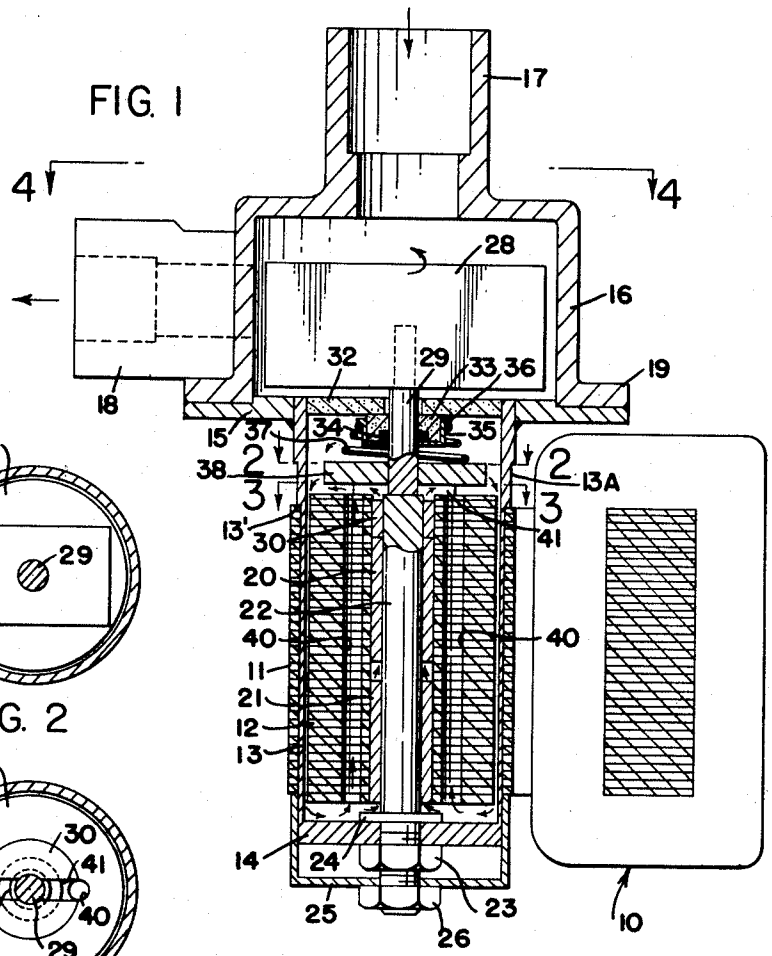
April 5, 1960 E. M. SMITH 2,931,307

ENCLOSED ROTOR CONSTRUCTION FOR MOTOR PUMP UNIT

Filed Dec. 4, 1957 2 Sheets-Sheet 1

FIG. 1



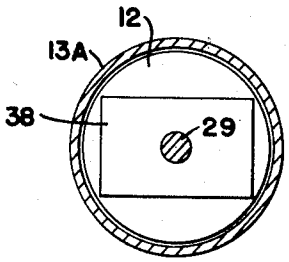


FIG. 2

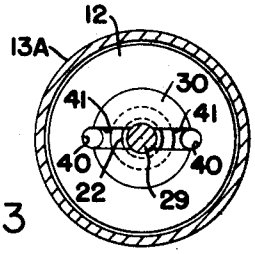


FIG. 3

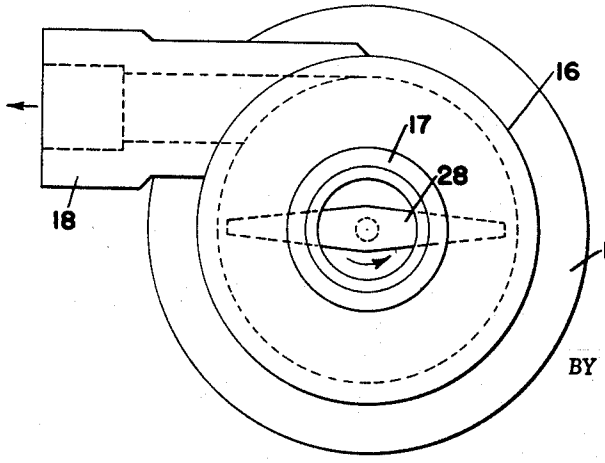


FIG. 4

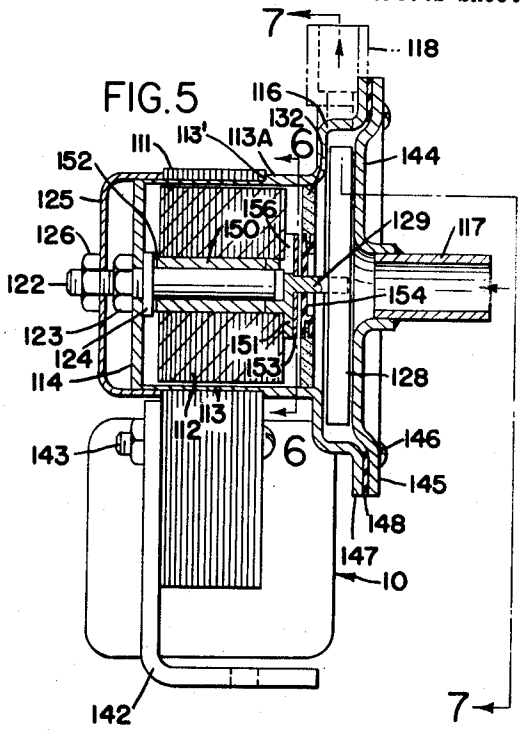
INVENTOR.
EDWARD M. SMITH
BY Ely, Fryer & Hamilton
ATTORNEYS

April 5, 1960 E. M. SMITH 2,931,307

ENCLOSED ROTOR CONSTRUCTION FOR MOTOR PUMP UNIT

Filed Dec. 4, 1957 2 Sheets-Sheet 2

FIG. 5



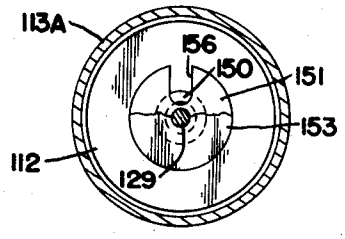


FIG. 6

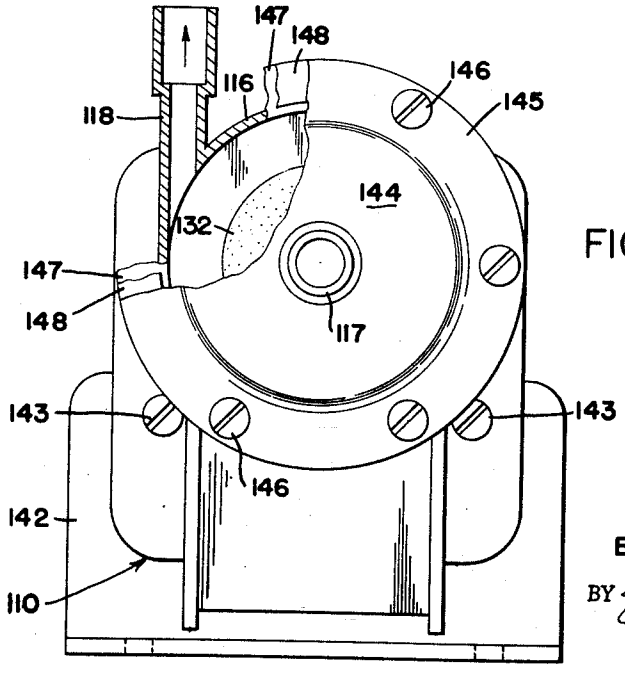


FIG. 7

INVENTOR.
EDWARD M. SMITH
BY Ely, Fraze & Hamilton
ATTORNEYS

United States Patent Office

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ENCLOSED ROTOR CONSTRUCTION FOR MOTOR PUMP UNIT

Edward M. Smith, Mansfield, Ohio, assignor to Gorman-Rupp Industries, Inc., Bellville, Ohio, a corporation of Ohio

Application December 4, 1957, Serial No. 700,687

6 Claims. (Cl. 103—87)

The invention relates generally to centrifugal pump units in which the motor rotor and rotating pump parts are enclosed in a single cavity, thereby eliminating the need for exterior mechanical seals and glands. More particularly, the invention relates to an improved enclosed rotor construction which has increased bearing lubrication and cooling for the rotor.

Certain prior enclosed rotor motor pump units have been unduly complicated in construction and expensive to manufacture and assemble. Others have required that part of the pumped fluid be recirculated exteriorly of the unit back through the rotor for cooling and lubrication thereof. Still other constructions have required the main flow of pumped fluid to be through the rotor which greatly restricted the kinds of fluid which could be handled, because of wear and abrasion on the rotor and its bearings.

It is an object of the present invention to provide an improved motor pump unit having an enclosed rotor and pump housing which will overcome the disadvantages of prior constructions.

More specifically, it is an object to provide an improved enclosed rotor motor pump unit which is inexpensive to manufacture, simple and easy to assemble with the motor stator, and which provides self-contained effective cooling and lubrication of the rotor without requiring the main flow of pumped fluid to pass through the rotor.

These objects and related objects which will appear from the following description are accomplished by the improved construction, which comprises a single cavity housing for the rotor and an axially spaced impeller driven thereby, said housing slidably fitting into the stator, and means within said housing for circulating a small amount of the pumped fluid around the rotor and through its bearings.

Preferred embodiments of the improved construction are illustrated by way of example in the accompanying drawings and described in detail herein, but it will be understood that various modifications and changes in details of construction are contemplated within the scope of the invention as defined in the appended claims.

In the drawings:

Fig. 1 is a sectional view on the rotor axis of one embodiment of the improved construction.

Fig. 2 is a transverse sectional view of the rotor housing on line 2—2 of Fig. 1.

Fig. 3 is a transverse sectional view on line 3—3 of Fig. 1.

Fig. 4 is an end elevation of the construction of Fig. 1.

Fig. 5 is a sectional view on the rotor axis of another embodiment of the improved construction.

Fig. 6 is a transverse sectional view on line 6—6 of Fig. 5.

Fig. 7 is an end elevation partly broken away, as on line 7—7 of Fig. 5.

Referring to the construction of Figs. 1–4, the stator of a conventional shaded pole induction motor is indicated generally at 10, and has the annular laminated portion 11 surrounding the rotor 12. The usual air gap between the stator and rotor is partly occupied by a thin annular housing wall 13 of non-magnetic material, which is integral with the closed end cylinder or cup totally enclosing the rotor.

The lower closed end of the housing is indicated at 14, and its upper open end 13A is secured, as by welding, in the base plate 15 of the impeller housing 16. The thin housing wall 13 terminates in an annular shoulder 13′ at its upper end, and the upper end of the portion 11 of the stator abuts said shoulder when the unit is assembled. The impeller housing 16 preferably has an axial inlet duct 17 and a tangential outlet duct 18. The base flange 19 of the housing 16 may be welded or removably secured to the base plate 15, as desired.

The rotor 12 is of the usual laminated construction, and preferably is encased in a shield of corrosion-resistant, non-magnetic material. Alternatively, the rotor laminations may be of a magnetic type of stainless steel, with their outer edges machined to provide a smooth surface, which construction does not require a non-magnetic shield. The bore of the rotor is provided with sleeve bearings 20 and 21 of carbon or other suitable material, which journals the rotor 12 on a stationary shaft 22. The shaft 22 extends through housing wall 14, and a nut 23 clamps the wall against a back-up washer 24 secured to the shaft so that the shaft has a cantilever support in the housing and wall 14. A cap 25 fits over the housing wall 14, and a clamping nut 26 screwed on the lower projecting end of shaft 22 holds the upper edge of the cup in abutment with the lower end of stator portion 11.

The impeller 28 is secured on the upper end of an impeller shaft 29 extending into the housing and having its lower end rotatively abutting the upper end of rotor shaft 22, so that shaft 22 forms a thrust bearing for impeller shaft 29. The lower end of shaft 29 is non-rotatively secured to rotor 12, preferably by means of a flanged bushing 30 which has a friction fit in the bore of the rotor. A disk 32 of sintered material having relatively low porosity substantially closes off the upper end of housing 14, and a sealing washer 33 of carbon or other suitable material surrounds the shaft 29 and abuts the underside of disk 32 to form a seal therewith.

The washer 33 may have an O-ring 34 therein around the shaft 29, and a metal case 35 holds the O-ring in place and has an outturned annular abutment flange 36 for abutting the upper end of a coil spring 37. The lower end of spring 37 yieldingly abuts an impeller plate 38, which may be rectangular and is secured to the shaft 29 against the flange of bushing 30. Thus, the spring 37 yieldingly holds the washer 33 in sealing abutment with disk 32.

The rotor chamber is filled with the fluid being pumped, and as the impeller 28 is rotated by rotor 12 to pump fluid from the inlet 17 to the outlet 18, the impeller plate 38 circulates the fluid captive in the rotor chamber to dissipate the heat from the rotor and to cool the rotor shaft bearings. As indicated by the arrows in Fig. 1, the fluid in the rotor chamber is circulated downwardly around the rotor 12 through the gap between the rotor and the thin housing wall 13, and then back upwardly around the shaft and through the bearings 20 and 21. Additional fluid return passages 40 may extend longitudinally through the rotor for the purpose of accelerating the flow of liquid through the rotor to conduct internally generated heat away from the rotor more effectively. Preferably, transverse slots 41 in the flange of bushing 30 allow fluid from around the upper end of the rotor bearing and from the holes 40 to return to the rotor chamber above the rotor. Thus the cooling fluid circulates entirely within the rotor chamber, and the fluid being

pumped by the impeller 28 does not pass through the rotor chamber.

The porous plate 32 compensates for changes in the volume of fluid within the rotor chamber due to changes in temperature, because the fluid can permeate through the plate in either direction to maintain the rotor chamber filled with fluid without exerting unequal pressures on opposite sides of the disk 32. Also, the porous plate 32 promotes heat transfer from the captive fluid in the rotor chamber to the fluid in the impeller chamber.

The rotor and impeller housing 14—16 is quickly and easily assembled within the stator coil 11 by sliding the housing 14 through the coil until the shoulder 13' abuts the upper end of the stator and then applying the cap 25 and clamping nut 26.

Referring to the embodiment of Figs. 5–7, the stator of a conventional shaded pole induction motor is indicated generally at 110, and has the annual laminated coil portion 111 surrounding the rotor 112, with the air gap between the stator and rotor partly occupied by a thin annular housing wall 113 of non-magnetic material. The thin housing wall 113 terminates in an annular shoulder 113' at its upper end which abuts the stator portion 111 to locate the rotor housing therein. Preferably, the stator coil has a mounting bracket 142 attached thereto by bolts 143. One end of the rotor housing is closed by end wall 114 and the other end 113A is integral with the impeller housing 116.

The housing 116 has a removable closure plate 144 having a peripheral flange 145 attached by screws 146 to the flange 147 of impeller housing 116, there being a sealing gasket 148 clamped between flanges 145 and 147. The closure plate is provided with an axial inlet duct 117 and the impeller housing has a tangential outlet duct 118.

The laminated rotor 112 is encased in corrosion-resistant, non-magnetic material, or may be of magnetic type stainless steel without a casing if desired, and the bore of the rotor is provided with a sleeve bearing 150 which is of carbon or other suitable material. The lower end of impeller shaft 129 is non-rotatively secured to rotor 112, preferably by means of a flanged bushing 151 which has a friction fit in the bore of the rotor. The impeller 128 is secured on the outer end of shaft 129 within the impeller housing 116.

The rotor bearing 150 is journaled on a stationary shaft 122 which extends through the housing end wall 114 and through the cap 125 surrounding the end wall and abutting the stator portion 111. A clamping nut 123 on shaft 122 clamps the wall 114 against a back-up washer 124 secured to the shaft, and a nut 126 on the outer end of shaft 122 holds the cap 125 around the housing end wall 114 with the inner end of the cap abutting the stator portion 111. Preferably, the sleeve 150 abuts the washer 124 to provide a thrust bearing for the rotor, there being a radial slot 152 in the end of the sleeve to allow passage of liquid through the sleeve around the shaft 122.

A thrust washer 153 is fitted on the impeller shaft 129 against the outer surface of closure flange 151 to take care of thrust in the opposite direction, and a disk 132 of sintered material having relatively low porosity substantially closes off the rotor chamber from the impeller chamber 116. The disk 132 preferably has a rubber gasket 154 bonded therein forming a seal around the shaft 129.

As the impeller 128 is rotated to pump fluid from the inlet 117 to the outlet 118, the radial slot 156 in flange 151 acts as an impeller within the rotor chamber to circulate the fluid captive therein outwardly and longitudinally past the rotor through the gap between the rotor and wall 113 to dissipate heat from the rotor. Fluid from within the closed end wall 114 of the rotor chamber is circulated back along the shaft 122 within bearing sleeve 150 to lubricate the same, and returns to

the opposite end of the rotor chamber through the radial slot 156 in the flange 151. Thus, in this embodiment also, the cooling fluid circulates entirely within the rotor chamber, and the fluid being pumped by the impeller 128 does not pass through the rotor chamber.

The porous disk 132 is sufficiently porous to allow fluid to permeate therethrough and compensate for changes in the volume of fluid within the rotor chamber, due to changes in temperature, without dislodging the disk 132.

Both embodiments of the invention are inexpensive to manufacture and easy to assemble, and both provide self-contained effective cooling and lubrication of the rotor without requiring the main flow of pumped fluid to pass through the rotor.

What is claimed is:

1. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a rotor, a cup-shaped rotor housing having an annular wall of reduced thickness passing through the gap between the rotor and stator, and forming a shoulder abutting one end of said stator, a shaft journaled in said rotor and extending through the closed end of the rotor housing, means on the projecting end of said shaft engaging the other end of said stator, an impeller housing connected to the open end of said rotor housing, a partition normally separating the rotor chamber from the impeller chamber, an impeller shaft extending through said partition and connected to said rotor, an impeller on said shaft within the impeller housing, and impeller means on said impeller shaft within the rotor chamber to circulate the fluid captive therein.

2. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a rotor, a cup-shaped rotor housing having an annular wall of reduced thickness passing through the gap between the rotor and stator and forming a shoulder abutting one end of said stator, a shaft journaled in said rotor and extending through the closed end of the rotor housing, means on the projecting end of said shaft engaging the other end of said stator, an impeller housing connected to the open end of said rotor housing, a porous disk separating the rotor chamber from the impeller chamber, said disk being permeable to liquid in said chambers to compensate for changes in the volume of fluid in said rotor chamber due to temperature changes, an impeller shaft extending through said partition and connected to said rotor, an impeller on said shaft within said impeller housing, and impeller means on said impeller shaft within the rotor chamber to circulate fluid captive therein.

3. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a rotor, a cup-shaped rotor housing having an annular wall of reduced thickness passing through the gap between the rotor and stator and forming a shoulder abutting one end of said stator, an impeller housing connected to the open end of said rotor housing, a rotor shaft journaling said rotor and extending through the closed end of said rotor housing, and a cap adjustable on the projecting end of said shaft surrounding the closed end of the rotor housing and abutting the other end of said stator.

4. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a rotor, a cup-shaped rotor housing having an annular wall of reduced thickness passing through the gap between the rotor and stator and forming a shoulder abutting one end of said stator, an impeller housing connected to the open end of said rotor housing, a rotor shaft journaling said rotor extending through and secured to the closed end of said rotor housing, a cap movable over the projecting end of said shaft and surrounding the closed end of said rotor housing, and a clamping nut on said shaft holding said cap in abutment with the other end of said stator.

5. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a cup-shaped rotor housing having a closed end wall, an axial rotor shaft secured in said closed end wall, a rotor journaled on said shaft, the annular wall of said rotor housing being located between said stator and said rotor, an impeller housing connected to the open end of said rotor housing, an impeller shaft non-rotatively connected to said rotor and extending into said impeller housing, means on the end of said rotor shaft between said rotor and said impeller housing forming a thrust bearing for the end of said impeller shaft, means normally partitioning said rotor housing from said impeller housing, a thrust bearing between the rotor and the positioning means to take the thrust of the rotor toward said impeller housing, and impeller means on said impeller shaft within said rotor housing for circulating fluid captive therein.

6. An enclosed rotor and pump unit for an electrical motor having an annular stator, said unit comprising a cup-shaped rotor housing having a closed end wall, an axial rotor shaft secured in said closed end wall, a rotor journaled on said shaft, the annular wall of said rotor housing being located between said stator and said rotor, an impeller housing connected to the open end of said

rotor housing, an impeller shaft non-rotatively connected to said rotor and extending into said impeller housing, means on the end of said rotor shaft between said rotor and said impeller housing forming a thrust bearing for the end of said impeller shaft, a fluid permeable disk surrounding said impeller shaft and normally closing the open end of said rotor housing, a thrust bearing between the rotor and said disk to take the thrust of the rotor toward said impeller housing, and impeller means on said impeller shaft within said rotor housing for circulating fluid captive therein.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,931,307 April 5, 1960

Edward M. Smith

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

Column 5, line 14, for "positioning" read --partitioning--.

Signed and sealed this 10th day of January 1961.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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