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K. R. LUNG

3,288,075

PUMPS

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FIG-1

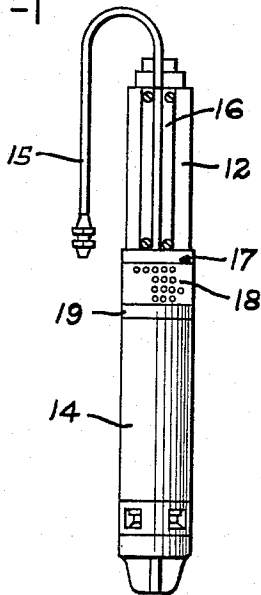


FIG-2

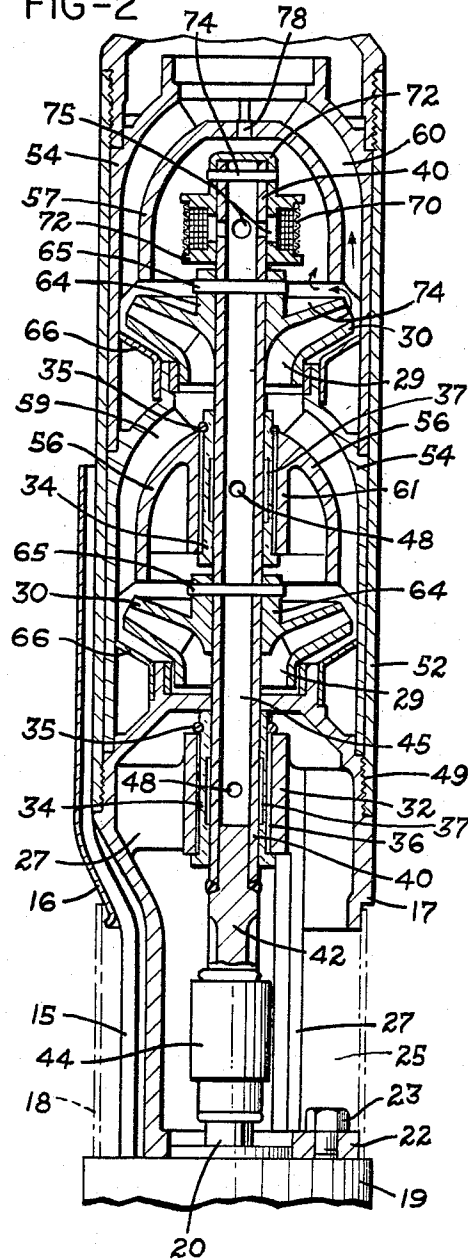
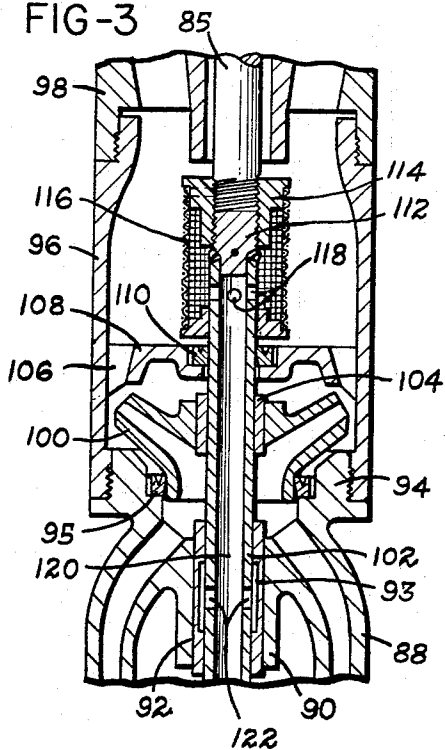


FIG-3



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3,288,075
PUMPS

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This application relates to pumps, and more particularly, to a submersible pump which is adapted for use with liquids containing sand or other foreign particles.

In many submersible pump installations, and especially those installations in the Southwestern part of the United States, foreign particles, generally referred to herein as sand, are present in the well and become stirred up as fluid is pumped from the well. This results in the sand becoming dispersed in the fluid to such an extent that the sand will enter the pump, and over a period of extensive use, the finer sand particles may seep into the pump bearings and cause abrasive wear.

Accordingly, it is a primary object of the present invention to provide a submersible pump which includes a system for continuously flushing and lubricating the pump bearings with liquid under high pressure and free of sand in order to prevent sand from contacting the supporting surfaces of the bearings.

As another object, the present invention provides a submersible pump wherein a passageway extends axially through the center portion of an impeller in order to conduct high pressure fluid from the discharge side of the impeller to a bearing support surface spaced ahead of the inlet side of the impeller.

Still another object of the present invention is to provide a submersible pump as outlined above wherein the pump is of the multi-stage centrifugal type and the axially extending passageway is defined by the means which connects the impellers together for common rotation and further includes radially extending passageways for supplying this high pressure liquid to the supporting surface of the bearings.

It is a further object of the present invention to provide a submersible pump as outlined above wherein the means defining the axially extending passageway is connected for rotation with a filter or other separating means spaced on the discharge side of an impeller so as to permit high pressure liquid which is free of sand to enter the passageway.

As another object, the present invention provides a submersible pump as described above with a rotating means for centrifugally separating the sand from the fluid and which is so positioned in relation to the discharge flow of liquid that the separating means is self-cleaning.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings—

FIG. 1 is an elevational view of a typical submersible motor-pump assembly which incorporates the novel bearing lubrication and flushing system in accordance with the invention;

FIG. 2 is an enlarged detailed view in axial section through a submersible pump showing one embodiment of the present invention; and

FIG. 3 is an enlarged detailed view in axial section of the top portion of a submersible pump showing a second embodiment of the invention.

Referring to the drawing, which illustrates preferred embodiments of the present invention, a typical submersible motor-pump assembly is shown in FIG. 1, and generally includes a pump 12, which is commonly of the multi-stage centrifugal type, a motor 14 and leads 15 which are protected by a shield 16. Surrounding the inlet

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portion 17 of the pump 12 is a cylindrically shaped screen 18 which serves to filter the fluid flowing into the pump 12.

Referring to the enlarged detailed view of FIG. 2, the motor 14 includes an end bearing support bracket 19 through which projects a motor shaft 20. The inlet housing 17 includes a bottom flange 22 which is mounted rigidly to the bearing bracket 19 by a series of screws 23. Spaced around the periphery of the inlet housing 17 are a series of openings 25 which permits the liquid to flow through the screen 18 past the radially extending ribs 27 and into the inlet portion 29 of the bottom closed type impeller 30.

A bearing retaining hub 32 is formed as an integral part of the inlet housing 17 and is centrally spaced therein by the radially extending ribs 27. Inserted within the hub 32 is a sleeve type bearing 34 which is retained positively within the hub by the retaining ring 35 and keyways 36. Preferably the bearing 34 is provided with an internal relief portion 37 which is centrally spaced to prevent a pressure build up within the center of the bearing.

Rotatably mounted within the bearing 34 is a tubular pump shaft 40 connected rigidly on the bottom end to a solid pump shaft extension 42 which is driven positively by the motor shaft 20 through a suitable coupling 44. As can be seen in FIG. 2, the tubular pump shaft 40 defines an internal axially extending passageway 45 adapted to receive a downward flow of liquid which flows out the opening or radially extending passageway 48 located near the center of each bearing 34 and into the relief portion 37 in order to lubricate and flush the bearing so as to prevent sand from seeping into the minute annular clearance between the pump shaft 40 and the bearing 34.

Rigidly connected to the inlet housing 17 by the threaded connection 49 is a tubular outer shell 52 which preferably is formed from a steel casing. Mounted within the shell 52 are the outer pump housings 54, one for each stage of the pump. Preferably, the outer housings 54 are formed from a suitable plastic material which provides resistance to corrosion by the pumping fluid.

Mounted within the outer pump housing 54 are the inner pump housings 56 and 57 which have integrally formed thereon a series of diffuser vanes 59 and 60. These vanes are provided to direct the flow of water from the discharge side of the bottom impeller 30 to the inlet portion 29 of the next adjacent stage impeller 30. Of course, it is to be understood that the outer pump housing 54 and inner pump housing 56 may be formed together as one part, as for example, by a metal casting. Included within the inner pump housing 56 is a bearing retaining hub 61 in which another sleeve type bearing 34 is mounted and retained therein by the ring 35.

As shown, the impellers 30 include a hub extension 64 through which a drive pin 65 extends to secure the impeller 30 to the tubular pump shaft 40 for rotation thereby. The deflectors 66 are mounted rigidly below the impellers 30 and serve to provide a smooth flow of fluid from the impellers to prevent sand from being trapped in the cavity defined below the deflector.

Rotatably mounted within the inner pump housing 57 and connected to the tubular pump shaft 40 is a cylindrical filter 70 which preferably is formed from a fine mesh metal screen. The filter 70 is mounted on the fitting 72 which serves to close the end of the tubular pump shaft 40 and is locked thereon by the pin 73. As the high pressure liquid leaves the discharge openings of the upper impeller 30, a portion of the liquid flows inwardly between the bottom edge of the inner pump housing 57 and the top side of the impeller 30 past the back vanes 74 formed on the impeller, as shown by the arrows. These back vanes 74 are provided to impart a centrifugal action to the liquid so that a portion of the sand particles

are held outwardly beyond the periphery of the impellers 30 and are prevented from entering the space defined under the inner pump housing 57. The liquid having a portion of the sand removed then flows through the filter 70 and the openings 75 and downwardly through the passageway 45 within the pump shaft 40 and out through the passageways 48 into the relief portion 37 to flush and lubricate the bearings.

An opening 78 is provided in the top of the inner pump housing 57 which allows any entrapped air to escape. In addition to sand separation provided by the vanes 74, the centrifugal action provided by the rotating filter 70 prevents sand from adhering to its outer surface. It is of course important that the inlet openings 75 within the pump shaft 40 be spaced to receive the high pressure discharge liquid in order that it will flow radial outward through the passageways 48 into areas of lower pressure.

Referring to FIG. 3, another embodiment of the invention is employed on a submersible pump which is driven by a line shaft 85 extending downwardly through the well casing from a motor mounted above the well. In FIG. 3, the inner and outer portions of the pump housing 88 are formed as a single part as mentioned above and include a hub 90 which retains the sleeve type bearing 92 having an internal relief portion 93. The upper portion of the housing 88 includes a flange portion 94 which retains the seal 95 and has a threaded connection to upper stage housing 96, which in turn is threaded to the main support housing 98. The impeller 100 is mounted for rotation with the tubular pump shaft 102 by a tapered sleeve 104. The spiral diffuser vanes 106 extend radially inward from the housing 96 and serve to support a ring 108 in which the shaft seal 110 is mounted.

The upper end of the tubular pump shaft 102 is connected rigidly to a threaded plug 112 which is attached to the threaded bottom end of the line shaft 85 by the coupling 114. In addition, the coupling 114 serves to support the cylindrically shaped screen type filter 116 so that the filter will rotate with the pump shaft 102 and line shaft 85. The openings 118 within the pump shaft 102 are spaced within the inside of the hollow filter 116 to allow liquid which passes through the filter to enter the axially extending passageway 120 within the pump shaft 102 so as to supply liquid to the supporting surface of the bearing 92 through the radially extending passageway 122.

Since the inlet passageways 118 are provided on the discharge side of the impeller 100, the passageway 120 receives high pressure fluid which will lubricate and flush the bearings in the same manner as explained above for the pump shown in FIG. 2. However, in the embodiment shown in FIG. 3, the filter 116 is not covered by an inner pump housing. Instead, centrifugal separation of the sand is provided by the spiral vanes 106 which produce a spiral flow of the liquid past the filter 116. Furthermore, centrifugal action is imparted to the sand particles by the rotating filter 116 and thus cooperates to provide for a self-cleaning filter 116. In some installations where the sand particles are relatively large, however, the filtering or separation of the sand from the fluid prior to its entering the inlet openings 118 may be provided solely by the vanes 106 which produce centrifugal action within the fluid to hold the particles outwardly of the inlet openings.

In view of the embodiments shown in FIGS. 2 and 3, it can be seen that the concept of the high pressure lubricating and flushing system for the pump bearings may be employed on multi-stage submersible pumps which are basically the same but have different specific structure. Furthermore, it is contemplated that the concept of the invention may be employed on any pump which may be required to handle liquid having foreign abrasive particles dispersed therein and is not intended to be limited to a multi-stage pump for submerging into a well casing.

Thus, while the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A pump assembly adapted to handle liquid having foreign particles dispersed therein, comprising means defining a pump housing, a tubular pump shaft rotatably mounted therein, at least one impeller mounted on said pump shaft for rotation thereby, at least one bearing connected to said housing and having a surface supporting said pump shaft on the inlet side of said impeller, means defining an axially extending passageway within said pump through the center portion of said impeller, means defining a lateral passageway within said pump shaft connecting said axially extending passageway with said bearing surface, inlet means to said axially extending passageway located on the discharge side of at least one of said impellers, and filter means mounted for rotation with said impeller and spaced adjacent said inlet means for supplying liquid free of foreign particles to said axially extending passageway for flushing and lubricating said bearing by way of said lateral passageway.

2. A pump assembly as defined in claim 1 wherein said bearing includes an internal relief portion in fluid communication with said passageway to prevent a high pressure build up within said bearing in the area where fluid flows from said passageway to said bearing surface.

3. A pump assembly as defined in claim 1 wherein said bearing includes an internal relief portion in fluid communication with said lateral passageway to prevent a high pressure build up within said bearing in the area where fluid flows from said lateral passageway to said bearing surface.

4. A pump assembly as defined in claim 1 wherein means are provided to produce centrifugal action within the liquid substantially adjacent said filter means.

5. A motor driven submersible pump for use in a well casing and adapted to resist the destructive effects of foreign particles dispersed in the liquid, comprising means defining a multi-stage pump housing, a plurality of impellers spaced in stacked relationship within said housing for increasing the pressure of the fluid progressively through said housing, means for connecting said impellers for common rotation as a unit about a central axis, at least one bearing having a surface for rotatably supporting said impellers within said housing and spaced on the inlet side of at least one of said impellers, means defining an axially extending passageway within said connecting means and adapted to conduct a reverse flow of liquid through the center of said impellers, means connecting said passageway with said supporting surface of each said bearing, inlet means to said axially extending passageway located on the discharge side of at least one of said impellers, and filter means mounted for rotation with said impellers and spaced adjacent said inlet means for supplying liquid free of foreign particles at discharge pressure to said axially extending passageway for flushing and lubricating each said bearing.

6. A motor driven submersible pump for use in a well casing and adapted to handle liquid having foreign particles dispersed therein, comprising means defining a multi-stage pump housing, a plurality of impellers spaced in a stacked relationship within said housing for increasing the pressure of the liquid progressively through said housing, a tubular shaft for connecting said impellers together for common rotation as a unit about a central axis, at least one bearing connected to said housing and having a surface supporting said pump shaft on the inlet side of at least one impeller, means defining a central axially extending passageway within said pump shaft and adapted to conduct a reverse flow of liquid through the interior of said shaft, means defining a lateral pas-

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sageway connecting said axially extending passageway with said bearing surface, inlet means to said axially extending passageway located on the discharge side of at least one of said impellers, and filter means mounted on said pump shaft adjacent said inlet means for supplying liquid free of foreign particles at discharge pressure to said axially extending passageway for flushing and lubricating said bearing by way of said connecting passageways.

7. A submersible motor-pump assembly for use in a well casing and adapted to handle liquid having foreign particles dispersed therein, comprising a motor having a submersible casing and a projecting motor shaft, means defining a multi-stage pump housing rigidly attached to said motor, a plurality of impellers spaced in a stacked relationship within said housing for increasing the pressure of the liquid progressively through said housing, means for connecting said impellers together for common rotation as a unit about a central axis, a positive drive coupling connecting said impellers to said motor shaft, at least one bearing connected to said housing and having a surface supporting said impellers for rotation within said housing and spaced on the inlet side of at least one of said impellers, an axially extending passageway defined by said connecting means and adapted to conduct a reverse flow of liquid through the center of said impellers, means defining a lateral passageway connecting said axially extending passageway with said bearing surface, inlet means to said axially extending passageway located on the discharge side of at least one of said impellers, and filter means mounted for rotation with said impellers adjacent said inlet means for supplying liquid free of foreign particles at discharge pressure to said axially extending passageway for flushing and lubricating said bearing by way of said lateral passageway.

8. A submersible motor-pump assembly for use in a well casing and adapted to handle liquid having foreign particles dispersed therein, comprising a motor having a submersible casing and a projecting motor shaft, a plurality of stage pump housings connected successively together and rigidly attached to said motor, a corresponding plurality of impellers spaced in a stacked relationship within said housings for increasing the pressure of the liquid progressively through said housing, means for connecting said impellers together for common rotation as a unit about a central axis, a positive drive coupling connecting said impellers to said motor shaft, at least one bearing connected to said housing and having a surface supporting said impellers for rotation within said housing and spaced on the inlet side of at least one of said impellers, internal relief means formed within said bearing, an axially extending passageway defined by said connecting means and adapted to conduct a reverse flow of liquid through the center of said impellers, means defining a lateral passageway connecting said axially extending passageway with said relief means, inlet means to said axially extending passageway located on the discharge side of at least one of said impellers, and filter means mounted for rotation with said impellers adjacent said inlet means for supplying liquid free of foreign particles at discharge pressure to said axially extending passageway for flushing and lubricating said bearing by way of said lateral passageway.

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ROBERT M. WALKER, *Primary Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,288,075

November 29, 1966

Kenneth R. Lung

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 15, after "pump" insert -- shaft and adapted to conduct a reverse flow of liquid --; column 5, line 16, for "lationship" read -- relationship --; line 21, for "lease" read -- least --.

Signed and sealed this 12th day of September 1967.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents