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Laing

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[54] **COOLING WATER PUMP FOR AUTOMOBILES**

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[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search** 417/420; 310/104; 123/41.12, 123/41.11

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[57] **ABSTRACT**

A coolant pump for liquid cooled engines where the pump casing has a chamber, a rotatable drive shaft in the pump casing, a first pole ring on the drive shaft and a second pole ring rotatably mounted in the pump chamber which has impeller blades thereon and means for hermatically sealing the pump chamber from the drive shaft and first pole ring. Means may also be included for varying the slippage between the first and second pole rings in order to vary pump output.

6 Claims, 6 Drawing Figures

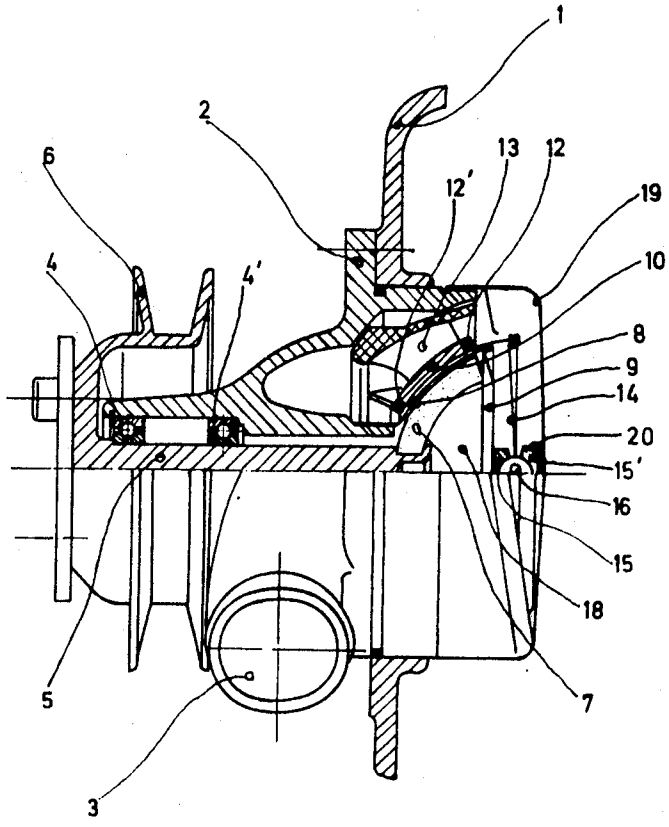


Fig. 1

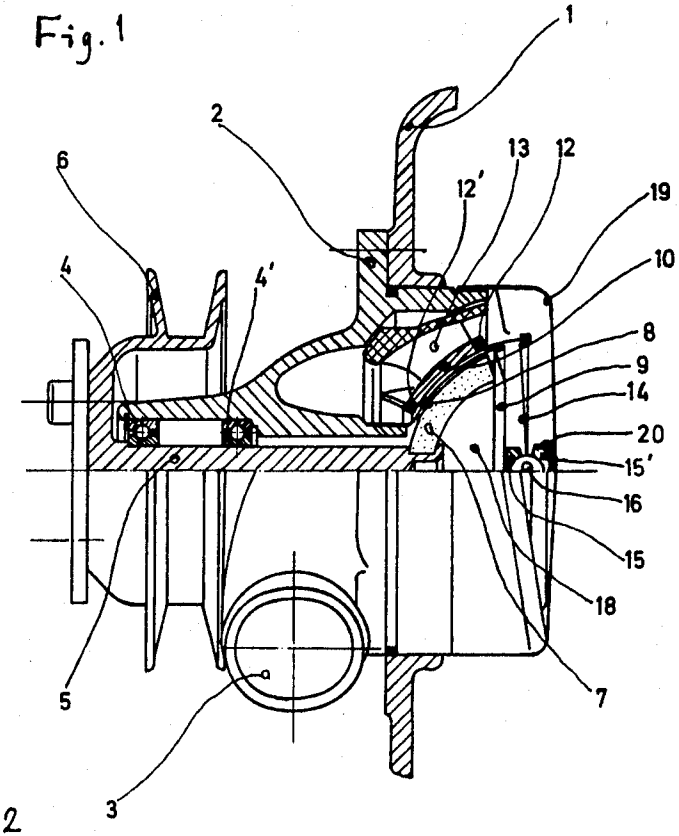
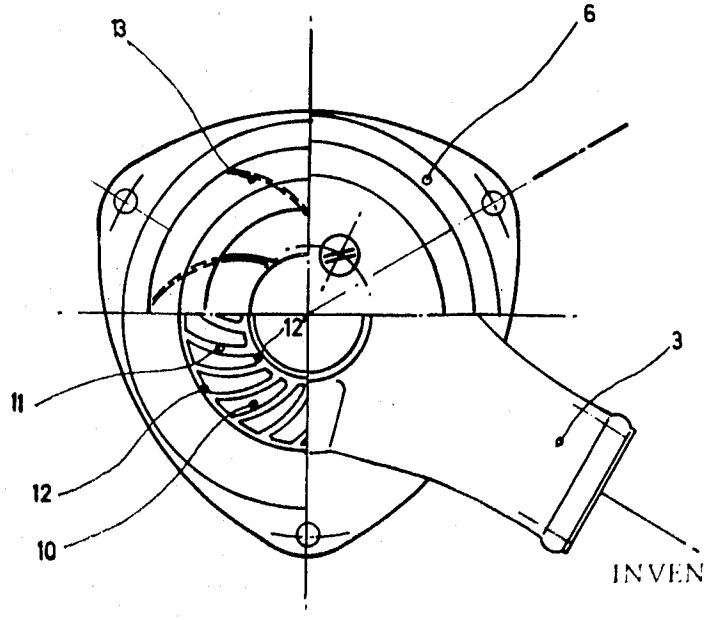


Fig. 2



INVENTOR

Fig. 3

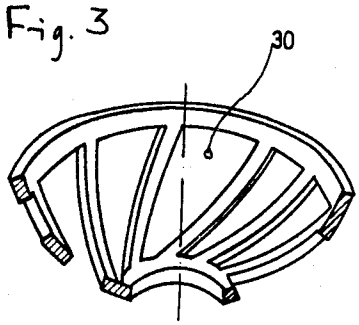
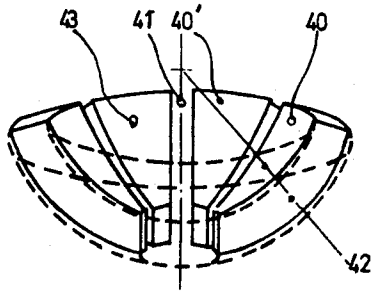


Fig. 4



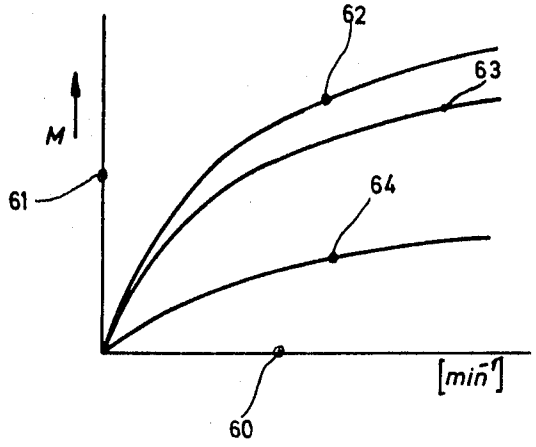
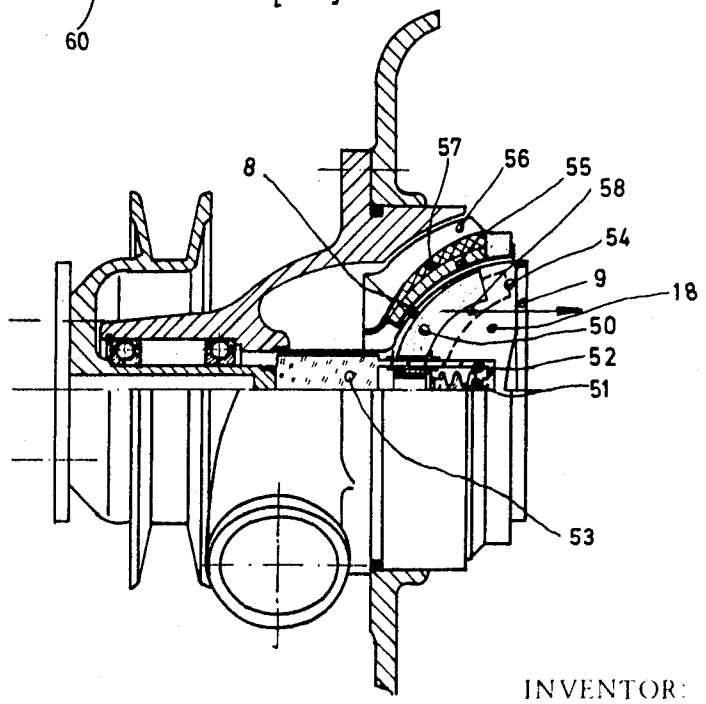


Fig. 6

Fig. 5



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COOLING WATER PUMP FOR AUTOMOBILES

BACKGROUND OF THE INVENTION

For water-cooled automobile engines cooling water pumps are required which, in general, are driven by a V-belt drive and which are sealed by rotary axial sealing systems. Since all rotary shaft sealings permit a certain amount of leakage to occur, however small it may be, it is necessary to add cooling water at more or less regular intervals. As soon as damage occurs to the sealing discs with their highly accurate sliding fits, e.g., by penetration of a sand grain from the molding sand, the cooling circuit will lose large amounts of cooling liquid in a very short time. Therefore, the shaft sealing presents a damage potential for the automobile engine.

With combustion engines about 60 percent of their heat losses are dissipated via the exhaust gases and cooling water while another 15 percent is dissipated to the air stream around the engine case. At idling conditions and small engine loads the cooling water dissipation rate is relatively large. This is because the exhaust gases escape very slowly thus transferring their heat to the cylinder walls since sufficient airstream cooling is not available to cool the engine block. At increasing engine speed the engine performance rate will rise to a maximum which occurs at a rate of 80 to 90 percent of the maximum speed. The cooling water minimum circulation rate, however, is, in general, achieved at about 40 percent of the crankshaft speed of rotation. At e.g. crankshaft speeds the circulation rate will also rise since the delivery of the engine-driven pump continues to increase proportionally with the engine crankshaft speed, but in this condition there is no need for a further improvement of cooling efficiency. The power consumption of a rotary pump increases cubicly with its speed of rotation so that with an increase in speed from 40 to 100 percent of maximum speed the power consumed by the pump will be fifteen times the value required for a sufficient cooling of the engine. With a 200 HP engine, e.g., the pump delivery rate required for maximum engine speed would consume .5 HP, while the actual power consumption of the pump at maximum engine speed amounts to 7.5 HP; thus 7 HP are wasted.

GENERAL DESCRIPTION OF THE INVENTION

The invention relates generally to a coolant pump for liquid cooled combustion engines where the drive portions of the pump, i.e., the drive shaft, are hermatically sealed off from the driven portions of the pump, i.e., impeller blades, to assure that there will be no leakage of coolant around the drive shaft. The invention also relates to structure to vary the circulation rate of the pump and hence of the power consumed, to the amount actually required for cooling the engine. To achieve this, the invention uses a pump, the impeller of which is provided with a magnetic pole ring which is driven by a mechanically driven pole ring and which is separated from the latter by a hermetic sealing wall of nonmagnetic material. Since bushings and shafts when arranged in the liquid circuit are easily blocked by penetrating dirt particles, the invention preferably uses pole rings the magnetic poles of which face a spherical cap type separation wall with the impeller and associated pole ring rotating in the liquid coolant being sustained by two supporting elements arranged in the geometrical center of the spherical separting walls for counterbalancing the magnetic axial force in the low speed range, and hydraulic thrust in the high speed range. Furthermore, the spherical cap separation wall is provided with a cover means so that the driving pole ring is position in a hemispheric cavity hermatically sealed from the coolant. One of the pole rings, preferably that one which forms an integral part with the impeller, is conceived to act as an induction rotor with the eddy current conductor element being dimensioned to give a small slip in the low speed range, and a large slip in the upper speed range.

A further adaptation of the pump power consumption in accordance with the coolant circulation rate actually required for engine block heat dissipation, as suggested by this invention, may be achieved by placing a thermostat into the cooling circuit which is fitted with a suitable device for converting temperature variations into distance variations. These distance variations are used to change the gap between the mutual magnetic pole rings. This invention will be illustrated by some examples for its practical applications, but is not limited to these applications.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional view of a coolant pump constructed according to the invention;

FIG. 2 is a cutaway plan view of the pump of FIG. 1 taken in the first quadrant at the V-belt pulley 6, in the second quadrant at the feed pipe connection 3, in the third quadrant at the pole ring 10 and in the fourth quadrant at the impeller blading;

FIG. 3 is an enlarged view of a portion of a conductor cage;

FIG. 4 is an enlarged view of a portion of a pole ring;

FIG. 5 is a partial sectional view of a second embodiment of a pump constructed according to the invention; and

FIG. 6 is a graph illustrating transmitted torque as a function of pump speed.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a pump case 2 is shown flanged to and an engine block 1 and has a feed pipe connection 3 on its intake side. Bearings 4 and 4' support a pump drive shaft 5 which forms an integral part with the V-belt drive pulley 6.

A first pole ring having a convex outer surface is rigidly mounted on the shaft 5 and comprises a permanent magnetic material. The permanent magnetic pole ring 7 is housed in a hemispheric case formed by the hemispheric cap 8 and a bottom cover 9 which is rigidly attached to the case 2. Closely joining the outer contour of the hemisphere 8 a second driven pole ring 10 is mounted for rotation in a chamber in the pump. Pole ring 10 has a convex outer surface and a concave inner surface and comprises a spheric cap type iron ring fitted with copper strips 11 which are connected to each other on their ends by copper rings 12 and 12' like the squirrel cage of an electric motor as shown in FIGS. 2 and 3. On the convex outer surface of the iron ring impeller blades 13 are arranged. On its larger diameter side the pole ring 10 is closed by a wheel disc 14 which is rigidly attached to a ball 16. The disc 9 which on its periphery is sealed to the hemisphere cap 8 and bears

the bushing 15 in its center hermetically seals the cavity 18 from the pump chamber. From casing 2 spokes 19 branch into a central hub 20, which bears a second bushing 15'. The ball 16 is mounted between the two bushings 15 and 15' so that the center of ball 16 approximately coincides with the center of the sphere associated with the hemispherical wall 8 and the convex and concave contours pole rings 7 and 10.

The copper cage winding is further illustrated in FIGS. 2 and 3. As shown in FIG. 3, the conductor cage may be made as a stamped copper part with the poles of the outer ring 10 extending into punched-out areas 30 of the cage.

FIG. 4 also shows the pole ring 7 made of ferro-magnetic material extending only over half the circumference. The segments 40 and 40' are constructed as cut-out spherical shells and cemented to each other in the slots 41. The magnetization proceeds in the direction of the spherical radius 42, so that the convex and concave spherical quadrangles of each sector have a different polarity. The adjacent segments 40 and 40' also display a different polarity.

FIG. 5 shows a design of the invention, in which the inner pole ring 50 is supported by a bellows 51. This bellows is connected through a capillary tube line with a tank 53. The interior of this system is filled with a substance which expands greatly under the influence of heat. At a low cooling water temperature the permanent magnetic pole ring is in the position 54, so that a large slip is developed between this pole ring and the outer pole ring 55, which forms an integral unit with the impeller blades 56. The permanent magnetic pole ring 50 does not move towards the hemispherical shell 8 until the cooling water temperature exceeds a predetermined level, whereby the transmitted torque is increased and the slippage thus reduced. The pole ring 50 is not moved into the indicated position until the safe cooling water limiting temperature has been reached. Even in this position the wall 9 creates a hermetic seal between the chamber 18 and the circulating water. The surface of the hemispherical shell 8 is machined extremely true to form, and the convex outer pole ring, which is adapted to it exactly, glides on it. The outer pole ring remains constantly locked to form through the axial component 58 of the magnetic forces.

FIG. 6 shows the flow of the transmitted torque as a function of speed, air gap interval and conductor resistance. Speed is plotted on the abscissa 60, while the torque is plotted on the ordinate 61. The curve 62 shows the course of the pump impeller speed with a soft iron pole ring 10 and a cage winding with large cross section as in FIG. 3. The curve 63 shows the same arrangement, in which, however, the cage winding cross section 11, 12, 12' is kept considerably smaller. The curve 64 shows the transmitted torque of a pump as in FIG. 5 in cold condition, in which thus the pole ring 50 is in the position 54. A similar effect to that from increasing the resistance of the cage winding 11, 12, 12' can be achieved by reducing the cross section of the iron backing 57. The air gap 50/54, the thickness of the iron backing 57 and the cross section of the cage winding 11, 12, 12' as functions of the desired power flow must therefore be coordinated with each other. A change of the slippage according to the invention can be achieved not only by an axial shift of the entire pole ring, but also by a shift of one of the iron short-circuit rings attached to the concave side 43 of the pole ring.

I claim:

1. A coolant pump for liquid cooled engines, said pump comprising a casing, a chamber in said casing through which coolant is adapted to circulate, a rotatable drive shaft journalled in said casing, a first pole ring having a convex outer surface mounted on said shaft, a second pole ring adapted to be driven by said first pole ring rotatably mounted in said chamber and having a convex outer surface and a concave inner surface with the concave surface thereof being positioned radially outwardly of the convex surface of said first pole ring to form a gap therebetween, impeller blades mounted on the convex surface of said second pole ring for inducing circulation of coolant in said chamber, a hemispherical separating wall positioned in said gap and affixed to said casing, and a cover means affixed to the end of said separating wall which covers the end of said first pole ring to hermatically seal said first pole ring and said drive shaft from said chamber.

2. A coolant pump according to claim 1 wherein one said pole ring has permanent magnets thereon and the other said pole ring has means thereon through which eddy currents may be induced by movement of said permanent magnets to form a magnetic couple between said pole rings.

3. A coolant pump according to claim 1 having in addition means for varying the magnetic couple between the pole rings in order to vary slippage of rotation of said second pole ring with respect to rotation of said first pole ring.

4. A coolant pump according to claim 3 wherein the means for varying the magnetic couple includes means for varying the width of the gap between the first and second pole rings.

5. A coolant pump according to claim 4 wherein said means for varying the width of the gap includes temperature responsive means for decreasing the width of the gap upon an increase in coolant temperature.

6. A coolant pump according to claim 1 having in addition a bushing mounted by said cover means concentric with said drive shaft, a ball rotatably mounted in said bushing, and a wheel disc fixed to said ball and to said second pole ring whereby said second pole ring may pivot about the center of said ball.

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