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PUMP FOR LIQUID COOLING SYSTEMS OF INTERNAL COMBUSTION ENGINES

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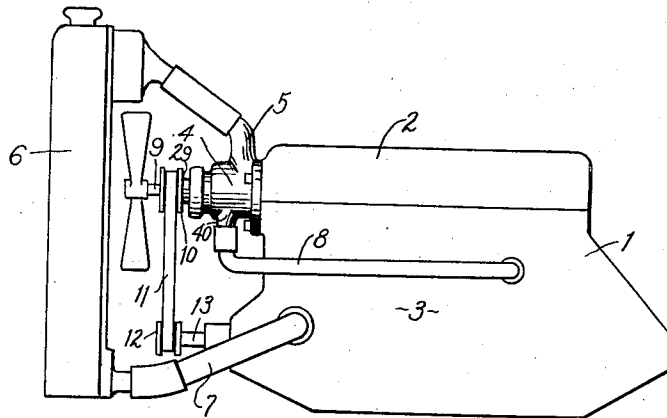


Fig. 1.

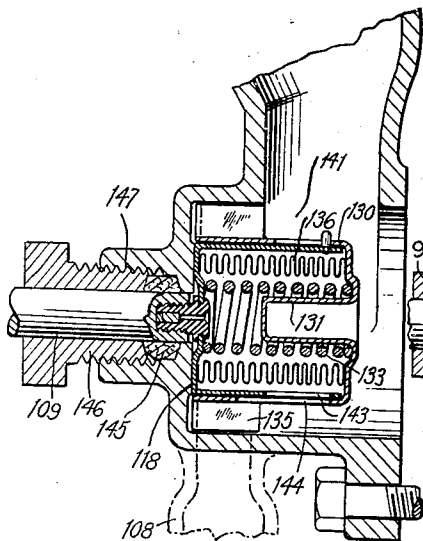


Fig. 4

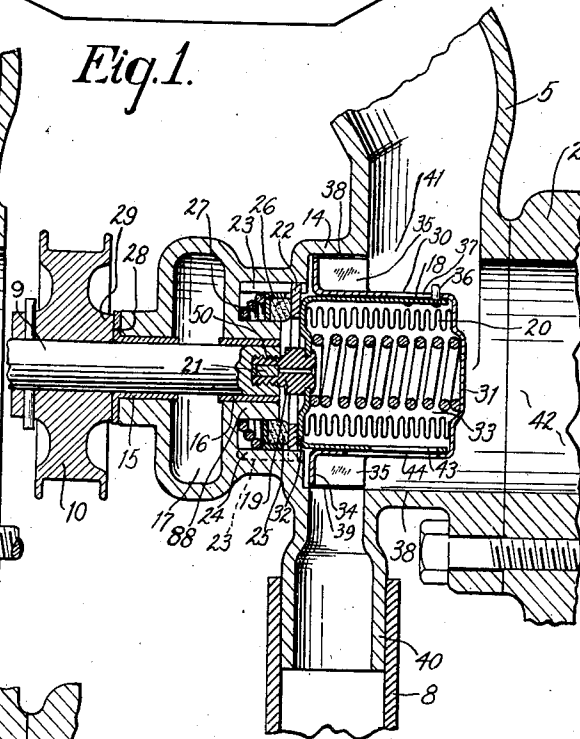


Fig. 2.

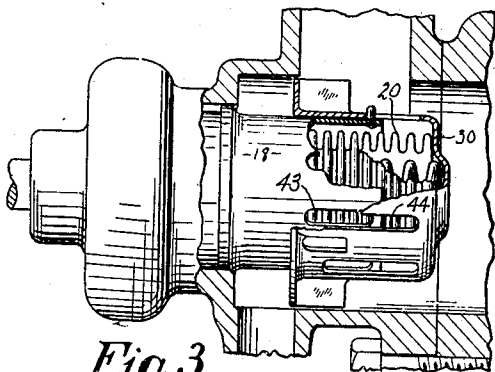


Fig. 3.

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PUMP FOR LIQUID COOLING SYSTEMS OF
INTERNAL COMBUSTION ENGINES

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This invention relates to apparatus for variably controlling the flow of fluid in a conduit system in accordance with variations of temperature thereof; and relates more particularly to apparatus for variably controlling the circulation of a cooling medium, such for example as water in the cooling system of an internal combustion engine in accordance with temperature conditions of the engine.

It is an object of this invention to provide an improved apparatus for controlling the circulation of fluid in a conduit system in accordance with variations of temperature of the fluid.

Another object is to provide an improved apparatus for effecting flow of fluid in a branched conduit system and for automatically directing flow from one branch to another in accordance with temperature changes of the fluid.

Another object is to provide an improved apparatus for controlling circulation of cooling medium through the cooling system of an internal combustion engine.

Another object is to provide, in connection with an engine cooling system comprising a radiator conduit circuit and a by-pass conduit therefor, improved means for automatically selectively directing flow of cooling medium through the by-pass or through the radiator circuit in response to predetermined low and high temperatures of the medium.

My invention is fully disclosed in the following description taken in connection with the accompanying drawing, in which:

Fig. 1 is a side elevational view of an internal combustion engine and cooling system and illustrating an embodiment of my invention applied thereto;

Fig. 2 is a sectional view to an enlarged scale of a part of the apparatus of Fig. 1;

Fig. 3 is a view similar to Fig. 2 illustrating parts thereof in different operative positions;

Fig. 4 is a view in general similar to Fig. 2 but illustrating a modification.

Referring to the drawing, I have shown at 1, generally, an internal combustion engine having a head 2 and base 3 in which, not shown, are the passageways constituting the well known water jacket through which water may circulate to subtract heat from the engine. A pump, shown generally at 4, communicates interiorly with the water jacket, preferably with a portion thereof in the head 2; and, being driven in a manner to be described, may pump water from the head or an upper portion of the water jacket system, through a conduit 5, radiator 6 and conduit 7 to a lower

portion of the water jacket; the pump may also pump water through a by-pass conduit 8 communicating with the pump and with the water jacket to by-pass the radiator 6.

The pump 4 is driven by a shaft 9 upon which is mounted a pulley 10 connected by a belt 11 with a pulley 12 on a shaft 13 rotatably driven by means not shown from the crank shaft of the engine. The pump 4, by a construction and mode of operation to be described, pumps the circulating fluid such as water from the water jacket around through the by-pass 8 when the fluid is relatively cool and while the engine is warming up so as to permit the engine to warm up quickly. After the fluid attains a predetermined temperature, however, corresponding to a predetermined engine temperature, the pump 4 then begins to direct the fluid through the radiator system above described and ultimately may direct all of the flow therethrough, gradually shutting off flow through the by-pass 8. The pump construction by which this is accomplished will now be described with reference to Figs. 2 and 3.

The pump housing, shown generally at 14, has aligned bearings 15 and 16 in which the pump shaft 9 rotates and intermediate these bearings is a lubricant chamber 17 for continuously supplying lubricant to the bearings.

A cup-form thermostat housing 18, preferably disposed coaxially of the shaft 9, has a stem 19 riveted at one end to the center of the cup bottom and at its outer end threaded as at 20 into a correspondingly threaded bore in the inner end of the shaft 9, whereby the stem 19 and cup-form housing 18 are rigidly connected to the shaft to rotate therewith.

The stem 19 has a bore therethrough communicating with the interior of the housing 18 through which thermally expansible fluid may be injected into the interior of a bellows type thermostat 20 to be described, and after the injection of the fluid, the bore may be closed and sealed by a plug means 21 in a well known manner.

The bottom of the cup 18 is sealed upon an annular washer of fiber or the like 22 surrounding the stem 19 and prevented from rotation, but permitted axial freedom of movement by being splined upon splines 23—23 formed in the cylindrical wall 24 of a recess in the housing 14. The washer 22 thus provides a sealed thrust bearing for the cup 18.

An annular ring of cork or like compressible material 25 is seated in a shallow cup 26, and a compression spring 27, abutting at one end upon

the bottom of the recess 24 and at its other end upon the bottom of the cup 26, exerts axial thrust upon the washer 22. The cork ring 25 effects a seal with the washer 22 and with the tubular portion 88 of the housing supporting the bearing 16 and which is surrounded by the cork ring 25. Thus lubricant which may be supplied to the chamber 17 under pressure and which may pass through the bearing 16 is prevented by the cork ring from leaking around the washer 22 through the splines 23 into the pump chamber to be described. The pressure engagement of the cup-form housing 18 with the other side of the fiber washer 22 prevents leaking of lubricant through said engagement into the pump housing. Similarly, these leak-proof connections prevent water in the pump chamber from leaking out through the bearings 16 and 15.

The axial thrust, toward the right as viewed in Fig. 2, upon the shaft 9 by the spring 27, may be absorbed by any suitable means, such for example as a collar on the shaft 9 engaging the housing 14 as at 28; or the hub 29 of the driving pulley 10 may engage the housing at 28 for this purpose and the pressure engagement thereof may be lubricated by lubricant escaping from the chamber 17 through the bearing 15.

A cup-form housing 30 is telescoped over the cup-form housing 18 fitting the same to slide thereon axially. The bottom 31 of the cup 30 is disposed axially opposite the bottom 32 of the cup 18 and the thermostatic bellows 20 has its opposite end sealed as by soldering upon the inner surfaces of the respective bottoms 32 and 31, thus providing a chamber comprising for its side wall the cylindrical bellows 20 and for its opposite end walls central portions of the cup bottoms 31 and 32.

A compression spring 33 is disposed within the bellows 20 abutting at opposite ends upon the bottoms 31 and 32 for a purpose to be described.

The open end of the cup 30 has an outwardly radially extending annular flange 34 thereon, and a plurality of pump vanes 35—35 are provided extending outwardly radially from the outer wall of the cup 30 and at one axial end being connected each to the flange 34 and extending for a substantial distance in the other axial direction.

A pin 36 is secured upon the wall of the inner cup 18 and projects outwardly through an axially extending slot 37 in the wall of the cup 30.

By the construction thus far described, it will now be apparent that when the shaft 9 is rotated, it will rotate the inner cup element 18 secured thereto and, by means of the pin 36 in the slot 37, will rotate the outer cup element 30 and with it the vanes 35—35.

The housing 14 has an inner wall portion 38 of cylindrical form substantially coaxial with the rotating parts above described and the radially outer ends of the vanes 35 are formed to rotate within the cylindrical portion 38 with slight clearance. The cylindrical portion 38 thus provides a pump chamber and the rotating vanes 35 a pump rotor.

A discharge orifice 39 communicates with the chamber 38 and connects with a conduit 40 to which the by-pass 8 may be connected. Another outlet orifice 41 communicates with the chamber 38 and connects with the conduit 5 leading to the radiator 6. The chamber 38 opens axially into a communicating passageway 42 in the head 2 of the engine or other suitable portion of the engine cooling water jacket.

The orifice 39 is so disposed that it is aligned generally radially with the vanes 35 when the cup 30 is in its extreme position toward the left as viewed in Fig. 2, and the orifice 41 is disposed so that, with the parts in the said position, preferably no portion of the orifice 41 is aligned radially with the vanes; so that with the parts in the position illustrated, and assuming that the system including the passageway 42, conduit 5, radiator 6, conduit 7, engine water jacket and by-pass 8 are filled with the cooling medium such as water, upon rotation of the shaft 9, the pump vanes 35 will be rotated and will draw water from the passageway 42 into the chamber 38 and will pump it thence out by the orifice 39 and by-pass 8 back to the water jacket.

When the temperature of the water rises as above referred to, the temperature thereof will be communicated to the bellows 20 and to the thermally expansible material therewithin, and the bellows expands and moves the cup 30 outwardly axially on the cup 18 while continuing to rotate through the spline connection 36—37. This movement moves the vanes 35 so that they are partly aligned with the orifice 41 and partly with the orifice 39, and therefore the water will be pumped partly through the by-pass 8 and partly out through the conduit 5.

As the water temperature rises still further, expanding the bellows still further, the vanes will be moved outwardly axially until they are no longer aligned with the orifice 39, and until the flange 34 occupies a position substantially to the right, as viewed in Fig. 2, of the orifice 39, thereby cutting off all communication with this orifice and by-pass 8 and thereafter the vanes, being now aligned with the orifice 41, will pump the water out through the conduit 5 only. Thus, when the water is cold, it will be pumped only through the by-pass and as it warms up it will be pumped less and less through the by-pass and more and more through the main conduit 5; and finally none will be pumped through the by-pass and all will be pumped through the conduit 5. The vanes 35 of the pump therefore take up at all times a position and effect a rate of pumping corresponding to temperature of the water and therefore to engine temperature conditions.

In order that the bellows 20 may be at all times responsive to the temperature of the water, registering longitudinally extending slots 43—43 and 44 in the inner and outer mutually telescoped walls of the cups 18 and 30 respectively are provided whereby water may flow into the cup 18 and come in contact substantially with all parts of the exterior wall of the bellows 20 and in all telescoped positions of the cups 18 and 30.

Obviously, if the engine cooling water should, due to weather temperature conditions or other cause, become cool while flowing to the radiator 6 and undesirably lower the temperature of the engine, the thermostat 20 will move the vanes 35 back to or toward the position in which they stop pumping through the conduit 5 to the radiator and pump through the by-pass 8.

If, due to any cause, the wall of the bellows 20 should break or become punctured, and its thermostatic action thereby be destroyed, the spring 33 will move the cup 30 and therewith the vanes 35 to their outermost position in which they pump the circulating fluid through the main conduit 5 and radiator 6. The spring 33, together with the arrangement of the other

parts, operates in the nature of a safety means in case of failure of the thermostatic action to insure that the water temperature may never reach an unsafe or undesirable high value.

5 In Fig. 4 I have illustrated a modification of my invention. In this form, the inner telescoped cup 118 is not sealed by its bottom upon the housing as in the form of Fig. 2, the shaft 109 in this case being sealed by an ordinary gland packing 145 surrounding the shaft 109 and by a packing nut 146 in which the shaft rotates, threaded into the housing as at 147 and compressing the packing.

15 It will be apparent that the form of Fig. 4 may be applied not only to the uses described for the form of Fig. 2 but to other uses not necessarily associated with an automotive engine. If desired, the by-pass 108 may be entirely omitted as indicated by the broken line drawing thereof. Thus when the vanes 135 are in their extreme position toward the left as illustrated, all flow of liquid may stop corresponding to a relatively low temperature thereof; and when the temperature of the liquid due to any cause rises, the vanes 135 will be moved outwardly toward the right as viewed in the drawing and pumping of the liquid out through the orifice 141 will begin and will reach a maximum rate when the temperature has risen sufficiently to move the vanes 135 to an axially outer maximum position.

The construction and mode of operation just described may be applied to an automotive vehicle where a by-pass is not employed, all circulation stopping at low water temperatures and the water beginning to circulate to the radiator when the temperature rises to a predetermined value and reaching the maximum rate of flow at a predetermined higher temperature.

40 In the form of Fig. 4 also, the outer cup 130 has the central portion of the head thereof pressed inwardly to provide a closed tube or thimble 131. This thimble provides a suitable axially extending projection to center the spring 133 within the bellows 136 and insure that it will be kept out of contact with the inner wall of the bellows, and also provides an auxiliary means for admitting water to the generally central portions of the bellows, although of course out of contact therewith to facilitate communication of the water temperature to the bellows or to the thermally expansible fluid within the bellows, the registering slots 143 and 144 communicating the temperature of the water to the outer wall of the bellows through which it is communicated to the expansible fluid within the bellows.

60 It will be apparent that elements of my invention may be variously modified and the functions thereof performed by variously constructed parts other than those illustrated in the two modifications hereinbefore described, and thus my invention is not limited to the exact details of construction shown and described, but contemplates all modifications and changes which may be made therein and which come within the scope of the appended claims.

I claim:

70 1. In a liquid cooling system for internal combustion engines, a pump for circulating cooling liquid through the system, comprising a casing and a rotor continuously driven commensurable to engine speed having impeller blades for discharging liquid admitted to the casing therefrom
75 under pressure, and thermostatic means asso-

ciated with the pump to vary the pumping effort effected by said pump, said thermostatic means effecting bodily movement of said rotor and blades in the direction of its rotational axis to displace it from a normal pumping position to another position in the casing.

2. The combination with the circulating cooling system of an internal combustion engine comprising a liquid containing engine jacket, a radiator, a liquid pump and conduit means interconnecting said pump, said jacket, and said radiator, and controlling means responsive to changes of temperature of the liquid at one point of the system to vary the flow inducing liquid pressure effected by the pump, said pump comprising a liquid impelling rotor continuously rotatably linked to the engine having a plurality of rotating positions within the casing, said controlling means adapted to bodily move said rotor in the direction of its rotational axis from one of said positions to another position.

3. In a liquid cooling system for internal combustion engines, a pump for circulating cooling liquid through the system, comprising a casing and a rotor having impeller blades for discharging liquid admitted to the casing therefrom under pressure, and thermostatic means associated with the pump responsive to the temperature of liquid circulated through the system to vary the pumping effort effected by said pump commensurably with changes of said liquid temperature, said thermostatic means effecting bodily movement of said rotor in the direction of its rotational axis to displace it from a normal pumping position to another position in the casing, progressively remote from the normal position according to the degree of temperature change there being an indefinite plurality of such possible rotor positions, the speed of said rotor at any position being commensurable to engine speed.

4. Pump means for an internal combustion engine liquid cooling system comprising a pump chamber, conduit means communicating therewith, and communicating liquid from the chamber to the system and a pump rotor in the chamber for pumping liquid through the conduit means, said rotor being continuously rotatably linked to the engine and means responsive to changes of temperature of the liquid to adjustably move the rotor in the direction of its rotational axis in the chamber to vary the pumping rate.

5. Pump means for an internal combustion engine liquid cooling system comprising a walled pump chamber having inlet and outlet orifices in the chamber wall, and a pump rotor therein for drawing liquid into and pumping it out of the chamber, the rotor being movable in the direction of its rotational axis relative to the discharge outlet to vary the rate of discharge and means responsive to variations of liquid temperature at the pump to variably move the rotor in axial directions, whereby the pumping effort effective to supply liquid from the pump to the system is modified commensurably with variations in said liquid temperature and means to maintain the speed of the rotor during temperature responsive movement thereof.

6. The combination with the fluid circulating system of an internal combustion engine comprising an engine liquid jacket, a radiator liquid circuit and a by-pass liquid circuit, of a pump for pumping liquid through said circuits, the pump comprising a walled chamber having in-

take orifice communication with the jacket, a pair of discharge orifices communicating respectively with the said liquid circuits, a rotatable element in the chamber, shiftable means supported by said rotatable element and being shiftable to vary the relative amounts of liquid pumped to the said liquid circuits, and thermostatic means responsive to changes of liquid temperature for adjustably shifting the shiftable means.

7. The combination with the circulating cooling system of an internal combustion engine comprising an engine liquid jacket, a radiator liquid circuit and a by-pass liquid circuit, of a pump for pumping liquid through said circuits, the pump comprising a walled chamber having intake orifice communication with the jacket and a pair of discharge orifices communicating respectively with said circuits and a pump rotor in the chamber, and thermostatic means responsive to changes of liquid temperature for axially adjustably moving the rotor relative to the discharge orifices to vary the relative amounts of liquid pumped to the said liquid circuits.

8. The combination with the circulating cooling system of an internal combustion engine comprising an engine liquid jacket, a radiator liquid circuit and a by-pass liquid circuit, including an inlet orifice to each circuit, of a pump for pumping liquid into said circuits through said inlet orifices, the pump comprising adjustably movable means to vary the relative amounts of liquid pumped into the respective circuits through the orifices, and thermostatic means responsive to variations of liquid temperature for moving the adjustably movable means, the rate of total discharge through both orifices being commensurable with engine speed.

9. The combination with the circulating cooling system of an internal combustion engine comprising an engine liquid jacket and a radiator liquid circuit, of a liquid pressure generating pump for pumping liquid through said circuit, the pump comprising a rotor, means movable responsive to variations of temperature of the liquid in the circuit to move the rotor into and out of the liquid circuit to correspondingly vary the rate of discharge into the radiator circuit.

10. The combination with the liquid circulating cooling system of an internal combustion engine, of a variable pressure pump comprising a rotor having vanes for circulating liquid through the system, and means responsive to variations of temperature of the liquid in the system for varying the rate of circulation of liquid through the system comprising means to variably move the rotor vanes into and out of the path of the circulating liquid.

11. In combination with the liquid circulating cooling system of an internal combustion engine, a rotary pump for pumping liquid through said system, comprising a rotor axially movable to vary the rate of circulation of liquid through the system, and thermostatic means for adjustably axially moving the rotor responsive to changes of temperature of the liquid passing through the system at a predetermined point therein, and means to maintain the rotor speed during thermally effected movement thereof.

12. In a fluid circulating system for an internal combustion engine comprising a plurality of conduit means, pump means for circuitously pumping liquid from a supply source into said conduit means, comprising a walled pump chamber communicating with the source and having a plurality

of discharge orifices communicating with the several conduit means, and comprising an operable liquid pressure developing means associated with the chamber, the pressure developing means being adjustable to vary the rate at which liquid is pumped to one of the several conduit means relative to that pumped to another conduit means, and means responsive to variations of temperature of the liquid to adjust the pressure developing means, and means comprising additional conduits for returning the liquid to said pump means.

13. In a fluid circulating system for an internal combustion engine comprising conduit means, a pump apparatus for circuitously pumping liquid from a source of supply to a plurality of discharge conduit means, a walled pump chamber communicating with the source, a plurality of discharge orifices in the chamber wall, communicating respectively with the discharge conduit means, a rotary liquid displacing element in the chamber for drawing liquid from the source into the chamber and discharging it from the chamber through the several discharge orifices, the rotary element being adjustably movable axially to vary the relative rates of discharge through the several discharge orifices, and thermostatic means for adjustably moving the rotary element responsive to changes of temperature of the liquid, and means comprising additional conduit means for returning the liquid to said pump apparatus.

14. Pump means for an internal combustion engine liquid cooling system comprising a pump chamber conduit means communicating therewith and communicating liquid from the chamber to the system and a pump rotor in the chamber for pumping liquid through the conduit means, and means responsive to changes of temperature of the liquid to adjustably move the rotor in the chamber in the direction of its rotational axis to vary the pumping rate, and to initiate or terminate the pumping of liquid through the conduit means in response respectively to change of liquid temperature to a predetermined high or low value and means to maintain the rotor speed at all adjusted positions.

15. Pump means for an internal combustion engine liquid cooling system comprising a walled pump chamber having inlet and outlet orifices in the chamber wall, and a pump rotor therein for drawing liquid into and forcing it out of the chamber through the inlet and outlet orifices, respectively, the rotor being movable in the direction of the rotational axis relative to the discharge outlet to vary the rate of discharge and means responsive to variations of liquid temperature at the pump to variably move the rotor in axial directions, whereby the pumping effort effective to supply liquid from the pump to the system is modified commensurably with variations in said liquid temperature, and whereby the pumping effort is respectively initiated or terminated upon change of liquid temperature to a predetermined high or low value and means to effect rotation of the rotor in all axial positions thereof.

16. The combination with the liquid circulating system of an internal combustion engine, of a supply conduit for heated liquid leading to the radiator, a bypass conduit from the supply conduit returning directly to the engine cooling jacket, pump means continuously coupled to the engine and associated with the supply conduit for pumping liquid therethrough, and thermostatic

means responsive to the temperature of the cooling liquid in the supply conduit for variably and selectively directing the flow of liquid through the supply conduit and the bypass conduit by axial movement of the pump means.

17. The combination with the circulating cooling system of an internal combustion engine comprising an engine liquid jacket, a radiator liquid circuit and a by-pass liquid circuit, of a pump for pumping liquid through the circuits comprising a casing having inlet and outlet orifices and a pump rotor in the casing for drawing liquid into the casing and pumping it out at the outlet orifice, the rotor being movable relative to the orifices to vary the effectiveness of its pump action, and thermostatic means associated with the pump to move the rotor to different positions relative to the orifices responsive to changes of circulating liquid temperature.

18. In a fluid circulating system for an in-

ternal combustion engine comprising a plurality of conduit means, pump means for circuitously pumping liquid from a supply source and discharging it under pressure into said conduit means, the pump comprising a walled chamber having an inlet and a plurality of outlets, said outlets being connected to the conduit means, a rotatable element, a shiftable rotatable means supported on said rotatable element and being shiftable to vary the rate of discharge at which the liquid is pumped to one of the several conduit means relative to the rate at which liquid is pumped to another conduit means, means comprising additional conduit means for returning the liquid to said pump means and thermo-responsive means for shifting the shiftable rotatable means responsive to changes of temperature of the liquid.

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