Sept. 4, 1928. 1,683,101

S. W. RUSHMORE

COMBINED ENGINE COOLING AND CAR HEATING SYSTEM

Filed Oct. 31, 1924 2 Sheets-Sheet 1

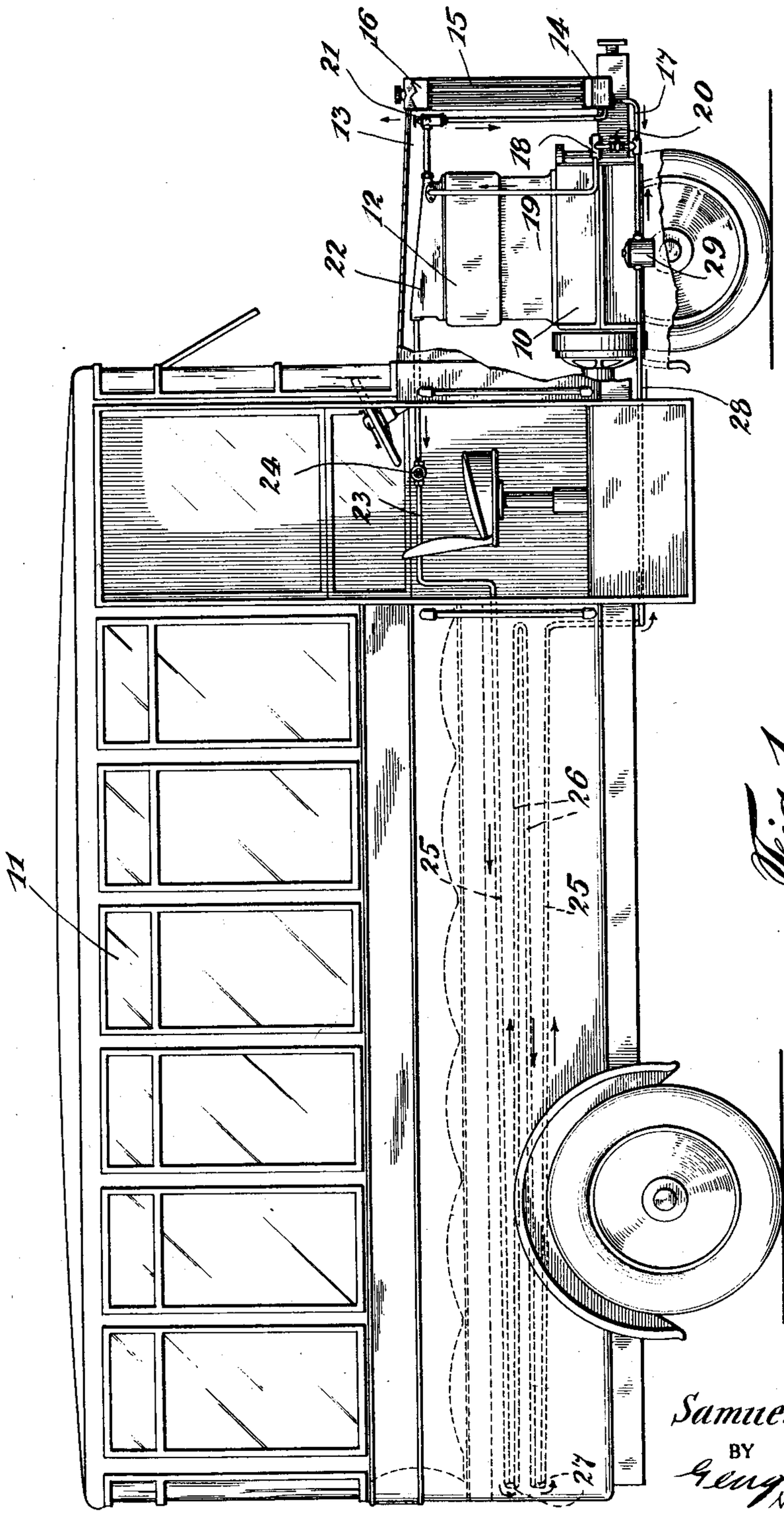

Fig. 1.

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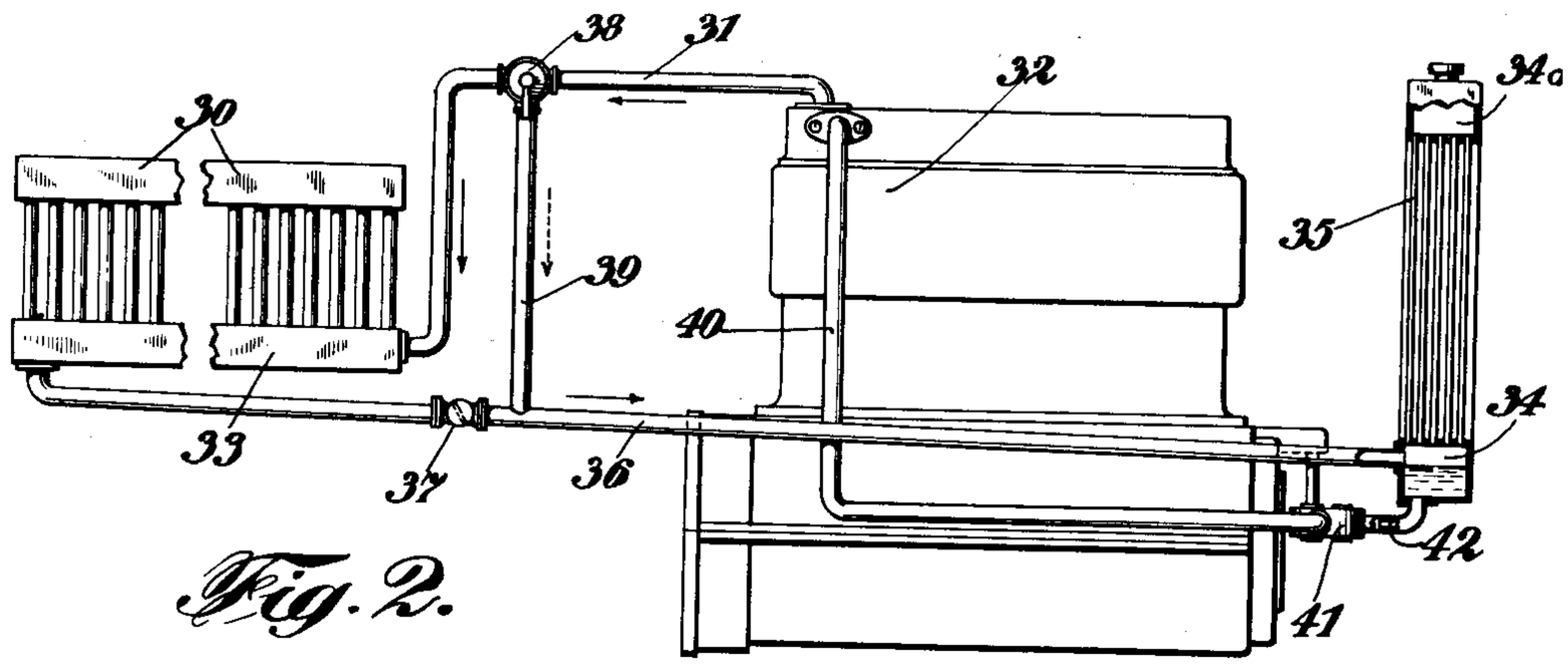

Fig. 2.

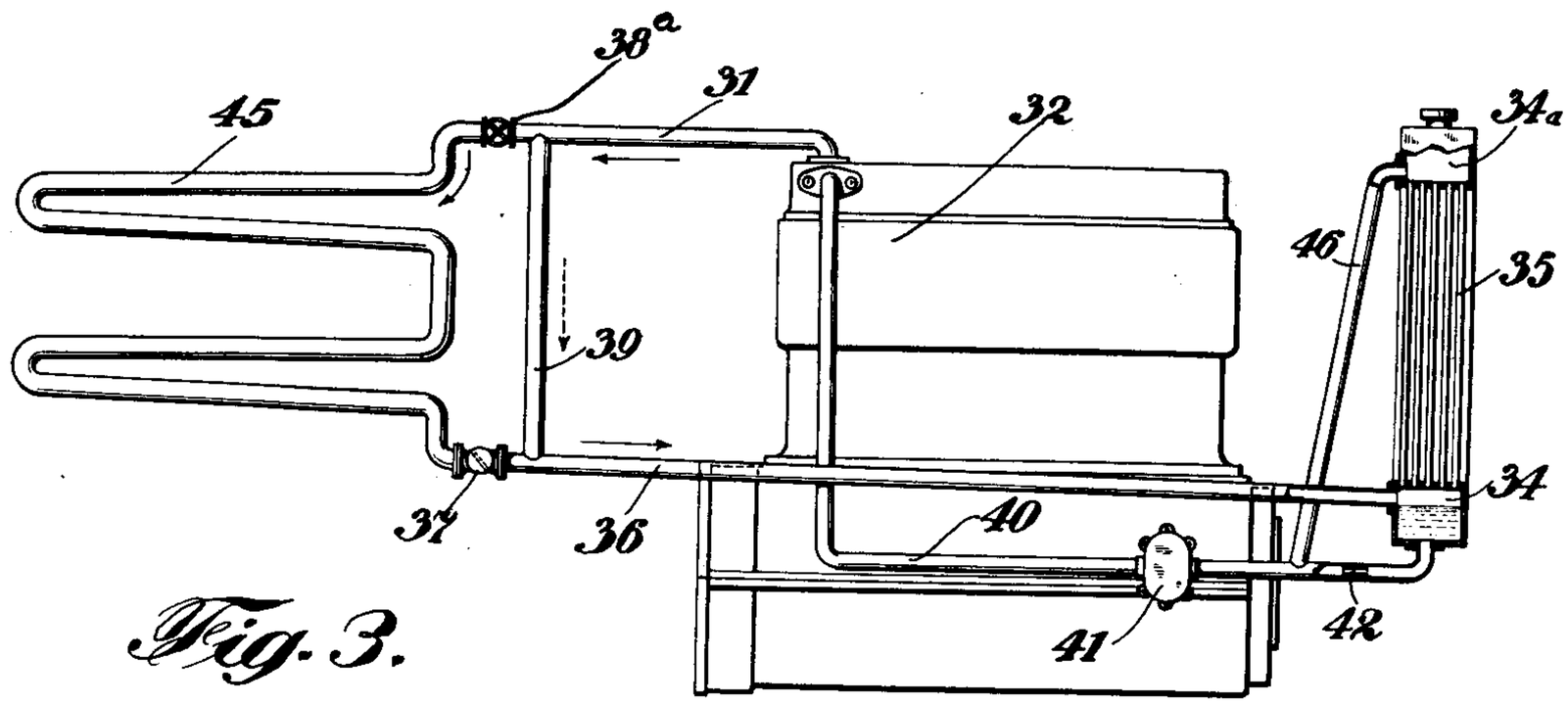

Fig. 3.

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UNITED STATES PATENT OFFICE.

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COMBINED ENGINE-COOLING AND CAR-HEATING SYSTEM.

Application filed October 31, 1924. Serial No. 746,926.

My present invention relates to an improved system for heating automotive vehicles from the cooling system of the engine, by circulating hot water alone, steam and hot water combined, or steam alone, according to the conditions.

Heretofore, various types of apparatus have been employed, some circulating hot gas from the engine exhaust, others hot water from the engine jacket and others steam from the engine jacket, but all of these have their own peculiar disadvantages. The use of steam alone has been proposed, but only in connection with a cooling system in which the radiator is used as a down-flow condenser whereby the full cooling effect of the radiator is utilized continually, so that it takes a long time to reach the stage where steam is evolved for circulation in the heating system and there is no circulation of hot water at any time.

The construction and arrangement of the up-flow steam condensing cooling systems disclosed in various of my prior patents and particularly in my application, Serial No. 746,023, filed October 27, 1924, makes it possible to utilize both the water and the steam from the engine jacket as a heating medium. The cooling system of said application embodies in addition to the jacketed element to be cooled, an air cooled upflow steam condenser provided with upper and lower tanks or headers connected by an intermediate honey comb, preferably in the nature of a plurality of vertically disposed tubes of restricted cross section. Cooling water from the jacket is short circuited through the lower tank of the radiator and pumped back to the jacket. The return conduit from the lower water tank of the radiator to the pump is provided with a restriction to limit the rate of flow to the pump to an amount considerably less than the capacity of the pump. The orifice or restriction is so proportioned that the water delivery therethrough will be just sufficient to supply the engine jacket with a quantity of water slightly greater than that needed to satisfy the maximum evaporative requirements of the engine. By thus regulating the size of the orifice, the supply of water to the jacket becomes a simple boiler feeding problem, the jacket itself being nothing but a miniature steam boiler, and water being fed thereto as fast as it can be boiled off. Since it is not a difficult matter to determine the flow necessary for supplying the jacket with slightly more than the maximum of water requirement and since the difference between the amount required when the engine is running at high speed and the amount required when the engine is idling, is not very great, the surplus water flowing with the steam from the jacket at normal speeds, may be made relatively small.

The fact that there is substantial surplus water thus flowing with the steam, at normal speeds and a much greater amount during the warming up period, is important as concerns my present invention.

The feature of short circuiting the radiator circulation through a short low resistance path in the water jacket, as in my application Serial No. 746,022, filed October 27, 1924, insures even quicker and more certain supply of steam for my present steam heating of the car.

In my present car heating system I associate with a system of the character above described, an elongated water and steam conduit disposed within the interior of the car or bus. A spring loaded check valve is provided in the usual line from the jacket outlet to the lower chamber of the radiator condenser. The water and steam heating line communicates at one end with the jacket and the back pressure developed in the jacket by the check valve causes the boiling fluid which is mostly steam to be forced through the heating pipes, where it is condensed and gravitationally returned to the return conduit from the lower tank to the pump at a point between the tank and the restricted orifice. The heating pipes thus serve to condense the steam generated in the jacket and no steam will pass to the usual radiator unless sufficient pressure is developed in the jacket to force the steam past the check valve, there being no spring loaded check valve in the lead to the heating pipes, hot water is free to flow through this pipe even when restrained from passing through the radiator.

Preferably the heater pipes may be entirely cut off by a manually operated valve when weather conditions render the use of the heater unnecessary. The check valve is preferably manually adjustable to exert any desired back pressure on the radiator or to entirely relieve such pressure and permit the usual cooling circulation to be maintained through the jacket, radiator and pump. The

manually operated valve is preferably located within the body of the car and when the check valve is properly adjusted, mere turning on or off of the hand valve in the heater circuit serves to automatically shift the circulation of water or steam or both, to or from the radiator without any manual adjustment of the check valve.

Inasmuch as the temperature of the water in the jacket is substantially constant, regardless of whether the engine is running under load or is idling, an adequate supply of steam or steaming water will always be furnished for heating the car and inasmuch as the supply of water to the jacket is nicely regulated, the surplus water which may be forced or blown into the heating pipes under normal full load condition becomes a negligible factor because it is at boiling temperature and its amount is small as compared with the steam. In one embodiment herein illustrated, the car heater outlet is from a higher level than the radiator outlet; consequently, when both circuits are working, the operation tends to be selective, to pass steam into the heater circuit while more of the boiling water will go with the steam into the radiator circuit. However, as will be obvious, there is no such selective action until the condensing capacity of the car heater has been considerably exceeded by the engine output of heat and, as before noted, the pressure check valve in the lead to the radiator ensures selectivity in favor of circulation of all the fluid, first water and then steam, through the car heater circuit before the radiator comes into action at all. Under extreme conditions of operation where some of the steam may possibly pass uncondensed through the heater pipes I prevent such steam from reaching the return pump, either by the use of a suitable steam trap or by the provision of a steam off-take leading directly to the lower tank of the upflow steam condenser.

By the construction above described, I have associated with the jacket, a pair of parallel steam and water circulating and condensing systems, one of which is through the heater pipes in the car and the other of which is through the usual air cooled condenser. When proper weather conditions prevail, these systems may be simultaneously operated but I make it possible to optionally cut off either of them and use only the other for condensing purposes without in any way interfering with the proper cooling of the engine, and while maintaining a supply of water to the engine, which is slightly above the minimum required for taking care of a maximum load on the engine.

In accordance with another embodiment of the invention, instead of using the parallel steam circuits, I may direct all of the steam from the jacket directly through the heating elements and thence to the usual condenser, the condensate and the steam which fails to condense in the heating elements being taken care of in the usual manner. With this form of construction, it is necessary to provide a by-pass for cutting the heating elements out of the circulation when heating is unnecessary. By arranging the heating elements in series instead of in parallel with the usual radiator, I am able to eliminate the spring loaded check valve and the usual direct communication from the engine jacket to the radiator, and insure that the water in the front radiator be kept from freezing regardless of the output of the engine.

With the heating element and the radiator serially arranged, I may use heater consisting of a number of lengths of pipe gravitationally draining to the front radiator or I may provide an upflow steam radiator very similar in construction to the condenser used at the front of the machine.

The invention may be more fully understood from the following detailed description in connection with the accompanying drawings wherein:

Figure 1 is a view mainly in side elevation and partly in section of a motor bus equipped with a heating and cooling system construction embodying my invention.

Figure 2 is a diagrammatic view mainly in side elevation illustrating a slightly modified construction.

Figure 3 is a similar view illustrating a further modification.

Referring to Figure 1, an internal combustion engine 10, is mounted in the usual position at the forward end of a bus 11. The ordinary cooling system for the engine includes a jacket 12 having an outlet pipe 13 at its upper forward end through which water is passed to a tank 14 at the lower end of a vertical upflow steam condenser including restricted upflow steam condensing passages 15 opening at their upper ends into an upper header 16. Water from the lower tank 14 is passed back through a conduit 17 to a pump 18 by which it is returned through a conduit 19 to the jacket, the inlet from 19 being arranged relatively close to the outlet of pipe 13 to make possible a short circuited water circulation through the jacket as described at some length in my copending application, Serial No. 746,022, filed Oct. 27, 1924. The return conduit 17 to the pump is controlled by the valve 20, this valve being manually adjustable to regulate the size of an orifice which controls the supply of water to the pump and consequently to the jacket. The orifice is proportioned to ensure circulation of a supply of water slightly above the maximum evaporative requirements of the engine. In other words, it is so proportioned,

that the output from the jacket through pipe 13 will be practically all steam when the engine is operating under a heavy load. Under such exceptional peak load conditions, the excess water will be carried in finely subdivided or vapor form, by the steam.

In accordance with the present invention, I employ a spring loaded valve 21 in the hot water and steam pipe 13 and this valve being manually adjustable to produce any desired back pressure in jacket 12 and under ordinary operating conditions being set for about five pounds pressure. A second outlet 22 at the rear upper end of the jacket, opens into an elongated hot water and steam conduit 23 running through the passenger compartment of the bus. Conduit 23 is preferably controlled by a manually operable valve 24 and may include in connected series, lengths of pipe 25, 25 on one side of the bus connected to lengths of pipe 26, 26 on the other side of the bus, by transverse lengths of pipe 27 which may be at the rear end of the compartment. The arrangement and extent of the pipe 23, 25 26 and 27 is obviously entirely optional, and various expedients might be resorted to in this connection. I prefer however, that the entire piping be so inclined as to drain throughout its entire length into a return pipe 28 which communicates with the pipe 17 at a point between the tank 14 and the control valve 20 so that a gravitational return of condensate may be had. I prevent steam which may find its way through the pipes 23, 25, 27 and 26 from going back to the pump either by providing a steam offtake from 28 to the tank 14 or by the use of a steam trap 29 of any appropriate construction in the return pipe 28.

In operation of the system, it will be understood that the water which is only slightly in excess of the requirements under the most trying conditions, will be in much greater excess under normal conditions and under extreme conditions in the other direction, namely, very cold weather, and during warming up periods will constitute the sole circulating medium. Thus, at starting the circulating fluid will be all water. As the engine warms up, the water will quickly become heated to the boiling point and then to a point where it carries substantial quantities of steam. Such conditions will vary back and forth according to the conditions. Naturally, when the object of the operator is to get plenty of heat in the car rather than to be sure of best running conditions for his motor, operation of the car heating branch of the circuit may be sufficient to keep the water at or below boiling for a much longer time than it would for circulating through the base of the radiator in the usual way.

In normal operation of the system, however, assuming valve 24 to be wide opened and valve 21 set for a pressure of say 5 lbs. practically no water or steam will escape to the lower tank 14 of the condenser but most of it as boiling water and steam in varying proportions as above described will be forced through the system of heating pipes 23, 25, etc., and the steam condensing in these pipes will return as condensate together with the original excess water through the pipe 28 to the pump. Under certain operating conditions as for instance where the engine is working under a heavy load or where temperature in the passenger compartment of the bus is very high, or the valve 24 is partly closed, steam and the slight amount of excess water escaping from the jacket 12 will divide, some going through the heating pipes and the rest forcing its way past the valve 21 and entering the tank 14 of the radiator where condensation will take place in the usual manner. When valve 24 is shut off, valve 21 is preferably manually adjusted to relieve back pressure and the regular circulation through the jacket radiator and pump will be maintained. Under normal working conditions, the steam trap prevents the pressure in the heater from forcing steam back up into the pump intake and cutting off the water supply. The vehicle is thus equipped for satisfactory all year round operation. The heating system may be used whenever necessary with whatever heating fluid may be then available from the engine, without interfering with proper cooling of the engine, at the same time, all of the disadvantages incidental to heating by exhaust gases or by hot water alone or by steam alone are done away with.

In Figure 2 I show a somewhat modified construction wherein an upflow steam radiator 30 is substituted for the down flow condenser of Figure 1 as the heating element within the car. A steam offtake pipe 31 from the upper rear end of the engine jacket 32 leads to the lower header 33 of the radiator. Condensate and steam from radiator 30 are drained directly to the bottom tank 34 of the usual upflow air cooled radiator 35 at the front of the machine through a pipe 36. Pipe 36 is provided with a one way flow valve 37 and pipe 31 provided with the manually operable three way valve 38 to permit the steam and excess water from jacket 32 to be optionally by-passed through a pipe 39 without entering the radiator 30. With this form of construction, I need no flow line from jacket 32 to the radiator 35 except through the by-pass 39 or through the radiator 30. The necessity for using the spring loaded check valve 30 is obviated, since excess pressures which might occur in radiator 30 are taken care of by the condenser 35 in the usual manner. The condensate from tank 34 is passed back to the engine 32 through a pipe 40 by pump 41. The flow of water to the pump is regu-

lated as by an orifice 33 in the pipe line from the lower tank 34, to an amount slightly in excess of the maximum evaporative requirements of the engine, and the pipe 40 preferably delivers into the jacket at the rear upper end thereof closely adjacent the offtake to the pipe 31 so that while the water in the jacket is heating, a short circuited water circulation may be maintained between 40 and 31.

The diagram of Figure 3 illustrates a further modification which is quite similar to the modification of Figure 2 except that I substitute a down flow condensing element 45 consisting of a number of lengths of piping for the radiator 30. With this construction as with the construction of Figure 2, the normal flow is through offtake 31, condenser 45, and pipe 36 to the lower tank 34 of a conventional upflow steam condenser 35 at the front of the machine and the return to the jacket is through a pipe 40 controlled by an orifice 42 to the circulating pump 41. I may provide a drain pipe 46 from the upper header 34ª of a condenser 35. The drain pipe 46 takes care of water which may be forced into the upper header 34ª under excessive load and also serves to equalize pressures on opposite sides of the orifice 42 so that excessive pressures in the condenser 35 can not appreciably increase the rate of flow through the orifice and force an undesirably large quantity of water to the pump. The advantage of using such a drain pipe have been set forth at some length in my copending application, Serial No. 746,023, filed October 27, 1924. The arrangement of Figure 3 also includes a pipe 39 for by-passing steam evolved in the engine jacket when the heating element 45 is not in use and the control valve 38ª in the pipe line 31 is shut off. Upflow of steam from 36 into the heating element 45 is prevented by a one way flow valve 37 of the character above described. With this construction, it will be noted that a certain amount of steam and excess water is always by-passed through 39 even when the valve 38 is open, the steam dividing and going through both the heating element and the by-pass pipe. The construction shown in Figures 2 and 3 insures against freezing the water in radiator 35 since some steam or hot water is sure to reach chamber 34.

I claim:

1. An automotive vehicle, including a vehicle body and an internal combustion engine having a closed circuit cooling system designed to circulate water slightly in excess of the maximum evaporative requirements for cooling the engine by the boiling and condensing cycle, said system including an engine jacket and a plurality of cooling circuits supplied therefrom, one being a primary cooling circuit including an exterior air cooled radiator connected to operate as an up-flow condenser with its lower portion only serially included in said circuit so that, in its normal operation, the heat transfer is by the boiling and condensing cycle and the excess water is kept at boiling point; and another cooling circuit including heat radiating means in the body of the vehicle; in combination with a common return and circulating pump for returning excess water and condensate from said circuits to the jacket.

2. An automotive vehicle, including a vehicle body and an internal combustion engine having a closed circuit cooling system designed to circulate water slightly in excess of the maximum evaporative requirements for cooling the engine by the boiling and condensing cycle, said system including an engine jacket and a plurality of cooling circuits supplied therefrom, one being a primary cooling circuit including an exterior air cooled radiator connected to operate as an up-flow condenser with its lower portion only serially included in said circuit so that, in its normal operation, the heat transfer is by the boiling and condensing cycle and the excess water is kept at boiling point; and another cooling circuit including heat radiating means in the body of the vehicle; in combination with a common return and circulating pump for returning excess water and condensate from said circuits to the jacket; and means for opening and closing the circuit through the heat radiating means in the body of the vehicle.

3. An automotive vehicle, including a vehicle body and an internal combustion engine having a closed circuit cooling system designed to circulate water slightly in excess of the maximum evaporate requirements for cooling the engine by the boiling and condensing cycle, said system including an engine jacket and a plurality of cooling circuits supplied therefrom, one being a primary cooling circuit including an exterior air cooled radiator connected to operate as an up-flow condenser with its lower portion only serially included in said circuit so that, in its normal operation, the heat transfer is by the boiling and condensing cycle and the excess water is kept at boiling point; and another cooling circuit including heat radiating means in the body of the vehicle; in combination with a common return and circulating pump for returning excess water and condensate from said circuits to the jacket; and loaded valve means for maintaining a predetermined back pressure opposing flow into said exterior radiator.

4. An automotive vehicle, including a vehicle body and an internal combustion engine having a closed circuit cooling system designed to circulate water slightly in excess of the maximum evaporative requirements

for cooling the engine by the boiling and condensing cycle, said system including an engine jacket and a plurality of cooling circuits supplied therefrom, one being a primary cooling circuit including an exterior air cooled radiator connected to operate as an up-flow condenser with its lower portion only serially included in said circuit so that, in its normal operation, the heat transfer is by the boiling and condensing cycle and the excess water is kept at boiling point; and another cooling circuit including heat radiating means in the body of the vehicle; in combination with a common return and circulating pump for returning excess water and condensate from said circuits to the jacket; and loaded valve means for maintaining a predetermined back pressure opposing flow into said exterior radiator; and means for opening and closing the circuit through the heat radiating means in the body of the vehicle.

5. An automotive vehicle, including a vehicle body and an internal combustion engine having a closed circuit cooling system designed to circulate water sligntly in excess of the maximum evaporative requirements for cooling the engine by the boiling and condensing cycle, said system including an engine jacket and a plurality of cooling circuits supplied therefrom, one being a primary cooling circuit including an exterior air cooled radiator connected to operate as an up-flow condenser with its lower portion only serially included in said circuit so that, in its normal operation, the heat transfer is by the boiling and condensing cycle and the excess water is kept at boiling point; and another cooling circuit including heat radiating means in the body of the vehicle; in combination with a common return and circulating pump for returning excess water and condensate from said circuits to the jacket; and means for determining greater flow through one of said circuits than through the other.

Signed at New York, in the county of New York, and State of New York, this 30th day of October, A. D. 1924.

SAMUEL W. RUSHMORE.