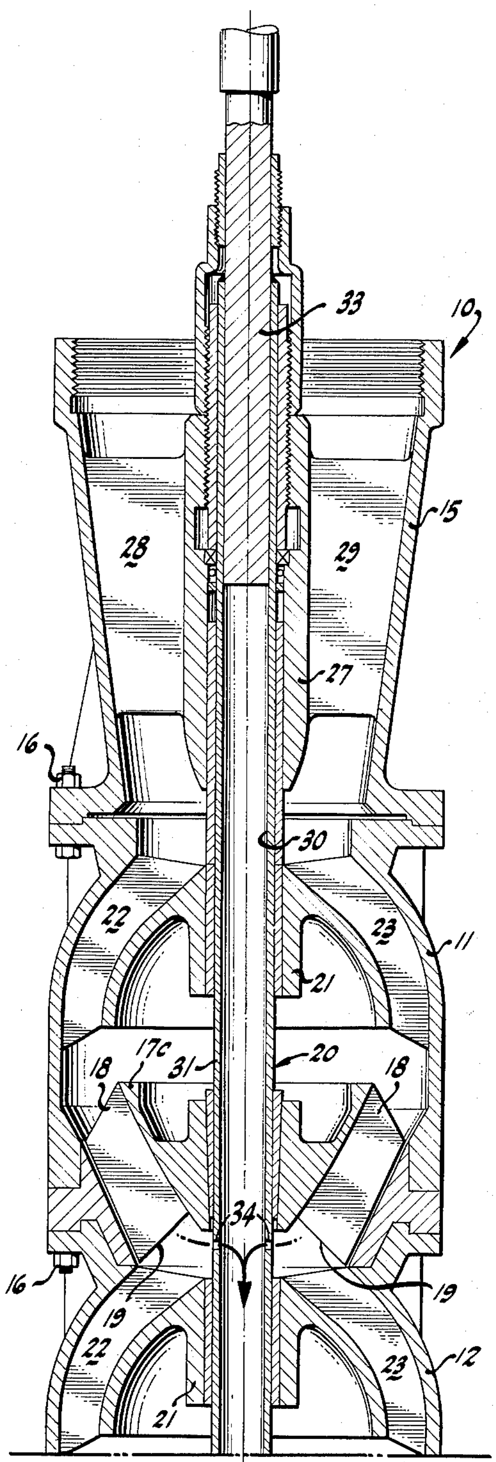

FIG-1

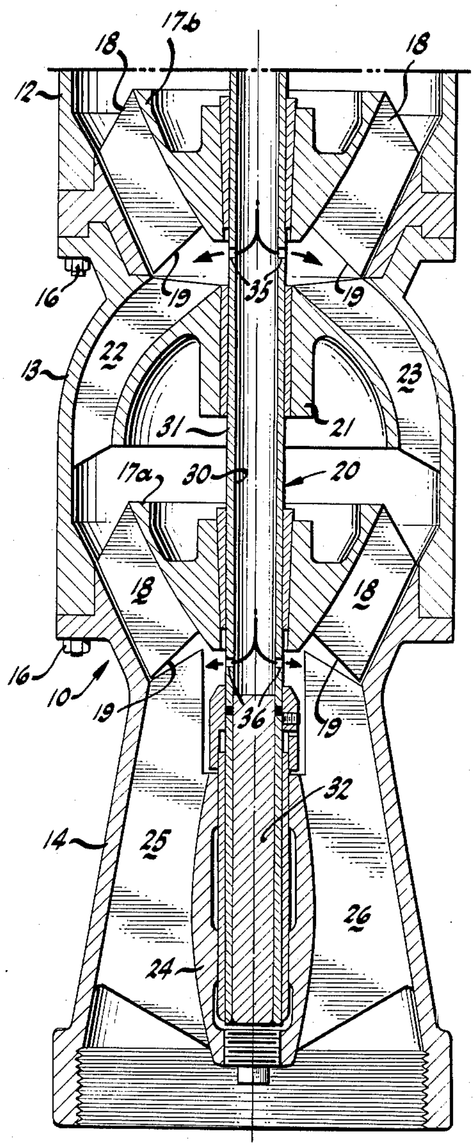

FIG-2

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ANTI GAS-LOCK CONSTRUCTION FOR TURBINE PUMP

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This invention relates to turbine pumps and, more particularly, to pumps constructed with the purpose of eliminating gas-locks, a phenomenon which occurs when entrained gases are centrifuged out of a liquid that is being pumped.

It is commonly known that entrained gas bubbles tend to accumulate along the impeller shaft of a turbine pump as the bubbles are centrifuged inwardly. The accumulation of gas may become such that the amount of liquid acted upon by the impeller blades is insufficient to keep the pump primed, and at this point the pump is said to have formed a gas-lock.

The problem of gas-locks is often experienced by persons who use vertical turbine pumps for raising fluids from a well bore formed in underground gas-bearing strata. In pumping fluids from certain of these well bores there may be such a rapid build-up of gases within the pump that it is impossible to operate the pump for any prolonged or worthwhile period of time. Under such circumstances, the well may have to be abandoned. However, it is sometimes possible, by adding a tail pipe to the lower end of the turbine pump, to extend its intake end to a level below existing gas-bearing strata, thereby avoiding liquids that contain too much gas. Alternatively, it is also common practice to merely lower the pump further in the well, increasing the pump's submergence and placing its intake below gas-bearing strata. Since this practice also increases the hydrostatic pressure at the pump's intake, the size of entrained gas bubbles is apt to be smaller, thereby decreasing the rate of gas accumulation and the frequency of gas-locks.

As indicated, various devices are now known and used to avoid a gas-lock, but provided certain conditions are found. Under some conditions of operation those devices are of little or no help, or are used with moderate or fair success. In any event, the additional cost and expense of relocating the pump's intake or adding to the length of the pump's housing, must be considered a disadvantage. Thus, it is one primary object of this invention to provide a turbine pump which will operate under adverse conditions where conventional pumps will form a gas-lock and without requiring expensive modifications.

In brief, this invention involves a turbine pump having a fluid passageway for recirculating a small portion of pumped fluid and discharging the fluid back into the flowstream at a point near the axis of impeller rotation and adjacent the leading edges of impeller blades. The small amount of recirculated fluid mixes with any gas that tends to collect along the impeller shaft, forcing the gas bubbles back into the flowstream so that it must pass on through the pump.

In addition, it is contemplated that a passageway of this type may be provided by a tubular impeller shaft having multiple pumping stages; that the inlet opening of said passageway should be smaller than outlet openings to prevent clogging of the recirculating passageway; that the impeller should be preferably of a semi-open type to aid in providing a mixing action; that flow straightening vanes are best employed to a point near the leading blade edges of an impeller and adjacent the discharge opening of the recirculating passageway; and that the recirculating passage for multi-stage pumps (having at least three impellers) should have its inlet opening upstream of the last impeller to avoid recirculating too much sand.

In the drawings forming a part of this application, FIGS. 1 and 2 are longitudinal sections of the upper and lower adjacent portions, respectively, for a vertical turbine, multistage pump constructed in a preferred manner as contemplated by the invention.

Referring to the drawings, there is illustrated a vertical turbine pump **10** of a multi-stage type having a housing comprising three vertically stacked impeller bowls **11**, **12**, **13**, an inlet sleeve **14**, and an outlet sleeve **15**. Standard bolt connections **16** secure each of the bowls and sleeves into a unitary assemblage. Impellers **17*a***, **17*b*** and **17*c*** are respectively housed within the impeller bowls, each impeller having blades **18** with leading edges **19** and being supported upon a common drive shaft **20**. Impeller bowls **11**, **12** and **13** are essentially the same shape, and each bowl has an internal bearing support **21** mounted from a pair of vanes **22** and **23**. Similarly, a lower terminal bearing **24** is mounted within sleeve **14** by a pair of vanes **25** and **26**; and an upper shaft bearing **27** is mounted within sleeve **15** upon vanes **28** and **29**.

The above general description of parts may be regarded conventional, since the invention is particularly directed to the use of a fluid passageway **30** formed within impeller shaft **20** for purposes of recirculating a smaller amount of fluid into regions where centrifuged gases normally collect. More specifically, impeller shaft **20** comprises a piece of tubular stock **31** that is sealed at its lower end by a plug **32** and at its upper end by a plug **33**; and lateral openings **34**, **35** and **36** are provided in shaft **20** intermediate plugs **32** and **33**. Openings **34**, it will be noted, are located between impellers **17*b*** and **17*c***, while openings **35** and **36** are located above and below, respectively, the lowermost impeller **17*a***. Moreover, each of the openings is located at a point adjacent one of the leading blade surfaces of the impellers, the areas in which gases tend to collect as they are centrifugally separated from liquids.

As with other types of multi-stage turbines, each impeller adds a measure of fluid pressure force, so that the downstream pressure immediately in back of a given impeller is greater than the fluid pressure upstream of that impeller. It will be evident, therefore, that the pressure at openings **34** will be greater than the fluid pressure in the pump's flow stream near openings **35** and **36**, which openings are relatively upstream from openings **34**. As a consequence, a small part of the fluid passing through the pump will be recycled through the passageway **30**, said fluid entering openings **34** and being expelled out either opening **35** or **36**. As fluid flows out through openings **35** and **36** it will be mixed with any gas that might have collected in this region due to the pump's impelling centrifugal action, and the resulting liquid-gas mixture will pass on through the impeller to the next pumping stage.

It is contemplated that openings **35** and **36** should be of greater size or dimension than inlet openings **34**. With such a construction any solid particles, such as sand, which may enter passageway **30** can escape through the outlet openings **35** and **36**, thereby preventing a clogging of either the passageway or the outlet openings.

While the present invention may be applied to turbine pumps having either semi-open impellers or closed impellers, the former type of impellers are preferred. A certain amount of water slippage between vanes and stationary impeller bowls is desirable since it produces a mixing effect that helps retain the gases in the liquid as they are advanced from one stage to another.

Referring to FIG. 2, vanes **25** and **26** extend from an interior wall of housing sleeve **14** into the area adjacent to the leading edges **19** of impeller **17***a*. This construction has been found useful since it minimizes any pre-rotation of the fluid which enters the impeller, thereby eliminating or reducing an early centrifugal separation of gases from the liquid.

It is to be understood that pumps are staged according to pumping requirements, and although three impeller stages are illustrated the invention can also be applied to any type of staging including a single stage unit. However, if turbine **10** possessed only the one stage, as might be provided by impeller **17***a* alone, then opening **35** would become an inlet port for recirculating fluid from the discharge side of the impeller back to the area in front of its impeller blades **18**.

It is to be noted that no openings are provided into passageway **30** at a level above or on the downstream side of impeller **17***b*. It has been found that there is an increased tendency to pick up sand or other gritty materials if such an opening is employed at that point or location in a multi-stage pump.

Although a preferred embodiment of the invention has been shown and described, it is to be understood that various changes may be made without departing from the spirit of the invention or the scope of the attached claims, and each of such changes is contemplated.

What I claim and desire to secure by Letters Patent is:

1. A multi-stage turbine pump comprising a housing including at least three impeller bowls, an impeller disposed within each of said three impeller bowls, means for driving each of said impellers, and a fluid passageway extending between points on the upstream and downstream sides of the first two impellers for conducting fluid from an inlet opening at a point downstream of said second impeller to outlet openings of lower pressure at relatively upstream points adjacent one of the leading blade surfaces of said first two impellers, respectively, each outlet opening being located near the axis of impeller rotation.

2. A multi-stage vertical turbine pump comprising a housing including at least three vertically aligned impeller bowls, a tubular impeller drive shaft supported for rotation within said impeller bowls, an impeller disposed within each of said three impeller bowls and coaxially mounted to said tubular drive shaft, said drive shaft defining a fluid passageway extending between points on opposite sides of the lowermost two impellers, respectively, for conducting fluid from an inlet opening at a point above both of said two impellers to outlet openings of lower pressure, each outlet opening being located at points adjacent one of the leading blade surfaces of said lowermost two impellers and including points on both sides, respectively, of the lowermost impeller.

3. The multi-stage vertical turbine pump of claim **2** wherein each of said outlet openings is of greater size than any of said inlet openings.

4. The multi-stage vertical turbine pump of claim **2** wherein said housing includes a pair of flow straightening vanes extending from an interior wall into proximate relation to the leading blade edge and to the outlet opening adjacent the leading blade surfaces of said lowermost impeller.

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