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A. J. HARLAMOFF

2,406,947

CENTRIFUGAL PUMP

Filed Aug. 30, 1944

2 Sheets-Sheet 1

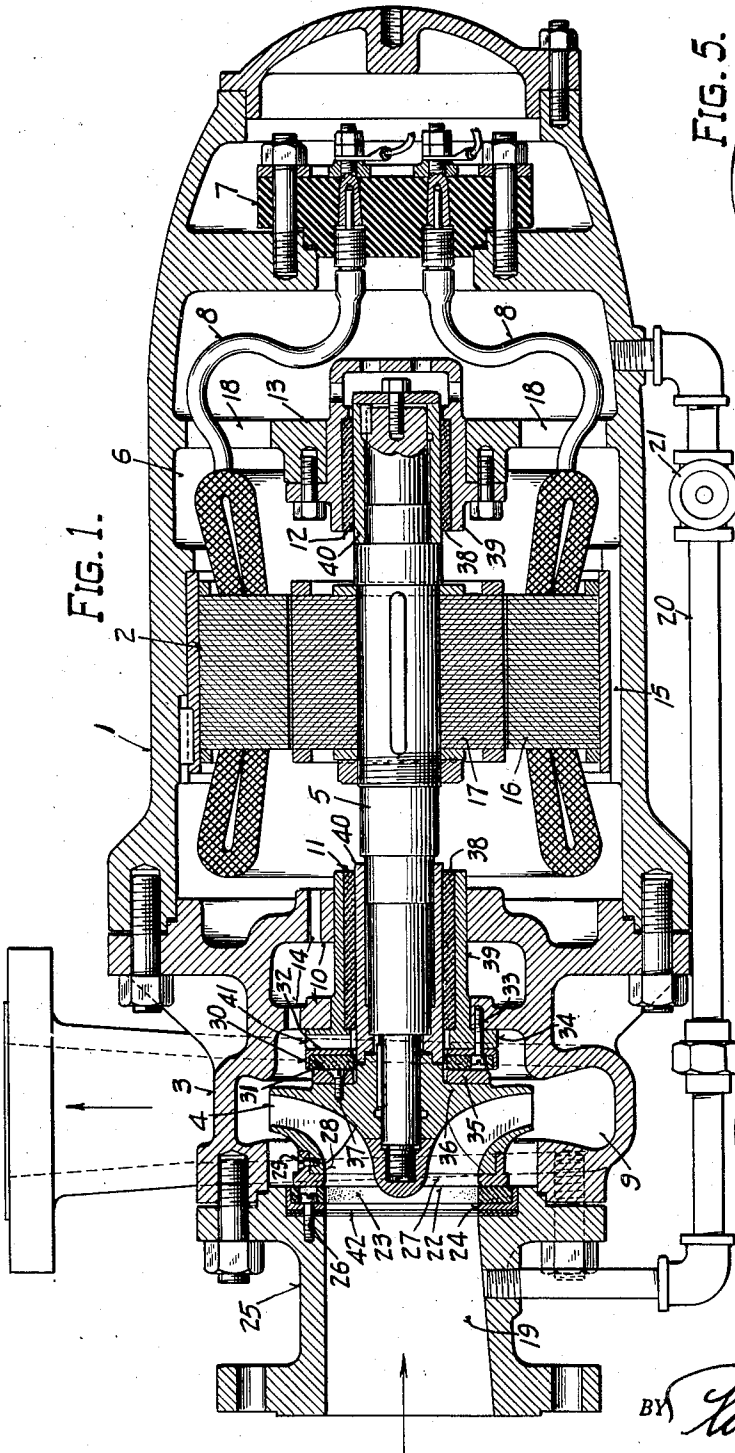


FIG. 5.

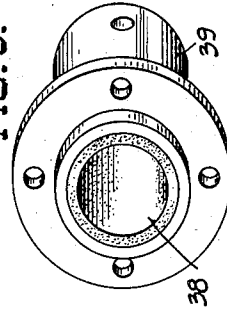


FIG. 4.

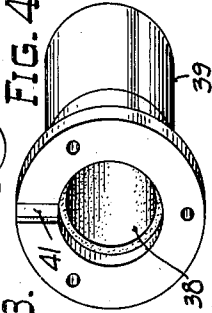


FIG. 3.

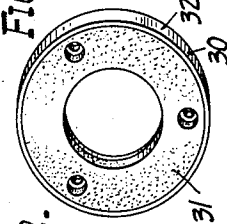
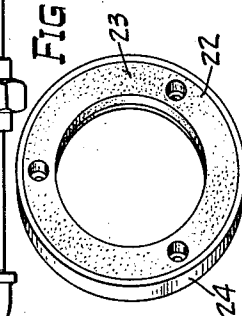


FIG. 2.



Anatol J. Harlamoff
INVENTOR.

BY *Twinkl C. Cudman*
ATTORNEY.

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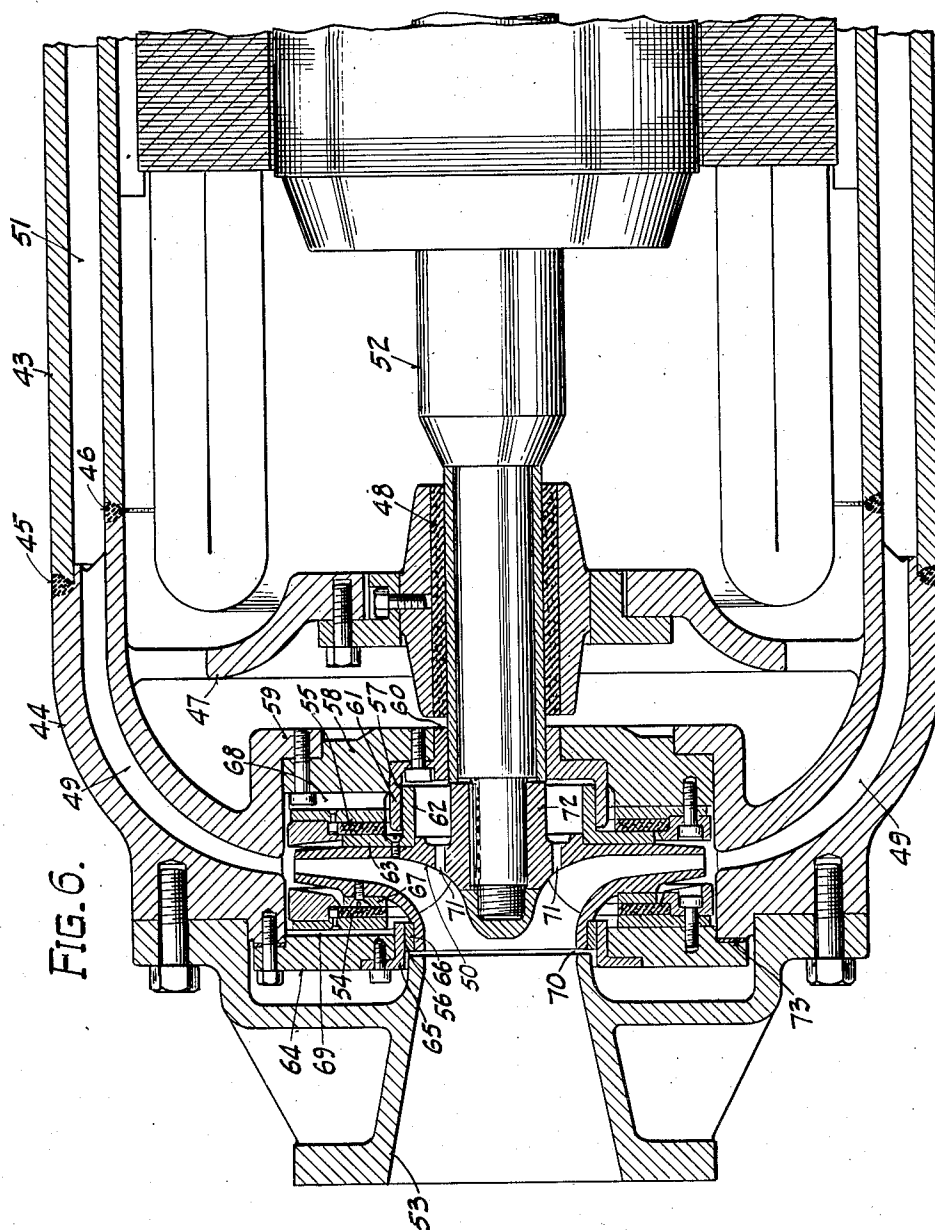


FIG. 6.

Anatol J. Harlamoff
INVENTOR.

BY *Erwin C. Anderson*
ATTORNEY.

UNITED STATES PATENT OFFICE

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CENTRIFUGAL PUMP

Anatol J. Harlamoff, South Gate, Calif., assignor
to A. O. Smith Corporation, Milwaukee, Wis.,
a corporation of New York

Application August 30, 1944, Serial No. 551,809

3 Claims. (Cl. 103—112)

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This invention relates to centrifugal pumps and may be employed in both single and multi-stage units.

The invention relates more particularly to the bearings and seals for centrifugal impellers and has been applied in the construction of motor pump units in which the motor and pump impellers are mounted on a single shaft. However, the invention is applicable to pumps having external drives.

The principal object of the present invention is to eliminate the longitudinal thrust stress in the shaft.

Another object of the invention is to provide a more efficient seal for the impeller.

Another object is to simplify the construction of the pumps and reduce its cost.

Another object is to reduce disc friction in the bearings.

In carrying out the invention the axial thrust bearings are mounted on the shrouds of the impeller and where both forward and rearward thrust bearings are employed they are disposed to provide a balanced thrust on the impeller. The bearings are lubricated by the pumped fluid and a bi-pass provides for lubrication of the wear plates which serve to seal the impeller.

The invention is illustrated in the accompanying drawings in which:

Figure 1 is a central longitudinal section through a motor pump unit embodying the invention;

Fig. 2 is a perspective view of the front thrust bearing ring;

Fig. 3 is a similar view of the rear thrust bearing ring;

Fig. 4 is a perspective view of the front radial bearing sleeve;

Fig. 5 is a similar view of the rear radial bearing sleeve; and

Fig. 6 is a detail section similar to Fig. 1 showing a modified form of construction which has been designed for use in a multi-stage pump unit.

The motor pump unit comprises, in general, a substantially cylindrical motor housing 1 containing the electric motor 2, and a cast pump housing 3 containing the pump impeller 4. The impeller 4 is mounted on the forward end of the motor shaft 5.

The motor housing 1 provides a motor chamber 6 closed at its rear end by the electrical insulating head 7 through which the motor leads 8 are connected to suitable supply cables. The motor chamber 6 is partially closed at its forward end by the pump housing 3 to separate it from

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the pump chamber 9, the housing 3 having an inward flange 10 for holding the forward radial bearing 11 for shaft 5.

The shaft 5 is supported for free rotation in the forward radial bearing 11 and the rear radial bearing 12, the latter being secured in an inward flange 13 of the motor housing 1.

Passages 14 are provided in the flange 10 for admitting pumped fluid from the pump chamber 9 to the motor chamber 6. Passages 15 are provided between the stator 16 of the motor and housing 1 to provide for the flow of pumped fluid toward the rear end of the motor housing. Pumped fluid also flows through the radial space 15 between the stator 16 and the rotor 17 and the submerging of the stator and rotor in the constantly circulating pumped fluid effectively cools the motor.

Passages 18 in flange 13 transmit the circulating fluid to the rear end of the motor housing 1 from which it is returned to the pump inlet 19 by the by-pass pipe 20. A suitable orifice plate or adjustable valve 21 is provided in pipe 20 to limit the flow of fluid therethrough and thereby prevent loss of pumped fluid in excess of that required to properly cool the motor.

According to the invention, the thrust bearings are disposed to engage the impeller and thereby relieve the shaft from all end thrust.

The forward thrust bearing 22 comprises a ring 23 of compressed carbon secured in a metal casing 24 of L-shaped radial section which in turn is secured to the inlet nozzle 25 of the pump housing 3 by screws 26. The carbon ring 23 has its bearing face engaging an alloy bearing plate 27 secured to the forward shroud 28 of impeller 4 by the screws 29.

The rear thrust bearing 30 comprises a similar carbon ring 31 secured in a metal casing 32 which is in turn secured to the flange 13 by screws 33 which also pass through a flange 34 on the bearing 11 to hold the latter in place. The carbon ring 31 has its bearing face engaging an alloy bearing plate 35 secured to the rear face 36 of the impeller by the screws 37.

The carbon rings 23 and 31 are secured by a shrink fit inside the circumferential flanges of the respective casings 24 and 32, and are preferably constructed of "Morganite" or similar material having either lead or silver impregnated therein to lend lubricating characteristics to the ring. Additional lubrication of the forward bearing 22 is obtained by the fluid being pumped seeping therethrough.

The radial bearings 11 and 12 are preferably of

the sleeve type employing carbon sleeves 38 shrunk fit in cylindrical metal casings 39 secured to the respective flanges 19 and 13 and bearing upon alloy liners 40 secured upon the shaft 5. The sleeves 38 may be made from the same material as the rings 23 and 31.

Lubrication of the rear thrust bearing 30 and of the front radial bearing 11 is obtained by seepage of fluid therethrough, the port 41 in the casing 39 of bearing 11 adjacent casing 32 serving to set up circulation of fluid through the bearings.

While it is preferable to mount the carbon rings 23 and 31, together with their holders 24 and 32, respectively, upon the outer casing, and to mount the bearing plates 27 and 35 upon the impeller, it is possible to reverse these elements and place the carbon rings on the impeller, and the bearing plates on the outer casing.

By constructing the thrust bearings to directly engage the impeller any reversal in stress in the shaft tending to cause fatigue is eliminated. The thrust bearings may be tightened by employing shims 42 beneath the casing 24 and between it and nozzle 25.

The construction shown in Fig. 6 has certain advantages over that of Fig. 1, in that the thrust bearings are not relied upon for sealing the impeller. This construction was designed to be employed with the multi-stage motor pump unit set forth in applicant's copending application Serial No. 566,044, filed December 1, 1944, for Multi-stage centrifugal pump.

In this construction the double walled motor housing 43 has a cast forward head 44 welded thereto by welds 45 and 46. The head 44 carries a web 47 for supporting the radial bearing 48 between the motor and impeller.

The forward end of head 44 has a large axial opening for receiving the impeller 50, and also has a plurality of spiral passages 49 registering circumferentially with the discharge from the impeller and delivering pumped fluid to the passage 51 between the walls of housing 43.

The pump comprises the impeller 50 mounted on the end of the pump shaft 52 which extends through bearing 48, the suction nozzle 53 bolted to head 44 and defining the inlet for the impeller, the forward thrust bearing 54, rear thrust bearing 55, forward wear ring seal 56 and rear wear ring seal 57.

The back plate 58 bolted to the rear inward flange 59 of head 44, extends inwardly to the shaft 52 to separate the motor chamber from the impeller chamber. A cylindrical wear ring 60 seals the plate 58 upon the shaft 52.

The back plate 58 supports the rear thrust bearing 55 and also the outer cylindrical rear wear ring 61 for seal 57. The inner cylindrical wear ring 62 for seal 57 is mounted on the rear face of impeller 50 and has a flange 63 which forms a bearing plate for bearing 55.

The forward plate 64 is bolted to the front of head 44 inside nozzle 53 and carries the forward thrust bearing 54 and the outer cylindrical wear ring 65 for seal 56. The inner cylindrical wear ring 66 for seal 56 is carried by the forward end of impeller 50. The bearing plate 67 carried by the front shroud of impeller 50 opposes the bearing 54 on plate 64.

In the construction of the thrust bearings 54 and 55, the carbon bearing elements are made similar to those of bearings 22 and 30 shown in Fig. 1.

A by-pass 68 constituting a radial passage in the back plate 58 supplies pumped fluid directly

from the outer impeller discharge to the inner circumference of bearing 55 for centrifugal seepage between the bearing surfaces to lubricate the same.

A similar by-pass 69 constituting a radial passage in the forward plate 64 supplies pumped fluid directly from the outer impeller discharge to the inner circumference of bearing 54 for centrifugal seepage between the bearing surfaces to lubricate the same.

Passages 68 and 69 tend to equalize the pressure on the bearings at the inner and outer circumferences thereof.

Passages 68 and 69 also supply lubricating fluid directly to the wear ring seals 57 and 56, respectively. These wear ring members are constructed with close clearances and need lubrication to prevent possible galling should the metal surfaces come in contact.

For those purpose a radial passage or axial clearance 70 exists between the forward end of impeller 50 and the suction nozzle 53 to conduct the lubricant fluid from seal 56 to the suction inlet for the impeller. Likewise longitudinal passages 71 are provided through the rear face of the impeller 50 near the hub 72 to conduct the lubricant fluid from seal 57 to the suction inlet for the impeller.

The impeller is balanced with respect to thrust by making the seals 56 and 57 of substantially the same diameter. Thereby the area on the front of the impeller outside the radius of the seal 56 is equal to the area on the back of the impeller outside the radius of the seal 57. Since both seals have the same radius the areas outside the same and which are subjected to the endwise pressure of the pumped fluid are equal. The same is true of the areas on the inside of seals 56 and 57 which are subjected to suction from the impeller.

The areas of the respective thrust bearings 54 and 55 are also preferably made equal to provide a more completely balanced structure.

In assembling the structure of Fig. 6, after the shaft 52 is located in its bearing 48, the back plate 58 with its wear ring 61 is secured to head 44. Then bearing 55 is secured to plate 58.

Wear ring 62 and bearing plate 63 are secured to the back face of impeller 50, wear ring 66 and bearing plate 67 are secured to the front shroud of impeller 50, and the latter is mounted on the end of shaft 52. Bearing 54 and wear ring 65 are secured to forward plate 64 and the latter bolted to head 44. Suitable shims 73 may be employed between plate 64 and head 44 to adjust the bearings.

The nozzle 53 is the last element to be applied in the assembly. The construction of the pump lends itself to ready and accurate assembly.

The invention may have various embodiments within the scope of the accompanying claims.

I claim:

1. In a pump of the class described, a housing, a pump shaft therein, an impeller mounted on said shaft, axial thrust bearings carried by the housing and engaging the forward and rear faces of said impeller to prevent axial movement of the same, cylindrical wear rings carried by the impeller, and complementary wear rings secured to the housing for sealing the impeller against leakage of fluid along its faces, and said wear rings being of substantially the same diameter to give a balanced construction and seal for the impeller.

2. In a pump of the class described, a pump casing, a centrifugal pump impeller in said cas-

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ing, an axial thrust bearing in said casing and disposed to resist the longitudinal thrust of the impeller in operation, a pair of opposed cylindrical wear rings for sealing the impeller against the casing adjacent said bearing, and a passage for pumped fluid directly from the impeller discharge to a circumferential space between the bearing and the wear rings to provide lubrication for the same.

3. In a pump of the class described, a pump 10

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casing, a centrifugal pump impeller in said casing, an axial thrust bearing in said casing and disposed to resist the longitudinal thrust of the impeller in operation, a pair of opposed cylindrical wear rings for sealing the impeller against the casing adjacent said bearing, and a by-pass passage around the bearing to prevent its sealing action and free it from possible freezing.

ANATOL J. HARLAMOFF.