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CIRCULATION OF HEATING MEDIUMS IN VAPOR HEATING SYSTEMS FOR AUTOMOTIVE VEHICLES

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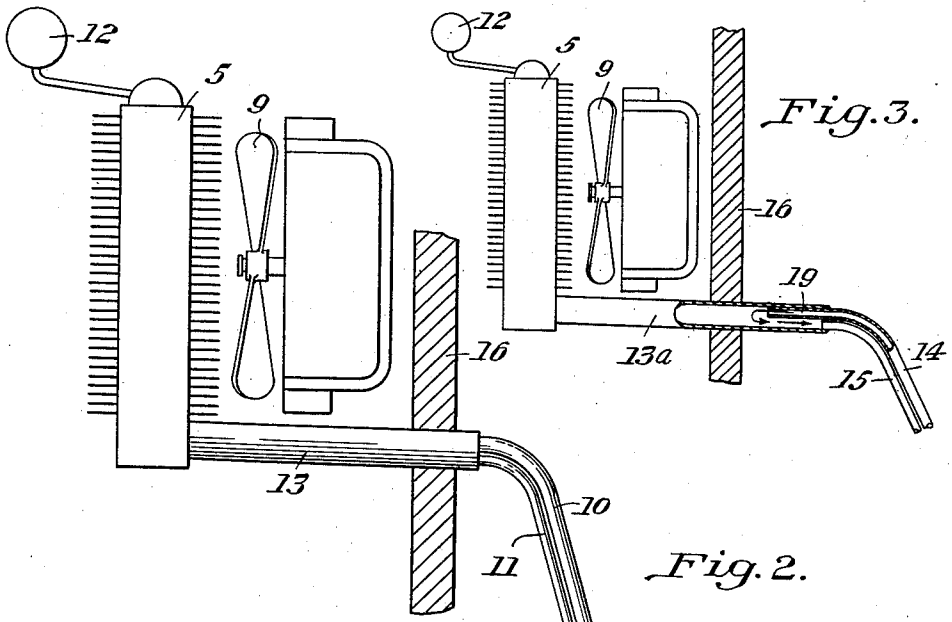
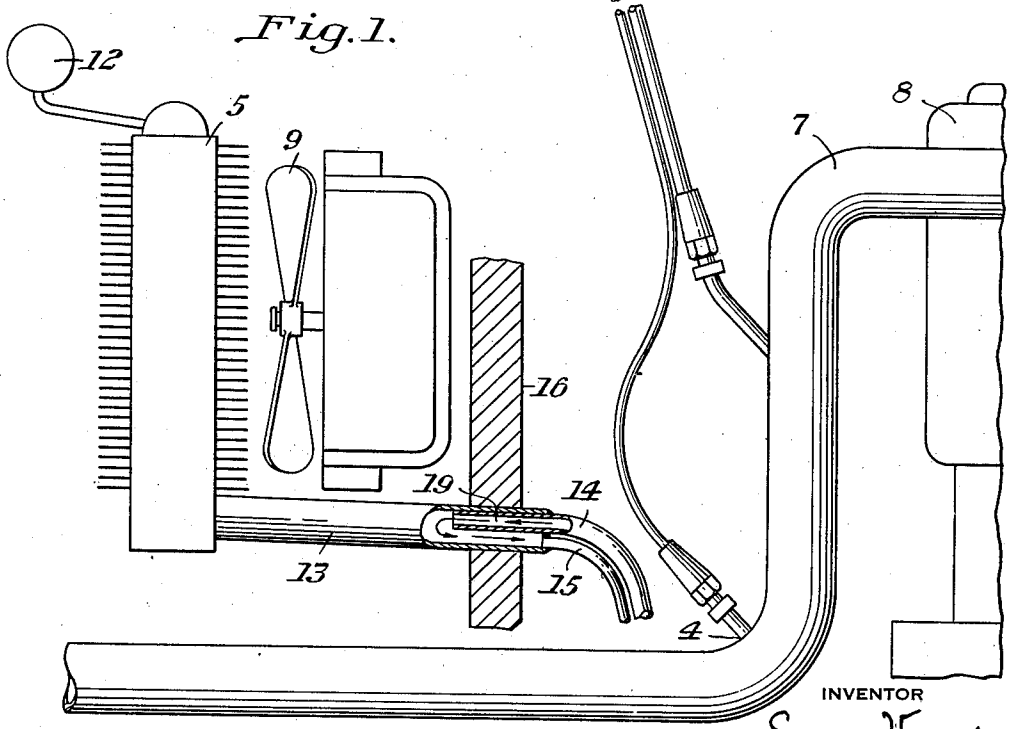


Fig. 3.

Fig. 2.

Fig. 1.



INVENTOR

Sergius Vernet

by Byrnes, Stebbins & Blenko

his attorneys

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CIRCULATION OF HEATING MEDIUMS IN VAPOR HEATING SYSTEMS FOR AUTOMOTIVE VEHICLES

Sergius Vernet, Brooklyn, N. Y., assignor to Foster Vernay Corporation, New York, N. Y., a corporation of New York

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15 Claims. (Cl. 237—12.3)

My invention relates to an improvement in vapor heating systems for automotive vehicles, and concerns more particularly the circulation of heating medium between the vapor generator and the radiator condenser of such systems. This application is a continuation-in-part of my prior application Serial No. 626,035 filed July 29, 1932.

In vapor heating systems of the type under consideration, the heating medium is transformed from a liquid state to the vapor state in the vapor generator, and heat is radiated from the radiator so as to condense the vapor therein to the liquid state again. The source of heat being the exhaust gases from the internal combustion engine driving the vehicle, which in the portion of the exhaust conduit adjacent the motor reach a temperature of 900° F. or higher, the generation of steam, if the major part of the available heat were used, would be so rapid as to heat the vehicle immoderately. Moreover the system must operate without skilled supervision, and in the main without any supervision whatsoever in order to be practical, as it is intended to be sold to the public generally. It is, therefore, highly desirable that an amount of liquid commensurate with the maximum amount of heat desired from the system be introduced therein and the system closed. It will be noted that this is in contrast to the design of steam heating system customarily employed in dwellings, etc. wherein a valve functions, especially after a fresh charge of water is introduced into the boiler, to permit the escape of air. With the type of system dealt with in the present application, the system remains closed throughout the operation of the system; and operates by the circulation of vapor from the vapor generator to the radiator condenser and of condensate back from the radiator condenser to the vapor generator, the amount of heat thus carried up to the radiator depending not upon the amount of heat in the exhaust gases primarily, but rather upon the rate of return flow of condensate to the vapor generator. The condensate is vaporized substantially as rapidly as it returns. In other words, the operation, once the system is fully heated, is that of a flash boiler. The pressure has meanwhile built up as the vaporization of the heating medium becomes more complete. An automatic control is preferably used, as will later be explained further in detail, to withdraw from circulation a portion of the heating medium as the temperature and pressure becomes elevated, thus establishing a reserve supply of heating medium which is automatically enlarged or decreased as the temperature and pressure rise and fall.

Water because of certain advantages, such as its cheapness and its inertness toward the walls of the radiator and vapor generator, is a desirable medium for use either alone or as one ingredient in a mixture in such a heating system. When the flow of exhaust gases from the engine ceases, the entire system cools off, and eventually substantially all of the heating medium gravitates into the boiler. If the temperature drops low enough during the winter months, as when the vehicle is placed in an unheated garage or parked at the curb, the heating medium freezes to the solid state. So far as the boiler is concerned, such freezing is not an insurmountable difficulty, as I have been able to provide in the boiler the necessary expansion space for avoiding damage from the expansion in freezing. It is of importance to note, however, that unless the total amount of liquid in the system is quite limited the boiler may become completely filled and be damaged by the expansion of the liquid in freezing.

Difficulty has, however, been encountered due to faulty operation when the heating system first starts up after being cold. Of course, when the operation of the motor starts the flow of hot gases through the exhaust conduit once more, the ice is melted; and as heating continues, vapor is generated. Two difficulties are encountered, the first occurring through the freezing of the heating medium in the radiator condenser. The first of the steam passing to the radiator condenser may meet with such cold walls that until a substantial amount of steam is circulated, there is a possibility of the steam depositing as ice; and in this way substantially the entire amount of heating medium may become deposited in the solid state within the radiator condenser so as to put the system out of operation.

The second difficulty is peculiar to a system having a vapor line and a separate condensate line uniting the vapor generator and the radiator condenser for the circulation of the heating medium. While the one pipe system shown in my Reissue Patent No. 18,110, granted June 23, 1931, is entirely practical, and was used to a considerable extent, a heating system provided with circulating means including both a vapor line and a condensate line has proved more reliable and better adapted for quick and economical installation. In order to have the latter desirable attributes, the conducting means should

be metallic, should be easily bent, and above all, the installation must not be susceptible to destructive vibration. This means that the pipes must be of small cross section; in other words, 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. Since the two-pipe system permits the use of pipes of smaller cross-section which stand up against the usual vibration in such installations, and thus are conducive of greater durability, it has been found more feasible commercially to use the two-pipe system. Such a system when starting up from a cold condition after a considerable period of inaction does not possess an established circulation in a single direction. The liquid is substantially all in the boiler, and air or other non-condensing gas, which was entrapped when the system was closed, extends throughout the system. The high heat of the exhaust gases sets up, in a short time, a vigorous boiling off of heating medium, which passes up both the vapor line and the condensate line toward the radiator. The heating medium is pushed up these lines in surges by the pressure generated in the boiler. As the condensate returns back down, substantially filling the small cross section of the conduit, it meets the heating medium driven off from the boiler so that there is considerable fluctuation of pressure and surging of heating medium up and down both lines, a phenomenon known as "blocking". This "blocking" is particularly troublesome while the system is warming up after a period of idleness, as both lines have cooled down to substantially the same temperature and both lines tend to become choked with condensate returning toward the boiler. A chamber intermediate the vapor generator, to which both the vapor line and the condensate line lead, militates against this objectionable surging or blocking.

In the drawing I have shown for purposes of illustration merely, one embodiment which my invention may assume; and in this drawing,—

Fig. 1 is a view showing more particularly the connection to the radiator;

Fig. 2 is a diagram illustrating the entire heating system; and

Fig. 3 is a view similar to Fig. 1 showing a modification of the connection.

The vapor heating system shown includes a vapor generator 4 and a radiator condenser 5, and is used in heat absorbing relation with the exhaust from the internal combustion engine of an automotive vehicle. The vapor generator or boiler 4 is in the form of a tube arranged longitudinally in the exhaust conduit 7 which conveys the waste gaseous products of combustion away from the engine 8. A fan 9 may, if desired, be employed for causing a forced circulation of air through the radiator 5 to the interior of the compartment of the vehicle to be heated. The heating medium is circulated from the boiler 4 to the radiator 5 and back again by conducting means including, in general, a vapor line or conduit 10 and a condensate line or conduit 11. The vapor line is preferably considerably larger than the condensate line.

The continued circulation of vapor to the radiator condenser and the building up of pressure in the closed system causes the air or other non-condensing gas to become segregated in the control chamber 12 which leads off from the radiator 5. As disclosed in my copending application Serial No. 298,242, filed August 8, 1928, and Serial No. 737,791, filed July 31, 1934, a continued increase in the pressure prevailing in the system causes heating medium to be forced into the control chamber as the air therein is further compressed, and there is an accumulation of liquid in an amount depending upon how high the pressure is driven. As this accumulation of liquid is withdrawn from active circulation, a nice balance is established to regulate the system. In other words, the system is self-regulating, as increases in pressure cause the withdrawal of more heating medium from active circulation, and decreases in pressure cause the return of heating medium to the system from the control chamber, thus regulating the generation of vapor by the boiler which by this time is operating as a flash boiler. This mode of control after the system is operating under normal running conditions is fully set forth and claimed in my above mentioned copending applications.

The improvements to which the present application is more particularly directed relate to the circulation of heating medium in a closed system, especially when starting up from a cold condition. The surging of heating medium up the conduits 10 and 11 as it boils off from the tube 4 or other boiler heated by the exhaust gases, is particularly troublesome when starting operation with the system cold. The vapor is condensed by the cold walls with which it comes in contact, and there is a return flow of condensate attempting to make its way down to the boiler 4, only to be driven back up the lines again with the next surge in pressure. The surges of pressure push up against a cushion or buffer constituted by the air driven into the radiator by the rising steam pressure. As the system is closed throughout its operation, that is, there is normally no communication with the atmosphere, this air is expanding and recompressing with the surges of the heating medium along the conduits 10 and 11 as the heating medium boils off from the boiler 4. It will be clear that conduits of small cross section connecting the boiler and radiator condenser have but small internal volume or capacity, even though fairly long. In other words, a slight differential in pressure in the boiler over the pressure in the radiator condenser would, in consequence, not be evened up short of a surge extending through practically the complete length of the conduits. A chamber such as provided at 13 intermediate the vapor generator and the radiator condenser has an important effect in taking care of the objectionable blocking and establishing unidirectional circulation of heating medium. The surges of vapor and liquid up the two lines discharge in common into this chamber, and push forward along this chamber displacing the air. Meanwhile there follows a recession of pressure, which causes the condensate to return more particularly down the condensate line 11.

This chamber has the function both of bringing about a separation of liquid from vapor, and also of providing a space into which the surges may extend without the heating medium being driven into the radiator 5. The volume of the chamber should be large enough to accommodate such heating medium as is driven up the lines from the boiler in the course of the surging incidental to the starting into operation of the system. Its volume will of course depend upon the size of the system and the amount of heating medium therein. I have used a chamber whose volume is ap-

proximately half the volume of the liquid accumulating in the boiler when cold. The length of the lines and other factors such as the mass of the radiator condenser 5 may vary the optimum volume for this chamber. The chamber has a substantial effect even though its volume is considerably lessened, but the ratio of the volume of the chamber to the volume of the liquid in the boiler when cold should not be less than one to ten. The chamber obviously should not be immediately adjacent the vapor generator, considering the invention from the point of view of its object of avoiding congealing of the heating medium in the radiator in cold weather. From the other point of view of its object of avoiding "blocking", the effectiveness of the chamber is too much reduced when arranged immediately adjacent the vapor generator. Accordingly, the chamber should be spaced from the vapor generator a substantial part of the length of the conducting means.

Due to a primary circulation being established by way of conduit 10, chamber 13 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 is far enough away from the vapor generator 4 so that by the time the surges of heating medium reach the chamber 13, considerable pressure has been built up in the system, and the air pressure in the radiator condenser 5 is acting as a buffer reacting against the surges of heating medium entering the chamber 13. With further increases in pressure in the system the air is further compressed; and radiation of heat from the radiator condenser 5 due to the condensing of vapor therein takes place according to the normal functioning of the system.

The chamber 13, furthermore, by its function of establishing a primary circulation in the conducting or circulating means only, acts to overcome the difficulty with the depositing of ice on the walls of the radiator which has been above referred to. The chamber 13 permits the first of the heating medium entering therein to circulate back to the vapor generator without entering the radiator 5 itself. During cold weather, the radiator 5, after a long period of idleness, may be so cold as to chill the heating medium, such as water, below its freezing point before the mass of the radiator is heated above such freezing point. Moreover, the blowing of cold air over the radiator by the fan 9 makes the chilling effect still more troublesome. The conduits 10 and 11 absorb so few calories, even though initially quite cold, that there is practically no danger of freezing of the heating medium if it thus be "short-circuited" before entering the radiator.

In Fig. 1 I have shown details of a preferred embodiment in which the chamber constitutes the connection for the vapor and condensate lines to the radiator condenser 5. As shown in this figure, the connection is in the form of a tube with branches 14 and 15. The branch 14 communicates with the vapor line 10, and the branch 15 delivers condensate to the condensate line 11.

In the connection 13 which is common to both the vapor line 10 and the condensate line 11, the vapor is directed along the tube 13 toward the radiator 5 by an extension of the conduit 10. In the preferred embodiment shown, a tubular extension 19 projects from the conduit 10 longitudinally of the connection 13. The connection 13 extends through the customary partition 16 between the engine and the interior of the vehicle.

The portion of the conducting or circulating means which is on the same side of the partition 16 as the exhaust conduit 7, is in a somewhat heated atmosphere shortly after the engine is started. Due to this fact, the circulation of heating medium within a part only of the conducting means so that circulation does not extend substantially beyond the partition 16 renders still more remote the possibility of a stoppage of flow due to ice formation when starting operation in extremely cold weather. As shown in Fig. 3 the connection 13a may be so related to the partition 16 that the initial circulation is entirely on the engine side of the partition.

The difficulty with depositing of the heating medium as ice in the radiator condenser does not arise where the heat capacity of the latter is relatively small. In other words, the steam is not sufficiently chilled by the conduits 10 and 11 to be congealed therein; but in heating systems such as are here under consideration, the heat capacity of the radiator is large relative to the lines leading thereto so as to act effectively as a heat exchange element taking the heat from the steam and transferring it to the air to be heated. The circulation of the heating medium within the conducting means itself avoids bringing the heating medium into contact with the relatively large mass of the radiator. The conducting means, including the connection 13, which are not materially cooled by the air from the fan 9, thus become rapidly heated. As the pressure increases, steam will make its way further and further into the radiator 5 until the heating system functions to its full extent. It will thus be apparent that the initial circulation of heating medium in my improved heating system rapidly heats up the conducting means by reason of the "short-circuiting" of the heating medium before it enters the radiator. Steam does not make its way into the radiator until the conducting means is hot, so that it is fairly dry steam which thus contacts the cold walls of the radiator. Due to the pushing of the air ahead of the steam into the radiator, and the increase in pressure as the steam is driven further and further into the radiator, a progressive warming of the radiator is effected. Thus the mass of the radiator is gradually warmed, with the advantage that sufficient heat is practically never abstracted from the heating medium to cause congealing of the latter into the solid state.

While I have disclosed a preferred embodiment of my invention, it is to be understood that my invention is not so limited, but that various changes may be made in the construction and arrangements shown, as well as in the size and shape of the parts, without departing from the scope of my invention as defined in the following claims.

I claim:

1. A vapor pressure heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, conducting means uniting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and which contains heating medium and non-condensing gas, said conducting means being adapted to circulate vaporized heating medium from the vapor generator to the radiator condenser and condensate from the radiator condenser to the vapor generator and providing sepa-

rate passages for the vapor and for the condensate throughout most of the travel of the heating medium, and a common chamber intermediate the radiator condenser and the vapor generator for the flow in common of the vapor and the condensate said common chamber being spaced from the vapor generator a substantial part of the length of the conducting means.

2. A vapor pressure heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, conducting means uniting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and which contains entrapped non-condensing gas and a quantity of heating medium such that the vapor generator under normal running conditions operates substantially as a flash boiler, said conducting means being adapted to circulate vaporized heating medium from the vapor generator to the radiator condenser and condensate from the radiator condenser to the vapor generator and comprising a vapor line, a condensate line and a common chamber intermediate the radiator condenser and the vapor generator placing the two lines in communication for permitting circulation of heating medium without entering the radiator condenser said common chamber being spaced from the vapor generator a substantial part of the length of the conducting means.

3. In a vapor pressure heating system, the combination with a conduit for the exhaust gases from the driving motor of an automative vehicle, of a vapor generator exposed to the heating effect of said exhaust gases, a radiator condenser, circulating means for heating medium operatively connecting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and which contains heating medium and entrapped non-condensing gas, said circulating means comprising a vapor line, a condensate line disposed closely adjacent the vapor line, and a connection intermediate the radiator condenser and the vapor generator and spaced from the latter a substantial part of the length of the circulating means for admitting heating medium from the vapor line into the condensate line at a point spaced from the radiator condenser to establish initial circulation of heating medium through a part only of said circulating means when starting operation of the system from a cold condition.

4. A vapor pressure heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, conducting means uniting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and in which heating medium and non-condensing gas are entrapped, the quantity of heating medium being such that the vapor generator under normal running conditions operates substantially as a flash boiler, said conducting means being adapted to circulate vaporized heating medium from the vapor generator to the radiator condenser and condensate from the radiator condenser to the vapor generator and comprising a vapor line and a condensate line connected intermediate the radiator condenser and the vapor generator by a common chamber spaced from the vapor generator a substantial part of the length of the conducting means for permitting circulation of heating medium without entering the radiator condenser.

5. A vapor pressure heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, conducting means uniting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and in which heating medium and non-condensing gas are entrapped, the quantity of heating medium being such that the vapor generator under normal running conditions operates substantially as a flash boiler, said conducting means being adapted to circulate vaporized heating medium from the vapor generator to the radiator condenser and condensate from the radiator condenser to the vapor generator and comprising a vapor line, a condensate line and a common chamber intermediate the radiator condenser and the vapor generator placing the two lines in communication for permitting circulation of heating medium without entering the radiator condenser, said common chamber being spaced from the vapor generator a substantial part of the length of the conducting means, and the volume of said chamber being at least one tenth the volume of the condensed heating medium in the radiator condenser when the system is cold.

6. A heating system as defined in claim 4 in which the chamber has a volume at least half the volume of the condensed heating medium in the radiator condenser when the system is cold.

7. A vapor heating system for an automotive vehicle including in combination with an exhaust conduit for the waste gaseous combustion products of the engine driving the vehicle, a vapor generator or boiler in heat absorbing relation to said waste gases, a radiator condenser and fluid conducting means connecting the vapor generator and the radiator condenser for the circulation of a heating medium in a system which is closed throughout the operation of the system, said fluid conducting means comprising a vapor line, a condensate line and a chamber communicating with said vapor line and said condensate line, said chamber being intermediate the vapor generator and the radiator condenser and spaced from the vapor generator a substantial part of the length of the conducting means, the chamber communicating with the radiator condenser by a connection of flow area at least as large as the combined areas of the vapor line and the condensate line.

8. A vapor heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle, a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, a blower for establishing a circulation of air past the radiator, and circulating means operatively connecting the vapor generator and the radiator condenser for the flow of vaporized heating medium to the radiator condenser and the return of condensate to the vapor generator in a system which is closed throughout the operation of the system, said circulating means including a vapor line and a condensate line provided with a connection at a point spaced from the radiator condenser for admitting heating medium from the vapor line into the condensate line to establish initial circulation of heating medium through

a part of the heating system not materially cooled by the air from the blower, said point being also spaced from the vapor generator a substantial part of the length of the circulating means.

9. A vapor heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle, a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, a fan propelling cooling air past the radiator, and circulating means for heating medium operatively connecting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system, there being heating medium and non-condensing gas entrapped in said closed system, said circulating means including a conduit for vapor and a conduit for condensate connected at a point spaced from the radiator condenser to establish initial circulation of heating medium through a part of the heating system not materially cooled by the air from the fan, said point being also spaced from the vapor generator a substantial part of the length of the circulating means.

10. In combination with a conduit for the exhaust gases from the driving motor of an automotive vehicle, a vapor pressure heating system comprising a vapor generator exposed to the heat of the exhaust gases, a radiator condenser, a fan cooperating with the radiator condenser for establishing a circulation of air past the radiator condenser, a partition between the exhaust conduit and the radiator condenser, and circulating means operatively connecting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system and which contains heating medium and entrapped non-condensing gas, said circulating means extending through the partition and comprising a vapor line, a condensate line, and a connection at a point spaced from the radiator condenser for establishing initial circulation of heating medium through a part of said circulating means not materially affected by the cooling fan, said connection being also spaced from the vapor generator a substantial part of the length of the circulating means.

11. A vapor heating system as defined in claim 1 in which the effective flow area of the common chamber is at least as large as the combined flow area of the separate passages for the vapor and the condensate.

12. In a vapor pressure heating system the combination with a conduit for the exhaust gases from the driving motor of an automotive vehicle, of a vapor generator exposed to the heating effect of said exhaust gases, a radiator condenser, a partition between the radiator condenser and the exhaust conduit, circulating means for heating medium extending through said partition and operatively connecting the vapor generator and the radiator condenser in a system which is closed throughout the operation of the system, said circulating means including a vapor line, a condensate line disposed closely adjacent the vapor line, and a connection for admitting heating medium from the vapor line into the condensate line at a point spaced from the radiator condenser to establish initial circulation of heating medium through a part of said circulating means not extending substantially beyond said partition, said connection being also spaced from the vapor generator a substantial part of the length of the circulating means.

13. In combination with a radiator, a branched conduit having a condensate line connected to one branch for draining condensate from the radiator, a vapor line connected to the other branch for supplying vapor to the radiator, and a tube extending toward the radiator but terminating short of the radiator for directing vapor from said vapor line toward the radiator.

14. A vapor pressure heating system comprising a vapor generator, a radiator condenser and means operatively connecting the generator and the radiator condenser for circulating a heating medium in the system, said means including a vapor conduit, a condensate conduit and a common connection for the two conduits to the radiator condenser, the vapor conduit extending into said connection beyond the point where condensate flows out of the connection by way of the condensate conduit.

15. A vapor pressure heating system for an automotive vehicle including in combination with a conduit for the exhaust from the engine driving the vehicle a vapor generator arranged to absorb heat from the exhaust gases, a radiator condenser, and conducting means operatively connecting the generator and the radiator condenser in a system which is closed throughout the operation of the system and which contains a heating medium and non-condensing gas, said conducting means being adapted to circulate vaporized heating medium from the vapor generator to the radiator condenser and condensate from the radiator condenser to the vapor generator and comprising a vapor conduit, a condensate conduit and a common chamber intermediate the radiator condenser and the vapor generator for the flow in common of the vapor and the condensate, said common chamber being spaced from the vapor generator a substantial part of the length of the conducting means, the vapor conduit extending into said chamber above the level of the outlet through which the condensate flows to the condensate conduit.

SERGIUS VERNET.