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THERMOSTATICALLY CONTROLLED VALVE

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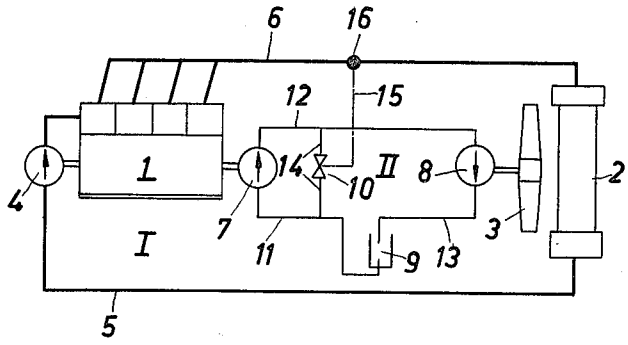

Fig. 1

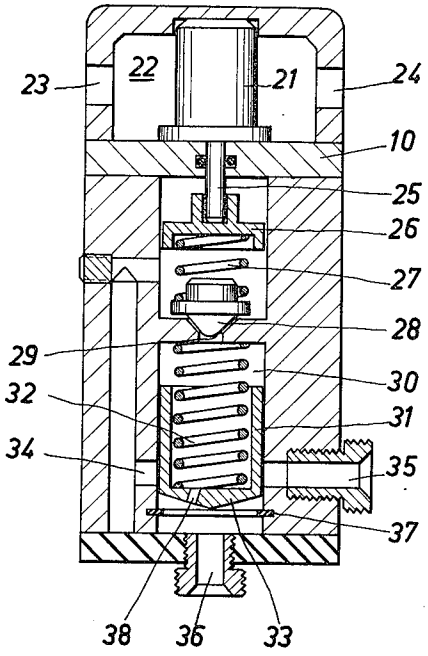

Fig. 2

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THERMOSTATICALLY CONTROLLED VALVE

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The present invention relates to control valves and is particularly concerned with control valves for hydraulic systems. More in particular, the invention relates to a thermostatically controlled control valve means for governing the operating medium of a hydraulic system, especially in cooling system of internal combustion engines. A cooling system of this nature such as known in the prior art comprises cooling water conduit means associated with an internal combustion engine, a cooler and a ventilator, on the one hand, as well as a hydraulic circuit with a hydraulic pump, a hydraulic motor and a control valve, on the other hand.

The thermostatically regulated control valve which depends for operation on the cooling water temperature serves for controlling the operating medium which is supplied by the hydraulic pump that is directly or indirectly driven by the internal combustion engine in a manner that the velocity of the ventilator driven by the hydraulic motor corresponds at any time to the quantity of heat that has to be conducted away from the cooling water circuit in order to keep the temperature of the cooling water constant.

A control valve is already known where the thermostat which is contacted by the cooling water acts upon a slide member which influences the passage of the operating medium, the apertures of which are so distributed around the circumference that the pressures which develop from the effective passages and act upon the slide substantially cancel one another. This direct actuation of the slide has the shortcoming that, on the one hand, the force to be developed by the thermostat for operating the slide is very substantial and that, on the other hand, the quantity of oil which rapidly rises due to fast acceleration of the velocity of the internal combustion engine and thus also of the hydraulic pump is directly fed to the hydraulic motor, whereby the ventilator velocity is increased very rapidly so that, in turn, as a result of the ventilator output the velocity of which increases in accordance with the third power or potential, a thrust-like increase in pressure of the hydraulic system occurs. The rapid increase in velocity is not desired due to the unpleasant noises which are developed, while the sudden thrust-like increase in pressure has a disadvantageous effect upon the hydraulic circuit, particularly upon the hydraulic output.

It is, therefore, an object of the invention to provide a thermostatically regulated control valve which is capable of eliminating the aforementioned unpleasant noise formation as well as the sudden thrust-like changes in pressure in the hydraulic circuit.

In accordance with the invention the problem is solved in that the control piston provided for regulating the operating medium is controlled directly by way of a pilot control valve. In a preferred embodiment of the invention a thermostatic working member which is acted upon by the coolant serves for controlling the preliminary control valve.

A particularly suitable and compact form of construction of the control valve in accordance with the invention is obtained in that the thermostatic operating element, the pilot control valve and the control piston of the control valve are arranged in axial alignment in a common housing. In this connection a compression spring which acts upon the control valve or the control piston is provided which has a very small resilient force. The effect of the control valve in accordance with the invention is advantageously increased if in accordance with a further feature of the invention the control piston is provided with a choke bore.

Further details and advantages of the invention will become apparent from the following specification with reference to the accompanying drawings which illustrate one embodiment, and in which

FIG. 1 illustrates schematically the circuit of the coolant and of the hydraulic system of an internal combustion engine, and

FIG. 2 shows a cross-section of a control valve in accordance with the invention.

A cooling system for internal combustion engines where the control valve in accordance with the invention is employed comprises a coolant circuit I which includes the internal combustion engine 1, the cooler or radiator 2, the ventilator 3, the cooling water pump 4, and the conduit system 5, 6 associated therewith. Furthermore a hydraulic circuit II is provided which comprises a hydraulic pump 7, a hydraulic motor 8 for driving the ventilator 3, an oil container 9, and a control valve 10 with associated conduits 11, 12, 13 and 14. The connection indicated by a dash and dot line at 15 is intended to convey that the control valve 10 is connected with a thermostat 16 in the circuit of the cooling agent 6 and controlled thereby.

The control valve 10 in accordance with the invention, as illustrated in FIG. 2, comprises a thermostatic operating element 21 which is arranged in a hollow space 22 and secured in the housing of the control valve 10. The hollow space 22 has an aperture 23 serving as a coolant intake and an aperture 24 serving for the coolant discharge opening. In this manner it is accomplished that the thermostatic operating element 21 becomes effective in response to the effective temperature of the coolant in the conduit circuit of the coolant of the internal combustion engine 1. An actuating pin 25 of the thermostatic element 21 acts upon a spring biased support member 26 which receives one end of a spring 27 which at the other end presses against a valve member 28 that is preferably of spherical configuration. This valve 28 entirely or partially closes an aperture 29 leading to hollow space 30. In this hollow space 30 a control piston 31 is slidably disposed. Also the control piston 31 is under the effect of a pressure spring 32 which, on the one hand, rests against the upper border of the hollow space 30 and, on the other hand, against the inner surface 33 of the control piston 31. In its lower position the control piston 31 closes an annular channel 34 which has an aperture 35 to which the return feed 11 of the hydraulic circuit II is connected. The lower part of the hollow space 30 is provided with a connecting plug 36 which is in communication with the feed line 12 of the hydraulic circuit II. In the aforementioned lower part of the hollow space 30 a snap ring 37 is inserted. The lower end wall 33 of the control piston 31 also has a small choke bore 38.

The control valve in accordance with the invention operates as follows:

With the internal combustion engine 1 at standstill the control piston 31 is seated upon the snap ring 37 due to the biasing of the spring 32 so that the return apertures 35 in the valve housing 10 are closed. The pilot control valve 28 is also pressed against the valve seat 29 by the associated pressure spring 27, while the actuating pin 25 of the thermostatic operating element 21 is

in its upper end position. As soon as the internal combustion engine is started the hydraulic pump 7 connected thereto produces a flow of coolant which corresponds to the number of revolutions.

The spring 32 which presses the piston 31 downwardly is arranged in such a manner that the pressure that is required in order to impart the necessary force for raising the piston 32 is smaller than that pressure which is required for producing the break-away moment of the hydraulic motor 8 that drives the ventilator 3. The control piston 31 is thus raised without the ventilator 3 being started because the oil which flows through the choke bore 38 that is in the base 33 of the control piston 31 can flow off without pressure through the pilot control valve 28, which is only slightly biased, into the return flow 35, 11. If the coolant temperature is increased to an extent that the response temperature of the thermostat is attained, which may be, for example, at 80° C., then the pin 25 projecting out of the thermostat 21 is pushed downwardly and increases the spring force that acts against the pilot valve 28 to an extent that the oil flowing through the choke bore 38 no longer can flow off without developing pressure. Due to the decreasing differential pressure between the front and the rear of the control piston, the control piston 31 is pressed downwardly by the spring 32 and thus closes a part of the cross-sectional area that leads to the return flow conduit 35. As a result the pressure in the hydraulic feed duct 12 increases, and the hydraulic motor 8 with the associated ventilator 3 is caused to rotate.

The spring bias force that acts on the pilot control valve 28 and therefore the differential pressure which determines the number of rotations of the ventilator by way of the control piston 21 are controlled in accordance with the extent to which the coolant acts on the thermostat 21.

If the pressure in the hydraulic pre-conduit 12 increases in a sudden thrust-like manner due to a rapid increase in the number of rotations of the hydraulic pump 7, then the pressure difference between the control piston front and rear causes the control piston 31 to rise and, depending on this difference in pressure, a greater or smaller partial flow is supplied to the hydraulic return flow lead 11. A sudden thrust-like increase in velocity of the hydraulic motor 8, i.e., of the ventilator 3, is thus prevented. Simultaneously a pressure equalization takes place through the choke bore 38 whereby the control piston 31 is gradually again returned to its initial position at the beginning of the pressure increase, provided that in the meantime the temperature of the coolant and therefore the position of the pilot valve 28 has not changed. The result is a slow increase in the velocity of the ventilator.

A decrease in velocity of the internal combustion engine 1, i.e., pressure decrease in the hydraulic circuit II, has exactly the opposite effect upon the operation of the control valve. The pressure at the rear of the control piston now becomes greater than that at the front so that the control piston 31 is pressed downwardly. As a result the return flow duct 11 is choked to a greater extent. Therefore the partial stream of the operating medium that flows to the hydraulic motor 8 does not drop in proportion to the decrease in the number of rotations of the combustion engine 1, i.e., a steep or sudden decrease in the number of rotations of the ventilator 3 does not occur. Only after the pressure is balanced by way of the choke bore 38 the velocity of the ventilator 3 is decreased, because now the control piston 31 has returned to its initial position at the beginning of the decrease of the velocity.

It is thus seen that there results a delayed control of the ventilator velocity without detours by way of a coolant temperature in the manner as was the case heretofore with the known control valves. Thus the thermal sluggishness of the coolant as well as also of the thermostat

which would cause a lagging of the required ventilator velocity is eliminated.

The invention is not limited to the embodiment illustrated and described. Particularly the control valve 10 may depart in structural form from the embodiment as long as the cooperation of a pilot control valve and a control piston is provided in the manner disclosed.

Having now described my invention with reference to the embodiment illustrated in the drawings, I do not wish to be limited thereto, but what I desire to protect by Letters Patent of the United States is set forth in the appended claims.

I claim:

1. Thermostatically regulated control valve means adapted to regulate the actuating medium of a hydraulic motor as determined by the coolant of an internal combustion engine or the like having a liquid cooling system of the type comprising a hydraulic pump operatively connected to the engine, a hydraulic motor, said valve, and fluid conduits connecting said pump, said hydraulic motor and said valve, and said valve having a housing, a hydraulic fluid path in said housing, a fluid intake and outlet opening, a spring biased main valve element in said path intermediate said inlet and said outlet opening, a pilot valve portion including a thermostatic element connected in the liquid cooling system of the engine and a pilot valve element disposed in axial alignment with said main valve element.

2. Thermostatically regulated control valve means adapted to regulate the actuating medium of a hydraulic motor as determined by the coolant of an internal combustion engine or the like having a liquid cooling system of the type comprising a hydraulic pump operatively connected to the engine, a hydraulic motor, said valve, and fluid conduits connecting said pump, said hydraulic motor and said valve, and said valve having a housing, a hydraulic fluid path in said housing, a fluid intake and outlet opening, a spring biased main valve element in said path intermediate said inlet and said outlet opening, a pilot valve portion including a thermostatic element connected in the liquid cooling system of the engine and a pilot valve element disposed in axial alignment with said main valve element, said pilot valve including a valve member, a support member, a spring extending between said valve member and said support member, and a pin extending between said thermostatic element and said support member.

3. Thermostatically regulated control valve means adapted to regulate the actuating medium of a hydraulic motor as determined by the coolant of an internal combustion engine or the like having a liquid cooling system of the type comprising a hydraulic pump operatively connected to the engine, a hydraulic motor, said valve, and fluid conduits connecting said pump, said hydraulic motor and said valve, and said valve having a housing, a hydraulic fluid path in said housing, a fluid intake and outlet opening, a spring biased main valve element in said path intermediate said inlet and said outlet opening, a pilot valve portion including a thermostatic element connected in the liquid cooling system of the engine and a pilot valve element disposed in axial alignment with said main valve element, said pilot valve including a valve member, a support member, a spring extending between said valve member and said support member, and a pin extending between said thermostatic element and said support member, said spring associated with said spring biased main valve element being a spring of small resiliency and said main valve having a bore for the passage of hydraulic fluid in one end thereof.

4. Thermostatically controlled and hydraulically operated valve for the cooling system of an internal combustion engine comprising a housing, a first space in said housing defining a passage for the cooling agent, a flow path in said housing for a hydraulic fluid including a second space separated from said first space and includ-

ing an inlet and an outlet for hydraulic fluid, a spring biased pilot valve in said second space, a thermostatic element in said first space presenting a pin extending into said second space and operatively engaging said pilot valve, a third space in said housing forming a part of said fluid flow path and to which said inlet and outlet are connected, a spring biased main valve in said third space having an end wall provided with a fluid passage bore, and an aperture between said second and third

space under control of said pilot valve, said first, second and third spaces and said thermostatic element, said pilot valve and said main valve being in axial alignment.

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