May 27, 1952 A. IVANOFF 2,598,547

PUMPING OF FLUIDS UNDER HIGH PRESSURES

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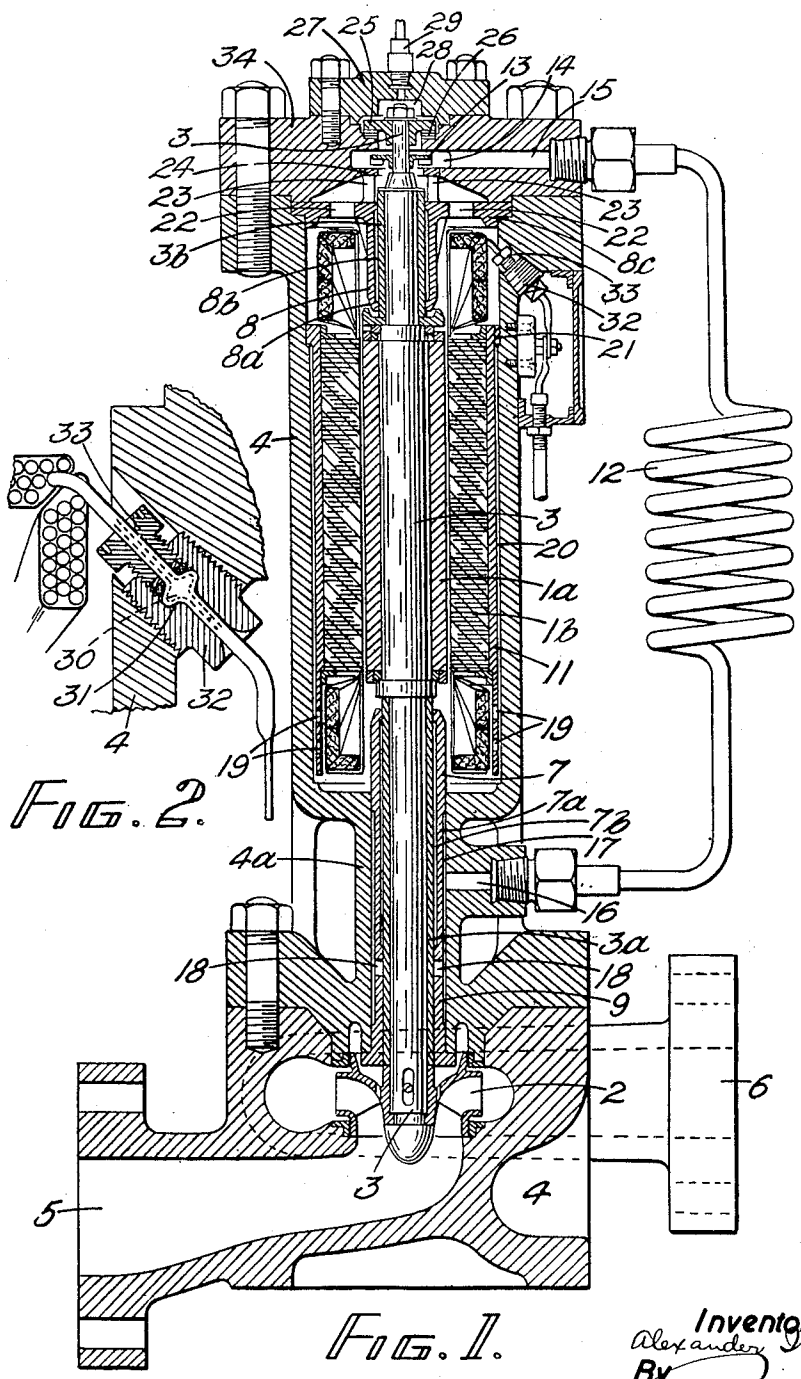


FIG. 2.

FIG. 1.

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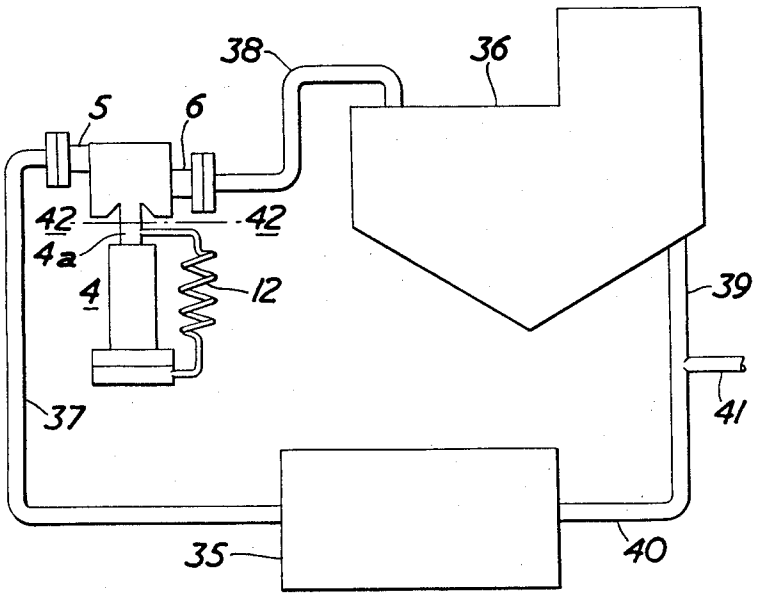


FIG. 3.

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UNITED STATES PATENT OFFICE

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PUMPING OF FLUIDS UNDER HIGH PRESSURES

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5 Claims. (Cl. 103—87)

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This invention relates to systems comprising a pump driven by an electric motor and in which the fluid being pumped is, independently of the action of the pump, of high pressure relative to the ambient pressure surrounding the pump casing. In such systems, whether the fluid is a liquid, vapour or gas, much trouble is experienced with the stuffing boxes or the like for the transmission between the motor and the pump, owing both to the said high pressure and, in some cases, to the high speed of rotation.

The present invention has for its object the provision of means for obviating these difficulties and in accordance with the invention the electric motor which drives the pump is itself immersed in fluid contained in what is in effect a part of extension of the pump casing and whose pressure is the same, or is of the same order, as the pressure of said fluid being pumped, so that the transmission between said motor and said pump does not require any bearing, stuffing box or the like, capable of withstanding high differential pressure on its two sides.

In order that the invention may be the more clearly understood an arrangement in accordance therewith will now be described, reference being made to the accompanying drawings, in which:

Figure 1 is a sectional elevation of said arrangement,

Figure 2 is a fragment of Figure 1 shown on a larger scale,

Fig. 3 is a diagrammatic view illustrating the application of the arrangement to the circulation of steam in a Loeffler boiler.

Referring to these drawings, the rotor 1*a* of an electric motor of the wet type and the impeller 2 of a centrifugal pump are mounted on a common vertical shaft 3 and, together with said shaft and the stator 1*b* of said motor, are enclosed within a common casing 4, the said impeller being mounted at the lower extremity of said shaft and being adapted to draw the fluid in radially through an inlet conduit 5 at the lower end of the casing and deliver it radially through an outlet 6 in the plane of said impeller. Said shaft 3 is mounted in two journal bearings 7 and 8, the journal bearing 7 being between the impeller and the motor and the journal bearing 8 being at the opposite side of said motor. As shown the journal bearing 7 fits closely in a reduced neck 4*a* of the casing 4 so that free fluid communication between the impeller and the motor is prevented, though seepage of the fluid between the bearing surfaces is permitted. If desired a

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special bush 9, fitting close on the shaft, may also be mounted in the reduced neck 4*a* of the casing between the bearing 7 and the impeller 2. As the casing 4 is full of fluid, which will be of the same pressure as that of the pump inlet, there will be no great tendency for the fluid to pass through this bush 9 and bearing 7, and usually it will be of no consequence if a certain amount does so.

The invention may be used in connection with the circulation of water in forced circulation boilers, such for instance as the La Mont type. In this case the pump is inserted in the circuit formed by the boiler tubes, so that both the inlet and the outlet are under full boiler pressure, which may range from four hundred to one thousand four hundred lbs. per square inch, while the differential pressure given by the pump is about thirty-five lbs. per square inch. The pressure on both sides of the reduced neck 4*a* of the casing 4 will be equal and of the same order as the full boiler pressure.

The invention could also be used in connection with Loeffler boilers where steam is circulated instead of water. In this case the device would preferably be arranged the opposite way to that shown with the motor at the lower end, and the casing 4 would be filled with water to a level say midway up the bush 9. Such a scheme is illustrated in Figure 3 in which the reference 35 designates the boiler drum of the Loeffler boiler, and the reference 36 the steam superheaters. The boiler drum 35 is connected by a pipe 37 to the pump inlet 5, and the pump outlet 6 is connected by a pipe 38 to the inlet of the superheaters 36. The outlet of the superheaters is connected by pipes 39 and 40 to the inlet of the boiler drum 35. The main pipe line 41 to the point of use extends from the junction of pipes 39 and 40. Thus, in the wel-known way, steam is circulated from the boiler drum 35 through the superheaters 36 and back to said boiler drum (where it evaporates more water), a proportion of the superheated steam flowing to the point of use. The broken line 42—42 designates the water level in the casing 4.

Again the device could be used for pumping such products as hot oil in oil refineries where high pressures are also frequently employed, or it may be used for pumping liquefied gas where a high pressure must be maintained to keep the product liquid.

The journal bearing 7 is constituted by a metal sleeve 7*a* fitting within the reduced neck 4*a* of the casing, said sleeve being interiorly recessed

for the reception of a filling of white metal 7b forming the actual bearing surface which bears on the surface of a metal tube 3a rigid on the shaft. In the arrangement shown the additional sleeve 9 is constituted as an extension of the sleeve 7a, this additional sleeve making a very narrow clearance with the metal tube 3a.

In the arrangement shown the motor is of the type employing a squirrel cage rotor 1a and having the individual wires of the winding of the stator 1b covered with insulation impervious to the fluid within the casing 4. In the arrangement shown the stator is mounted within a sleeve member 11 fitting within the casing 4.

The journal bearing 8 is constituted by a metal sleeve 8a interiorly recessed for the reception of a filling of white metal 8b forming the bearing surface which bears on the surface of a metal tube 3b rigid on the shaft. Said sleeve 8a is formed by a downward extension of a disc shaped part 8c mounted on the upper end of the body portion of the casing 4 as shown. The head 34 of the casing 4 is mounted on the top of said body portion above said part 8c as shown.

To prevent undue temperature rise owing either to flow of heat from the pump or to heat generated by the motor, means are provided for cooling the fluid within the casing. In the arrangement illustrated, this is done by circulating the fluid in the casing from the upper end of said casing through a coil 12 immersed in a cooling tank and back to the lower end of said casing. Thus a small centrifugal impeller 13 is mounted on the shaft 3 in a recess 14 in the head 34 of the casing 4, which recess constitutes the impeller housing, and said impeller delivers the fluid from said recess 14, through a conduit 15 in the head of the casing 4, and thence through the coil 12 to a conduit 16 through the wall of the reduced neck 4a of the casing. From this conduit 16 the fluid flows through a narrow annular clearance 17 formed as shown between the major portion of the inner surface of said neck 4a and the outer surface of the sleeve 7a, 9, and from this clearance it flows through a ring of holes 18 through said sleeve, between the parts 7a and 9, to the surface of the tube 3a. It then flows upwards between the bearing surfaces 3a, 7b to the upper end of the bearing 7, and from there it flows from the lower to the upper end of the motor, in part between the rotor 1a and the stator 1b, and in part through holes 19 in the sleeve member 11 to an annular clearance 20 formed between the major portion of the outer surface of said sleeve member and the inner surface of the casing 4, and from the upper end of this annular clearance through vertical slots 21 in said sleeve member. From the space at the upper end of the motor the fluid flows through holes 22 in the disc-shaped part 8c and thence between posts 23 integral with said disc shaped part, and through a ring 24 integral with and supported by said posts, back to the impeller 13. As shown, flow round the outer periphery of the ring 24 is substantially prevented by a surrounding part of the head of the casing.

It will be seen that, by circulating the fluid in this way, not only is the motor cooled but also the bearings 7 and 8. Adequate lubrication of the bearing 7 by the circulating fluid is also ensured. The bearing 8 will also be sufficiently lubricated by the fluid in the casing.

It will be appreciated, furthermore, that the flow of heat from the pump to the motor is also kept down by the provision of the reduced neck

4a. The heat has to pass by conduction along this reduced neck and the bearing elements within it, and, as said neck is exposed to atmospheric air, much of the heat is dissipated.

In the construction shown, it will be seen that the whole rotating unit comprising the shaft, rotor and impeller is supported by the engagement of a bearing flange 25, which is rigid with the upper end of the shaft, on a ring of suitable bearing material 26 mounted in a recess in the upper surface of the head of the casing 4. A cover member 27 mounted on the head 34 of the casing, is provided for enclosing these bearing parts and the upper end of the shaft.

This cover member 27 has a central port 28 through it which is normally closed by means of a valve 29. This port and valve are to enable air to escape when the casing 4 is being filled with fluid from below, which is usually done by simply introducing high pressure liquid to the pump which will seep up rapidly between the bearing surfaces and through the paths heretofore traced in connection with the circulation of liquid for cooling purposes. To enable the escaping air to reach the port 28 holes may be provided through the bearing flange 25 or the ring 26. The casing is filled up completely to a level above the bearing flange 25 and thus this bearing is lubricated by the fluid in the casing.

Owing to the high working pressure of the fluid within the casing 4 some difficulty has been experienced, in introducing into said casing, the conductors to the stator windings. In the present arrangement this has been overcome by providing each conductor, at the region where it passes to the outside of the casing, with an enlarged flange 30 which is pressed, by the pressure within said casing, against a shoulder 31 formed in the outlet passage through which the conductor passes, thereby forming a seal. In practice this enlarged flange 30 is formed on a separate length of metal which is connected at its two ends to the conductor ends inside and outside the casing. The whole of course is covered by the insulation, which actually provides the sealing surface. The said outlet passage is formed in a bush 32 screwed into the wall of the casing 4. The part 33 is simply a locating bush for the conductor, and is screwed into the larger or inner end of the outlet passage through the bush 32.

All other constructional details are deemed clear from the drawing.

I claim:

1. A liquid pumping system comprising a rotary pump impeller, a pump casing for said impeller, an electric motor having a rotor, a motor casing for said motor, said pump casing and motor casing forming parts of a common casing and having means for establishing liquid communication between said pump casing and said motor casing, a shaft for said impeller and said motor and on which said impeller and motor rotor are mounted, whereby said motor drives said impeller, a bearing for said shaft between said pump and said motor, said impeller impelling liquid through said pump casing and said motor being immersed in liquid in said motor casing whose pressure, owing to the liquid communication within said common casing is of the same order as that of said liquid being impelled, a cooling device externally of said common casing and operatively connected at one end with the motor casing and at its opposite end with the common casing in the region of said

bearing, and means for circulating liquid from said motor casing through said cooling device, for cooling said liquid, and back into said common casing at the region of said bearing, and thereby cooling said motor and said bearing.

2. A liquid pumping system, comprising a rotary pump impeller, a pump casing for said impeller, an electric motor having a rotor, a motor casing for said motor, a reduced neck joining said pump casing and said motor casing and constituting, together with said pump casing and said motor casing a common casing, means within said common casing for establishing liquid communication between said pump casing and said motor casing, a shaft for said impeller and said motor and on which said impeller and motor rotor are mounted, whereby said motor drives said impeller, a bearing for said shaft within said reduced neck, said impeller impelling liquid through said pump casing, and said motor being immersed in liquid in said motor casing whose pressure, owing to the liquid communication within said common casing, is of the same order as that of said liquid being impelled, a cooling device externally of said common casing and operatively connected at one end with the motor casing and at its opposite end with the reduced neck aforesaid, and means for circulating liquid from said motor casing through said cooling device, for cooling said liquid, and back into said reduced neck, and thereby cooling said motor and said bearing.

3. A liquid pumping system as defined in claim 2, wherein said reduced neck is exposed to air for cooling.

4. A liquid pumping system, comprising a rotary pump impeller, a pump casing for said impeller, an electric motor having a rotor, a motor casing for said motor, a reduced neck joining said pump casing and said motor casing and constituting, together with said pump casing and said motor casing a common casing and having means for establishing within the same liquid communication between said pump casing and said motor casing, a shaft for said impeller and said motor and on which said impeller and motor rotor are mounted, whereby said motor drives said impeller, a bearing for said shaft within said reduced neck, said impeller impelling liquid through said pump casing, and said motor being immersed in liquid in said motor casing whose pressure, owing to the liquid communication within said common casing, is of the same order as that of said liquid being impelled, a cooling device externally of said common casing, a conduit connecting said motor casing to said cooling device, another conduit connecting said reduced neck to said cooling device, and means for circulating liquid from the common casing through one of said conduits to said cooling device and back through the other conduit to said common casing, whereby both said motor and said bearing are cooled.

5. A liquid pumping system comprising a rotary pump impeller, a pump casing for said impeller, an electric motor having a rotor, a motor casing for said motor, said pump casing and motor casing forming parts of a common casing and having means for establishing within the same liquid communication between said pump casing and said motor casing, a shaft for said impeller and said motor and on which said impeller and motor rotor are mounted, whereby said motor drives said impeller, a bearing for said shaft between said pump and said motor, said impeller impelling liquid through said pump casing, and said motor being immersed in liquid in said motor casing whose pressure, owing to the liquid communication within said common casing is of the same order as that of said liquid being impelled, a cooling device externally of said common casing and operatively connected at its opposite ends to the common casing, and means for circulating liquid from said motor casing through said cooling device and back into said motor casing.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,347,732	Cooper	July 27, 1920
1,377,326	Durnford	May 10, 1921
1,736,002	Frickey et al.	Nov. 19, 1929
1,897,784	Apple	Feb. 14, 1933
1,974,183	Gunderson	Sept. 18, 1934
1,974,678	Lafont	Sept. 25, 1934
2,243,208	Hawley, Jr.	May 27, 1941
2,283,117	Arutonoff	May 12, 1942
2,520,880	Harlamoff	Aug. 29, 1950