Oct. 22, 1935. R. W. ANGSTMAN 2,018,339

STEAM HEATING SYSTEM FOR AUTOMOBILE BODIES

Original Filed June 6, 1934

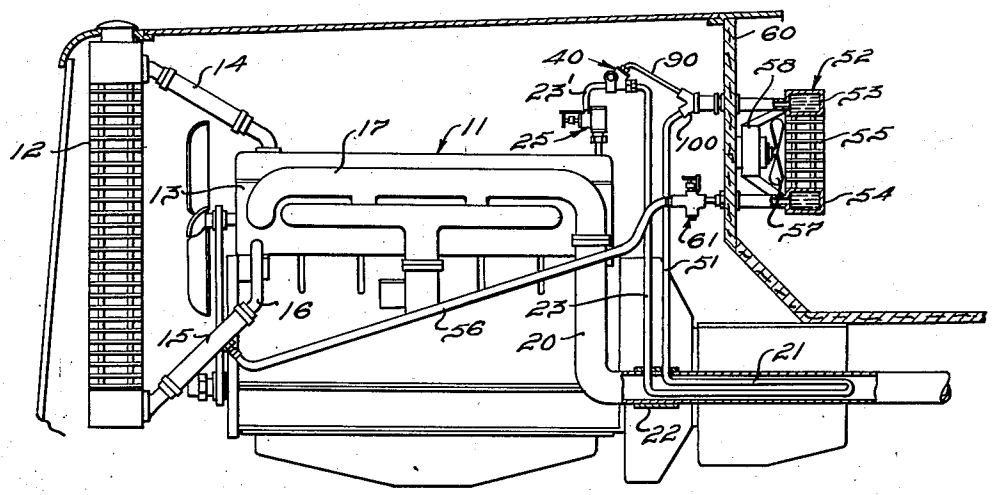

Fig. 1.

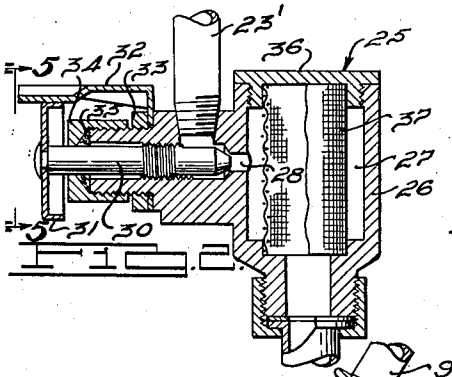

Fig. 2.

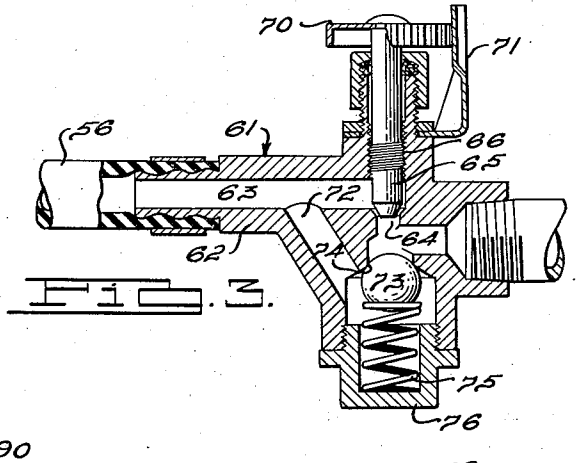

Fig. 3.

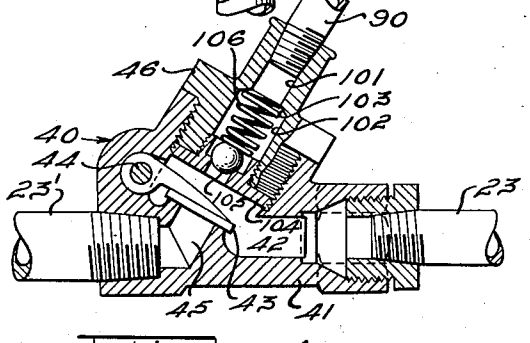

Fig. 4.

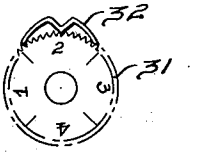

Fig. 5.

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STEAM HEATING SYSTEM FOR AUTOMOBILE BODIES

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Original application June 6, 1934, Serial No. 729,212. Divided and this application December 12, 1934, Serial No. 757,192

9 Claims. (Cl. 237—12.3)

This invention relates to motor vehicle heating systems and more particularly to systems which utilize the waste heat from the exhaust gases of the internal combustion engine which drives the vehicle to generate steam or vapor from the water or other liquid in the cooling system of the engine, the steam or vapor then being passed through a radiator or radiators to heat the interior of the body of the vehicle, and is a division of my application for Letters Patent of the United States filed June 6, 1934 for Improvements in steam heating systems for automobiles, Serial No. 729,212.

The principal object of the present invention is to provide means for automatically reducing the temperature of the steam being fed from the steam generator to the heater radiator under those conditions of operation during which the temperature of such steam may approach and/or exceed a value which may prove deleterious to the heater radiator.

Other objects of the invention include the provision of an automobile steam heating system including a steam generator and a heater radiator in which means are provided for reducing the temperature of the steam being fed to the heater radiator during certain conditions of engine operation; the provision of means in connection with a device of the type described for mixing lower temperature fluid with the steam being fed to the heater radiator under certain conditions of operation so as to reduce the temperature of such steam; the provision of an automobile body steam heating system including a steam generator heated by the exhaust gases of the engine and a heater radiator to which steam from the generator is fed, together with means for introducing fluid from the cooling system of the engine for mixture with the steam being fed to the heater radiator from the generator so as to reduce the temperature of such steam; the provision of an automobile steam heating system including a steam generator and a heater radiator connected in circuit with different portions of the liquid cooling system for the engine of the automobile, together with means for introducing fluid from the cooling system to the steam being fed from the generator to the radiator, and without such fluid having been passed through the generator, so as to reduce the temperature of such steam in the radiator; the provision of means for reducing the temperature of steam being fed to the heater radiator of a construction as above described during those periods of operation when such steam may become super-heated to an undesirable extent, by mixing with such super-heated steam fluid of a lower temperature; the provision of an automobile body steam heating system including a steam generator and a heater radiator connected in circuit with different portions of the engine cooling system, together with means for reducing the temperature of the steam being fed to the heater radiator from the generator including a duct adapted to introduce fluid taken from the engine cooling system to the heater radiator without passing it through the steam generator, and including a spring pressed check valve opening in the direction of the heater radiator only; and the provision of an automobile body steam heating system including a steam generator and a heater radiator connected in circuit with different portions of the cooling system for the engine which drives the automobile, together with a by-pass between the inlet and outlet ends of the steam generator and means for governing the flow of fluid through the by-pass.

Further objects of the invention include the provision of a method of operating an automobile body steam heating system so as to prevent the introduction of steam at excessively high temperatures to the heater radiator; and the method of operating an automobile body steam heating system including a steam generator and a heater radiator connected in series with different portions of the cooling system for the automobile engine so as to prevent the introduction of steam of excessively high temperature to the heater radiator by introducing into the steam fed from the generator to the heater radiator, fluid of a lower temperature effective to reduce the temperature of such steam.

The above being among the objects of the present invention the same consists in certain novel features of construction, combinations of parts and method of operation to be hereinafter described with reference to the accompanying drawing, and then claimed, having the above and other objects in view.

In the accompanying drawing which illustrates a suitable embodiment of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a more or less diagrammatic side elevation, partly in section, of a portion of an automotive vehicle illustrating the application of a steam heating system to such vehicle.

Figs. 2, 3 and 4 are central, vertical and longitudinal sections of parts of the steam heating system shown in Fig. 1.

Fig. 5 is a detail of parts shown in Figs. 1, 2 and 3 as viewed, for instance, on the line 5—5 of Fig. 2.

The present invention deals with that type of automobile body steam heating systems in which a steam generator, which may be conveniently formed of a length of tubing, is so positioned as to be heated by the exhaust gases of the engine which drives the automobile, and is adapted to deliver steam generated thereby to a radiator positioned within the automobile body for the purpose of heating the air in such body. The inlet end of the steam generator is connected to the water jacket or other part of the cooling system for the engine, preferably with the inter-position of a check valve permitting the flow of water from the engine cooling system only in the direction of the generator. The discharge side of the body radiator is also connected with the engine cooling system so that the steam which is passed therethrough or which has condensed therein may be returned to the engine cooling system. Preferably the inlet and outlet ends of the body heating system are connected into the engine cooling system on opposite sides of the pump for such cooling system so that a pressure differential will be created at opposite ends of the body heating system tending to cause a circulation of fluid from the cooling system therethrough.

The parent patent application from which the present patent application was divided, as above identified, deals particularly with the introduction of means between the discharge side of the body radiator and the engine cooling system for normally restricting the flow of fluid from the body radiator so as to cause a positive pressure to be built up therein, thereby enhancing the heating effect of the body radiator as is desirable under certain conditions of operation, and providing means for rendering the restriction inoperative or at least to limit the restricting effects therof so as to prevent an excessive pressure from being built up in the body radiator. Such restricting feature, while it may be employed in connection with the present invention, is entirely independent thereof and the present invention is not to be limited thereby.

It has been found in connection with automobile body steam heating systems of the type described that under certain conditions of engine operation, particularly at high speeds and full load, that the amount of heat being transferred from the exhaust gases of the engine to the water or other liquid in the steam generator of the automobile body steam heating system is more than sufficient to turn such liquid into steam, and accordingly super-heats the steam thus formed. In extreme conditions at least the amount of super-heat thus imparted to the steam and which steam is consequently fed to the body radiator is of a sufficiently high temperature to melt the solder holding and sealing the various parts of the radiator together, thus permitting the highly super-heated steam to escape into the interior of the auomobile body where it may constitute a danger and menace to the occupants thereof. The present invention provides a means whereby the destructive effects of such super-heated steam on the heater radiator may be eliminated but without rendering the heater any less effective during normal operation at lower speed.

The temperature of the super-heated steam fed from the steam generator to the heater radiator is reduced by mixing with it fluid of a lower temperature. Preferably this fluid is a liquid of the same type as is employed in the heating system so that when it is mingled with the super-heated steam a material portion if not all of the super-heat of such steam will be expended in vaporizing this additionally introduced fluid. While, in the broader aspects of the present invention, it is not important how such additional fluid is introduced for mixture with the super-heated steam, it will be apparent that it will be most convenient to employ liquid from the cooling system of the engine for this purpose. Additionally, it will be apparent that such liquid may be introduced for mixture with the super-heated steam without having previously passed through any of the body heating system, but for the purpose of simplicity in construction and economy in manufacture it has been found advantageous to take such fluid from that portion of the heating system on the upstream side of the steam generator. Furthermore, it will be understood that it is more or less immaterial whether such additional fluid is introduced for admixture with the super-heated steam in the heater radiator or at any point between the steam generator and the heater radiator, the desired result being accomplished in any case, but again because of simplicity in construction and economy in manufacture it is desirable to introduce such additional fluid at a point as close to its source as is possible.

Referring to the drawing, the numeral 11 indicates an internal combustion engine of the type usually employed in motor vehicles and having a radiator 12 in front of the same as a part of the cooling system of the engine, the radiator having its upper and lower portions connected with the corresponding portions of the water jacket 13 of the engine by means of conduits 14 and 15 respectively. A pump 16 is interposed, in circuit, between the conduit 15 and the lower portion of the water jacket 13 to cause a forced circulation in the cooling system of the engine during operation of the latter. The engine is provided with an exhaust manifold 17 and an exhaust pipe 20 for conducting the exhaust gases from the engine to a suitable point of discharge.

A steam generator 21 is associated with the exhaust pipe 20 and, as illustrated in Fig. 1, for the purpose of illustration, is shown as consisting of a single re-entrant tube, the end portions of which may be supported by the saddle clamp 22 or other suitable means, the tube extending a substantial distance longitudinally of the pipe 20. Cooling liquid is supplied to the steam generator 21 by means of feed conduits 23 and 23', the greatest proportion of the latter of which in the construction shown constitutes an extension of the inlet side of the steam generator 21, extending to the upper portion of the water jacket 13 which is on the pressure side of the pump 16. The feed water conduits 23 and 23' are provided with a throttling or metering valve means 25 interposed therein adjacent the upper portion of the water jacket 13 for the purpose of controlling the rate of flow of feed water from the cooling system of the engine to the steam generator.

Reference may now be had to Fig. 2 which illustrates the construction of the valve 25 more in detail. The supply valve 25 comprises a body casting 26 provided with a strainer chamber 27 communicating at one end with the conduit portion leading from the top of the water jacket 13 or other points in the cooling system on the high pressure side of the circulating pump, and communicating through an orifice 28 leading into the

side of the chamber 27 and communicating with the portion of the conduit 23 leading to the steam generator 21. A needle valve stem 30 is threaded into the supply valve body 26 and arranged to regulate the flow through the restricted orifice 28. A needle valve adjustment knob 31 is secured to the end of the needle valve stem 30 for rotating the latter so as to regulate the effective opening of the orifice 28 and thus restrict, throttle and/or meter the amount of water flowing through the valve 25 so that the desired amount of water will be fed to the steam generator. The needle valve adjusting spring 32 is secured to the supply valve body 26 by means of a lock nut 33 and cooperates with the periphery of the adjustment knob so as to retain the needle valve in the desired adjusted position. A packing nut 34 and packing 35 are employed to effect a seal about the valve stem 30. One end of the strainer chamber 27 may be closed by a plug 36 threaded to the supply valve body 26 to hold the strainer 37 in position, and removable therefrom for the purposes of cleaning or replacing the strainer 37 which is employed to separate out scale, dirt or other foreign matter from cooling liquid passed through the valve so that such foreign matter will not be conveyed by the liquid into the heating system.

Referring now to Figs. 1 and 4 it will be noted that a check valve 40 is also interposed between the feed water conduits 23' and 23, consequently between the regulating valve 25 and the steam generator 21 but at a point relatively close to the valve 25 so as to permit the use of a minimum length of by-pass tubing to be hereinafter referred to. The valve 40 comprises a body 41 provided with a chamber 42 in which is disposed a gravity operated check valve flapper 43 pivoted to the valve body 41, as indicated at 44, and adapted to close a valve port 45 against the flow from right to left as viewed in Fig. 4 but to permit flow from left to right through the valve port 45. The valve body 41 is provided with a removable plug 46 which upon removal will permit cleaning, inspection or replacement of the check valve flapper 43. For the purpose of simplicity in construction and economy in manufacture the plug is additionally formed to provide a part of the present invention, but this will be described later and for the present stage of description may be considered simply as a plug.

Referring again to Fig. 1, it will be noted that the discharge side of the steam generator 21 is extended as at 51 to form a conduit connecting the steam generator with the upper end of a heater radiator 52 adapted to be arranged within the body of the automobile. The radiator 52 comprises upper and lower headers 53 and 54 respectively and tubes 55 or other suitable heat transfer means interconnecting the headers. A return conduit 56 leads from the bottom header 54 and communicates with the conduit 15 at a point adjacent the inlet of the pump 16. A fan 57 operable by a suitable electric motor 58 is mounted in back of the tubes 55 or equivalent heat transfer means of the radiator 52 in order to cause a forced circulation of air therethrough. The radiator 52 and motor and fan assembly may be connected to the dash 60 of the automobile in any suitable manner for supporting the same, a convenient method being to support it by means of the pipes or conduits leading into and out of the upper and lower header thereof.

Reference may now be had to Figs. 1 and 3 which illustrate the arrangement and construction of an exhaust throttling and safety valve 61 interposed in the return conduit 56 leading back to the engine cooling system. This valve comprises a body portion 62 provided with a longitudinal passage 63 communicating at the left hand end, as viewed in Fig. 3, with the portion of the return conduit 56 and communicating at the right end with the portion of the return conduit leading to the radiator 52. The passage 63 is provided with an orifice 64 which cooperates with a needle valve stem 65 threaded to the valve body 62, as indicated at 66, for regulating the effective area of the orifice 64. The valve stem 65 is of the same construction as the valve stem 30 illustrated in Fig. 2 and is provided with a similar adjusting knob 70 adapted to be locked in fixed position by means of the needle valve adjusting spring 71. A by-pass 72 is provided in the valve body 62 and communicates with the passage 63 on both sides of the restricted orifice 64. A ball valve 73 is adapted to cooperate with a valve port 74 provided in the by-pass 72 and is yieldably urged into position closing such port by means of a spring 75. A spring retainer nut 76 is threaded to the valve body 62 to retain the spring 75 in compressed condition to urge the ball valve 73 toward its closed position.

The valve 61 is adjusted to impede the flow of water or steam through the return conduit 56 so as to cause a positive pressure to be built up within the radiator 52 and thereby increase the heating effect of such radiator, especially for low operating speed of the engine 11. If excessive pressures develop within the radiator 52, these pressures will depress the ball valve 73 against the force of the spring 75 and by-pass steam or water, or both, through the by-pass passage 72 into the return conduit 56 to prevent damage to the radiator. The compressive stress of spring 75 determines the pressure at which the valve 73 will be depressed and consequently the maximum pressure that may be built up in the radiator 52.

In the operation of the apparatus thus far described, when the engine 11 is operating, water from the water jacket 13 and which is under the discharge pressure of the pump 16 will be forced through the valve 25 at a rate determined by the setting thereof, through the check valve 40 to the steam generator 21 where the exhaust gases passing through the exhaust pipe 20 will cause such water to be turned to steam which will flow through the duct 51 to the radiator 52 and after passing through the radiator 52 will be returned to the engine cooling system on the suction side of the pump 16 through the duct 56, the valve 61 normally retarding the flow from the radiator 52 so as to maintain a positive pressure on the steam within the radiator. The steam in passing through the radiator 52 will give up heat to the surrounding air and this transfer of heat will be accelerated or increased by operation of the fan 57 and motor 58. Should the pressure of the steam in the radiator 52 exceed a desirable maximum value the ball valve 73 will be moved away from its seat 74 to permit steam to be by-passed around the stem 65 until the pressure of the steam in the radiator 52 has been reduced to the desired value. Now it will be readily understood that the capacity of the steam generator 21 for a given diameter of tubing, and it may be noted that five-sixteenths inch tubing may be advantageously employed for the steam generator in the majority of installations, will be approximately proportional to the length of the steam generator. Considering that the greatest mileage put on the average automobile

is at a speed of 30 miles per hour or less, when the engine is running at only part speed and under part load conditions, it will be understood that the generator 21 should be made of such length as to permit an ample supply of steam at such speed to maintain the desired high degree of temperature in the automobile body. I have found, however, that when the generator is so proportioned and the automobile is driven at relatively high speed and particularly at high speeds and under full loads, the amount of heat transferred to the fluid in the generator is in excess of that required to turn the water within it into steam, and consequently the steam formed becomes super-heated, in some cases to such a degree that its temperature is sufficient to melt the solder employed in the construction of the radiator 52, and when this occurs the radiator 52 leaks and allows such super-heated steam to escape into the interior of the automobile body, creating a dangerous condition.

To overcome this defect and still permit ample amounts of heat to be provided at lower engine speeds and loads, means are provided as previously mentioned for introducing fluid of a lower temperature for admixture with the super-heated steam fed from the generator, thus reducing the temperature of the steam to a value below that which is liable to have destructive effects on the heating system. The particular method of doing this as illustrated in the drawing, by way of illustration, is to provide a by-pass tube 90 between the check valve 40 and the conduit 51 adjacent its point of connection with the radiator 52. This connection with the conduit 51 is effected by the employment of a Y 100 in the conduit 51. To connect the by-pass tube or conduit 90 to the check valve 40 the plug 46 is provided with a central bore 101 into which the corresponding end of the tube 90 is threaded. The bore 101 which leads into the hollow interior 42 of the valve body 41 on the down stream side of the flapper valve 43, is enlarged as at 102 to provide a shoulder 103. The lower end of the bore 101 is closed by an apertured plug 104 which provides a seat for the ball valve 105 which, in turn, is constantly urged toward seated position by means of a coil spring 106 maintained under compression between the ball 105 and the shoulder 103. Liquid and/or vapor may thus pass from the upper end of the duct 23, past the ball valve 105 and through the duct 90 to the radiator 52 without having passed through the steam generator 21, but may not flow in the opposite direction. It will be evident that any liquid or vapor in the upper portion of the conduit 23 will not be super-heated and consequently in passing through the duct 90 and being discharged into the upper end of the duct 51 or radiator 52 with super-heated steam from the steam generator 21, will reduce the super-heat in and the temperature of such steam.

At first glance it might appear that where the pressure of the spring 106 is appreciable, no flow of lower temperature fluid through the duct 90 as above described would ever occur due to the fact that those portions of the ducts 23 and 51 connected by the by-pass tube 90 are fully open to each other through themselves and through the steam generator 21. Tests conclusively prove, however, that such flow does actually occur. The force of the spring 106 is desirably such as to permit a flow of fluid through the by-pass 90 to the radiator 52 only when conditions of operation make this desirable.

Two theories may explain the opening of the valve 105 to permit by-passing of fluid through the duct 90. One of these is that because the length of the tube forming the steam generator 21 and its conduit branches 23 and 51, and because of their relatively small diameters, the frictional resistance offered to the flow of fluid therethrough causes a sufficient drop in pressure to occur between the opposite ends of the by-pass 90, under the influence of the difference in pressures existing on opposite sides of the cooling system pump 16 at high engine speeds, to cause opening of the ball valve 105 and consequent feeding of water, saturated steam, or a mixture of both to be passed from the upper end of the conduit 23 through the by-pass 90 to the radiator 52.

Another theory is that at high engine speed the capacity of the generator 21 is so great that the limited amounts of water fed to it through the valve 25 are almost instantly turned to steam in the generator, and that this sets up surges in the generator 21 and conduits 23 and 51. When such a surge occurs, the column of water between the generator 21 and valve 40, because of its inertia, acts in the same manner as a water ram, causing a momentary build up of pressure in the upper end of the conduit 23 of sufficient extent to overcome the spring 102 and force some of the water of this column past the ball valve 105 into the by-pass 90. It will be observed that in such case the same water ram effect would not be present in the conduit 51 for the reason that only steam, and of a superheated nature, would exist simultaneously therein and, therefore, such steam would not have sufficient mass or offer sufficient resistance to flow to be effective as a water ram. In any case it may be taken as a fact that in constructions substantially identical to that shown in the drawing, the provision of the by-pass 90 and cooperating parts will act to materially reduce the temperature of steam in the radiator 52, at a predetermined high engine speed and load, over that which would otherwise be present if the by-pass 90 were eliminated. The effectiveness of the by-pass 90 in this respect will, of course, vary in accordance with the design and adjustment of different installations.

While but one embodiment of the present invention has been shown in the accompanying drawing various modifications thereof will be apparent to those skilled in the art once the teachings herein are disclosed to them and, accordingly, it will be understood that formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. In combination with a water cooling system of an internal combustion engine, a heating radiator, a feed pipe connecting said cooling system and radiator, a steam generator in said feed pipe, a check valve in said feed pipe between said cooling system and said generator for preventing return flow of fluid from the generator to the cooling system, a return pipe connecting said radiator and cooling system, a by-pass conduit communicating at one end with the portion of said feed pipe extending between the check valve and the steam generator and at the other end with a second portion of the feed pipe extending between the steam generator and the radiator,

said by-pass being subjected to a varying pressure differential between the ends thereof during operation of the heating system, and pressure responsive means in said by-pass conduit operable in response to a predetermined pressure differential to pass fluid from the first named portion of said feed pipe into the second portion of the feed pipe.

2. In combination with a water cooling system of an internal combustion engine, a heating radiator, a feed pipe connecting said cooling system and radiator, a steam generator in said feed pipe, a check valve in said feed pipe between said cooling system and said generator but separated a material distance from said generator for preventing return flow of fluid from the generator to the cooling system, a return pipe connecting said radiator and cooling system, a by-pass conduit communicating at one end with the portion of said feed pipe extending between the check valve and the steam generator at a point adjacent the check valve and at the other end with a second portion of the feed pipe extending between the steam generator and the radiator, said by-pass being subjected to a varying pressure differential between the ends thereof due to steam flow toward the radiator, and pressure responsive means in said by-pass conduit operable in response to a predetermined pressure differential to pass fluid from the first named portion of said feed pipe into the second portion of the feed pipe.

3. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the body radiator, of means responsive to a condition in the system which accompanies excess heating in said radiator for introducing lower temperature fluid thereinto for the purpose of reducing the temperature of fluid therein.

4. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the body radiator, of means responsive to a condition in the system which accompanies excess heating in said radiator for introducing lower temperature fluid from one of said systems thereinto for the purpose of reducing the temperature of the fluid therein.

5. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the connection between the steam generator and body radiator and the first mentioned connection of means responsive to a condition in the system which accompanies excess heating in said radiator for feeding fluid from said first mentioned connection to said connection between the steam generator and body radiator.

6. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the connection between the steam generator and body radiator, of means responsive to an increase in pressure differential between the inlet and outlet of said generator which accompanies excess heating in said radiator for introducing lower temperature fluid from one of said systems into the last mentioned connection for the purpose of reducing the temperature of the fluid therein including a by-pass between said one of said systems and the last mentioned connection, and a check valve for controlling the direction of flow through said by-pass.

7. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the connection between the steam generator and body radiator and the first mentioned connection, of means responsive to an increase in pressure differential between the inlet and outlet of said generator which accompanies excess heating in said radiator for feeding fluid from said first mentioned connection to said connection between the steam generator and body radiator including a by-pass between said first mentioned connection and the last mentioned connection, and a spring pressed check valve in said by-pass.

8. In an automobile body steam heating system including a steam generator and a body radiator connected in series with different portions of the automobile engine cooling system and having a metering device and a check valve in the connection for conducting fluid from the cooling system to the generator, the combination with the connection between the steam generator and body radiator of means responsive to an increase in pressure differential between the inlet and outlet of said generator which accompanies excess heating in said radiator for introducing lower temperature fluid from one of said systems thereinto for the purpose of reducing the temperature of the fluid therein including a by-pass between said one of said systems and the last mentioned connection, and means in said by-pass for restricting the flow therethrough.

9. The method of preventing excess temperatures in the heating radiator of an automobile heating system including a steam generator receiving heat from the exhaust gases, and said radiator in series wherein an increase or decrease in pressure differential, produced between the supply and discharge lines of the generator due to the rate of steam formation therein, is accompanied by a corresponding change in the temperature in said radiator, said method comprising introducing fluid of lower temperature than the temperature of the steam from said generator into said radiator when said pressure differential exceeds a predetermined value.

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