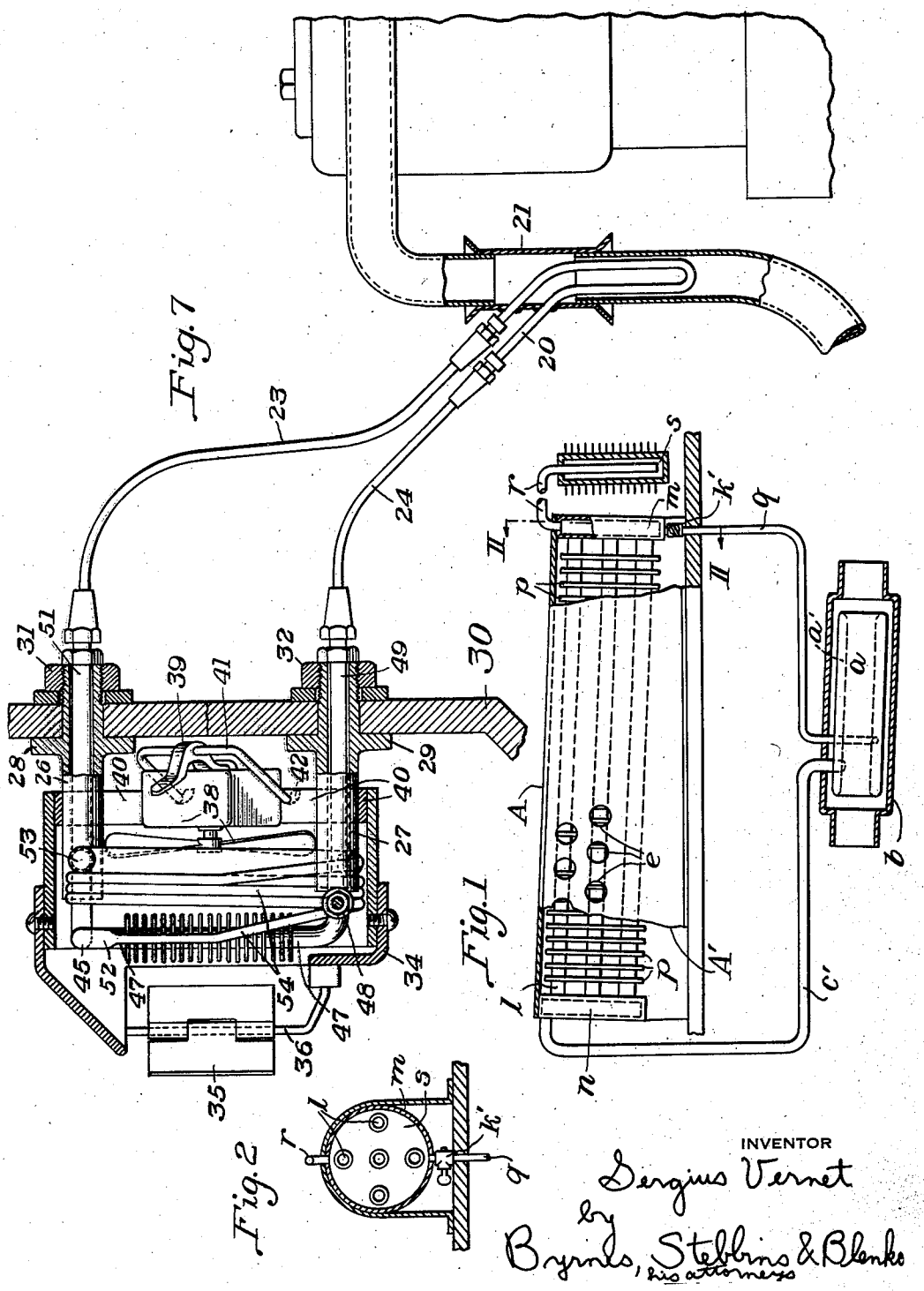
Jan. 21, 1936. S. VERNET 2,028,261

AUTOMATIC CONTROL FOR VAPOR HEATING SYSTEMS

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AUTOMATIC CONTROL FOR VAPOR HEATING SYSTEMS

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Fig. 4.

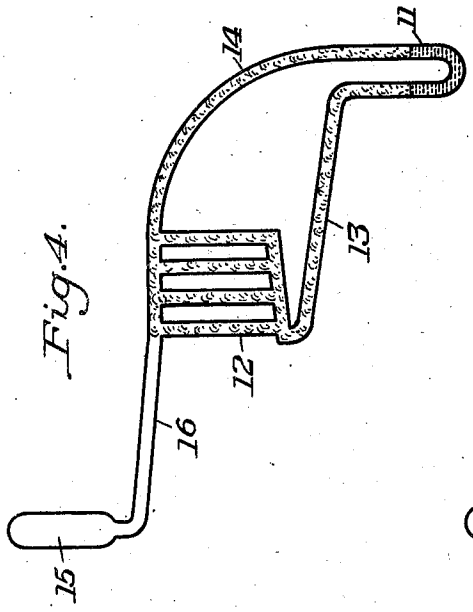


Fig. 6.

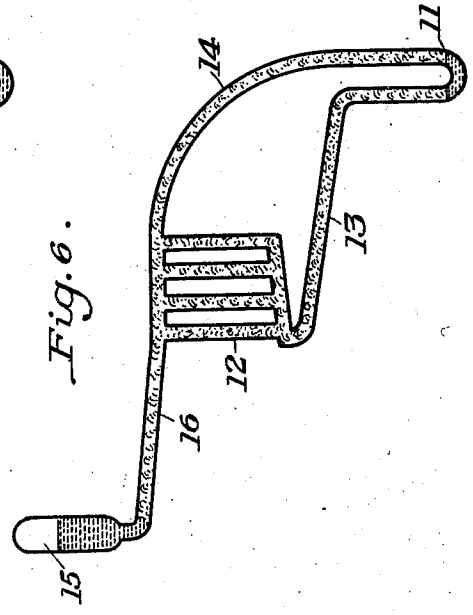


Fig. 3.

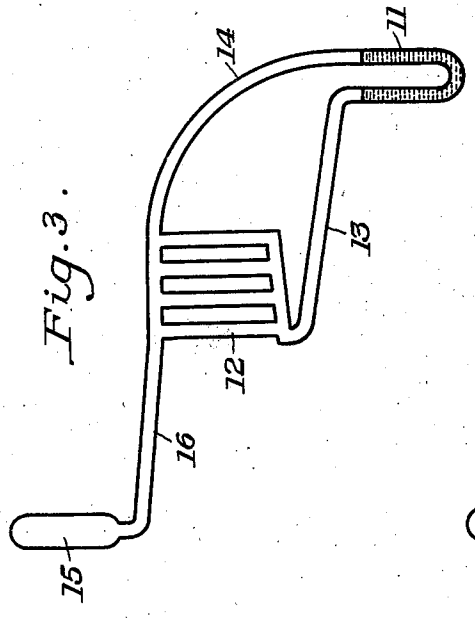
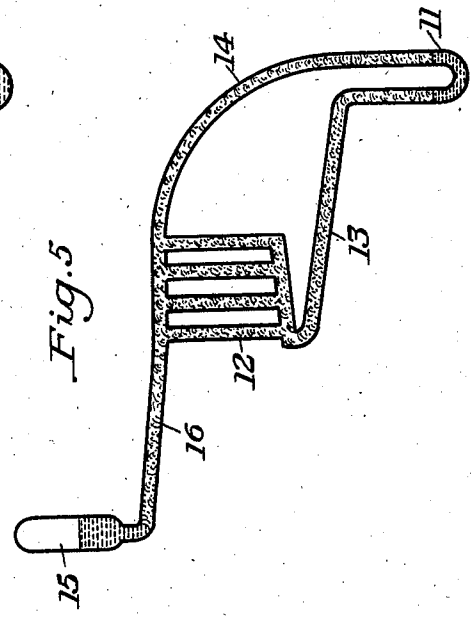


Fig. 5



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Fig. 8.

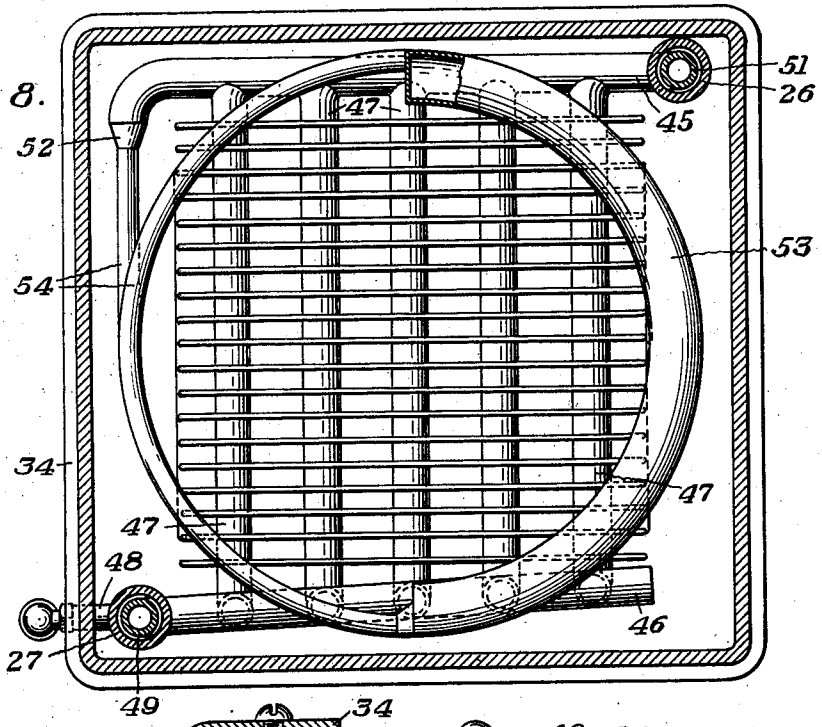
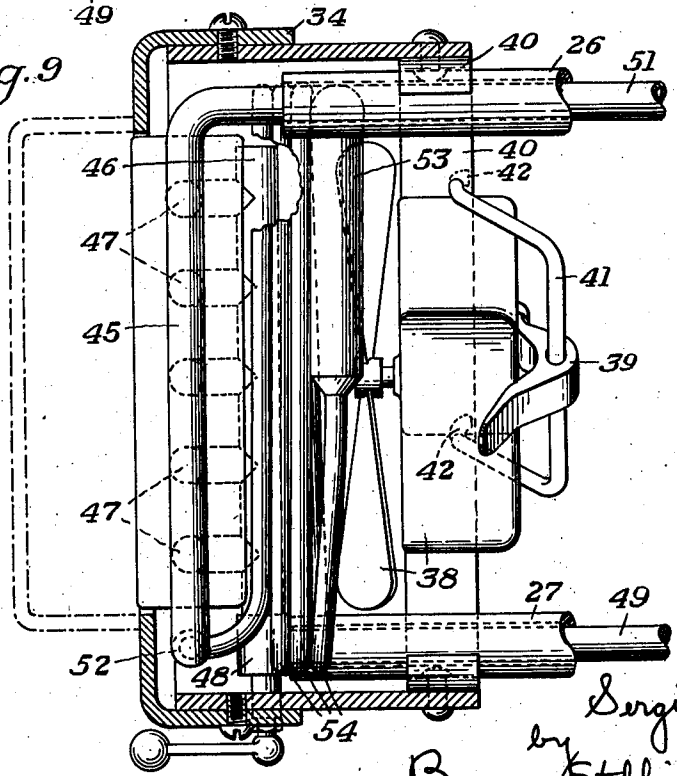


Fig. 9



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UNITED STATES PATENT OFFICE

2,028,261

AUTOMATIC CONTROL FOR VAPOR HEATING SYSTEMS

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

Substitute of applications Serial No. 415,712, December 21, 1929, and Serial No. 560,996, September 3, 1931. This application July 31, 1934, Serial No. 737,791

18 Claims. (Cl. 237—12.3)

This is a substitute application for applications Serial No. 415,712 filed December 21, 1929, and Serial No. 560,996, filed September 3, 1931; and is a continuation-in-part of application Serial No. 298,242 filed August 8, 1928.

My invention relates to improvements in vapor heating systems. In accordance with principles underlying my invention, provision is made for withdrawing fluid from circulation when excessive pressure is generated in the system, and returning a portion or all of the withdrawn fluid to the system if the pressure drops. These basic principles were taught in my prior application Serial No. 298,242 filed Aug. 8, 1928. In accordance with further developments of these basic principles which are set forth and claimed herein, the control chamber into which the fluid is thus withdrawn for decreasing the amount in active circulation is sufficiently isolated from the heating effect of the fluid in the radiator condenser so that this control chamber may function properly in response to increases and decreases in pressure in the radiator condenser. The functioning of the system under this control is still further perfected by other developments requiring that there be a definite drop in pressure in the radiator condenser in order to induce a return of fluid thereto from the control chamber. This last feature is illustrated more particularly in Figs. 3 to 9 inclusive of the drawings.

In the drawings which are to be taken as illustrative, and not as limiting my invention:

Fig. 1 is a view partly in elevation and partly in section of a heating system having a control chamber sufficiently remote from the radiator condenser to be substantially unaffected by the heat given out by the fluid in the radiator condenser;

Fig. 2 is a vertical section taken on the line II—II of Fig. 1;

Figs. 3, 4, 5, and 6 show diagrammatically the changes in the distribution of liquid and vapor in a vapor heating system arranged to obviate fluctuations in the amount of heating medium in active circulation as a result of slight fluctuations in pressure in the system;

Fig. 7 shows in vertical section a preferred embodiment of vapor generator, radiator condenser and control means constructed to embody this feature of my invention;

Fig. 8 is a view in elevation of the radiator condenser and the control means shown in Fig. 7; and

Fig. 9 is a plan view of the apparatus shown in Fig. 8, together with a fan for circulating air relative to the same.

My improvements are shown in Fig. 1 as applied to an automobile heater, the requisite heat being absorbed from the exhaust gases by a hollow vaporizing element *a* shown as consisting of a tubular element having a liquid receiving chamber *a'* within it. The exhaust pipe of the internal combustion engine is shown as formed with an enlargement *b* within which the vaporizing element *a* is disposed. From the vaporizer *a* a pipe or conduit *c'* is carried up to and into a radiator condenser A which is shown as being composed of a plurality of tubes *l* connected with headers *m* and *n*, the tubes being furthermore preferably provided with radiating fins *p* as in the first embodiment. The vapor tube *c'* carries the vapor generated in the vaporizer *a* to the header *n* from which it is distributed through the tubes *l* and passes into the header *m* from which a condensate return line *q*, of much smaller diameter than the pipe *c'*, carries the condensate back to the vaporizer *a*. This return pipe *q* may be provided with a manually operable control cock *k'* to entirely cut off the return of condensate if desired. The radiator condenser is preferably mounted within a suitable casing A' which may be provided with openings *e* to facilitate the circulation of air around the tubes *l* and fins *p*.

From the header *m* a pipe *r* leads to a control chamber which as illustrated in Fig. 1 is provided by a reservoir *s* preferably provided with radiating fins. The end of the pipe *r* extends down to near the bottom of the reservoir *s*. The length of the pipe *r* should be sufficient to remove the control chamber from the direct influence of the radiated heat of the radiator. Furthermore, the pipe *r* should be of sufficient length to accommodate a column of condensate, the drag of which in the pipe will retard the too rapid redischarge of condensate from the reservoir *s* into the header *m*.

Like the rest of the system when cold after a period of non-use, the reservoir *s* contains air or some other non-condensing gas which is entrapped therein. In the operation of the system a small quantity of liquid, for instance water, is placed in the system which is then closed entrapping the liquid together with the air or other non-condensing gas with which the system is filled. The water naturally drains down into the vaporizer *a*. When the heat of the exhaust gas raises the temperature of the vaporizer and turns the water into vapor, the vapor passes up

the pipe c' and is discharged into the header n. The vapor entering the tubes l forces the air ahead of it and compresses it into the control chamber s. As the vapor loses its heat through the radiator A, condensation takes place, the condensate running down to the lower end of the radiator and through the return pipe q to the vaporizer a, where it will be reconverted into vapor to return through the conduit c' to the radiator condenser A. The generation of vapor which has somewhat compressed the air in the system, increases the prevailing pressure due both to this compression and to the rise in temperature of the gases. The purpose of the automatic control, as explained in application Ser. No. 298,242, is to prevent the generation of excessive pressure in the system by the vaporization of substantially all of the liquid contained therein. The present application deals more particularly with an automatic control which functions by bleeding off from active circulation vaporized heating medium.

Such automatic prevention of excessive pressure by the control chamber s is effected as follows:—As the vaporizer a generates higher and higher vapor pressure, the entrapped non-condensing gases in the system are pushed more and more completely into the chamber s. This continues until a pressure has been reached in the radiator which is sufficient to force vapor into the reservoir s. This vapor continuously condenses in the reservoir until a point is reached where the pressure in the radiator begins to drop below the pressure in the reservoir. Some of the liquid is then returned by the pressure in the reservoir to the radiator, and thence to the vaporizer to be vaporized over again. An automatic control of the amount of heating medium in active circulation in the system is thus automatically effected. Whenever the pressure in the system becomes excessive, flow takes place along the pipe r in the direction of the reservoir s; and on the other hand, when the generation of vapor again drops to a slower pace, condensate is sucked back through the pipe r into the system.

It is important that no considerable quantity of condensate should be suddenly returned to the radiator to enter abruptly into active circulation before the gradual increase in the return flow of the condensate for revaporization increases the pressure in the radiator, as this will disturb the proper functioning of the system. Hence the diameter and length of the pipe connecting the radiator and reservoir should be such that the return flow of the condensate through it is retarded to permit a more gradual rate of increase of the pressure generated by vaporization of condensate as it circulates to the vaporizer; and the pressure within the radiator will be gradually increased by the pressure of the added vapor, and no abnormal differences of pressure will be suddenly developed in different parts of the system.

As already stated, the condensate return pipe q is of a much smaller diameter than the vapor pipe c'. This is not simply because a larger conduit is requisite to carry the vapor; but rather because the small diameter of the return pipe can be utilized to prevent the escape of vapor up that pipe in opposition to the return of the condensate. It may occasionally happen that a degree of heat and pressure will be produced in the radiator-condenser which is so excessive that practically all of the condensate may be forced into the control reservoir s. The temperature and pressure within the radiator-condenser will then fall because fresh vapor will not be entering the radiator-condenser. Should condensate then be ejected from the control reservoir s into the header m, it would immediately start down the return pipe q. The vaporizer a being empty, and very hot, the first portion of condensate entering the vaporizer will be instantly turned into vapor, in an explosive-like manner, which will tend to drive the vapor out of the vaporizer through both the outlet and inlet tubes; and this action will be repeated with each successive injection of a small amount of condensate into the vaporizer. But by employing a tube of a small diameter, I increase the resistance of the tube to the movement of the column of condensate to a point where the pressure of the vapor will be insufficient to back up the condensate materially against the drag of the tube and the pressure in the radiator-condenser, and the condensate will substantially retain its position in the tube until the vapor rushing up through the tube c' raises the pressure within the radiator-condenser to a point where the condensate will normally continue to flow back into the vaporizer. This is of very considerable importance for the satisfactory functioning of the apparatus.

If it is desired to stop the transfer of heat by the system, the cock k' may be closed. All of the condensate in or reaching the vaporizer will then be turned into vapor and will pass up into the radiator-condenser, where it will be gradually condensed and held trapped above the cock k', and the system will cease to function as a heater.

My improvement in vapor heaters provides for operation of the system under control of a chamber or receptacle responsive to the rise and fall in pressure in the system. This operation automatically withdraws a portion of the liquid from circulation, and to that extent reduces the flow of condensate back to the vaporizer. This consequently diminishes the amount of vapor generated and checks the tendency for the temperature and pressure of the circulating vapor to exceed those desired for proper operation of the heating system.

In this way a control is automatically established, the desired temperature and pressure automatically regulating the amount of liquid at any time in circulation through the vaporizer, so that the desired temperature and pressure may be maintained in the radiator condenser. If that temperature and pressure fall, the pressure of the entrapped air in the control chamber will force some of the withdrawn condensate back through the pipe r for active circulation through the vaporizer, the amount being controlled by the temperature and pressure produced in the radiator condenser by the vaporization of the liquid passing through the vaporizer.

I have obtained improved results by placing the control chamber outside the heating effect of the radiator condenser. By placing the reservoir s outside of the radiator condenser A I relieve it from the immediate influence of the varied degrees of temperature within the radiator condenser, and thereby secure a more normal functioning of its control of the surplus liquid of condensation. It will be evident that if the control chamber is exposed directly to the heat of the vapor issuing from the conduit c', which vapor is sometimes highly superheated,

not only will the air within the control chamber be unduly expanded so as to increase its back pressure, but condensate in the control chamber will be revaporized, thereby still further raising the pressure within the control chamber; and in consequence the proper functioning of the automatic control will be more or less seriously interfered with.

Figs. 3 to 6 illustrate how a properly proportioned communicating passageway between the radiator condenser and its control chamber promotes a smoother functioning of the heating system and obviates the rapid fluctuations of fluid driven back and forth between the radiator condenser and the control chamber with accompanying abrupt surges in pressure in the heating system. A vapor heating system of the general type described and claimed in my copending application Serial No. 298,242, filed August 8, 1928, is shown in these figures, the same comprising a vapor generator 11, a radiator condenser 12, and controlling means for withdrawing fluid from circulation between the vaporizer and the radiator condenser when excessive pressure is generated in the system. Let it be assumed that a suitable liquid, such as water, has been placed in the vapor generator 11, and that the remainder of the system is filled with air. If heat is absorbed by the vapor generator 11 as, for instance, by the flow of exhaust gases from an internal combustion engine past the vapor generator 11, vapor, such as steam, will make its way through both of the tubes 13 and 14 which connect the same with the radiator condenser. As the radiator condenser becomes filled with vapor, the air is driven into the control chamber. This air will accordingly be under considerable pressure, since it has practically all been driven into the controlling means. This condition is shown in Fig. 4. Up until this time, the controlling means has not functioned to lessen the amount of fluid in circulation. With the continued absorption of heat by the vapor generator 11, the vapor pressure increases so as to further compress the air in the controlling means and force vapor into the control chamber. The vapor which has been driven into the control chamber condenses but does not come back into circulation until the pressure in the vapor heating system again falls.

Fig. 5 shows the condition of the system when a portion of the fluid has been withdrawn, this fluid being shown at the left of Fig. 5 in a condensed state.

Should the pressure in the system drop again, the volume of the air trapped in the control means would increase so as to force a portion of the condensed liquid back into circulation in the system. If, on the other hand, the vapor generator 11 be maintained in a highly heated condition, the pressure in the system will rise to such a point that still more fluid will pass into the control means and be condensed. This condition is shown in Fig. 6. Under the usual operating conditions, a less quantity of liquid will remain in the controlling means than that shown in Fig. 6. The tendency in the operation of the system is to come to a balanced condition, the condition shown in Fig. 5 being the normal condition when the vapor generator 11 is being heated an average amount.

I find it of particular advantage, when employing a receptacle as part of the controlling device, that the receptacle shall not lead directly from the radiator condenser 12; because ordinary fluctuations in the pressure generated in the system would give rise to sudden transfers of condensate from the receptacle to the radiator condenser, if one led directly out of the other. This unfortunate effect would be heightened, were the transfer of condensate from the controlling device to the radiator condenser to occur substantially simultaneously with an increase in the amount of heat applied to the vapor generator. Now it is evident that if an automotive vehicle is changing speed or is starting up, there is a rapid change in the amount of heat supplied to the vapor generator. Assuming, therefore, that such an increase in the amount of heat occurs just after the pressure in the system has dropped, the result with directly connected condenser and controlling device would be that the condensate returned from the controlling device would be rapidly vaporized in the vapor generator 11 so that the pressure in the system would rise to an unusual extent. Furthermore, another maximum of heat supplied to the vapor generator might by chance occur at the very time a portion of condensate was being again returned from the control device; and as a result an extreme of pressure might occur in the system. My invention is not subject to such abrupt rushes of pressure, as no condensate is returned to my heating system from the receptacle 15 until a definite drop in pressure has occurred in the system.

In describing my invention, I have set forth what I believe to be the correct theories, but I do not intend the invention to be limited to such theory, since further knowledge may cast further light on the variations in pressure, and other conditions within the system which may not be thoroughly understood at the present time. It has, at any rate, been determined that extremely high pressures sometimes occur in a system where the supply of heat to the vapor generator is not uniform. One explanation of this may be that liquid is returned from the controlling means before an equilibrium in pressure has been reached in the system.

The extreme pressure may occur after a quick start of the automotive vehicle, at a time when the radiator and control means have not as yet had time to condense all of the liquid that should be taken out of circulation. Under these conditions considerable liquid would be returned to the vapor generator while high pressure still existed in the system. The quick return of condensate from the controlling means should in general be avoided. As a preferred manner of taking care of this difficulty, I have connected the receptacle of the control means with the radiator by an intermediate chamber, in this case a long tube. Such a chamber conducts vapor to the receptacle of the control means where the vapor cools and condenses. Upon a drop in the pressure in the system, the vapor thus condensed tends to return; but this condensate must pass through the intermediate chamber before entering again into circulation. In passing through this chamber, a definite volume of liquid is withdrawn from the receptacle before any is returned to the radiator; and, therefore, a definite drop in pressure occurs before any liquid is returned to the radiator.

In the embodiment shown in Figs. 3 to 6, the controlling means comprises a receptacle 15 and a connection 16 placing the receptacle in communication with the system. In Fig. 3, where the generation of vapor has not commenced,

there is nothing but air in either the receptacle 15 or the connection 16. In Fig. 4, sufficient vapor has been generated by the boiler 11 to force all of the air into the connection 16 and receptacle 15. In Fig. 5, which is intended to indicate normal running condition, a portion of the fluid has condensed and collected in the receptacle 15, the connection 16 and the radiator condenser 12 containing fluid which, as it cools, condenses and returns to the vapor generator 11. In Fig. 6 such a large portion of the fluid has been driven into the receptacle 15 that there is but little fluid left to circulate between the vapor generator 11 and the radiator condenser 12. Under these conditions but a slight cooling is necessary to cause a considerable drop in pressure in the system.

Let it be assumed that the pressure has dropped so that the high pressure of the air shown in the upper part of the receptacle 15 in Fig. 6 is unbalanced. This tends to drive condensate out of the receptacle 15. It will be noted, however, that the connection 16 must first be filled by this condensate. Due to this cause, a definite drop in pressure must precede the return of condensate to the system for revaporization. Accordingly, the quick rise and fall of pressure in the system is to a large extent done away with. The extent of drop in pressure which must occur before the liquid is again added to that in circulation in the system may be varied by varying the relative volumes of the receptacle 15 and the connection 16.

Controlling means of a simple type are illustrated in Figs. 3, 4, 5 and 6. In Figs. 7, 8 and 9, I have shown a form of controlling means which, in practice, has given quite satisfactory results. The vapor generator is present in the form of a U-type boiler 20 projecting through the wall of a sleeve 21 which is interposed between sections of the exhaust conduit 22. The boiler is made of a continuous length of pipe bent to provide a U-shaped portion disposed within the exhaust conduit 22 and legs extending laterally at an angle so as to pass through the sleeve 21. The boiler is connected by a conduit 23 for steam and a conduit 24 for condensate with the radiator condenser unit.

The latter unit is shown mounted on the cowlboard of a car. Tubular members 26 and 27 provide support for this unit, the respective conduits for the vapor and for the condensate extending through the pair of tubular members 26 and 27 to communicate with the radiator condenser. A flange 28 on the tubular member 26 and a flange 29 on the tubular member 27 abut against the cowlboard 30, nuts 31 and 32 cooperating respectively with the tubular members 26 and 27 to draw the tubular members tight with the flanges 28 and 29 against the cowlboard.

A casing 34 surrounds the radiator condenser and is supported by the tubular members 26 and 27. A deflector 35 pivoted on a rod 36 is arranged so that it may be adjusted for deflecting the heated air to the desired portion of the vehicle.

As shown in Figs. 7 and 9, a fan 38 is held in proper position with relation to the radiator condenser by a clamp 39. A supporting bridge 40 extends transversely between the tubular members 26 and 27; and a spring 41 provided with hooked ends 42 attaches the clamp 39 and fan 38 to the casing 34.

With the above arrangement of bridge, spring and clamp, it is a simple matter to remove the fan. At the same time the construction has the quality of rigidity, and all strains are taken from the working parts and transmitted to the outside casing of the unit.

The radiator condenser is present in the form of headers connected by a plurality of tubes. As shown in greater detail in Fig. 8, the headers 45 and 46 are connected to the extremities of fin tubes 47. In the embodiment shown, five of these fin tubes are provided, although a greater or less number may be employed if a greater or less amount of radiation is desired. The header 46 is bent at right angles to the main radiator; and is provided with the shut-off valve 48 by means of which the unit may be put out of operation. From the extension 49 the conduit 24 returns the condensate to the boiler 20.

The header 45 is bent at right angles to the radiator as shown at 51 and connects to the conduit for steam 23.

The controlling means is wound in the form of a helical coil and is fastened to the header 45 at the point 52. The controlling means includes a receptacle 53 and connecting tubing 54. The connecting tubing is purposely selected of a small diameter so that capillary action will maintain within the same a continuous column of liquid. A further advantage of the small diameter of the tubing 54 is that rapid flow of air or other fluid takes place through the same when there is a variation in pressure in the system. Due to this rapid flow of gas or vapor, the tubing 54 is scavenged so as to remove any liquid collecting in the turns of the same. In the embodiment shown in the drawings, a coil in excess of three complete turns in length is used.

The receptacle 53 consists of an arcuate tube of considerably larger diameter than the tubing 54. The size of the receptacle 53 is selected in accordance with the proportions of the other parts of the heating system; and in the embodiment shown in Fig. 8, the diameter of the receptacle 53 has been selected of such magnitude that this tube makes a half circle. It is preferred that the receptacle 53 be arranged so that the connection with the tubing 54 is at the bottom thereof. Accordingly, as shown in Fig. 8, condensate, if any of the same collects in the receptacle 53, will be collected in the bottom where the connection is made with the tubing 54.

In accordance with the principles of my invention, it is possible, by changing the proportions of the tubing 54 relative to the receptacle 53, to obtain a greater or less drop in pressure before liquid will be returned to the header 45. It is preferable to fix this drop in pressure in accordance with the amount of heat radiated by the system when the fan is turned off during hot weather with the radiator practically covered. A drop in pressure of sufficient magnitude should be chosen so that the liquid condensed and returned to the boiler 20 may be revaporized as quickly as it returns without occasioning as high a rise in pressure as occurred when a previous portion of liquid was vaporized and forced into the radiator condenser. As an example, the following proportions are given:—If the volume of the radiator be 5.82 cubic inches, the volume of conduits 23 and 24 be 1.93 cubic inches, the volume of boiler 20 be 3.96 cubic inches, the volume of the entire system, aside from the controlling means will be 11.71 cubic inches. A receptacle 53 having a volume of two cubic inches may be employed in connection with tubing 54 having a volume of 2.65 cubic inches.

By reason of the insertion of a chamber such as the elongated tubing **54**, between the receptacle **53** of the controlling means and the radiator condenser, a definite drop in pressure in the system must precede the return of condensate to the boiler **20**. This much improves the operation of the system, since there is much less tendency for excessive pressure to be generated in the system. My improved arrangement has the further advantage that the return of condensate from the controlling means is retarded and made more gradual so that there is an opportunity for the radiation of heat by the radiator condenser so as to condense the vapor generated in the boiler **20** as fast as the same is forced from the boiler **20** into the radiator condenser.

The advantages of entrapping a body of air or other suitable gas in a closed controlling chamber removed from the direct influence of the temperature conditions in the radiator condenser have been above discussed, it being particularly noteworthy that this avoids upsetting the normal functioning of the controlling means by abnormal variations in the temperature prevailing in the radiator condenser as occasioned by extraneous causes.

While I have illustrated and described a closed heating system in accordance with a preferred mode of construction, and have described a specific type of radiator condenser and controlling means forming a part of such a closed system, it will be understood that the invention is not restricted to the particular style of controlling means nor to the particular construction of radiator condenser shown, but may be variously modified within the contemplation of the invention and under the scope of the following claims.

I claim:

1. A vapor heating system comprising a radiator condenser, a vaporizer, a heating medium adapted to be converted into vapor by the vaporizer and condensed in the radiator condenser, means for conducting the vapor to the condenser and for returning the condensate to the vaporizer, and control means including a chamber separated from the radiator condenser by an air space and means for placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and to return condensed heating medium to said radiator condenser, said control means containing entrapped non-condensing gas effective for varying the amount of heating medium in said control means in response to differences in pressure arising between the control means and the radiator condenser.

2. A vapor heating system comprising a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium in the system adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser and returned to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system including a chamber closed to the atmosphere and means for placing said chamber in unobstructed communication at all times with the radiator condenser to receive vaporized heating medium therefrom and to return condensed heating medium to said radiator condenser, said control means containing entrapped non-condensing gas effective for varying the amount of heating medium in said control means in response to differences in pressure arising between the control means and the radiator condenser, and said chamber being substantially isolated from the heating effect of the medium in the radiator condenser so that said entrapped gases are substantially unaffected by the heat thereof.

3. A vapor heating system comprising a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium in the system adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser, and returned to the vaporizer, and control means including a chamber outside of the radiator condenser and sufficiently spaced therefrom to be substantially unaffected by the heat given out by the medium in the radiator condenser, and means for placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and to return condensed heating medium to said radiator condenser, said control means containing entrapped non-condensing gas effective for varying the amount of heating medium in said control means in response to differences in pressure arising between the control means and the radiator condenser.

4. A vapor heating system comprising a radiator condenser, a vaporizer, a heating medium adapted to be converted into vapor by the vaporizer and condensed in the radiator condenser, means for conducting the vapor to the condenser and for returning the condensate to the vaporizer, a manually operable valve for preventing return flow of condensate through said conducting means, and control means including a chamber separated from the radiator condenser by an air space and means for placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and to return condensed heating medium to said radiator condenser, said control means containing entrapped non-condensing gas effective for varying the amount of heating medium in said control means in response to differences in pressure arising between the control means and the radiator condenser.

5. A vapor heating system comprising a radiator condenser, a vaporizer, a heating medium adapted to be converted into vapor by the vaporizer and condensed in the radiator condenser, means for conducting the vapor to the condenser and for returning the condensate to the vaporizer, and control means including a chamber separated from the radiator condenser by an air space and provided with radiating fins and means for placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and to return condensed heating medium to said radiator condenser, said control means containing entrapped non-condensing gas effective for varying the amount of heating medium in said control means in response to differences in pressure arising between the control means and the radiator condenser.

6. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser as a closed system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system, said control means including a condensing chamber constructed

and arranged to accumulate non-condensing gas contained in said system and means placing said chamber in communication with the closed system to receive vaporized heating medium therefrom and return heating medium thereto as the pressure in said chamber is less or greater than the pressure in the system, said last mentioned means being constructed and arranged to delay discharge of condensed heating medium from the chamber into the system to avoid fluctuations in the amount of heating medium in active circulation as a result of slight fluctuations in pressure in the system.

7. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser and returned to the vaporizer, control means for regulating the amount of heating medium in active circulation in the system, and non-condensing gas adapted when accumulated in said control means to respond to differences in pressure arising between the control means and the radiator condenser so as to change in volume with accompanying change in the amount of heating medium stored in said control means, said control means including a condensing chamber and means placing said chamber in communication with the radiator condenser to receive vaporized heating medium from the system and to return condensed heating medium thereto, said last mentioned means being constructed and arranged to delay a return of heating medium until a definite drop in pressure occurs in the system.

8. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser as a closed system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system, said control means including a condensing chamber constructed and arranged to accumulate non-condensing gas contained in said system and a conduit for placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and to return heating medium thereto as the pressure in said chamber is less or greater than the pressure in the radiator condenser, said conduit having a passageway constructed to delay discharge of condensed heating medium from the chamber into the heating system.

9. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser and returned to the vaporizer, a control receptacle constructed and arranged to condense vapor, non-condensing gas contained in said system and adapted to accumulate in said receptacle during periods of operation of the system, and a conduit for placing said receptacle in communication with the closed system to receive vaporized heating medium therefrom and to return condensed heating medium thereto, said conduit having a passageway constructed to retard return flow of condensate so as to delay discharge of heating medium from the chamber into the system.

10. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser as a closed system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system, said control means including a condensing chamber constructed and arranged to accumulate non-condensing gas contained in said system and a connection placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and return heating medium thereto as the pressure in said chamber is less or greater than the pressure in the radiator condenser, said connection being sufficiently small in cross section to prevent flow of liquid and vapor in opposite directions simultaneously and of sufficient extent to delay the return of condensed heating medium into the radiator condenser whereby slight fluctuations in pressure in the system are not accompanied by corresponding fluctuations in the amount of heating medium in circulation in the system.

11. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser as a closed system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and a control receptacle communicating with a portion of the radiator condenser remote from said conducting means so as to accumulate non-condensing gas contained in said system and to receive vaporized heating medium from the radiator condenser and return heating medium thereto as the pressure in said receptacle is less or greater than the pressure in the system.

12. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser as a closed system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system, said control means including a condensing chamber constructed and arranged to accumulate non-condensing gas contained in said system and means placing said chamber in communication with the closed system to receive vaporized heating medium therefrom and return heating medium thereto as the pressure in said chamber is less or greater than the pressure in the system.

13. In combination, a radiator condenser, a vaporizer, conducting means operatively connecting the vaporizer and the radiator condenser for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and control means for regulating the amount of heating medium in active circulation, said control means including a condensing chamber constructed and arranged to accumulate non-condensing gas contained in said system and means placing said chamber in communication with the radiator condenser to receive vaporized heating medium therefrom and return heating medium thereto as the pressure in said

chamber is less or greater than the pressure in the radiator condenser.

14. In combination, a radiator condenser, a vaporizer, conducting means operatively connecting the vaporizer and the radiator condenser in a heating system for the circulation of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and condensing means constructed and arranged to accumulate non-condensing gas contained in said system and operatively connected to the radiator condenser to receive vaporized heating medium from the radiator condenser when the pressure in said means is less than the pressure in the radiator condenser and return heating medium to the radiator condenser when the accumulated pressure of the non-condensing gas in said means is greater than the pressure in the radiator condenser to automatically regulate the amount of heating medium in active circulation in the system.

15. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium in the system adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser and returned to the vaporizer, and control means for regulating the amount of heating medium in active circulation in the system, said control means being constructed and arranged to accumulate non-condensing gas contained in said system, said control means including a condensing chamber and a coil of tubing operatively connecting the lower portion of said chamber with the vapor space of the radiator condenser, said tubing being of sufficiently small cross section to prevent flow of liquid and vapor in opposite directions simultaneously.

16. In combination, a radiator condenser, a vaporizer, conducting means uniting the vaporizer and the radiator condenser in a closed heating system, a heating medium in the system adapted to be converted into vapor by the vaporizer, condensed in the radiator condenser and returned to the vaporizer, control means for regulating the amount of heating medium in active circulation in the system, and non-condensing gas adapted when accumulated in said control means to respond to differences in pressure arising between the control means and the radiator condenser so as to change in volume with accompanying change in the amount of heating medium stored in said control means, said control means including a condensing chamber and a conduit operatively connecting the lower portion of said chamber with the upper portion of the radiator condenser, said conduit being constructed and arranged to delay a return of condensed heating medium to the radiator condenser until a definite drop in pressure has occurred in the radiator condenser.

17. In combination, a vaporizer, a radiator condenser, conducting means uniting the radiator condenser and the vaporizer in a closed heating system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and a control chamber communicating with the radiator condenser to receive vaporized heating medium expelled from the system as the pressure in the system rises above the pressure in the control chamber, said chamber being constructed and arranged to accumulate non-condensing gas contained in said system, the accumulated pressure of said non-condensing gas being effective for returning heating medium to the system when the pressure in the system drops below the pressure in the control chamber.

18. In combination, a vaporizer, a radiator condenser, conducting means uniting the radiator condenser and the vaporizer in a closed heating system for the flow of vaporized heating medium from the vaporizer to the radiator condenser and the return of condensate from the radiator condenser to the vaporizer, and a condensing chamber constructed and arranged to accumulate non-condensing gas contained in said system and communicating with the radiator condenser through a passageway of sufficiently small cross section to prevent flow of liquid and vapor in opposite directions simultaneously, said passageway extending between the radiator condenser and the lower part of said chamber for the flow of vaporized heating medium to said chamber and the return of heating medium therefrom to the radiator condenser as the pressure in said chamber is less or greater than the pressure in the radiator condenser.

SERGIUS VERNET.