

Feb. 14, 1956

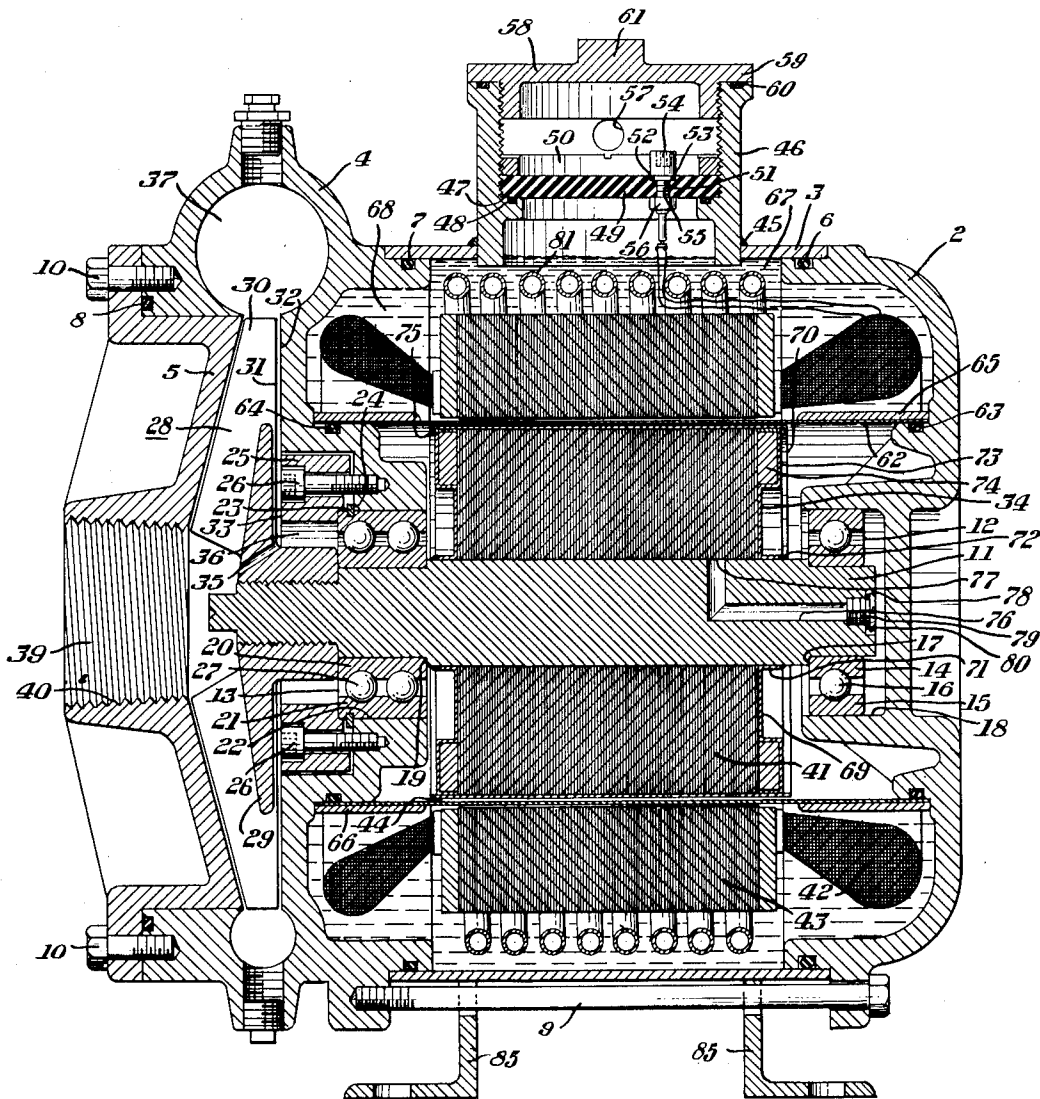
J. J. ZIMSKY
MOTOR-PUMP UNIT

2,734,459

Filed March 22, 1952

3 Sheets-Sheet 1

Fig. 1.



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3 Sheets-Sheet 2

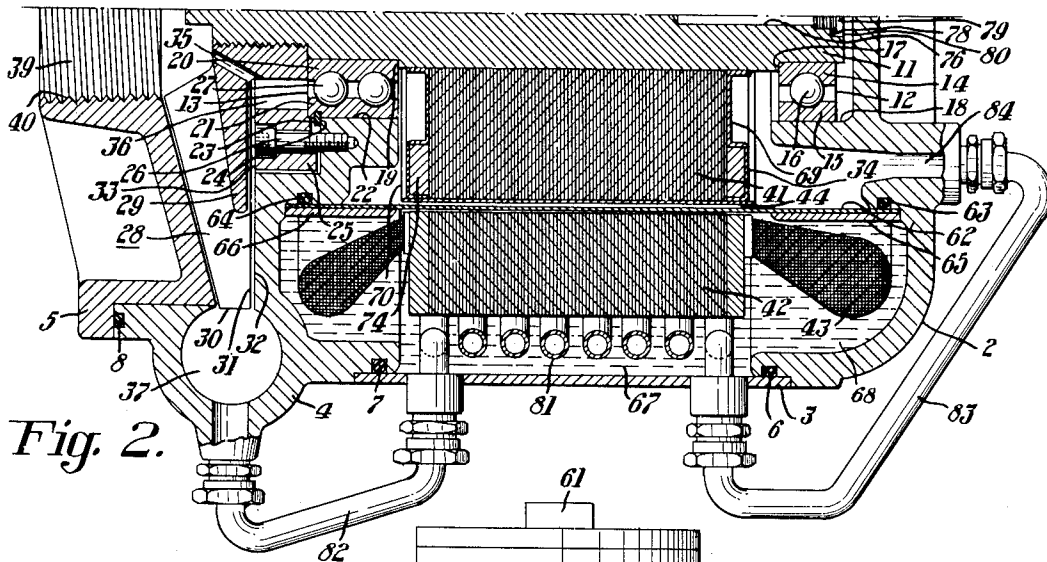


Fig. 2.

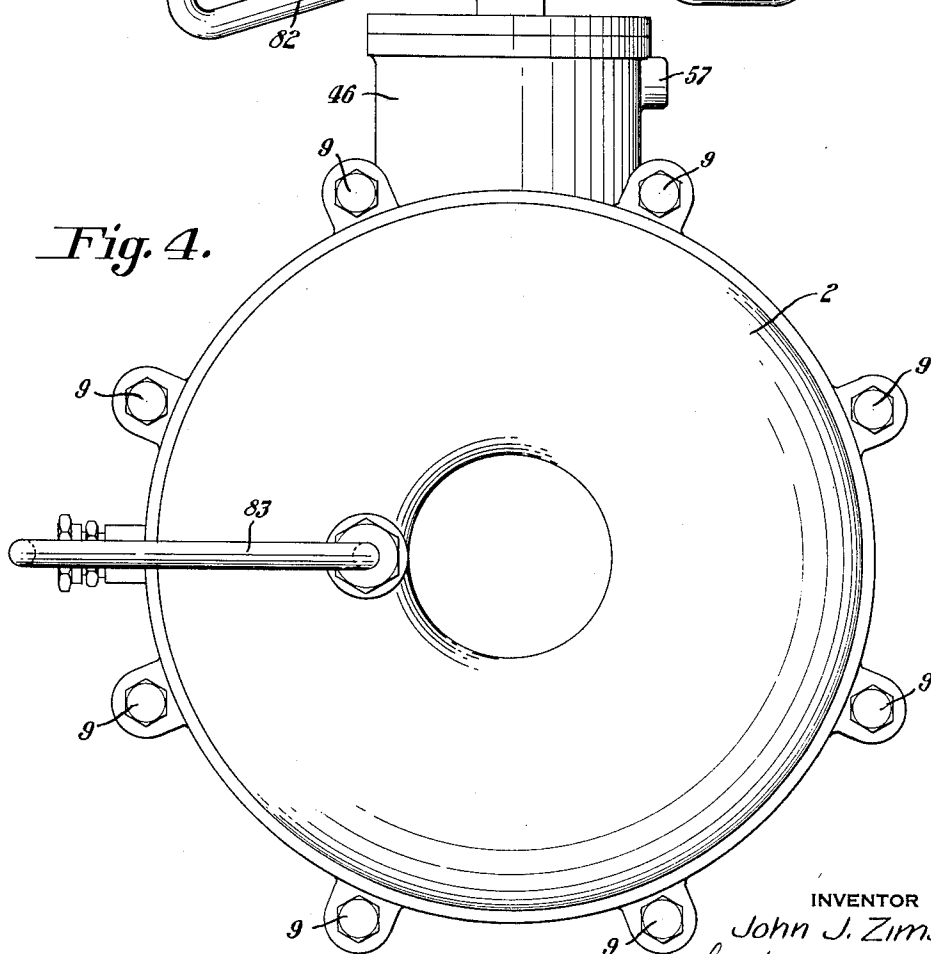


Fig. 4.

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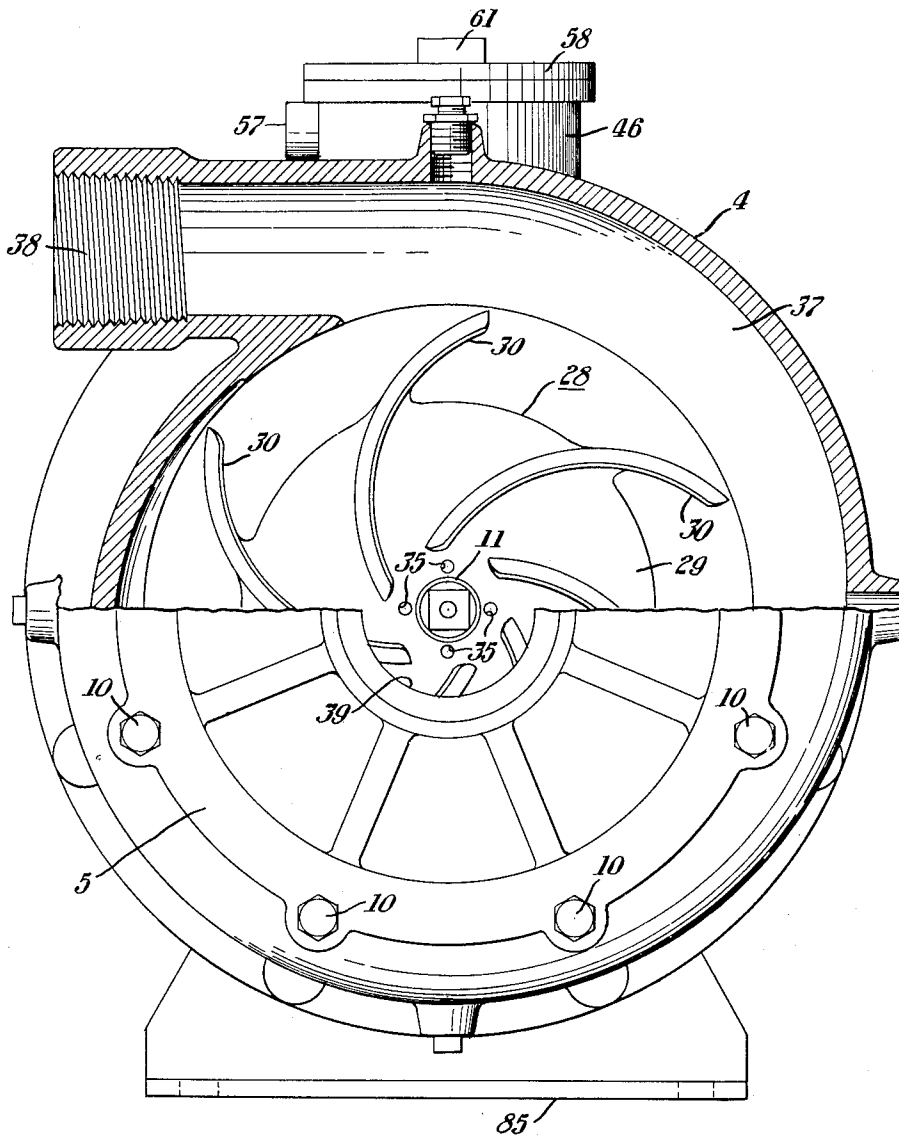
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3 Sheets-Sheet 3

Fig. 3.



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1

2,734,459

MOTOR-PUMP UNIT

John J. Zimsky, Canonsburg, Pa., assignor, by mesne assignments, to McGraw Electric Company, a corporation of Delaware

Application March 22, 1952, Serial No. 277,933

10 Claims. (Cl. 103—87)

This invention relates to a motor-pump unit and particularly such a unit comprising an electric motor with a centrifugal pumping element connected to the motor shaft to be driven thereby. The invention provides certain constructional features whereby important advantages in operation are realized.

In my copending application Serial No. 277,931, filed March 22, 1952, now Patent No. 2,718,193, I have disclosed a motor-pump unit in which a portion of the fluid being pumped is employed for cooling and lubricating the motor bearings and cooling the motor. In that case a portion of the fluid being pumped is circulated in contact with the bearings, the rotor and the stator of the motor-pump unit.

In my copending application Serial No. 277,932, filed March 22, 1952, now Patent No. 2,725,012, I have disclosed the employment of a different coolant for the stator such as a coolant having different thermal properties than the fluid being pumped. In that case the rotor is disclosed as being segregated from the fluid being pumped although a portion of the fluid being pumped is utilized to cool the rotor as well as to lubricate the motor bearings.

The present invention is concerned with making provision for more effective cooling of the stator or of the outer or peripheral portion of the motor. Such provision may be important when the motor-pump unit is employed in a location where it is subjected to intense heat or when in use it is subjected to great variation in temperature.

I provide a motor-pump unit comprising a motor having a shaft carrying a rotor, a stator disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a fluid coolant in thermoconductive relationship with the motor, a conduit having its outside in thermoconductive relationship with the fluid coolant and fluid coolant separate from the first mentioned fluid coolant passing through the conduit.

I may employ a cooling conduit in thermoconductive relationship with the motor and a connection to the cooling conduit through which a portion of the fluid pumped by the centrifugal pumping element passes so that such portion of the fluid pumped by the centrifugal pumping element cools the motor. A cooling coil may surround the stator and a connection to the cooling coil may be provided through which a portion of the fluid pumped by the centrifugal pumping element passes so that such portion of the fluid pumped by the centrifugal pumping element cools the stator.

In a preferred structure I provide a cooling chamber about the stator, a fluid coolant in the cooling chamber, a cooling coil in the cooling chamber having its outside in contact with the fluid coolant and fluid coolant separate from the first mentioned fluid coolant passing through the cooling coil. I may provide a connection to the cooling coil through which a portion of the fluid pumped by the centrifugal pumping element passes so that such

2

portion of the fluid pumped by the centrifugal pumping element extracts heat from the fluid coolant.

I may provide in combination with a cooling conduit in thermoconductive relationship with the stator connections to the cooling conduit and to the interior of the motor through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the stator and cool the interior of the motor and lubricate the motor bearings. Desirably there is a connection to the cooling conduit through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the stator and a connection from the cooling conduit to the interior of the motor through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the interior of the motor and lubricate the motor bearings.

In the illustrated motor-pump unit a cooling coil surrounds the stator and I provide a connection to one end of the cooling coil through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the stator and a connection from the other end of the cooling coil to the interior of the motor through which said portion of the fluid pumped by the centrifugal pumping element passes to cool the interior of the motor and lubricate the motor bearings. Desirably there is a cooling chamber about the stator with a fluid coolant therein, a cooling conduit in the cooling chamber having its outside in contact with the fluid coolant, a connection to the cooling conduit through which a portion of the fluid pumped by the centrifugal pumping element passes to extract heat from the fluid coolant and a connection from the cooling conduit to the interior of the motor through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the interior of the motor and lubricate the motor bearings.

I further provide a motor-pump unit comprising a motor having a shaft carrying a rotor, a stator disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, means isolating the stator from the rotor and means for circulating a portion of the fluid pumped by the centrifugal pumping element in thermoconductive relationship with the stator and in thermoconductive relationship with the rotor.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown a present preferred embodiment of the invention in which

Figure 1 is an axial cross-sectional view through a motor-pump unit;

Figure 2 is a half axial cross-sectional view through the motor-pump unit shown in Figure 1, the section of Figure 2 being at a plane intersecting the plane of the section of Figure 1;

Figure 3 is a view partly in end elevation of the left-hand end of the motor-pump unit and partly in transverse cross section of the motor-pump unit shown in Figure 1; and

Figure 4 is an end elevational view of the right-hand end of the motor-pump unit viewing Figure 1.

Referring now more particularly to the drawings, the motor-pump unit comprises cooperating casing members 2, 3, 4 and 5. The casing member 2 forms the right-hand end of the motor casing viewing Figure 1, the casing member 3 telescopes over a portion of the casing member 2 as shown in Figure 1 and forms the central generally cylindrical portion of the motor casing and the casing member 4 telescopes within the casing member 3 and forms the left-hand portion of the motor casing and defines part of the centrifugal pumping element compartment. The casing member 5 telescopes within a portion of the casing member 4 and cooperates there-

3

with to form the centrifugal pumping element compartment. The casing members 4 and 5 form in effect a casing about the centrifugal pumping element later to be described. The casing members 2 and 3 are sealed together by an O-ring 6, the casing members 3 and 4 are sealed together by an O-ring 7 and the casing members 4 and 5 are sealed together by an O-ring 8. The casing members 2, 3 and 4 are fastened together by bolts 9. The casing members 4 and 5 are fastened together by bolts 10.

The motor-pump unit comprises a shaft 11 mounted in bearings 12 and 13. The left-hand end of the shaft viewing Figure 1 extends outwardly beyond the bearings 13 and projects from the motor casing into the centrifugal pumping element compartment or casing. The bearing 12, in which the non-projecting end of the shaft 11 is mounted, has an inner race 14 and an outer race 15 with bearing balls 16 operating between the races in usual manner. The inner race 14 is pressed onto the shaft 11 and seats against a shoulder 17 on the shaft. The casing member 2 is provided with a recess 18 of cylindrical shape coaxial with the shaft 11, the recess 18 forming a guideway for the outer race 15 and hence for the bearing 12. The guideway maintains the bearing 12 in fixed position relatively to the motor casing transversely but so that it is free for limited axial movement relatively to the motor casing due to thermally induced changes in length of the shaft 11.

The shaft 11 has a shoulder 19 against which the inner race 20 of the bearing 13 is positioned. The outer race 21 of the bearing 13 is disposed within a bore 22 in the casing member 4. A circular key or retaining ring 23 is inserted into the outer generally cylindrical surface of the outer race 21 and projects therefrom and bears against the left-hand face viewing Figure 1 of the casing member 4 at 24. A holding ring 25 is bolted to the casing member 4 by bolts 26 and bears against the left-hand face of the outer race 21 viewing Figure 1 whereby to hold the outer race in place. Bearing balls 27 operate between the inner race 20 and the outer race 21 of the bearing 13 in usual manner.

The centrifugal pumping element is shown at 28 and comprises a hub portion 29 and centrifugal pumping means 30. The hub 29 is internally threaded and is screwed onto the externally threaded left-hand end of the shaft 11 viewing Figure 1. The hub 29 of the centrifugal pumping element 28 maintains the inner race 20 of the bearing 13 in place against the shoulder 19 of the shaft 11. Thus since the inner race 20 of the bearing 13 is fixedly positioned on the shaft 11 and the outer race 21 of the bearing 13 is fixedly positioned with respect to the motor casing the left-hand end of the shaft remains in substantially unvarying axial position relatively to the motor casing. Upon thermally induced changes in length of the shaft the bearing 12 moves within the guideway 18 as above described. Thus the unit is free from binding or excessive wear brought about by temperature changes.

The parts are proportioned so that the right-hand face 31 of the body portion of the centrifugal pumping element 28 is slightly spaced from the left-hand face 32 of the casing member 4 and the left-hand face 33 of the holding ring 25 as shown in Figure 1. Also, the holding ring 25 is slightly spaced from the casing member 4 both radially and axially. Further, the holding ring 25 is spaced radially from the hub 29 of the centrifugal pumping element 28. Bores 35 are provided in the hub 29 of the centrifugal pumping element 28 affording communication between the interior of the centrifugal pumping element compartment or casing and the annular space 36 between the holding ring 25 and the outer peripheral surface of the hub 29, which annular space communicates with the interior of the bearing 13.

The casing member 4 is shaped to provide a volute 37 into which the fluid being centrifugally pumped is de-

4

livered, the volute discharging the delivered fluid through an outlet 38. The centrifugal pumping element 28 rotates in the counterclockwise direction viewing Figure 3.

The casing member 5 is provided centrally with an axial inlet 39 through which the fluid being pumped enters the centrifugal pumping element compartment or casing. The inlet 39 is internally threaded as shown at 40 so that a pipe or coupling for introduction of the fluid to be pumped into the motor-pump unit may be screwed thereinto.

Fastened to the shaft 11 centrally of the motor casing is a rotor 41. Carried within the motor casing is a stator having windings 42 and laminations 43 which may be conventional. The stator surrounds the rotor 41 forming a radial fluid gap motor. The gap between the rotor and the stator is designated 44.

Welded to the casing member 3 at 45 is an internally threaded collar 46 having an internal outwardly facing annular seat 47 to which is sealed by an O-ring 48 a disc or panel 49 which may be of insulating material such as Bakelite. The disc 49 is pressed against the seat 47 and the O-ring 48 by a nut 50 which is threaded into the collar 46.

The disc 49 has therethrough a bore 51 having an enlarged upper end 52 to which is sealed by an O-ring 53 a stud 54 having a threaded stem 55 passing through the bore, the stud being held in place by a nut 56. The electrical conductors or leads for operating the motor are brought out through the stud 54, or a plurality of such studs may be provided, one for each lead. The leads may emerge from the collar 46 into a suitable conduit sealed to the collar at an opening 57 therein. The upper end of the collar is closed by a cap 58 threaded thereinto, the cap having an outward radial flange 59 sealed to the upper end of the collar by an O-ring 60. The cap 58 may have a polygonal central upward projection 61 for receiving a wrench.

The unit is thus completely sealed and self-contained and may be employed anywhere, even being submerged in water or other liquid. The O-rings prevent moisture or liquid from either entering or leaving the unit. No stuffing boxes or rotating seals are used anywhere in the structure.

The motor-pump unit may be used for pumping any fluid which has a lubricating and cooling value. Oil is such a fluid and it is contemplated that normally the motor-pump unit herein disclosed will be used for pumping oils such as transformer oil, diesel engine oil, etc.

The stator is segregated from the remainder of the motor by a hollow cylinder 62 sealed to the casing member 2 by an O-ring 63 and sealed to the casing member 4 by an O-ring 64. The hollow cylinder 62 may be of any suitable material, stainless steel being preferred. Bands 65 and 66 which may, for example, be of steel, hold the hollow cylinder 62 in place and firmly press it against the O-rings 63 and 64. An annular space 67 substantially surrounding the stator contains a coolant 68 separate from the fluid being pumped. The coolant 68 may for example be transformer oil which can operate up to a temperature rise of the order of 55° C. or askarel which is a non-inflammable liquid which will operate at a temperature rise of 55° C. or a silicone oil which is non-inflammable and can operate at temperatures up to 200° C. or higher.

The rotor 41 has thereabout an enclosure 34 which may for example be made of stainless steel and which isolates the rotor from the remainder of the motor except the shaft 11. The enclosure 34 comprises opposed end discs 69 and a hollow cylinder 70. Each of the discs 69 has an inner annular foot or flange 71 embracing the shaft 11 and welded thereto at 72. Each of the discs has an enlarged outer annular pocket 73 containing a reinforcing ring 74. Each of the discs 69 is welded to the cylinder 70 by a weld 75. The cylinder 70 is at the inside and the cylinder 62 at the outside of the radial fluid gap 44, such gap being defined by the two cylinders.

5

Within the gap 44 is circulated a portion of the fluid being pumped as will presently be described. A portion of the coolant 68 is disposed outside the cylinder 62 and inside the stator.

I provide a passage extending from within the enclosure 34 to a point outside the enclosure to test the enclosure for pressure tightness. Preferably the passage is in the shaft and I show a passage 76 terminating at one end at 77 within the enclosure and at the other end at 78 at an exposed portion of the shaft. In the structure shown the end 78 of the passage 76 is at the non-projecting end of the shaft 11. The passage 76 is closed by a removable screw plug 79 sealed to the passage by an O-ring 80.

In the annular space 67 is a cooling coil 81 having its outside in contact with the coolant 68 so that when a coolant separate from the coolant 68 is passed through the cooling coil 81 it extracts heat from the coolant 68, such heat being conducted from the coolant 68 through the wall of the cooling coil 81. Any suitable coolant may be circulated through the cooling coil 81. A portion of the fluid pumped by the centrifugal pumping element may be circulated through cooling coil 81. That same portion of the fluid pumped by the centrifugal pumping element may also be circulated through the motor to cool the motor and lubricate the motor bearings within the cylinder 62. In the structure shown in the drawings a connection 82 extends from the centrifugal pumping element compartment or casing or from the volute 37 to one end of the cooling coil 81 and a connection 83 extends from the opposite end of the cooling coil 81 and communicates with the interior of the motor within the cylinder 62 through a passage 84.

The cooling coil 81 is immediately adjacent the stator laminations 43; i. e., the motor housing is disposed outside the coil and there is no portion of the housing between the cooling coil and the stator laminations.

In operation of the motor-pump unit the fluid to be pumped which will be assumed to be oil enters the centrifugal pumping element compartment from the left viewing Figure 1 through the inlet 39 and is delivered by the centrifugal pumping element 28 to the volute 37 and the outlet 38. A small proportion of the oil passes between the centrifugal pumping element and the left-hand face 32 of the casing member 4 and circulates through the motor bearings and about the enclosure 34 and passes back into the centrifugal pumping element compartment through the passages 35, thus maintaining a constant circulation within the motor of a portion of the fluid being pumped to lubricate and cool the motor bearings and cool the motor, especially the rotor, but while remaining completely segregated from the rotor. The portion of the fluid being pumped which circulates through the motor is also segregated from the stator by the cylinder 62. That fluid circulates through the gap 44 as above explained.

The coolant 68 is maintained entirely separate from the portion of the fluid being pumped which cools the motor within the cylinder 62 so that the stator is largely cooled by the coolant 68 while the rotor is largely cooled by the portion of the fluid being pumped which is circulated about the rotor and through the bearings.

A portion of the oil being pumped passes through the connection 82, the cooling coil 81 and the connection 83 to the passage 84 and thence to the interior of the motor within the cylinder 62 and back to the centrifugal pumping element compartment through the passages 35. That portion of the fluid being pumped extracts heat from the coolant 68 which in turn extracts heat from the motor and particularly from the stator. The fluid within the cooling coil 81 then passes through the connection 83 and cools the stator and lubricates the motor bearings.

Connected with the casing member 3 are feet 85 through which the motor-pump unit may be fastened in operating position to any suitable supporting structure.

While I have shown and described a present preferred

6

embodiment of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the scope of the following claims.

I claim:

1. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a fluid coolant in thermoconductive relationship with the motor and disposed thereabout radially outwardly from the stator in direct contact with the laminations of the stator, a conduit immersed in the fluid coolant and fluid coolant separate from the first mentioned fluid coolant passing through the conduit.

2. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling chamber about the stator, a fluid coolant in the cooling chamber in direct contact with the laminations of the stator, a cooling coil in the cooling chamber having its outside in contact with the fluid coolant and fluid coolant separate from the first mentioned fluid coolant passing through the cooling coil.

3. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling chamber about the stator, a fluid coolant in the cooling chamber in direct contact with the laminations of the stator, a cooling coil in the cooling chamber having its outside in contact with the fluid coolant and a connection to the cooling coil through which a portion of the fluid pumped by the centrifugal pumping element passes so that such portion of the fluid pumped by the centrifugal pumping element extracts heat from the fluid coolant.

4. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling chamber about the stator, a fluid coolant in the cooling chamber in direct contact with the laminations of the stator, a cooling conduit completely immersed in the fluid coolant in the cooling chamber having its outside in contact with the fluid coolant, a connection to the cooling conduit through which a portion of the fluid pumped by the centrifugal pumping element passes to extract heat from the fluid coolant and a connection from the cooling conduit to the interior of the motor through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the interior of the motor and lubricate the motor bearings.

5. A motor-pump unit comprising a casing, a motor within the casing, the motor having a shaft carrying a rotor, a stator disposed about the rotor, the stator having laminations, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling conduit on the inside of the casing immediately adjacent the stator laminations and a connection to the cooling conduit through which a portion of the fluid pumped by the centrifugal pumping element passes so that such portion of the fluid pumped by the centrifugal pumping element cools the motor.

6. A motor-pump unit comprising a casing, a motor within the casing, the motor having a shaft carrying a rotor, a stator disposed about the rotor, the stator having laminations, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling coil on the inside of the casing immediately adjacent and surrounding the stator laminations and a connection to the cooling coil through which a portion of the fluid pumped by the centrifugal pumping element passes so that such portion of the fluid pumped by the centrifugal pumping element cools the stator.

7. A motor-pump unit comprising a casing, a motor within the casing, bearings within the casing, the motor having a shaft rotatable in the bearings and carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, a cooling conduit on the inside of and separate from the casing immediately adjacent the stator laminations and connections to the cooling conduit and to the interior of the motor through which a portion of the fluid pumped by the centrifugal pumping element passes to cool the stator and cool the interior of the motor and lubricate the motor bearings.

8. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, means forming a pump chamber, a centrifugal pumping element in the pump chamber carried by the shaft at one end of the motor, a cooling conduit immediately adjacent the stator laminations, a bypass connection extending directly from the pump chamber to the cooling conduit through which a portion of the fluid delivered by the centrifugal pumping element passes to cool the stator and a connection from the cooling conduit to the interior of the motor through which said portion of the fluid delivered by the centrifugal pumping element passes to cool the interior of the motor.

9. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor laminations, a centrifugal pumping element carried by the shaft at one end of the motor, means receiving fluid delivered centrifugally by the pumping element during operation of the unit, a cooling coil immediately adjacent and surrounding the stator, a connection from the receiving means to one end of the cooling coil through which a portion of the fluid delivered by the centrifugal pumping element passes to cool the stator

and a connection from the other end of the cooling coil to the interior of the motor through which said portion of the fluid delivered by the centrifugal pumping element passes to cool the interior of the motor.

10. A motor-pump unit comprising a motor having a shaft carrying a rotor, a stator comprising laminations disposed about the rotor, a centrifugal pumping element carried by the shaft at one end of the motor, means receiving fluid delivered centrifugally by the pumping element during operation of the unit, a cooling conduit immediately adjacent the stator laminations, a connection from the receiving means to the cooling conduit through which a portion of the fluid delivered by the centrifugal pumping element passes to cool the stator and a plurality of connections to the interior of the motor through which a portion of the fluid delivered by the centrifugal pumping element passes to cool the interior of the motor, one of said connections being from the cooling conduit so that at least a portion of the fluid passing through the cooling conduit also passes to the interior of the motor.

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