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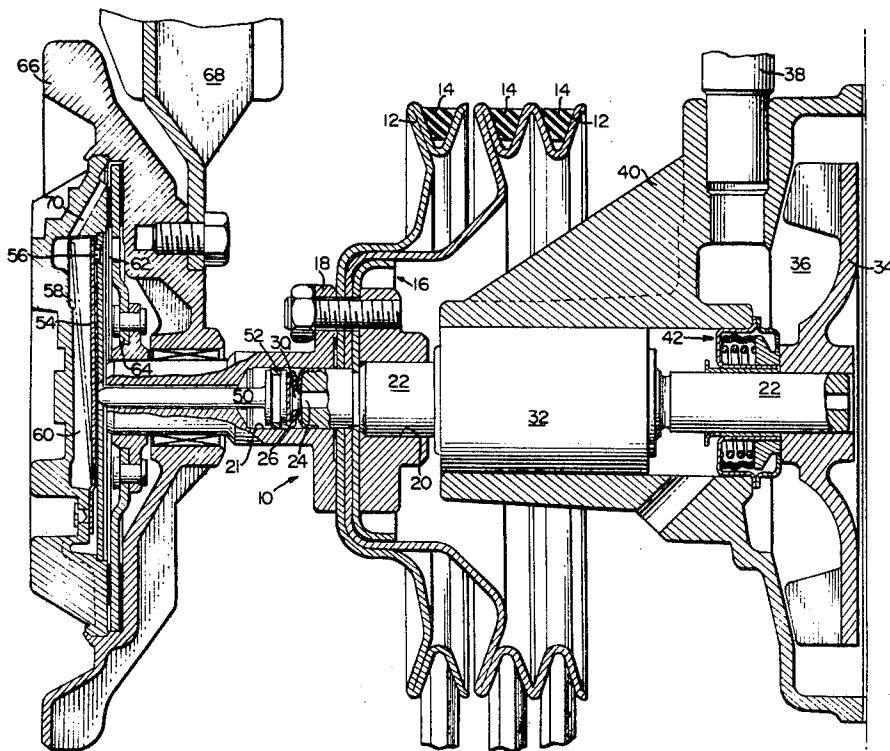
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2,633,697	4/1953	Johnson	192/58
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930,911	7/1963	Great Britain	123/41.12
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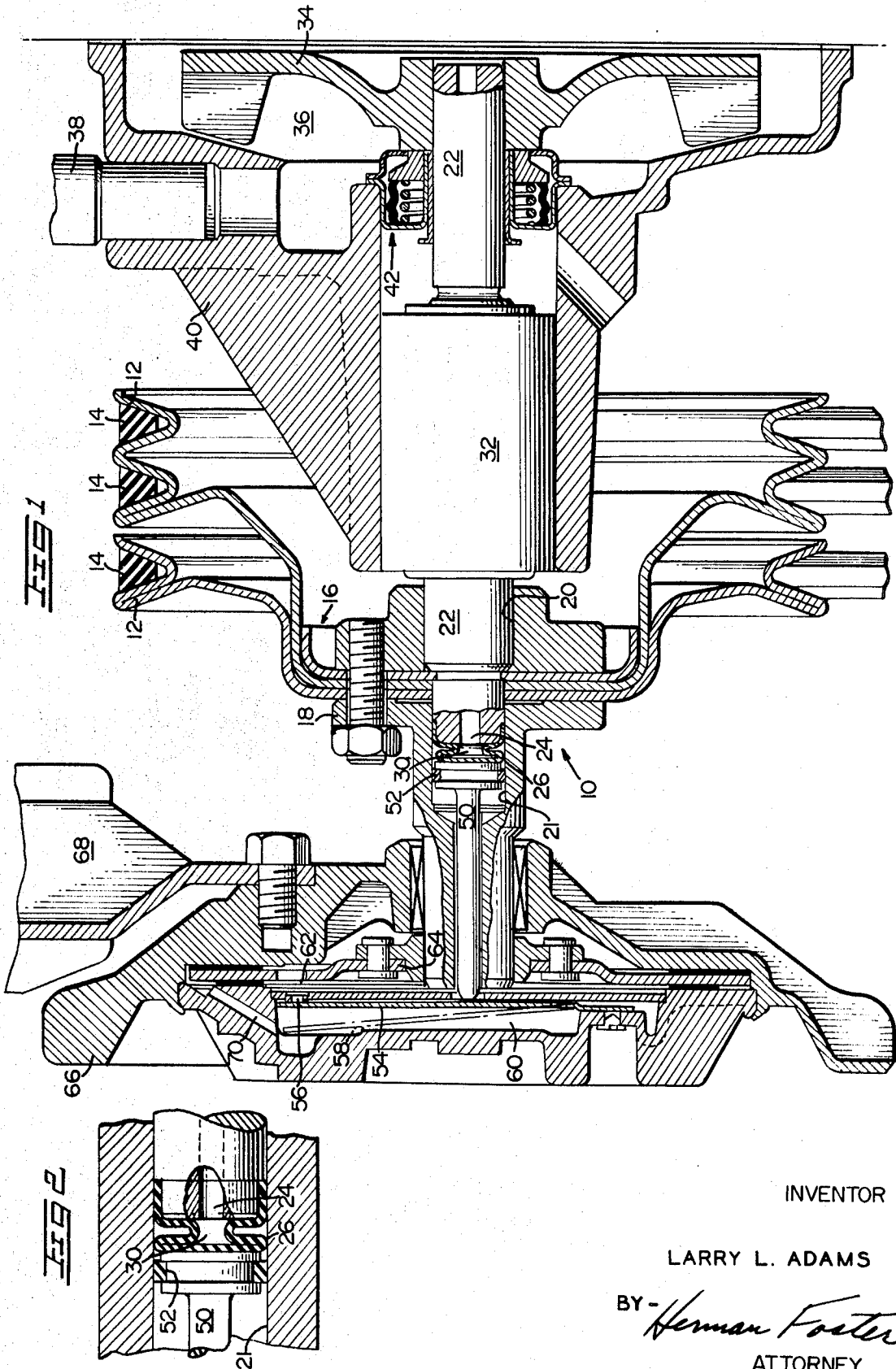
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[54] **ENGINE COOLING CONTROL DEVICE**
 3 Claims, 2 Drawing Figs.

[52] U.S. Cl. 123/41.12,
 192/58, 192/82
 [51] Int. Cl. **F01p 7/02**,
 F16d 31/00, F16d 11/04
 [50] Field of Search..... 123/41.12;
 192/58 (Cursory)

ABSTRACT: A pressure-responsive fluid-shear coupling for an automobile engine fan. The pressure increase with increasing temperature of a circulating liquid coolant in the cooling system acts directly against a bellows. The bellows in turn controls the flow of a silicone fluid and the degree of coupling between the engine and the fan.





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ENGINE COOLING CONTROL DEVICE

This invention relates to a temperature-responsive fan and more particularly to a direct-acting, coolant-temperature-responsive cooling fan for a liquid-cooled internal combustion engine. It has been known in the automotive arts to provide some form of temperature-responsive actuating device for the fans that are employed in the liquid coolant type of heat exchanging systems. The temperature responsive control is provided to reduce the overall cost of operating the system by operating the fan only intermittently and reduce airflow at times when the temperature does not warrant it. With the increasing number of power consuming accessories used in conjunction with automotive internal combustion engines it becomes even more necessary to conserve power and to drive the engine cooling fan only at times when the coolant temperature requires it. The cooling fan can require considerable driving power and it is accordingly advantageous to uncouple it when the coolant temperature does not require its operation. Further, uncoupling of the cooling fan at low coolant temperatures improves the warmup characteristics of the engine.

Many commercially employed temperature-responsive engine cooling fans are not directly responsive to the temperature of the liquid coolant of the engine. Rather, they are often directly responsive to the temperature of the air that circulates through the radiator. In many instances such air temperature does not give a true indication of the coolant temperature. Although devices have been proposed that are directly responsive to the coolant temperature, these devices are often complicated and costly to produce.

A great number of temperature-responsive fan drives embody some form of element that has thermal properties for actuating the drive. Examples of such elements are bimetallic springs, metals having high coefficients of thermal expansion and wax pellets. Certain of these devices deteriorate with age or their thermal properties may change with age. In addition, in the case of engine cooling systems, a change in engine coolant may make it desirable to operate at higher or lower temperatures. It is thus sometimes necessary to replace the temperature-responsive element in these instances.

Examples of prior art temperature-responsive fan devices are U.S. Pat. No. 3,262,528 to Weir (employing a silicone fluid-shear coupling and a bimetallic strip), U.S. Pat. No. RE. 24,157 to Johnson (employing an expandible fluid and a bellows), U.S. Pat. No. 3,180,571 to Caroli (employing a bellows), and U.S. Pat. No. 3,228,382 to Stefan (employing a venturi throat and a collant in the vapor phase acting against a fan clutch device).

In distinction to these and other efforts of workers in this art, the present invention utilizes the direct force of the liquid coolant itself upon a bellows to activate a clutch device for engaging the fan for rotation. The particular clutch system employed is a fluid-shear coupling, although other types are compatible with the invention. In the Drawings:

FIG. 1 is a cross-sectional view of an engine cooling system according to the present invention.

FIG. 2 is an enlarged fragmentary view of a portion of FIG. 1.

Turning now to the drawings, the numeral 10 denotes generally the pump and clutch assembly of this invention. The illustrated environment is in an internal combustion engine which is cooled by a liquid passing through cavities in the metal block which defines the engine cylinders. The numeral 12 denotes any one of the plurality of generally V-shaped pulley members each of which is driven by a flexible power transmission belt 14. The belt 14 is suitably coupled to a power output shaft of the internal combustion engine. The numeral 16 denotes generally a hub assembly to which the radially innermost portions of the pulleys 12 are attached. The hub assembly includes a central hub member 18 in two halves which are clamped together. The right-hand half of the hub element is provided with an aperture 20, similar to aperture 21 in the left-hand portion, which receives an elongated shaft 22. A

central bore 24 traverses the entire length of shaft 22, and at the left-hand portion the shaft is then provided with a diaphragm or bellows 26. The interior of the bellows defines, together with the left-hand portion of shaft 22, a cavity 30. The bellows or diaphragm 26 may be placed on and secured to the left-hand end of shaft 22 in any convenient manner.

The numeral 32 denotes an elongated bearing of any desired construction and carries and otherwise supports shaft 22. The numeral 34 denotes a pump impeller secured to the right-hand portion of shaft 22 by a suitable means such as a press fit. The numeral 36 denotes a pump cavity adapted to be filled with a liquid coolant, the input to the cavity is designated by the numeral 38 and the entire left-hand portion of the pump casing is denoted by the numeral 40. The liquid coolant is adapted to be circulated by the force of impeller 34 throughout various cavities within the engine block. In general, the cavity 36 and those in the block define a closed volume or plenum.

A rotary seal 42 of conventional construction is provided between the coolant cavity 36 and the interior of the casing 40 which carries shaft 22 and bearing 32.

The numeral 50 denotes a piston element having an enlarged right-hand portion whose periphery carries a seal or guide 52. The piston 50 is adapted to execute limited reciprocating motion in bore 21 under the action of diaphragm 26. The numeral 54 denotes an elongated metal spring or strip whose midportion is engaged by the left-hand tip or end of piston 50. The upper portion of metallic strip 54 is adapted to close an orifice 56. The metallic strip 54 is also adapted to assume a second position indicated by the numeral 58. In this latter position, the orifice 56 is opened between chamber 60 and chamber 62 and a viscous fluid such as a silicone fluid passes to 62 from chamber 60. When orifice 56 is closed passage of silicone fluid can occur from chamber 62 to chamber 60 through passage 70 in the same manner as is described in U.S. Pat. No. 3,179,221, to T. J. Weir. The numeral 64 denotes a relatively thin disc element secured to the left-hand end of hub 18 and rotatable with shaft 22. The radially outermost portions of disc 64 are adapted to frictionally engage through a fluid-shear coupling complementary portions of rotating hub elements 66, with the degree of drag being dependent upon the quantity of silicone fluid passing from chamber 60 to chamber 62 through the orifice 56. A fan 68 adapted to blow air across the engine is conveniently mounted on the hub element 66.

The mode of operation of the above described mechanism is as follows. Assuming firstly the internal combustion engine to be operating at relatively light loads and at relatively low ambient temperatures, the pressure of the coolant liquid within the chamber 36 will be low. Accordingly, the pressure within chamber 30 will be low with a consequence that the force exerted by the coolant liquid in chamber 30 against the piston 50 will be negligible. In this circumstance, the position of metal strip 54 will be as indicated by the solid lines. The orifice 56 will be blocked and little if any silicone fluid from chamber or reservoir 60 will be able to pass to the interfaces between disc 64 and the complementary recesses in rotating hub element 66. With little or no such fluid there, rotation of shaft 22 and consequent rotation of disc 64 will result in only limited rotation at relatively slow speeds of fan 68. At relatively low speeds the force of the blades of fan 68 on the air is negligible and accordingly there is practically no countertorque exerted by the hub element 66 on shaft 22. Accordingly, there is very little resistance to the rotation of pulleys 12 by the fan 68.

Assume now that either operating conditions or ambient temperatures or both change, so that the temperature of the coolant in chamber 36 and which courses through the engine block increases significantly. In this circumstance, the increased temperature will cause a corresponding increase in pressure throughout closed cooling system volume and this pressure will be transmitted by Pascal's principle to all parts of the hydraulic coolant system, including the chamber 30. Increase of pressure in chamber 30 will result in movement to

the left of piston 50, overcoming the resistance of the spring force of strip 54. The strip will now move to the dotted position as illustrated by the numeral 58, thereby opening the orifice 56 for the passage of silicone fluid from chamber 60 to chamber 62. Increasing the amount of silicone fluid in the spaces 62 between the disc 64 and the complementary recesses in hub 66 results in a greater coefficient of coupling between these elements. Consequently, the fan 68 begins to rotate, thereby placing a greater drag or resistance to rotation on shaft 22 and consequently on the engine by virtue of the blades thereof forcing ambient air against the engine to cool it.

When temperature and operating conditions change so as to no longer require cooling of the engine by the fan, the pressure within chamber 30 decreases, the spring force of arm 54 urges piston 50 back through the illustrated position and closes the orifice between supply chamber 60 and chamber 62. The silicone fluid now in the radially outermost portions of these interfaced chambers flows back into chamber 60 through passage 70 and stabilizes itself. Upon the cessation of silicone fluid flow from chamber 60 through the orifice 56, the fluid drag coupling ceases and the fan is once again quiescent.

I claim:

1. A cooling system for an internal combustion engine having coolant cavities including:

- a. a fan;
- b. a power shaft adapted to be driven by an internal combustion engine;
- c. fluid clutch means for engaging and disengaging said fan from rotation by said power shaft, said clutch means

being actuated by a reciprocating piston carried within an extension of said power shaft;

- d. a pump, driven by said power shaft, and having within it a closed volume containing a liquid coolant;
- e. means responsive to a change in pressure in said closed volume of said liquid coolant for actuating said clutch means;
- f. said means (e) including a bore longitudinally through said power shaft, one end of said bore being in fluid communication with said closed volume of liquid coolant;
- g. the other end of said bore positioned within a cylinder having one end of said reciprocating piston slidable therein, said other bore end having a bellows around it to thereby define an expansible chamber whose volume is responsive to pressure within said bore, said expansible chamber actuating said piston;
- h. said cylinder, reciprocating piston, and bellows lying axially outside of said pump; and
- i. said reciprocating piston provided with a seal therearound, said seal being in sealing and sliding engagement with said cylinder.

2. The cooling system of claim 1 wherein said seal is an O-ring.

3. The cooling system of claim 1 wherein the cross-sectional area of said cylinder is greater than the cross-sectional area of said bore, whereby the pressure in said bore is distributed over an area greater than the bore cross section.