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VAPOR HEATER FOR AUTOMOTIVE VEHICLES

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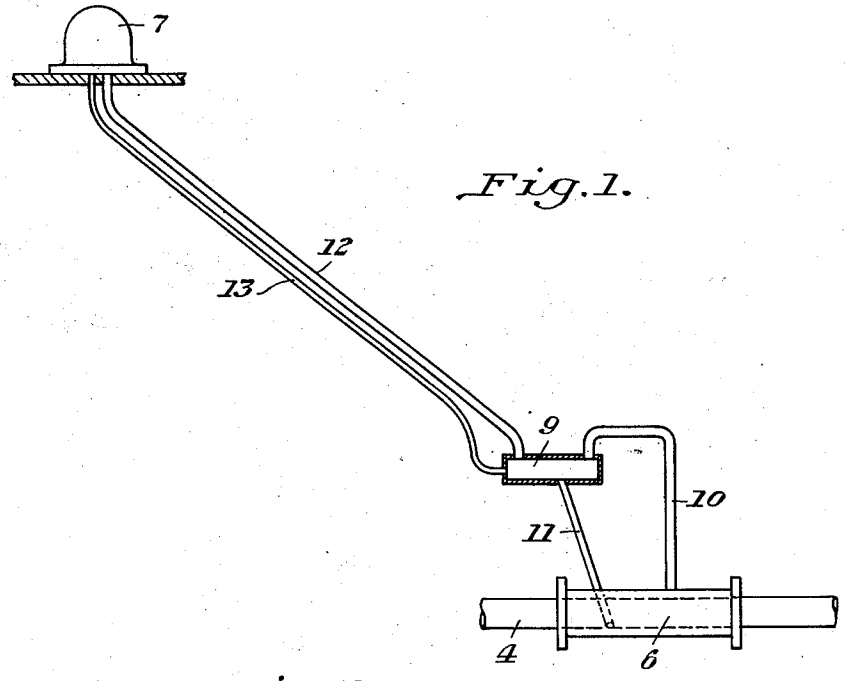


Fig. 1.

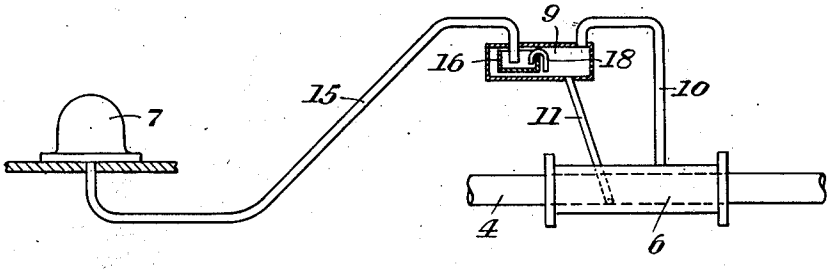


Fig. 2.

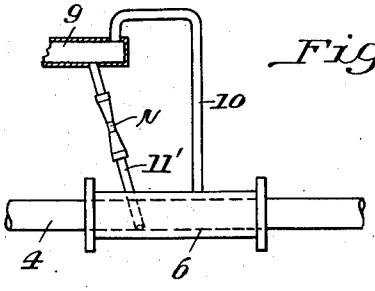


Fig. 3.

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VAPOR HEATER FOR AUTOMOTIVE VEHICLES

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15 Claims. (Cl. 237—12.3)

This invention relates to a closed vapor heating system in which heating medium absorbs heat from the exhaust gases discharged through an exhaust conduit from an internal combustion engine and gives up this heat by way of a radiator condenser to a compartment of the vehicle driven by the internal combustion engine. The system operates as a closed system, and with the heating medium is entrapped in the system a non-condensing gas or gases such as air. The heating medium is changed by the heat of the exhaust gases into a vapor, is circulated to the radiator condenser, there gives up its heat in returning to the liquid state, and returns to the vapor generator or boiler.

A closed vapor heating system, because of the generation of heat quickly up starting up, is peculiarly adapted for use in automobiles, aeroplanes, and the like, wherein the vaporizing heat may be obtained from the exhaust of the internal combustion engine furnishing the motive power of such vehicles. In the operation of such a system, however, unusual conditions arise because of the unsteady source of heat, namely, the exhaust gases. Sometimes the engine will be idling, and again the engine will be running at high speed; and there is not the steady source of heat which is ordinarily an essential part of a heating system. Moreover, the operator of the automobile or the like is not apt to have the skill and generally cannot be brought to exercise such supervision over the operation of such a heating system as to regulate valve so as to control conditions of circulation or to, in some fashion, control the pressure in the system. It is thus wellnigh essential that a restricted quantity of heating medium be installed with the system in the automotive vehicle, a quantity of liquid heating medium which is indeed so small that in normal operation the vapor generator or boiler acts as a flash boiler. Accordingly, the amount of heat carried up to the radiator depends not upon the amount of heat in the exhaust gases primarily, but rather upon the rate of return of condensate to the vapor generator.

In saying that the vapor generator will, with this restricted amount of heating medium in the system, operate as a flash boiler, I mean that a very small portion of condensate enters a substantially dry and very hot boiler, and as the liquid accordingly vaporizes almost instantly, there is a puff of vapor (such as steam) which of course momentarily gives rise to a higher pressure in the boiler. The return of condensate to the boiler is momentarily interrupted. Each minute amount of condensate returned to the boiler causes such a puff of vapor.

These puffs of vapor cause the pressure in the boiler to be momentarily at least much higher than the pressure in the remainder of the system. Of course, if resort is made to a forced feed of liquid to the boiler, the pressure thus generated in the boiler cannot prevent the liquid from gaining access to the boiler. Then again, if the boiler cools down sufficiently, the pressure will drop enough to bring a further increment of liquid into the boiler. It has been my experience, however, that pressure conditions in the system tend to reach a condition of substantial equilibrium during normal operation of the internal combustion engine of the vehicle, the heat of the exhaust gases keeping the pressure in the vaporizer or boiler at a point approximately as high as the pressure in the radiator. Consequently, there is no substantial tendency for a return of condensate to the boiler; and the heating system practically ceases to function. The present invention avoids such a condition of stagnation.

In accordance with my invention, I do away with the necessity for a forced feed of liquid to such a flash boiler. I overcome the back pressure in the flash boiler by closing the system and entrapping therein a non-condensing gas such as air, and furthermore by interposing in the conducting means leading to the radiator condenser an intermediate chamber where the puffs of vapor generated in the boiler may expend themselves without forcing the returning condensate back into the radiator condenser. This intermediate chamber minimizes surges of pressure along the conducting means, which is one of the most serious drawbacks to a two-pipe system having pipes of relatively small cross-section. A two-pipe system has the inherent advantage that the pipes may be of small cross-section, too small to permit the wall flow of condensate which is necessary in a one-pipe system where the condensate must flow in the opposite direction to the vapor within the same pipe. The pipes of relatively small cross-section which the two-pipe system makes possible stand up against the usual vibration in such installations; and as this is conducive of greater durability, it has been found more feasible for the general run of commercial installations to use the two-pipe system. In further perfecting the operation of a two-pipe system, I furthermore overcome any tendency for the condensate to surge back up the return line by sufficiently restricting the return line, so that there is a drag on the liquid should the puff of

pressure in the boiler tend to force this condensate back up the return line.

The function in the system of the non-condensing compressible medium such as air apparently is to maintain the pressure in the radiator above that in the boiler in between the puffs of vapor, to ensure the necessary feed of liquid heating medium to the boiler. Obviously, after each recession of pressure, there must be a pressure differential in favor of flow toward the boiler or else the boiler will operate dry. This pressure differential is accomplished by the air which is placed under compression when displaced by the vaporized heating medium, and acts as a buffer capable of overcoming the vapor pressure in the boiler between the minute explosions or maxima of pressure.

It will be noted that in the above discussion, it has been assumed that with each puff of vapor there is brought about an increase in pressure in the boiler above the pressure in the rest of the system. This must be so if the vapor is to be driven off from the boiler and circulated to the radiator condenser. Obviously, at the time the puff of vapor is generated, there is a pressure differential along the return line tending to drive condensate away from the vaporizer. These momentary excesses of pressure due to puffs of vapor in the boiler occur in all operative closed vapor heating systems, of which I am aware, using such a restricted amount of heating medium as to result in flash-boiler operation; and such puffs of vapor would occur in the system disclosed in my Reissue Patent No. 18,110, granted June 23, 1931. These momentary excesses of pressure in the boiler are not, however, troublesome in a system such as that shown in my reissue patent where there is ample flow area in the connection to the radiator condenser, and where this connection is relatively short. However, in systems where the arrangement of the vapor generator and the radiator condenser is such as to require a connection which is relatively long, a puff of vapor in the generator may force back along the connection the returning condensate so as to cause the boiler to become practically dry. The ensuing loss of pressure differential in the boiler over the rest of the system may cause enough condensate to return to the boiler to again generate a surge of pressure up the connection toward the radiator.

Surging of heating medium up and down the condensate line, known as "blocking", is particularly troublesome where the heating system is installed in an automotive vehicle using the exhaust gases as the source of heat, and is apt to be most pronounced when starting up from a cold condition. Blocking can so seriously interfere with the operation of a closed heating system of this type as to greatly reduce the amount of heat transferred to the radiator and there given off to the compartment of the vehicle. The cushion of air or other non-condensing gas causes the puff of pressure to expend itself in the intermediate chamber; and the condensate in the return line is not driven back into this chamber, especially if the return line is sufficiently restricted so that resistance is offered to quick oscillations of liquid, although the normal flow is not obstructed. This restricting of the quick oscillations can be effected, for example, by using a tube of sufficiently small inner diameter or by placing a restriction in the return line.

In accordance with one aspect of my invention, the intermediate chamber can be made use of to periodically withdraw condensate from the radiator condenser and discharge the same to the vaporizer. With such operation of the system in view, I so construct and arrange the conducting means as to bring about a dispensing action whereby the condensate is periodically returned to the vaporizer or boiler. This permits the use of a closed vapor heating system where the condensate must be automatically returned to the vapor generator from a collecting point at or below the level of the vapor generator.

These and other features of my improvements I will now proceed to point out and explain.

In the drawing which is intended merely to illustrate my invention,—

Fig. 1 illustrates diagrammatically a system in which an intermediate chamber in the conducting means provides a cushion to alleviate blocking;

Fig. 2 illustrates a modification making provision for returning condensate from a collecting point at or below the level of the vaporizing element;

Fig. 3 illustrates a modification in the conducting means which substitutes a restriction for the return line of small cross-section.

This application is a continuation-in-part of my co-pending application Serial No. 298,242, filed August 8, 1928, for Car heaters, and of application Serial No. 415,225, filed December 19, 1929, for Vapor heaters for automotive vehicles.

The vapor generator or vaporizer may be of any suitable type which, when placed in heat absorbing relation to the exhaust conduit 4 discharging waste gases from the internal combustion engine of the automotive vehicle, vaporizes the heating medium for circulation to the radiator condenser which heats the air in a compartment of the vehicle.

As illustrated in the drawing, a vaporizer or boiler 6 is thus related to the exhaust conduit 4, and the vaporized heating medium is circulated by way of conducting means to the radiator condenser 7. Said conducting means include an intermediate chamber 9 common to both the vapor line and the condensate line. This chamber has the function both of providing a space in which the surges of pressure generated by the vaporizer 6 may expend themselves, and also the function of bringing about a separation of liquid from vapor. As pointed out in my copending application Serial No. 752,947, filed November 14, 1934, the volume of the chamber will depend upon the size of the system and the amount of heating medium therein. The length of the lines and the mass of the radiator condenser 7 are both factors which may vary the optimum volume for this chamber. As specified in the above identified application, the ratio of the volume of the chamber to the volume of the liquid in the boiler when cold should not be less than 1 to 10.

The portion of the conducting means which connects the intermediate chamber 9 with the vaporizer 6 comprises a vapor line 10 and a condensate line 11. The condensate returned by the line 11 preferably enters the lower part of the vaporizer 6. In the embodiment shown in Fig. 1 the portion of the conducting means which connects the intermediate chamber 9 with the radiator condenser 7 comprises a vapor line 12 and a return line 13.

When the system is installed, a small amount of liquid heating medium, for instance 1½ ounces, is enclosed in the system, together with non-condensing gas such as the air which naturally

fills the system. Due to the closing of the system, the heat supplied to the boiler 6 by the exhaust gases and the resulting vaporization of the heating medium cause the pressure in the system to rise. The vapor driven off from the boiler 6 drives the entrapped non-condensing gas ahead of it; and after the system has been in operation for a time, the air or other non-condensing gas has been swept by the vaporized heating medium into the radiator condenser 7. The air is, of course, under considerable pressure when thus reduced in volume by being displaced by the heating medium; and acts to cushion surges of heating medium due to flash boiler operation of the vaporizer 6.

As the heating medium boils off from the vaporizer 6 in a succession of puffs or maxima of pressure, the air is compressed and again expanded with the surges of the heating medium along the conducting means. An intermediate chamber such as provided at 9 has an important effect in overcoming "blocking", and establishing unidirectional circulation of heating medium. The surges of vapor and liquid discharge into this chamber when the system starts up from the cold condition. Meanwhile, there follows a recession of pressure, which causes the condensate to return, more particularly down the condensate line. It will be noted that in Figs. 1 and 2 the condensate line 11 is of less cross-section than the vapor line 10. A modification is shown in Fig. 3 according to which a definite restriction r is placed in the condensate line 11'. The purpose of restricting the return line as illustrated in Figs. 1, 2 and 3 is to offer resistance to quick oscillations of liquid heating medium. This resistance should not be sufficient to obstruct normal flow of condensate. Ordinarily, a tube which is of sufficiently small cross-section so that flow of liquid in one direction and of vapor in the other direction simultaneously cannot take place offers such resistance to quick oscillations of liquid therein that the objectionable blocking is dampened.

In the embodiment shown in Fig. 2 the intermediate chamber is made use of to periodically receive from the radiator condenser the condensate which has accumulated therein and to automatically return such condensate in volume to the vaporizing chamber, the cycle being repeated again and again. This arrangement of the heating system is particularly desirable where the condensate collects at a point below the level of the vaporizer 6. In this arrangement of the system, as in the embodiment shown in Fig. 1, a small amount of liquid is so placed in the system that it will gravitate into the boiler 6. As the hot exhaust gases pass along the conduit 4, this heating medium is vaporized and circulates by way of the vapor line 10 into the intermediate chamber 9. From this intermediate chamber it proceeds through the single conduit 15 to the radiator condenser 7 where it gives up part of its heat and condenses. The air or other non-condensing gas pushed ahead of the vapor into the radiator 7 is compressed thereby. This process may continue until all the liquid in the vaporizer has been vaporized and expanded into the closed heating system.

When the flow of hot vapor into the closed chamber 9 diminishes or ceases, which may be when all the liquid in the boiler 6 has been vaporized and expanded into the system, that chamber will be cooled by the surrounding air, which causes a drop in the pressure within this portion of the system to a point below that of the pressure of the noncondensing gas within the radiator condenser 7. This condition is accentuated by the fact that air has already been driven out of the closed chamber 9 into the radiator condenser 7 by the vapor driven off from the boiler 6. When the pressure of the trapped gas in the radiator exceeds that in the closed chamber 9, the trapped gas will force the condensate in the radiator condenser out through the conducting means 15 into the closed chamber 9 where it will accumulate in a reservoir or receptacle 16 therein. It will thus be apparent that vapor is caused to flow to the radiator condenser 7, or on the other hand that condensate is caused to flow back into the chamber 9 along the common conduit 15 in accordance with whether the pressure is greater in the chamber 9 than in the radiator 7 or vice versa.

Until the level of the liquid in the receptacle 16 reaches the top of the siphon 18 no liquid returns to the boiler 6, the condensate forced out of the radiator condenser 7 and along the conduit 15 being collected in the reservoir or receptacle 16. But when the liquid has risen above the level of the top of the siphon 18 it will be immediately, and practically entirely, discharged from the receptacle 16 into the closed chamber 9, from which it will run back to the boiler 6 through the return line 11 to be revaporized and to again travel to the radiator condenser to give off its heat and recondense.

This brings about a dispensing action, which is important. For if a few drops of liquid were allowed to return to the vaporizer, the vapor generated would immediately raise the pressure in the closed chamber 9, so that no further condensate would be returned through the conduit 15. This would prevent the satisfactory operation of the system.

It will be observed that this system permits the condensate to be forcibly propelled and thus returned by the trapped compressed gas within the radiator condenser 7 to a point on the level with, or even substantially above the point of condensation, so that the system can be installed under conditions which would not allow the condensate to return to the vaporizer under the influence of gravity alone. Thus, the applicability of my system in unusual situations is permitted. For instance, I have found it peculiarly adapted for use in connection with aeroplanes where the preferential point of vaporization is above the desired point of radiation. Various other similar situations will occur to the minds of those familiar with the art.

A common feature of the embodiments shown is the improvement which overcomes troublesome "blocking" due to a primary circulation being established by way of conduit 10, chamber 9 and conduit 11. The intermediate chamber has a tendency to suppress the surging or blocking set up by the starting of operation of the heating system. The chamber permits the surges of heating medium to spend their force so that by the time liquid heating medium is forced into the chamber 9, considerable pressure has been built up in the system. The air pressure thus acts as a buffer, reacting against surges of heating medium entering the chamber 9. The pressure which is produced in puffs or minute explosions by the vaporization of the returning condensate is cushioned in the intermediate chamber 9; and by restricting the flow of liquid in the return line 11 (or 11') so that there is produced a consider-

able amount of adhesion or drag of the condensate against the inner wall of this conduit, I overcome the tendency of the puffs of pressure to force back the condensate into the intermediate chamber 9. Such restriction to the flow of liquid along the return line in combination with the buffer effect of the trapped air materially improves the operation of the system so that the heating medium is prevented from rushing up the return conduit in case of the sudden development of an unusual amount of vapor and pressure in the boiler 6.

The cooperation of these two features, when properly proportioned, is sufficient to prevent the almost instantaneous puff of vapor which is generated in the vaporizer from forcibly driving the condensate back through its return conduit until the vapor has passed up through the vapor conduit 10 into the closed chamber 9 and built up the pressure in that chamber into substantial equilibrium with the pressure in the vaporizer 6. The difficulty with blocking is inherent in closed vapor heating systems using the heat from the exhaust gases from an internal combustion engine driving a vehicle, whether of the type shown in Fig. 1 or the specialized embodiment shown in Fig. 2. In the latter embodiment, this difficulty with blocking is outstandingly difficult because the vaporizer 6 may become heated to substantially the temperature of the exhaust gases just before the first of the condensate flows down the return line 11 to enter the vapor generator 6. The principle involved is that of using the drag of a restricted return line, reinforced by a body of trapped gas or air, to resist the back flow of condensate away from the vaporizer, as I have explained.

I desire it to be understood that the forms of embodiment of my improvements which I have described are to be considered as typical and not exclusive, for it is obvious that details may be modified, as by the use of mechanical equivalents, without departing from the scope of my invention as described and claimed.

I claim:

1. A vapor heating system for an automotive vehicle including, in combination with the conduit discharging exhaust gases from the internal combustion engine, a vapor generator in heat absorbing relation to the exhaust gases passing along said conduit, a radiator condenser, conducting means for heating medium uniting the vapor generator and radiator condenser in a closed system, non-condensing gas such as air entrapped in said closed system, and an amount of vaporizable heating medium sufficiently small in said system so that the vapor generator operates substantially as a flash boiler under normal running conditions, said conducting means being of sufficient length and sufficiently restricted in flow area to tend to cause interference between condensate returning to the vapor generator and surges of pressure away from the vapor generator, and including an intermediate chamber in which surges of pressure generated by the vapor generator may expend themselves, said chamber being spaced both from the vapor generator and from the radiator condenser a substantial part of the length of the conducting means.

2. A vapor heating system for an automotive vehicle including, in combination with the conduit discharging exhaust gasses from the internal combustion engine, a vapor generator in heat absorbing relation to the exhaust gases passing along said conduit, a radiator condenser, conducting means for heating medium uniting the vapor generator and radiator condenser in a closed system, non-condensing gas such as air entrapped in said closed system, and an amount of vaporizable heating medium sufficiently small in said system so that the vapor generator operates substantially as a flash boiler under normal running conditions, said conducting means being of sufficient length and sufficiently restricted in flow area to tend to cause interference between condensate returning to the vapor generator and surges of pressure away from the vapor generator, and including an intermediate chamber in which surges of pressure generated by the vapor generator may expend themselves, means for the passage of heating medium to and from the intermediate chamber from the vapor generator and means including a vapor line and a condensate line for the passage of heating medium to and from the radiator condenser from the intermediate chamber, the condensate line communicating with said intermediate chamber at a lower level than the vapor line.

3. A vapor heating system as defined in claim 2 in which said condensate line is restricted.

4. A vapor heating system for an automotive vehicle including, in combination, a vapor generator or boiler in heat absorbing relation to the exhaust conduit from the internal combustion engine driving the vehicle, a radiator condenser, conducting means for heating medium uniting the vapor generator and the radiator condenser in a closed system, and heating medium together with non-condensing gas entrapped in said closed system, said conducting means including a vapor line, a condensate line and a chamber spaced both from the vapor generator and from the radiator condenser a substantial part of the length of said lines for cushioning surges of heating medium from the boiler, the condensate line having an outlet from the intermediate chamber below the level at which the vapor line and said means for the passage of heating medium to and from the radiator condenser communicate with the intermediate chamber.

5. A vapor heating system as defined in claim 4 in which the condensate line leading to the vapor generator from the intermediate chamber is sufficiently restricted to act as a drag on liquid heating medium tending to surge along the same away from the boiler.

6. A vapor heating system comprising a vaporizer, a radiator condenser, conducting means operatively connecting the vaporizer and the radiator condenser as a closed system for the flow of vaporized fluid from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, said conducting means being continuously open interiorly yet precluding gravitational return of condensate from the radiator condenser to the vaporizer under normal conditions, heating medium and non-condensing gas entrapped in said closed system, said conducting means including an intermediate chamber through which the vapor passes to the radiator condenser and a conduit connecting said intermediate chamber and said radiator condenser constructed and arranged for the flow alternatively of vapor to the radiator condenser or of condensate back to said intermediate chamber in accordance with the relative pressures in said intermediate chamber and radiator condenser, said intermediate chamber having heat transmitting walls effective for lowering the temperature and pressure therein

when flow of vapor through said chamber is interrupted, and an accumulator for the condensate returned to said intermediate chamber, said accumulator being constructed to discharge intermittently to said vaporizer.

7. A vapor heating system comprising a vaporizer, a radiator condenser, conducting means operatively connecting the vaporizer and the radiator condenser as a closed system for the flow of vaporized fluid from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, heating medium and non-condensing gas entrapped in said closed system, said conducting means being continuously open interiorly yet precluding gravitational return of condensate from the radiator condenser to the vaporizer under normal conditions, said conducting means including an intermediate chamber, a vapor conduit for conducting vapor from the vaporizer to said intermediate chamber, a condensate conduit of smaller cross-section than said vapor conduit operatively connecting said vaporizer and said intermediate chamber, and a common conduit connecting said intermediate chamber and said radiator condenser constructed and arranged for the flow alternatively of vapor to the radiator condenser or of condensate back to said intermediate chamber in accordance with the relative pressures in said intermediate chamber and radiator condenser, said intermediate chamber having heat transmitting walls effective for lowering the temperature and pressure therein when flow of vapor through said intermediate chamber is interrupted, and an accumulator arranged to receive the condensate from said common conduit and to effect intermittent gravity discharge thereof through said condensate conduit to the vaporizer, said condensate conduit having an outlet from the intermediate chamber below the level at which the vapor conduit communicates with the intermediate chamber.

8. In combination, a vapor generator, a radiator condenser, conducting means operatively connecting the vapor generator and radiator condenser as a closed system for the circulation of a heating medium, said conducting means being continuously open interiorly but precluding gravitational return of condensate to the vapor generator under normal conditions, non-condensing gas in the system, said system being so constructed and arranged as to effect the trapping of said non-condensing gas in the radiator condenser, said conducting means including means functionally interposed between said vapor generator and radiator condenser for causing pulsations in pressure in the system to bring about expulsion of condensate from the radiator condenser by the gas pressure therein and an accumulator arranged to receive the condensate and to effect the intermittent gravity discharge thereof to the vapor generator.

9. In combination, a vapor generator, a radiator condenser, conducting means operatively connecting the vapor generator and radiator condenser as a closed system for the circulation of a heating medium, said conducting means being continuously open interiorly but precluding gravitational return of condensate to the vapor generator under normal conditions, non-condensing gas in the system, said system being so constructed and arranged as to effect the trapping of said non-condensing gas in the radiator condenser, said conducting means including means functionally interposed between said vapor generator and radiator condenser for causing pulsations in pressure in the system to bring about expulsion of condensate from the radiator condenser by the gas pressure therein, and an accumulator arranged in cooperation with said last mentioned means for receiving condensate from the radiator condenser and for effecting intermittent gravity discharge thereof to the vapor generator.

10. In a closed vapor heating system, a vapor generator, a radiator condenser, conducting means operatively connecting the vapor generator and radiator condenser for the circulation of a heating medium, gravitational return of condensate to the vapor generator being precluded under normal conditions, heating medium and non-condensing gas entrapped in said closed system, said conducting means including a variable pressure chamber functionally interposed between said vapor generator and radiator condenser for causing intermittent discharge of condensate from said radiator condenser, there being a conduit connecting said chamber and said radiator condenser constructed and arranged for the flow alternatively of vapor to the radiator condenser or of condensate back to said intermediate chamber in accordance with the relative pressures in said intermediate chamber and radiator condenser, and means for accumulating in said chamber condensate discharged from the radiator condenser and for effecting intermittent discharge thereof to the vapor generator so as to provide a dormant period in the functioning of the vapor generator, said conducting means being constructed and arranged to convey the accumulated condensate by gravity to the vapor generator.

11. In a vapor heating system, the combination of a vapor generator, a radiator condenser, conducting means connected to the lower portion of the radiator condenser to receive condensate therefrom and uniting the vapor generator and the radiator condenser in a closed system for the flow of vaporized heating medium from the vapor generator to the radiator condenser yet precluding gravitational return of condensed heating medium to the vapor generator under normal conditions, heating medium and non-condensing gas entrapped in said closed system, said conducting means including automatic means for effecting the return of condensate intermittently to said generator comprising a chamber arranged in said conducting means so as to cool when the flow of vapor thereto ceases and thereby establish a pressure in said chamber below that in the radiator condenser, said conducting means being constructed and arranged to effect the return of condenate to said automatic means due to such pressure differential, said automatic means including an accumulator arranged to receive the condensate returned to the automatic means and to effect intermittent gravity discharge of condensate to the vapor generator.

12. In a vapor heating system, the combination of a vapor generator, a radiator condenser, conducting means connected to the lower portion of the radiator condenser to receive condensate therefrom and uniting the vapor generator and the radiator condenser in a closed system for the flow of vaporized heating medium from the vapor generator to the radiator condenser, heating medium and non-condensing gas entrapped in said closed system, said conducting means precluding gravitational return of condensed heating medium to the vapor generator under nor-

mal conditions and including automatic means for effecting intermittent pumping of condensate back to the vapor generator comprising a chamber arranged in said conducting means so as to cool when the flow of vapor thereto ceases and thereby establish a pressure in said chamber below that in the radiator condenser, said conducting means providing a single conduit of sufficiently restricted cross-section to preclude flow therethrough of vapor and condensate simultaneously in opposite directions connecting the radiator condenser in said chamber, said automatic means including an accumulator arranged to receive the fluid returned to the automatic means and to effect intermittent gravity discharge of condensate to the vapor generator.

13. In a vapor heating system, the combination of a vapor generator, a radiator condenser, conducting means connected to the lower portion of the radiator condenser to receive condensate therefrom and uniting the vapor generator and the radiator condenser in a closed system for the flow of vaporized heating medium from the vapor generator to the radiator condenser, heating medium and non-condensing gas entrapped in said closed system, said conducting means including means for effecting intermittent pumping of condensate back along said conducting means from the radiator condenser for return to the vapor generator, said conducting means providing a single conduit of sufficiently restricted cross-section to preclude flow therethrough of vapor and condensate simultaneously in opposite directions connecting the radiator condenser and said pumping means, and said heating system being constructed and arranged so that gravitational return of condensed heating medium from said radiator condenser to said pumping means is precluded under normal conditions.

14. In a vapor heating system, the combination of a radiator condenser, conducting means connected to the lower portion of the radiator condenser to receive condensate therefrom, a vapor generator united by said conducting means with the radiator condenser in a closed system for the supplying of heating medium vaporized by the vapor generator to the radiator condenser, heating medium and non-condensing gas entrapped in said closed system, pressure changing means interposed in said conducting means and heated during the supplying of vaporized heating medium to the radiator condenser, said conducting means providing a single conduit with a portion thereof at a higher level than the radiator condenser connecting the radiator condenser and said pressure changing means, said pressure changing means effecting, when vaporization of heating medium by said vapor generator is interrupted so as to permit cooling of said means, a drop in pressure in the conducting means below that of the radiator condenser to cause condensate to be discharged from the radiator condenser and through said elevated portion, and an accumulator arranged to receive the liquid thus discharged and to dispense the liquid to the vapor generator to delay the increase in pressure in said pressure changing means resulting from access of condensate to the vapor generator.

15. In combination, a vapor generator, a radiator condenser, conducting means operatively connecting the vapor generator and radiator condenser as a closed system for the circulation of a heating medium, said conducting means having an inlet in the lower portion of the radiator condenser and having at least a portion inclined upwardly in the direction of flow toward the vapor generator to preclude gravitational return of condensate to the vapor generator under normal conditions, non-condensing gas in the system, said system being so constructed and arranged as to effect the trapping of said non-condensing gas in the radiator condenser, means functionally interposed in said conducting means between said vapor generator and radiator condenser for causing pulsations in pressure in the system to cause the non-condensing gas to expel condensate from the radiator condenser and along said upwardly inclined portion of the conducting means, and an accumulator arranged to receive the condensate and to effect intermittent gravity discharge thereof to the vapor generator.

SERGIUS VERNET.