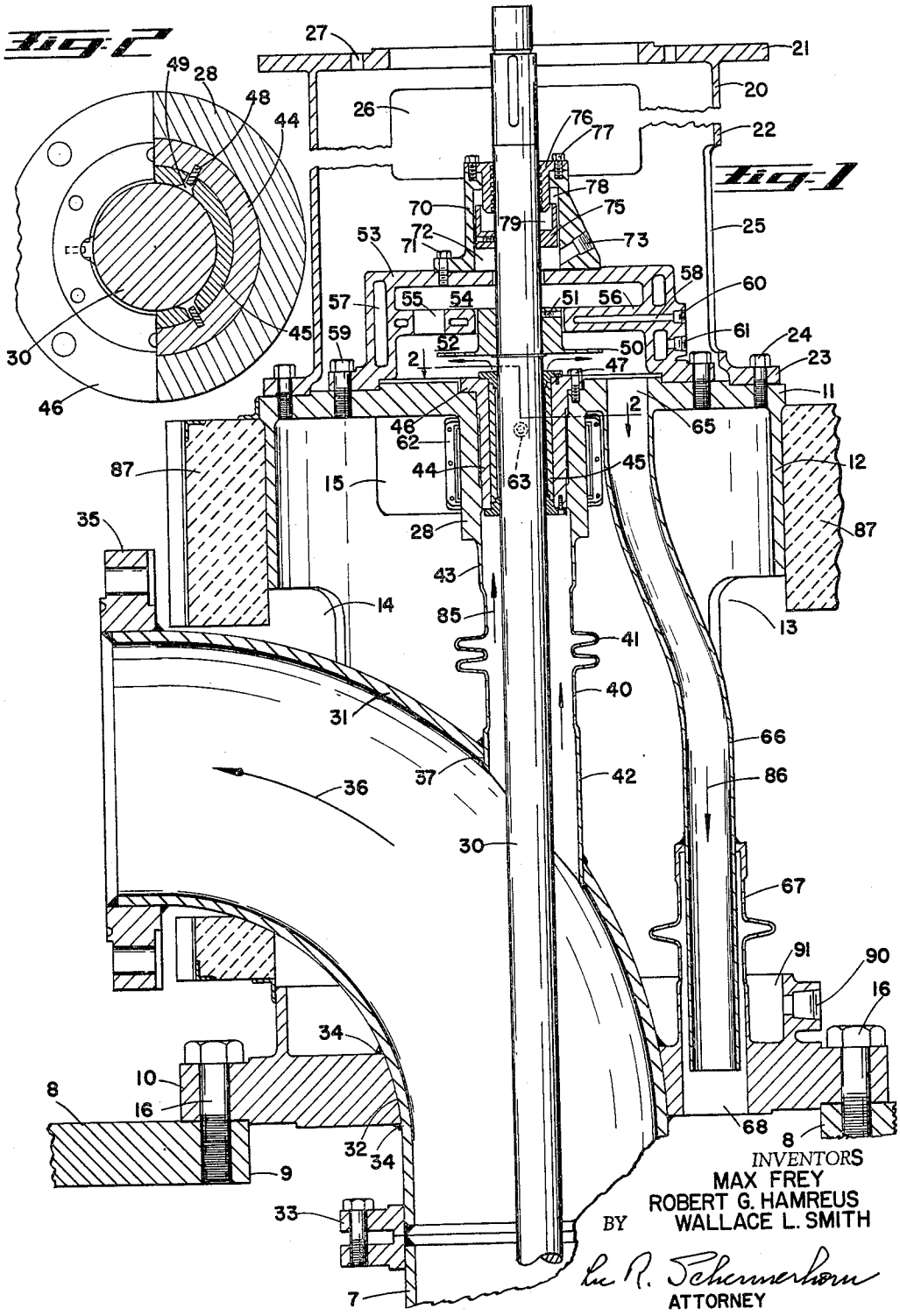
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PUMP DISCHARGE HEAD WITH HEATED BEARING

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PUMP DISCHARGE HEAD WITH HEATED BEARING

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This invention relates to a discharge head and bearing construction for a pump.

The invention has particular reference to a discharge head and bearing for a vertical centrifugal pump handling hot corrosive liquid which may solidify or congeal at ambient temperature. In such pumps operating in a high temperature liquid, there exists the problems, among others, of dealing with expansion strains, freezing of the pumped material in the shaft bearings and seals when the apparatus is cooled down, and preventing the escape of corrosive or obnoxious liquids, fumes and vapors.

Objects of the invention are, therefore, to provide a pump discharge head of the type described with improved means for preventing the occurrence of expansion strains which would cause the misalignment of the bearings, to provide relief against freezing or congelation of the pumped liquid in the shaft bearings and seals, to provide means to facilitate starting of the pump from cold condition, and to provide improved means to prevent the escape through the shaft bearings and seals of fumes and vapors from the pumped liquid.

In the present discharge head, a vertical pump shaft passes concentrically through a vertical discharge conduit carrying an upward flow of the pumped liquid from a pumping chamber. The discharge head includes an elbow having an opening for the pump shaft, and immediately above the elbow, a bearing for the shaft. A shaft seal is provided above the bearing whereby the bearing is exposed to the pumped liquid. The invention resides in novel means for circulating the pumped liquid through the bearing and back to the pumping chamber arranged to maintain the bearing and its supporting structure at approximately the same temperature that exists in the pumping chamber. The invention further resides in a novel arrangement for introducing an inert sealing gas in certain spaces and chambers above the bearing and immediately beneath the shaft seal to maintain the pumped liquid, as well as all fumes and vapors therefrom, below the seal so that any leakage through the seal will pass only the sealing gas and will not pass the pumped liquid, fumes and vapors. The invention further includes novel heating means for the discharge head to establish and assist in maintaining a desired temperature in the head structure.

The foregoing and other objects and advantages will become apparent and the invention will be better understood with reference to the following description of a preferred embodiment illustrated on the accompanying drawing. It is to be understood, however, that various changes may be made in the arrangement and construction of parts and that certain features may be used without others, all such modifications within the scope of the appended claims being included in the invention.

In the drawing:

FIGURE 1 is a vertical sectional view of a pump discharge head embodying the principles of the invention; and

FIGURE 2 is a fragmentary enlarged cross sectional view taken on the line 2—2 of FIGURE 1.

The pump discharge head has a rigid supporting frame comprising a heavy base plate 10 and a horizontal top plate 11 integrally connected together by a generally cylindrical vertical wall 12 having various openings therein as indicated at 13, 14 and 15. The three parts

10, 11 and 12 may be formed separately and then integrally connected by welding. Base plate 10 is equipped with marginal bolt holes 16 for mounting the head frame over a top opening 9 in a tank or reservoir 8 containing liquid to be pumped. Top plate 11 serves as a base for a motor support 20 which has its own top plate 21 supported by a cylindrical wall 22 having a bottom flange 23 secured to the plate 11 by bolts or screws 24. Cylindrical wall 22 is provided with access openings as indicated at 25 and 26. Plate 21 contains bolt holes 27 for mounting an electric motor in vertical position.

Plate 11 has a shaft opening in its center defined by a depending, cylindrical bearing housing 28 for a vertical pump shaft 30. In a large apparatus, this bearing housing is separately fabricated as a cylindrical sleeve which is welded into an opening in plate 11. The upper end of shaft 30 is adapted to receive a coupling for connection with the shaft of a motor mounted on the plate 21. The lower end of shaft 30 is connected with a centrifugal pump impeller submerged in the tank or reservoir on which the base plate 10 is mounted. The complete installation also includes a suitable thrust bearing, which in this instance is in the motor, not shown, for supporting the weight of shaft 30 and its impeller.

Pump shaft 30 is disposed in axial position in the vertical lower end of a 90° elbow 31 forming a part of the discharge conduit for liquid pumped upwardly by said impeller. The lower end of elbow 31 projects downwardly through an opening 32 in base plate 10 and is equipped with a bolting flange 33 for connection with the upper end of a vertical discharge conduit section 7 concentric with shaft 30. Elbow 31 is rigidly secured and sealed in base plate 10 by welds 34. The upper end of elbow 31 projects horizontally through opening 14 and is equipped with a bolting flange 35 for connection with an external pipe section in the discharge conduit. When the pump is operating, the main discharge flow follows the direction of arrow 36. The pump may comprise one or more impeller stages housed within or connected to the lower end of conduit section 7.

Elbow 31 is provided with an opening 37 for the pump shaft. A thin walled flexible metal expansion tube 40 having bellows-type expansion folds 41 surrounds the pump shaft 30 between the elbow and bearing housing 28. Tube 40 has a thick walled lower end portion 42 secured and sealed in the elbow opening 37 by welds and a thick walled upper end portion 43 similarly secured and sealed in the lower end of bearing housing 28.

Bearing housing 28 contains a cylindrical bearing shell 44 with three arcuate bushings 45 surrounding the shaft 30, as shown in FIGURE 2. Bearing shell 44 is equipped with a top flange 46 secured by screws 47 to plate 11. Rotation of bushing segments 45 is prevented by three keys 48. There are longitudinal open spaces at 49 between the bushings permitting liquid under pump discharge pressure in tube 40 to flow upward through the bearing.

During operation of the pump, such liquid is discharged from the upper end of the bearing against a circular slinger plate 50 which is secured to the shaft 30 by a set-screw 51. Slinger plate 50 is spaced a short distance above the upper end of the bearing for rotation in the lower chamber 52 of a pumpage housing 53 which also has an upper chamber 54. These upper and lower chambers are interconnected by a plurality of openings 55 in a partition wall 56. Partition wall 56 has a central opening concentric with shaft 30 which is substantially closed by the hub of slinger plate 50. Pumpage chambers 52 and 54 are surrounded by a steam chamber 57 which also connects with a steam chamber 58 in the partition wall 56. Numeral 60 designates a steam inlet connection and numeral 61 designates a steam outlet connection for

circulating steam through the steam chambers 57 and 58. Pumpage housing 53 is equipped with a bottom flange secured by screws 59 to plate 11 in sealing relation therewith.

Bearing housing 28 is surrounded by an electric strip heater 62 controlled by a thermocouple 63 in a small cavity in the bearing housing.

Plate 11 is further provided with a pumpage outlet opening 65 of large area in relation to the total cross sectional area of the three bearing openings 49 whereby the liquid pumped upwardly through the bearing may escape readily through opening 65 in gravity flow without filling the chambers 52, 54. The upper end of a return flow pipe 66 is sealed in opening 65 and the lower end projects into a flexible expansion tube 67 similar to the expansion tube 40. The upper end of expansion tube 67 is sealed to return flow pipe 66 and the lower end is sealed in an opening 68 in the base plate 10. Thus, the return flow of pumpage from chambers 52, 54 is directed into the tank or reservoir 8 outside the discharge conduit 7.

Mounted on top of pumpage housing 53 is a sealing gas housing 70 having a bottom flange secured by screws 71 to the top of the pumpage housing. Shaft 30 extends through a shaft opening in the top wall of the pumpage housing which communicates with a lower chamber 72 in housing 70. This chamber is supplied with inert sealing gas injected through a gas connection 73. A cup 75 is secured on shaft 30 within the housing 70, said cup having running clearance within the housing 70 and defining the upper wall of chamber 72.

The rim of cup 75 surrounds the lower end of a labyrinth sealing sleeve 76 having a plurality of inwardly open annular grooves surrounding the shaft 30. Sealing sleeve 76 has a top flange secured to the top of housing 70 by screws 77. Cup 75 provides a tortuous passageway between chamber 72 and the grooves in sealing sleeve 76 whereby any fluid in order to escape must first pass upwardly around cup 75 into a small chamber 78 and thence downwardly into another small chamber 79 before gaining access to the lower end of sleeve 76.

In view of the large area of pumpage outlet 65 and return tube 66 in relation to the aggregate area of openings 49 in the bearing, the pumped liquid does not tend to develop sufficient pressure in chambers 52 and 54 to fill these chambers and rise into chamber 72. Moreover, chambers 52 and 54 are in open communication through return tube 66 with approximately atmospheric pressure existing above the surface of the liquid in the tank or reservoir 8. Thus, a relatively low gas pressure, slightly above atmospheric pressure, maintained in chamber 72 prevents any fumes or vapors from rising into this chamber, or the chambers 78 and 79. At the same time there is a flow of the inert gas downwardly through the shaft opening in the top wall of housing 53, through chambers 52 and 54 and through return tube 66 to maintain an inert gas atmosphere above the liquid in the tank, the gas replacing the liquid pumped out of the tank as the liquid level lowers in the tank. This downward flow of gas purges fumes and vapors from chambers 52 and 54.

Most importantly, any leakage through labyrinth seal 76 will be of the sealing gas and not the pumped liquid or fumes or vapors therefrom. The chamber having the highest gas pressure at all times will be chamber 72 from which there may exist a pressure gradient in an upward direction through chambers 78 and 79 in the event of leakage of the gas through labyrinth seal 76 to the atmosphere and a pressure gradient in a downward direction as above described as liquid is pumped out of the tank and, also, in the event of any gas leakage from the tank.

During normal operation in pumping a hot liquid, a portion of the liquid flows upwardly through tube 40 as indicated by arrow 85, through the bearing and back through return tube 66 as indicated by arrow 86. This keeps the bearing heated so that there will not be excessive temperature variations between upper and lower portions of the discharge head whereby there are no expansion strains to cause misalignment of the pump shaft bearings nor misalignment between the motor and pump shaft. In order to compensate for heat loss to the atmosphere, additional heat is supplied as required by electric strip heater 62 and steam chambers 57, 58. Heat loss to the atmosphere is reduced by thermal insulation 87 around the cylindrical wall 12. In this way the upper plate 11 may be maintained at approximately the same temperature as lower plate 10 and the lower pump bearings which are submerged in the high temperature liquid. Strip heater 62 and steam chambers 57, 58 serve to bring the discharge head up to operating temperature before the pump is started and are also used during operation should the temperature drop to a predetermined minimum.

Elbow 31 being mounted solely in base plate 10 may expand or contract without disturbing the bearing plate 11. Flexible expansion tubes 40 and 67 accommodate relative movements at their upper and lower ends in horizontal as well as vertical directions whereby these tubes do not impose any stress on the bearing which might disturb its alignment in either heating or cooling. The openings 13 and 14 are arranged symmetrically to avoid distortion of the frame from expansion strains.

A connection 90 is shown to drain off any water, condensed or from the outside, that may collect in drip pan 91.

Having now described our invention and in what manner the same may be used, what we claim as new and desire to protect by Letters Patent is:

1. In a pump discharge head for a hot liquid which congeals to a solid state at ambient temperature, a bottom plate for mounting the head on a support, a discharge conduit elbow mounted solely in said plate, a shaft opening in said elbow, a bearing support mounted on said plate at a distance above said elbow and said plate and including a segmented shaft bearing spaced above said opening in said elbow, a flexible pumpage tube connected at its lower end with said elbow about said opening and connected at its upper end with said bearing support about the lower end of said bearing, a pumpage chamber in said bearing support receiving pumpage through the upper end of said bearing, a return flow conduit from said pumpage chamber to an opening in said plate, a shaft seal on the upper end of said pumpage chamber, a gas chamber between said pumpage chamber and said seal, and an external gas pressure supply connection in said gas chamber.

2. In a pump discharge head, a bottom plate for mounting the head on a support, a discharge conduit elbow mounted in said plate with its lower end projecting vertically below said plate, a vertical shaft opening in said elbow, a bearing support mounted on said plate at a distance thereabove and including a shaft bearing spaced above said opening in said elbow, a flexible pumpage tube connected at its lower end with said elbow about said opening and connected at its upper end with said bearing support about the lower end of said bearing, a pumpage chamber in said bearing support receiving pumpage through the upper end of said bearing, a return flow conduit from said pumpage chamber to an opening in said plate, an annular electric heater surrounding said bearing, and a steam chamber surrounding said pumpage chamber.

3. In a pump discharge head, a bottom plate for mounting the head on a support, a discharge conduit elbow mounted in said plate with its lower end projecting vertically below said plate, a shaft opening in said elbow, a bearing support mounted on said plate at a distance thereabove and including a shaft bearing spaced above said opening in said elbow, a flexible pumpage tube connected at its lower end with said elbow about said opening and connected at its upper end with said bearing support

about the lower end of said bearing, a pumpage chamber in said bearing support receiving pumpage through the upper end of said bearing, a flexible return flow conduit from said pumpage chamber to an opening in said plate, an annular electric heater surrounding said bearing, a steam chamber surrounding said pumpage chamber, a shaft seal on the upper end of said pumpage chamber, a gas chamber between said pumpage chamber and said seal, and an external gas supply connection in said gas chamber.

4. In a pump discharge head for a hot liquid which congeals to a solid state at ambient temperature, a bottom support plate adapted to be mounted on top of a tank, a bearing plate above said bottom plate, a pump discharge conduit comprising an elbow having a lower vertical end mounted in and projecting downwardly through said bottom plate and an upper end projecting horizontally between said two plates and separated from said bearing plate, a vertical bearing housing in said bearing plate, a segmental bearing in said bearing housing spaced above said elbow, a shaft opening in said elbow aligned with said bearing, a flexible pumpage tube concentric with said bearing connected at its upper end with said bearing housing and at its lower end with said opening in said elbow, a pumpage chamber on the upper side of said bearing plate communicating with the upper end of said bearing and bearing housing and receiving pumpage through said flexible tube and bearing, and a flexible return flow conduit from said pumpage chamber communicating with an opening in said bottom plate.

5. In a pump discharge head, a bottom support plate adapted to be mounted on top of a tank, a bearing plate above said bottom plate, a pump discharge conduit comprising an elbow having a lower vertical end projecting downwardly through said bottom plate and an upper end projecting horizontally between said two plates, a vertical bearing housing in said bearing plate, a segmental bearing in said bearing housing spaced above said elbow, a shaft opening in said elbow aligned with said bearing, a flexible pumpage tube concentric with said bearing connected at its upper end with said bearing housing and at its lower end with said opening in said elbow, a pumpage chamber on the upper side of said bearing plate communicating with the upper end of said bearing and bearing housing and receiving pumpage through said flexible pumpage tube and bearing, a flexible return flow conduit from said pumpage chamber communicating with an opening in said bottom plate, means for heating said bearing and said pumpage chamber from an external source of energy, a gas chamber on the upper end of said pumpage chamber, a shaft seal on the upper end of said gas chamber aligned with said bearing, and means for injecting a sealing gas into said gas chamber.

6. In a pump discharge head for pumping liquid from a tank, a vertical pump shaft, a base plate adapted to be mounted on the tank, a pump discharge elbow having a vertical lower end mounted in said base plate concentric with said shaft and a horizontal upper end spaced above said plate, said elbow having an opening for said shaft, a bearing support plate mounted on said base plate in spaced relation above said elbow, a vertical bearing housing in said bearing support plate, a segmental bearing for said shaft in said housing, a flexible pumpage tube surrounding said shaft, said tube being connected at its upper end with said bearing housing and conected at its lower end with said elbow, a pumpage chamber on the upper side of said bearing support plate surrounding said shaft and receiving pumpage through said tube and bearing, a flexible return flow conduit from said pumpage chamber communicating with an opening in said base plate, a slinger plate on said shaft in said pumpage chamber, a heating unit surrounding said bearing housing, a steam chamber surrounding said pumpage chamber, a gas chamber surrounding said shaft above said pumpage chamber and communicating with said pumpage chamber through a shaft opening in the top of said pumpage chamber, an external inert gas supply connection with said gas chamber, and a shaft seal in the upper end of said gas chamber, said gas chamber being in communication with said tank through said pumpage chamber and said return flow conduit to maintain an inert gas atmosphere in said tank.

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