Nov. 9, 1937. H. A. REYNOLDS 2,098,712

BYPASS ARRANGEMENT

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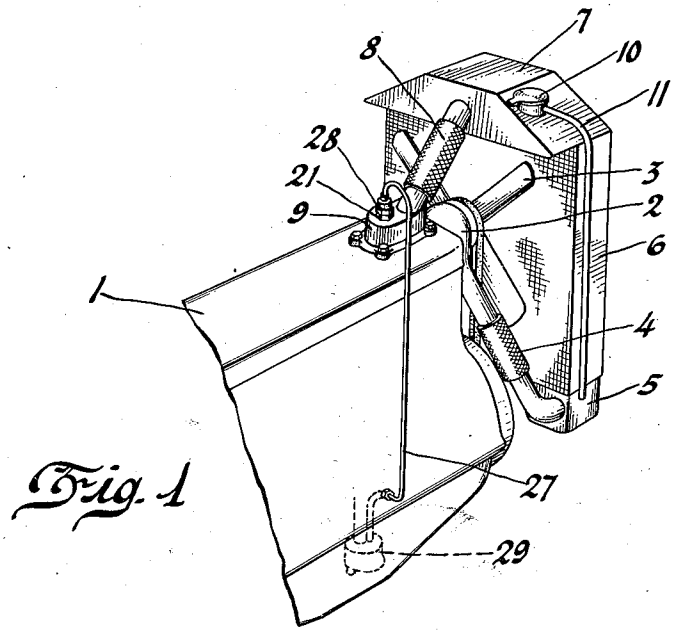


Fig. 1

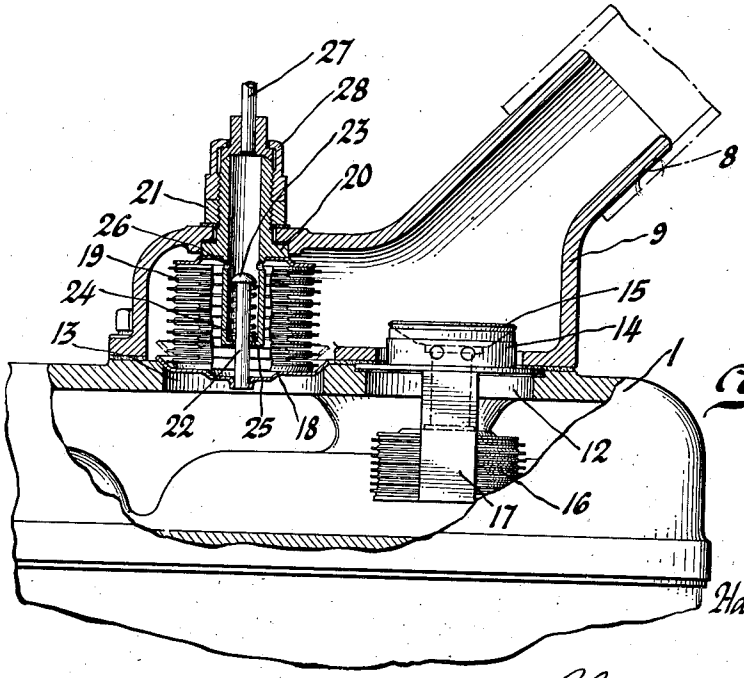


Fig. 2

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BY-PASS ARRANGEMENT

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12 Claims. (Cl. 123—178)

This invention relates to automobile engine cooling systems and has to do particularly with the conservation of cooling liquid supply.

It is an object of the invention to provide an engine cooling system which makes more practical the use of the cheaper but more volatile anti-freeze solutions, by reducing liquid loss due to after-boiling. More particularly the invention aims to provide a circulating system which overcomes the objection to the use of a thermostat valve in the jacket outlet and yet retains its advantage as an aid to quick warm up at the start of engine operation. A preferred embodiment involves a more or less conventional cooling circuit in which a by-pass around a temperature operated valve, is provided with a valve which is closed during engine operating periods and opens when the engine is out of operation to allow thermosiphon circulation to take place freely.

To explain the purpose more fully it may be stated that it is common practice to install a temperature regulated valve in the jacket connection with the vented inlet header of the radiator assembly, the valve being designed to open at a predetermined temperature. When the liquid within the cylinder block is cold the valve prevents flow to the radiator for the dissipation of heat and, therefore, the liquid standing in the jacket warms up quickly to bring the engine block to an efficient operating temperature. Ordinarily, the jacket passages are so designed that when the valve is closed, the engine driven water circulating pump keeps the liquid moving in the jacket for uniform heat absorption and finally the liquid circulating in the jacket and acting on the thermostat causes the valve to open in proportion to the temperature rise thereby establishing circulation between the jacket and radiator in accordance with cooling requirements. After operation of the engine is stopped the valve closes as the liquid cools off.

The liquid does not cool off uniformly throughout the system inasmuch as forced circulation is dependent upon the engine driven pump and the liquid standing in some parts of the system gives off its heat rapidly while that in other and hotter parts of the system may still be absorbing heat. That situation is presented especially upon a sudden stop after a hard run when both the engine driven pump and the radiator fan are idle. Certain parts of the cylinder block may then be extremely hot while others are comparatively cool and if the thermostat is positioned in a relatively cool part of the jacket and is set to close the valve at a rather high temperature, thermosiphon flow may be cut off too soon and, without circulation, heat localization causes boiling in spots. The formation of steam, because of its expansion, tends to push the liquid ahead and out of the jacket through the jacket return connection with the radiator and in consequence liquid moves upwardly in the radiator assembly to the level of the overflow and a part spills out of the system.

This is known as after boiling loss and in some cases the loss constitutes a substantial portion of the supply. Its occurrence is a source of annoyance and is expensive when the system is operating with an anti-freeze solution. In this connection the loss is most likely to occur with an anti-freeze solution having a low boiling point, as, for example, would be the case if the thermostat is set to operate at 150° F., and a 50% alcohol solution is used with a boiling point of approximately 165° F. The thermostat setting mentioned is common when the automobile is equiped with the well known type of hot water heater.

To allow thermosiphon flow throughout intervals between engine operating periods and as soon as the operation is cut off, it is here proposed to incorporate in the system a by-pass around the thermostatically controlled valve, with means to close the by-pass whenever the engine is in operation. With the by-pass closed, liquid flow to the radiator is regulated solely by the thermostatically controlled valve and the system operates in a conventional fashion, but as soon as engine operation is stopped the by-pass is opened and thermosiphon circulation throughout the system may take place irrespective of the position of the thermostatically controlled valve. As a result, heat localization and vapor formation with after boiling is largely eliminated. However, should there be any tendency toward steaming in extreme cases an unobstructed path leading directly to the system vent is afforded through the jacket outlet connection and surging with liquid loss is minimized. Thus an alcohol or other low boiling point solution may be used without the serious consequences heretofore experienced.

As a convenient and simple control for the by-pass valve it may have associated with it a spring to hold the valve open and a pressure responsive device to close the valve against spring resistance, and to which fluid pressure is supplied under the action of some mechanism which functions with engine operation. Such mechanism, by preference, may consist of the engine driven oil pump forming a part of the pressure feed lubricating system for the engine and having a pressure line leading therefrom to the pressure responsive de-

vice. By this arrangement the by-pass will be closed and opened substantially concurrently with the starting and the stopping, respectively, of engine operation.

For a better understanding of the structure involved, reference will be made to the accompanying drawing wherein Figure 1 is a perspective view showing the general assembly of an engine cooling system, and Figure 2 is a detail view, partly in section, to illustrate the construction and parallel arrangement of the two outflow valves.

In the drawing the reference character 1 indicates a water jacketed engine cylinder block having at the front thereof a water pump assembly 2 and a radiator fan 3, both driven from the engine crankshaft. The suction side of the pump is joined through the connection 4 with the outlet tank or header 5 of the radiator assembly. The outlet header 5 is fastened on one end of the heat radiating core 6 through which cooling air is drawn by the operation of the fan 3 and on the opposite end of the core 6 is fastened the inlet header or tank 7, which in turn is joined by the connection 8 with an outlet fitting 9 bolted or otherwise secured to the top of the cylinder block 1. The inlet header is provided with a filling spout 10 from which leads an overflow or vent pipe 11 for communication of the system to atmosphere. As thus far described, the construction constitutes the conventional engine cooling system, in which the engine driven pump 2 draws water or other cooling medium from the outlet tank 5 and forces it through the jacketed block 1 and then out through the connection 8 into the vented inlet header 7 for return to the outlet header 5 through the heat radiating core 6, where the water gives off its heat to the air stream moving through the core under influence of the engine driven fan 3.

Such systems are usually provided with a temperature regulated valve controlling the outflow of water from the engine jacket, and the passages within the cylinder block are so arranged that when the valve is closed, the operation of the pump causes the body of water within the jacket to move continuously from end to end so that the temperature of the liquid is even throughout the cylinder block. A valve of that type is used here, but in addition, a by-pass is provided around the valve.

As seen in Figure 2 the outlet fitting 9 communicates with the water jacket through a pair of spaced openings 12 and 13 and one opening is controlled by a temperature responsive valve assembly, while the other opening is controlled by the pressure responsive valve assembly.

The thermal responsive valve assembly may include a mounting ring 14 having a lateral flange clamped between the outlet fitting 9 and the wall of the water jacket, with a plate valve 15 cooperating with the collar 14 to close the opening. The valve 15 is connected to one end of a thermostat or expansible bellows 16, the other end of which is fixedly supported by a mounting strap 17 carried by the collar 14, to position the expansible bellows in the path of liquid flow through the jacket. With temperature changes within the water jacket, the bellows will expand or contract to open or close the valve 15.

Over the by-pass opening 13 is positioned the pressure responsive valve which includes a closure disc or valve element 18 secured to one end of an expansible bellows 19 whose other end is fixed to a mounting stud 20 adapted to project through the wall of the fitting 9 and to be secured thereto by a nut 21. The mounting stud 20 is hollow and within the end thereof is slidable a stud 22 having one end fixed to the valve 18 and its other end provided with a head 23 which forms a seat for a coil spring 24 interposed between the head and an inturned flange 25 at the bottom of the stud. This spring, in the absence of fluid pressure within the bellows 19, tends to unseat the valve 18 and permit flow through the opening 13 of liquid from the jacket to the vented inlet header 7. Pressure to close the valve is supplied to the interior of the bellows 19 through one or more openings 26 in the wall of the hollow stud 20 and through a pressure line or conduit 27 joined to the stud by a suitable fitting 28 and extended down the side of the cylinder block for connection with the pressure side of the engine driven oil pump 29 located within the engine crankcase.

Whenever the engine is in operation, oil pressure is supplied by the pump 29 to hold the valve 18 closed, but as soon as engine operation is cut off, lack of pressure allows the spring 24 to open the valve. Consequently, thermosiphon circulation can take place in the engine cooling system regardless of the position of the valve 15. This is important especially when the thermostat is set to close at a temperature higher than or near the boiling point of the liquid. It is pointed out, furthermore, that the usual position of the thermostat is such that the water in the vicinity thereof may be relatively cooler than that in other portions of the cylinder block and in the absence of circulation by reason of pump operation, the thermostat tends to close the valve 15 much too soon and at a time when spotty boiling would occur, were it not for the fact that the by-pass allows thermosiphon flow.

I claim:

1. In an engine cooling system wherein an engine jacket has outlet and return connections with a radiator, a pair of independently acting valves controlling liquid flow through the outlet, heat responsive means affected by liquid temperature at the outlet to operate one of said valves, and means acting concurrently with the start of engine operation to close the other valve and hold it closed until engine operation stops.

2. In a liquid circulation system for the cooling of engines, a thermostatically operated valve controlling flow through the engine jacket outlet, a by-pass connecting the jacket with the outlet beyond said valve, and means to close the by-pass concurrently with the start of and throughout continued engine operation.

3. For use with a thermostatically controlled valved outlet of an engine cooling jacket, a by-pass around said valved outlet, a normally open valve for said by-pass and means to maintain said valve closed concurrently with engine operation, said means being active from the start of engine operation.

4. The combination with a radiator and an engine cooling jacket having a pair of outlet openings arranged in parallel for communication with the radiator, of a thermostatically operated valve controlling one of said outlet openings, a valve for the other opening and operating means therefor arranged to open the valve when the engine is out of operation.

5. In combination, an engine cooling radiator, an engine jacket, a connection for the flow of cooling liquid from the jacket to the radiator, a normally open valve to allow liquid flow through said connection, means for closing said valve

when the engine is to be operated, and a thermostatically controlled by-pass valve controlling liquid flow through said connection when the first mentioned valve is closed.

6. In combination, an engine cooling radiator, an engine jacket, a connection for the flow of cooling liquid from the jacket to the radiator, a pair of valves arranged in parallel to control liquid flow through said connection, liquid temperature responsive means for operating one of said valves, a pressure responsive device for operating the other valve from open to closed position, and engine operated means for actuating said pressure responsive device.

7. In an engine cooling system, a radiator having a heat transfer unit with an outlet header and a vented inlet header, an engine jacket having an intake connection with said outlet header and outlet means connecting the jacket with said inlet header and including a pair of outlet openings arranged in parallel flow relation, temperature responsive means to close one of said openings, pressure responsive means to close the other opening, and engine operated means associated with said pressure responsive means to provide actuating pressure therefor.

8. In combination, an engine having an engine driven pressure feed lubricating system and a circulatory engine cooling system, a temperature responsive device controlling liquid circulation in the cooling system when the engine is in operation, a by-pass around said device, a valve in said by-pass adapted to be open when the engine is out of operation to permit thermosiphon circulation, and pressure responsive means associated with the lubricating system to close said valve during engine operating periods.

9. In combination with an engine cooling radiator having an outlet header at its cool end and a vented inlet header at its hot end, of an engine jacket having an intake connection with the outlet header and an outlet connection with the vented inlet header, a temperature responsive valve to control liquid flow through said outlet connection when the engine is in operation, a by-pass around said valve to allow liquid flow through the outlet connection when the engine is out of operation, a pressure responsive valve to close said by-pass when the engine is in operation, and an engine driven pressure supply pump connected with said pressure responsive valve.

10. In an engine cooling system, a temperature operated valve controlling liquid flow from an engine jacket to a vented inlet header of a radiator, a by-pass around said valve for flow to the inlet header, a by-pass valve and by-pass valve operating means to close the by-pass coincidentally with engine operating periods and to open the by-pass coincidentally with intervals between engine operating periods.

11. In combination, an engine jacket, a radiator, an outgoing connection from the jacket to the radiator, means controlling cooling medium flow through said connection in accordance with thermal conditions and additional flow control means closed when the engine is in operation and opened to permit free thermosyphon flow to the radiator when the engine is out of operation and irrespective of said thermally controlled means.

12. In combination, an engine jacket, a radiator, an outgoing connection from the jacket to the radiator, temperature responsive means controlling flow through said connection, and means active irrespective of the temperature responsive means to permit free thermo-syphon flow to the radiator when the engine is out of operation.

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