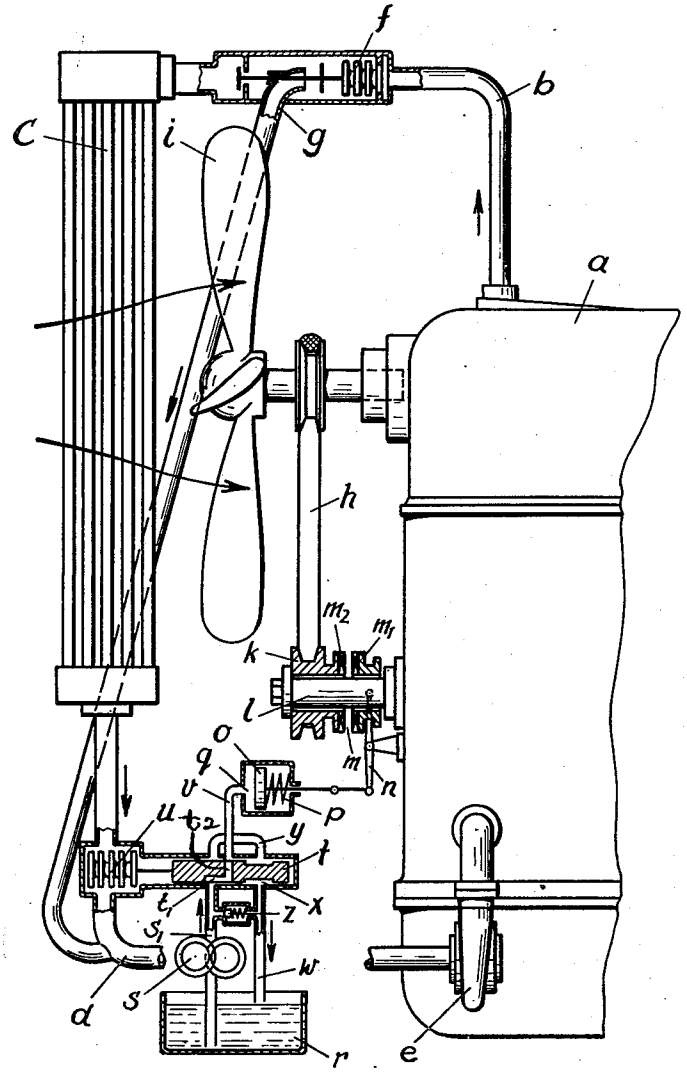
Sept. 23, 1952 F. K. H. NALLINGER 2,611,347

CONTROLLABLE COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Filed Jan. 13, 1950



INVENTOR
FRIEDRICH K. H. NALLINGER

By: Wasserting, Lake & Co.
AGENTS

Patented Sept. 23, 1952 2,611,347

UNITED STATES PATENT OFFICE

2,611,347

CONTROLLABLE COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Friedrich K. H. Nallinger, Stuttgart, Germany, assignor to Daimler-Benz Aktiengesellschaft, Stuttgart-Unterturkheim, Germany

Application January 13, 1950, Serial No. 138,279
In Germany December 6, 1948

18 Claims. (Cl. 123—41.12)

1

This invention relates to a controllable cooling system, in particular for internal combustion engines for vehicles.

To obtain a more efficient cooling, the cooling systems of internal combustion engines for motor vehicles as a rule are provided with a fan (e. g. also with an air pressure increasing blower). The power consumed for this purpose is, however, only in part usefully utilized, since for the most part of its operating time—with the conventional fan drive arrangements for instance up to 80% of the operating time and more—the cooling effect of the head-wind alone will suffice in general without there being the necessity to have the fan in operation. During this time the fan necessarily continues running and causes waste power and noise.

The main object of the invention is to provide for a more economic operation of the cooling system and accordingly one of its features consists in that the fan is put into operation only or substantially only if the cooling effect of the cooling system with the fan being disengaged does no longer suffice to ensure a sufficiently low thermal state of the engine. Throwing in or out of the fan is effected in this case in particular in dependence upon the temperature of the coolant or of the intercooling means leaving the cooler, e. g. of the cooling water circulating through the engine and a recooler, conveniently by means of a thermostat between recooler and engine.

To engage or disengage the fan a mechanically, hydraulically, pneumatically or electrically actuated clutch may be used. If desired, also a stepwise or infinitely variable disconnectable gear may be provided anterior to the fan.

One form of embodiment of the invention including a hydraulically actuated mechanic clutch is diagrammatically shown in the accompanying drawing.

The cooling water leaving the engine a flows through conduit b to the radiator (recooler) c and from there through conduit d and a cooling water circulating pump e back to the engine a. A by-pass conduit g controlled by a thermostat f branches off the conduit b and serves at lower temperatures of the cooling water to feed the cooling water directly back to the return flow conduit d without passing it through the cooler c. A fan i driven by a belt h sucks cooling air through the radiator c in the direction of the arrows resp. aids to increase the cooling effect of the head-wind impinging the cooler.

The pulley is loosely mounted on its drive shaft l, e. g. the valve timing shaft, but in fixed relation thereto in longitudinal direction. Positive driving connection between the pulley and the shaft l can be established by means of the clutch m, one half m_1 of which being slidably, but unrotatably mounted on the shaft l and connected by means of a double-armed lever n or the like to a spring loaded piston o in such a manner that the latter is maintained by the spring p in the "off"-position, the "on"-position being effected under the action of a pressure liquid in the cylinder q by establishing frictional engagement between the clutch halves m_1 and m_2, of which m_2 is positively connected to the pulley k.

2

The pressure liquid, e. g. the lubricating oil of the engine, or any other liquid suitable for the purpose in view, is withdrawn (as diagrammatically illustrated in the drawings) from a tank r and supplied by the pump s through conduit s_1 to an operating piston t having a groove t_1 and a bore t_2 and being subject to adjustment by a thermostat u conveniently located anterior to the junction of the by-pass conduit g with the return flow conduit d of the cooling water. A conduit v connects the casing of the operating piston to the cylinder q. A return line w conducts the oil from the space x of the casing of the slide valve back into the tank r. Further there is a by-pass conduit y which in the left-hand position of the operating piston connects the bore t_2 to the space x, and a pressure relief valve z between the conduits s_1 and w.

The mode of operation of the form of embodiment described is as follows:

The thermostat u is under normal conditions, below a predetermined elevated temperature of the cooling water flowing through conduit d, in its contracted state, which means that the operating piston is in its left-hand position. In this case the pump s, which is e. g. continually driven by the engine (or which, when controlled by the thermostat u, may under normal conditions also remain in its "off"-position) delivers the liquid through the control bore t_2 to the by-pass conduit y and from there through the space x of the slide valve and the return flow line w back to the tank r. The space x and consequently the interior of the cylinder q in connection therewith in this position of the operating piston through the conduit v are substantially without positive pressure, the clutch m being thus disengaged under the action of the spring p and the fan at a standstill. Recooling of the cooling water in the radiator c is exclusively effected by the head-wind, the cooling effect being controlled by the thermostat f. It is convenient, to adjust the

thermostat so as to include the radiator in the cooling water circulation already at a lower temperature than usual, in order to provide for a sufficient exchange of heat in spite of the fan being put out of operation.

In the event of the cooling effect of the radiator *c* impinged only by the head-wind being no longer sufficient (e. g. even if the total quantity of cooling water flowing through the engine is passed through the radiator by means of the thermostat *f*) to maintain the cooling liquid at the low temperature level required, the expanding thermostat *u* interrupts the connection between *v* and *x*, and between *y* and t_2 or s_1 resp. and, as illustrated in the drawing, establishes the connection between the conduits s_1 and *v* through the bore t_2. The pump *s* therefore forces the liquid into the cylinder *q* at a pressure determined by the load applied by the spring to the valve *z*. The piston *o* is displaced to the right against the action of the spring *p*, which results in coupling the fan with its drive shaft *l* by means of the clutch *m*. The liquid delivered in excess by the pump *s* is returned through *z* and *w*.

If the temperature in *d* is lowered so that the piston *t* is urged again towards the left, the conduit *v* and the cylinder *q* resp. are connected again through *x* to *w*, whereby owing to the expansion of the spring *p* the liquid is forced out of the cylinder *q* and the fan disconnected.

Accordingly the fan will be put into operation only or substantially only if all other possibilities of recooling the cooling water are already exhausted. For reasons of safety the clutching of the fan may, of course, be effected also more or less earlier. Likewise the fan may be put out of operation, e. g. by friction on the piston *t* or the like, with a certain delay with relation to its throwing in (i. e. only at a lower temperature than the throwing in of the fan) to avoid a continuously repeated connection and disconnection of the fan within the range of the control temperature.

Instead of being mounted on the drive shaft *l*, the clutch may be arranged also directly on the fan shaft or at any other suitable place. The clutch may be designed e. g. also as an electrically or hydraulically operated clutch, for instance as a fluid coupling capable of being engaged and disengaged by filling and emptying. As a further modification e. g. a disconnectable fluid converter, a planetary gear, an infinitely variable friction gear or the like may be used, providing an infinitely variable transmission in dependence upon the temperature of the cooling water.

In the case of air-cooled engines, throwing in or out of the fan or of the blower may be effected in dependence upon the temperature of the heated cooling air. If desired, provision can be made also to effect connection and disconnection in dependence of the thermal state of the engine.

While this invention has been described in connection with road vehicles, it is understood, that it may find application also to all other types of vehicles e. g. rail cars, aircrafts and watercrafts and correspondingly to all engines operating under similar conditions.

What I claim is:

1. A recooling device for the cooling liquid of an internal combustion engine for vehicles, comprising a cooler for said cooling liquid, delivery means for a cooling medium to increase the heat exchange in said cooler from the cooling liquid to the cooling medium, control means responsive to the temperature of the cooling liquid for controlling the operation of the cooler, and control means responsive to the temperature of the cooling liquid for controlling the operation of the delivery means, both said control means being so constructed that an increasing temperature of the cooling liquid increases first the operation of said cooler and thereafter the operation of said delivery means.

2. A device as specified in claim 1, wherein both said control means are so constructed as to disconnect the delivery means below a predetermined temperature of the cooling liquid and to connect said delivery means above said temperature.

3. A device as specified in claim 1 wherein both said control means are so constructed that the cooler and delivery means are not connected until the cooling fluid exceeds an individual temperature for each of the cooler and delivery means and are disconnected when it falls below said individual temperatures.

4. A recooling device for the cooling liquid of an internal combustion engine, comprising a cooler for the cooling liquid, a supply conduit connecting the engine and the cooler, a return flow conduit leading from the cooler to the engine, a by-pass between the said conduits, thermostatic means controlling the by-pass, a fan for delivering air through said cooler, control means for controlling the delivery rate of the fan, and thermostatic means for controlling said control means.

5. A recooling device for the cooling liquid of an internal combustion engine, comprising a cooler for the cooling fluid, a supply conduit connecting the engine and the cooler, a return flow conduit leading from the cooler to the engine, a by-pass between the said conduits, thermostatic means controlling the by-pass, a fan for delivering air through said cooler, a control device for controlling the output of the fan, and thermostatic means for controlling said control means.

6. A recooling device for the cooling liquid of an internal combustion engine, comprising a cooler for the cooling liquid, a supply conduit connecting engine and cooler, a return flow conduit leading from the cooler to the engine, a thermostatically controlled by-pass between the supply and return conduits, a fan for delivering air through said cooler, a thermostat in said return flow conduit and control means for controlling the fan including driving means for the fan, a clutch device for disconnecting the fan from its drive and control means for the clutch associated with said thermostat capable of disengaging the clutch below a predetermined temperature of the cooling liquid at the place of the thermostat and engaging said clutch above said temperature for the purpose of driving the fan.

7. A recooling device for the cooling liquid of an internal combustion engine, comprising a cooler for the cooling liquid, a supply conduit from the engine to the cooler, a return flow conduit from the cooler to the engine, a thermostatically controlled by-pass between the supply and return conduits, a fan for delivering air through said cooler, driving means for said fan, a clutch for disconnecting the fan from its driving means, a device responding to the thermal state of the engine and actuating means associated with said last mentioned device for said clutch capable of engaging said clutch only at

an increased thermal state of the engine thereby putting the fan into operation.

8. A device as specified in claim 7, wherein said actuating means comprise control means for a servomotor operating in dependence upon the thermal state of the engine and a transmission device effecting the operation of the clutch for said servomotor.

9. A recooling device for the cooling liquid of an internal combustion engine comprising a cooler for the cooling liquid, a fan for delivering air through said cooler, driving means for the fan, a clutch permitting the disconnection of the fan from its drive, a supply conduit connecting engine and cooler, a return flow conduit from the cooler to the engine, a thermostatically controlled by-pass between said supply and return conduits, a thermostat in said return flow conduit, an operating piston controlled by said thermostat for a servomotor, a transmission device for said servomotor actuating said clutch in such a manner that at a low temperature of the cooling liquid at the thermostat the clutch is in its disengaged position, while being in its engaged position at a high temperature of said cooling liquid.

10. A device as specified in claim 7 wherein the clutch is designed as a smoothly operating clutch.

11. A device as specified in claim 7 wherein the clutch is designed as a friction clutch.

12. A device as specified in claim 5 in combination with a thermostat for controlling the by-pass conduit and located in the supply conduit.

13. A recooling device for the cooling fluid of an internal combustion engine, comprising a cooler for the cooling fluid, a supply conduit from the engine to the cooler, a return flow conduit from the cooler to the engine, a by-pass between the supply and return conduits, a thermostat located in the by-pass for controlling the flow of fluid through the by-pass in response to the temperature of the cooling fluid, a fan for delivering air through the cooler, a further thermostat in the return conduit, and a control device for controlling the output of the fan in response to the control position of the further thermostat, both thermostats being so calibrated that upon an increase in the temperature of the cooling fluid the by-pass is first closed and the fan is thereafter rendered operative.

14. A device according to claim 13 wherein the by-pass is so arranged that it opens into the return conduit upstream of the thermostat controlling the fan.

15. A recooling device for the cooling fluid of

an internal combustion engine, comprising a cooler for the cooling fluid, a supply conduit from the engine to the cooler, a return flow conduit from the cooler to the engine, thermostatic control means in the supply conduit for controlling the cooling action exerted upon the cooling fluid, thermostatic control means in the return conduit for controlling the cooling action exerted upon the cooling fluid, the said means being so constructed and calibrated relatively to each other that the first said means will respond earlier than the second said means to an increasing temperature of the cooling fluid.

16. A device according to claim 15 wherein the first said means comprise means for controlling the cross-sectional area of flow of the cooling fluid through the cooler and the last mentioned means comprise means for controlling a cooling medium adapted to withdraw heat from the cooler.

17. A recooling device for the cooling fluid of an internal combustion engine, comprising a cooler, a conduit from the engine to the cooler, a conduit from the cooler to the engine, first thermostatic control means responsive to the temperature of the cooling fluid for controlling the circulation of cooling fluid, means for delivering a further cooling medium adapted to abstract heat in the cooler, second thermostatic control means responsive to the temperature of the cooling fluid in said conduit for controlling the supply of said cooling medium, both said control means being so calibrated relatively to each other that upon an increase of temperature of the cooling fluid the second said control means are rendered operative at a higher temperature of the cooling fluid than the first said control means thereby to exert an increased cooling action.

18. A device according to claim 17 wherein air is used as the further cooling medium and the means for supplying the air comprise an adjustable fan.

FRIEDRICH K. H. NALLINGER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,558,009	Giesler	Oct. 20, 1925
1,820,035	Stokes	Aug. 25, 1931
1,837,564	McCaleb	Dec. 22, 1931
1,921,042	Roos	Aug. 8, 1933
2,341,789	Justus	Feb. 15, 1944