Oct. 26, 1954 N. L. LIEBERMAN 2,692,732

HEATING SYSTEM

Filed Aug. 14, 1951 2 Sheets-Sheet 1

Fig. 3.

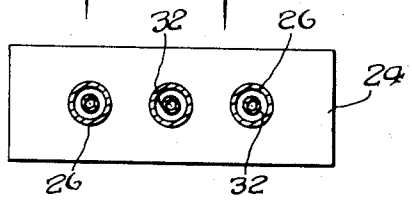
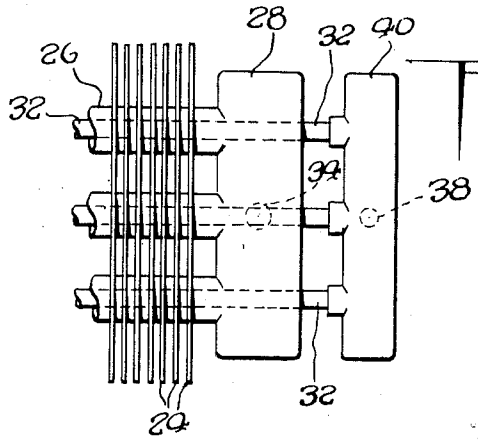


Fig. 1.

Fig. 2.



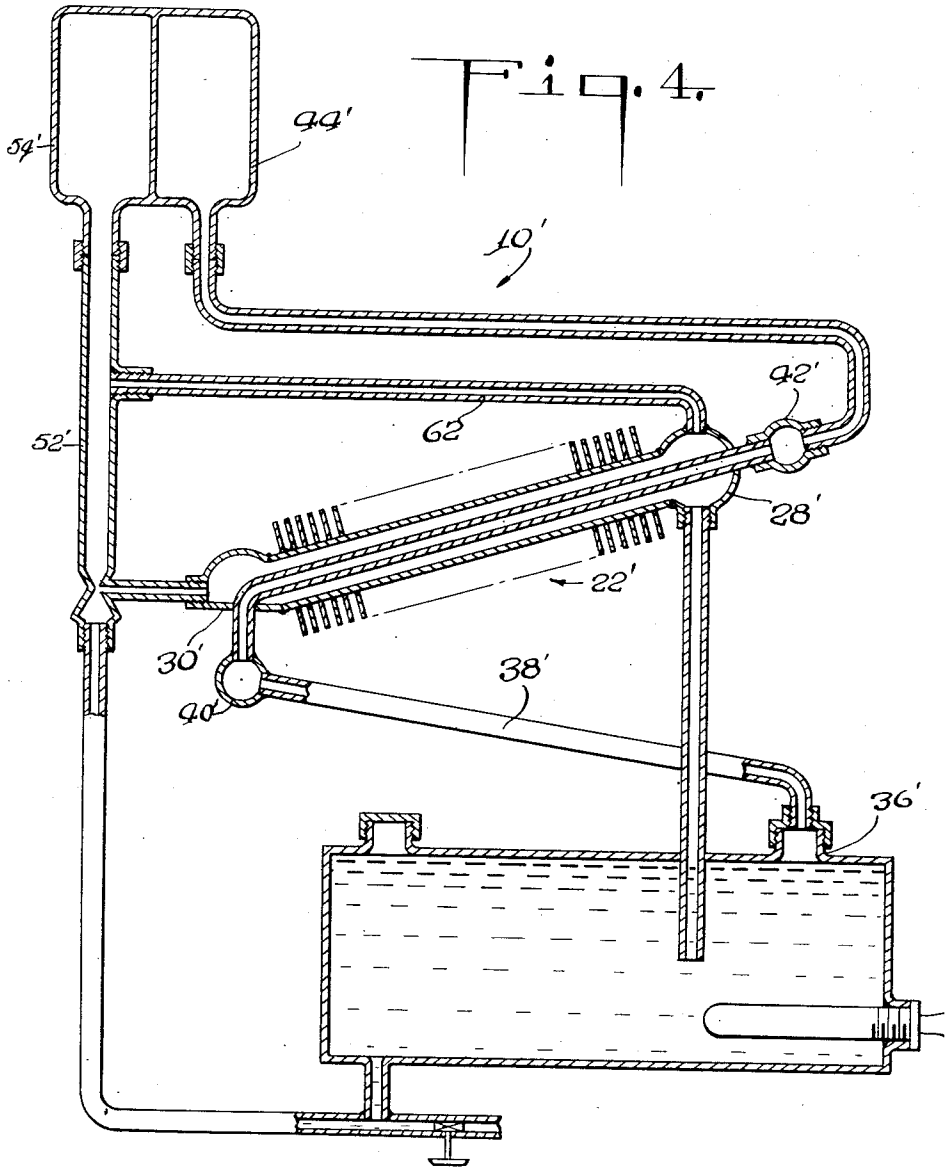
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ATTORNEY

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Filed Aug. 14, 1951 2 Sheets-Sheet 2

Fig. 4.



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Patented Oct. 26, 1954

2,692,732

UNITED STATES PATENT OFFICE

2,692,732

HEATING SYSTEM

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Application August 14, 1951, Serial No. 241,709

17 Claims. (Cl. 237—16)

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This invention relates to heating systems.

By way of example the invention will be described herein with respect to a single-radiator heating system such, for example, as is employed for an auxiliary or emergency heater. However, it is to be understood that this specific form of my invention is to be considered only as illustrative and my invention is not to be deemed as limited thereby except to the extent to which features of such embodiment are pointed out below and are incorporated in the appended claims.

It is an object of my invention to provide a heating system of the character described which is efficient in operation, constitutes relatively few and simple parts, and is inexpensive and easy to make and install, and may, if desired, be portable.

It is another object of my invention to provide a heating system of the character described whose radiation surfaces attain operative temperatures within a short time after the system is placed in operation.

It is another object of my invention to provide a heating system of the character described which is so constructed as to require but little attention over an extended period of time.

It is another object of my invention to provide a heating system of the character described in which there are no moving parts but which, nevertheless, affords a positive circulatory action to a heat exchange liquid in the system.

Other objects of my invention in part will be obvious and in part will be pointed out hereinafter.

My invention accordingly consists in the features of construction, combinations of elements and arrangements of parts which will be exemplified in the heating systems hereinafter described and of which the scope of application will be indicated in the appended claims.

In the accompanying drawings in which are shown various possible embodiments of my invention,

Fig. 1 is a vertical sectional view through a heating system constructed in accordance with my invention;

Fig. 2 is a fragmentary top view of said system in the vicinity of the radiator inlet manifold;

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 1; and

Fig. 4 is a view similar to Fig. 1 of a heating system embodying a modified form of my invention.

Referring now in detail to the drawings, the reference numeral 10 denotes a heating system

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embodying the present invention. Said system comprises a generator 12 constituting a tank of any suitable shape and size. Conveniently, the generator may comprise an elongated cylindrical boiler shell closed at both ends and having its longitudinal axis horizontally disposed. The generator has a top filling inlet 14 closed by a cap 16 whereby a vaporizable liquid may be introduced into the system. For reasons which later will appear, the generator in idle (cold) condition is substantially filled with a suitable liquid, e. g. water.

A standard means is included to heat the liquid to the point of vaporization. As shown herein said means constitutes a waterproof electric resistance heating cartridge 18 disposed within the generator and supported on one of the ends of the shell. The heater is energized conventionally through a pair of leads 20.

The heating system also includes a radiator 22. To outward appearances, the radiator is of conventional construction and consists simply of a large number of parallel metal plates, i. e. fins, 24, which are pierced by one or more liquid-carrying tubes 26 to which the fins are secured. It may be mentioned at this point that although fin-type radiation is used in the preferred form of my invention, my invention embraces all other conventional types of radiation as cast iron, tubular, etc. As is usual in fin-type radiation, the inlet ends of the tubes 26 are connected to an inlet liquid manifold 28. Likewise, the outlet ends of the tubes 26 are connected to an outlet liquid manifold 30.

The radiator 22 differs from a conventional radiator in that an inner vapor carrying tube 32 is nested within each of the outer tubes 26 so that, in effect, each outer tube has within it two fluid passageways, one a cylindrical passageway comprising the inside of the inner tube, and the other, an annular passageway comprising the space between the external surface of the inner tube and the internal surface of the outer tube. As will be pointed out hereinafter, one of the passageways will contain the heated liquid and the other, the heated vapor of the liquid.

In the form of my invention now being described, the inlet liquid manifold 28 is at a higher level than the generator and the outlet liquid manifold 30 is higher than the inlet liquid manifold.

An open-ended conduit 34 connects the inlet liquid manifold 28 to the generator. Said conduit pierces the wall of the generator, being hermetically sealed thereto, and extends below

the idle (cold) level of the liquid in the generator whereby said conduit forms a trap for all liquid above its open bottom.

At a high point on the generator a dome 36 is provided in which heated vapor released by liquid in the generator accumulates when said liquid is heated. The dome may be of comparatively small dimensions and, if desired, can be entirely omitted, it being employed only for convenience in facilitating initial collection of vapor. A conduit 38 connects the vapor dome, or if said dome is omitted, a high point on the generator, to an inlet vapor manifold 40 that is connected to the inlet ends of the inner tubes 32. Said inner tubes extend through the inlet liquid manifold 28 being hermetically sealed thereto where they pierce the wall of the manifold.

The outlet ends of the inner tubes 32 are connected to an outlet vapor manifold 42 which in turn is connected to a vapor expansion tank 44. The inner tubes 32 pass through a wall of the outlet liquid manifold 30 and are hermetically sealed thereto.

A conduit 46 connects the outlet liquid manifold to the throat 48 of a vertically extending Venturi tube 50. The upper end of the Venturi tube is connected by a riser 52 to a liquid balance tank 54, juxtaposed to the vapor expansion tank 44. The lower end of the Venturi tube is connected to the upper end of a return conduit 56 that runs to a liquid return tap 58 at a low point of the generator. Liquid may be let out of the system by a drain valve 60 at a low point on the return conduit.

The idle volume of liquid trapped in the generator above the bottom of the conduit 34 must exceed the volume of the liquid containing portion of the system above the generator. This latter volume consists of the spaces within the Venturi tube 50, the portion of the conduit 34, 56 above the generator and the two liquid manifolds 28, 30 and the annular spaces between the tubes 26, 32.

The operation of the heating system 10 is as follows:

In idle (unheated) condition the generator 12 is substantially filled with a vaporizable liquid, e. g. water. Provided that the trapped idle volume of liquid exceeds the volume of the liquid containing portion, it is not essential for the generator to be exactly filled. It will be observed that the liquid levels in the generator, the return conduit and the conduit 34 are the same when the generator is idle. The remainder of the system is filled with gas, e. g. air, and the system is hermetically closed.

Heat is applied to raise the temperature of the liquid in the generator, as by energizing the cartridge 18. Initially this simply expands the liquid which, if the generator is not quite full, will raise the level of the liquid in the generator and, if the generator is full, will force the liquid up higher into the vapor dome, the conduit 34 and the return conduit.

As the heating continues vapor will be formed. Since the connections between the return conduit and the generator and between the conduit 34 and the liquid in the generator are below the liquid level, no vapor will enter conduit 34 or the return conduit and the vapor will be released in the vapor dome. Said vapor will travel through the vapor containing portion of the system including the tube 38, manifold 40, inner pipes 32 and vapor expansion tank in the same fashion as steam rising in a steam heating system. The vapor released in the vapor containing portion of my heating system will raise the pressure therein and thereby raise the boiling point of the liquid in the generator so that as operation continues the liquid will boil at a progressively higher temperature. By making the vapor expansion tank an appropriate size, this pressure and temperature rise can be held within suitable limits, e. g. 10 pounds and 15° C. over the normal boiling point.

It particularly is to be noted that there is no connection between the liquid containing portion of the heating system and the vapor containing portion of said system externally of the generator so that the condensate from the vapor expansion tank and the vapor tubes returns to the generator exclusively through the vapor containing portion of the system.

As the pressure increases over initial starting conditions in the vapor containing portion of the system, such pressure will exceed the pressure in the liquid containing portion of the system. The resulting disturbance of equilibrium will cause the liquid to rise in the conduit 34 and in the return conduit 56. Eventually, sufficient liquid rises in the conduit 34 to fill this conduit, the inlet liquid manifold 28, the annular space between the tubes 32, 26 and the outlet liquid manifold 30. Liquid also will fill the return conduit 56, so that eventually the entire liquid containing portion of the heating system is filled except for the liquid balance tank.

The liquid in the feed leg of the system consisting of the conduit 34, inlet liquid manifold 28, annular spaces between the tubes 26, 32 and outlet liquid manifold 30 is heated by the vapor in the inner tubes 32 and, therefore, is hotter than the liquid in the return leg consisting of the return conduit 56. Accordingly, the density of the liquid in the feed leg is less, so that the height of the liquid in said feed leg will be higher than that of the liquid in the return leg, both being sustained by the same vapor pressure in the generator. Therefore, the water in the feed leg will reach the throat of the Venturi tube where the two legs join before the liquid in the return leg reaches this junction point. As a result, liquid from the feed leg will spill into the throat of the Venturi and down the return leg. Since the liquid in the return leg at this time still has a greater density than the liquid in the feed leg, liquid will flow down the return leg under the added head of liquid spilling over from the feed leg. This results in a positive circulating action until, after a short time, the pressure present in the vapor containing portion of the heating system becomes sufficiently high to raise the level of the liquid in the return leg to the height of the junction point (the throat of the Venturi tube). Thereafter positive circulation still is maintained due to the fact that the liquid in the feed leg is heated by the vapor tubes 32, and is therefore less dense than the liquid in the return leg which is not heated, so that liquid will rise in the feed leg and descend in the return leg.

As the liquid containing portion of the system fills, the gas in the liquid balancing tank 54 is compressed so that after the liquid containing portion of the system is filled above the level of the throat of the Venturi tube, the gas in the balancing tank is under a substantial pressure. This pressure forces the elevated liquid in

the system back to the generator when the vapor pressure in the vapor containing portion of the system falls off either due to removal of heat, i. e. when the heating cartridge is deenergized, or due to condensation in the vapor containing portion of the system, caused, for example, by a change in ambient temperature in any part of the vapor containing portion. The pressure accumulated in the balancing tank functions to rapidly restore the liquid in the generator to its idle level when the source of heat for the generator is deactivated. Such rapid return of liquid from the liquid containing portion of the system back to the generator is expedited by the return tube. The overall effect is to shorten the period required to restore the system to its idle condition and thereby ready it for another heating cycle.

This feature makes the system particularly adaptable for thermostatic control since if the return to idle condition were not rapid there would be a tendency for liquid in the feed leg simply to fluctuate between the generator and a point short of the throat of the Venturi tube. Although this liquid has its temperature raised by heat transferred from the vapor containing portion of the system, its temperature nevertheless is below that of the heated liquid in the generator since heat constantly is being dissipated through the radiator. By enabling the system to be restored quickly to idle position and to be placed quickly into full operating condition, I avoid the foregoing difficulty.

The return tube also permits circulation of heated liquid through the radiators, i. e. permits liquid from which some heat has been extracted to flow back to the generator through the return tube and freshly heated liquid to take its place. Furthermore the return tube speeds the flow of liquid to the conduit **34** so as to shorten the period between energization of the cartridge and full utilization of the radiator.

Fluctuations in the heat of the liquid in the liquid containing portion of the system after filling of the same above the level of the throat of the Venturi tube will cause flow of liquid through the Venturi tube and thereby lower the pressure at the throat **48**, thus inducing the flow of liquid from the outlet liquid manifold into the tube. This aids positive circulation of the liquid throughout the system. Such fluctuations are caused by variations in voltage applied to the heating cartridge and by local variations in ambient temperature at any part of the vapor containing portion of the heating system.

It will be observed that by having both the liquid and vapor portions of the system hermetically sealed, I am able to prevent loss of liquid to the ambient air, can more quickly force liquid up the conduit **34** and am able to increase the pressure in the liquid containing portion of the system whereby to elevate the boiling point of the liquid and thus raise the temperature of the radiator.

Although the radiator has been shown as having the outlet liquid manifold higher than the inlet liquid manifold it is within the scope of my invention to have the radiator horizontally positioned or even to have the outlet liquid manifold lower than the inlet liquid manifold. This latter arrangement is shown in a heating system **10'** illustrated in Fig. 4 wherein all parts similar to those illustrated and described with reference to Figs. 1–3 are denoted by the same reference numerals primed.

In the heating system **10'** the radiator **22'** is

disposed so that its inlet liquid manifold **28'** is higher than its outlet liquid manifold **30'**. In order to prevent an air-lock in the radiator suitable means is included such for example as an air relief conduit **62** connecting the top of the inlet liquid manifold **28'** to the conduit **52'** running between the Venturi tube and the liquid balancing tank **54'**.

The heating system **10'** also reverses the connections to the vapor manifolds in order to prevent formation of a condensate trap in the vapor containing portion of the system. More specifically, the vapor conduit **38'** runs from the stream dome **36'** to the vapor inlet manifold **40'** which is located at the lower end of the radiator. The outlet vapor manifold **42'** is located at the higher end of the radiator and is connected to the vapor expansion chamber **44'**. It will be observed that in this system, as in the system **10**, the vapor condensate returns to the generator exclusively through the vapor containing portion of the system.

It thus will be seen that I have provided devices which achieve all the objects of the invention and are well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments above set forth, it is to be understood that all matter herein described, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having two openings, the first opening being at a low point in the generator and the second opening being at a point intermediate said low point and a high point in the generator, a radiator having a hollow liquid-containing interior with an inlet and an outlet, the inlet and outlet being located below the highest point of the system external to the generator, conduit means directly connecting the second opening to the radiator inlet, conduit means connecting the first opening to the radiator outlet, that part of the system external to and above the generator being empty when at ambient temperature and liquid containing when hot, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the second opening, the radiator outlet being above the second opening and means to heat liquid in the generator.

2. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having two openings, the first opening being at a low point in the generator and the second opening being at a point intermediate said low point and a high point in the generator, a radiator having a hollow liquid-containing interior with an inlet and an outlet, the inlet and outlet being located below the highest point of the system external to the generator, said inlet being higher than the second opening, conduit means directly connecting the second opening to the radiator inlet, conduit means connecting the first opening to the radiator outlet, that part of the system external to and above the generator being empty when at ambient temperature and liquid containing when hot, the volume of the liquid con-

taining portion of the system external to and above the generator being less than the volume of the generator above the second opening, the radiator outlet being above the second opening and means to heat liquid in the generator.

3. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

4. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, said inlet being higher than the third opening, a vapor tube extending through said hollow interior of said radiatior and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

5. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, said inlet being higher than said outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

6. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, said outlet being higher than said inlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, and means to heat liquid in the generator.

7. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, said outlet being higher than said inlet and higher than the second opening, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

8. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, said inlet being higher than the third opening, said outlet being higher than said inlet and higher than said second opening, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate

from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

9. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, a vapor expansion chamber, conduit means connecting said vapor tube outlet to said expansion chamber, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

10. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, means blocking said vapor tube outlet to the ambient air, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, a liquid balancing chamber higher than the radiator outlet conduit means connecting said balancing chamber to the juncture of the radiator outlet and the conduit means running from said radiator outlet to the second opening, and means to heat liquid in the generator.

11. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, an expansion chamber, conduit means connecting the expansion chamber to the vapor tube outlet, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, a liquid balancing chamber higher than the radiator outlet, conduit means connecting said balancing chamber to the juncture of the radiator outlet and the conduit means running from said radiator outlet to the second opening, and means to heat liquid in the generator.

12. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, a Venturi tube having two open ends and an opening at its throat, the radiator outlet being higher than the radiator inlet, the radiator inlet being higher than the third opening, the radiator outlet being higher than the second opening, the vapor tube inlet being higher than the first opening, a vapor expansion tank, a liquid balancing chamber, said balancing chamber being higher than the radiator outlet, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the vapor tube outlet to the vapor expansion tank, conduit means connecting the radiator inlet to the third opening, conduit means connecting the radiator outlet to the throat of the Venturi tube, conduit means connecting one end of the Venturi tube to the balancing chamber, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

13. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator having a hollow liquid containing interior with an inlet and an outlet, a vapor tube extending through said hollow interior of said radiator and having an inlet and an outlet, a Venturi tube having two open ends and an opening at its throat, the radiator outlet being higher than the radiator inlet, the radiator inlet being higher than the third opening, the radiator outlet being higher than the second opening, the vapor tube inlet being higher than the first opening, a vapor expansion tank, said expansion tank being higher than the vapor tube outlet, a liquid balancing chamber, said balancing chamber being higher than the radiator outlet, conduit means connecting the vapor tube inlet to the first opening, conduit means connecting the vapor tube outlet to the vapor expansion tank, conduit means connecting the radiator inlet to

the third opening, conduit means connecting the radiator outlet to the throat of the Venturi tube, conduit means connecting one end of the Venturi tube to the balancing chamber, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tube returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

14. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator comprising a plurality of fins pierced by a set of liquid tubes to which the fins are secured, a inlet liquid manifold connected to one set of ends of the set of tubes, a outlet liquid manifold connected to the other set of ends of the set of tubes, a set of vapor tubes, each vapor tube being nested within a different liquid tube, an inlet vapor manifold connected to the inlet ends of the vapor tubes, an outlet vapor manifold connected to the outlet ends of the vapor tubes, the inlet manifolds being higher than the generator, the outlet manifolds being higher than the inlet manifolds, a vapor expansion tank, a liquid balancing tank, a Venturi tube having two open ends and an opening at its throat, conduit means connecting the inlet vapor manifold to the first opening, conduit means connecting the inlet liquid manifold to the third opening, conduit means connecting the outlet vapor manifold to the vapor expansion tank, conduit means connecting the outlet liquid manifold to the throat of the Venturi tube, conduit means connecting one of the ends of the Venturi tube to the liquid balancing tank, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tubes returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

15. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator comprising a plurality of fins pierced by a set of liquid tubes to which the fins are secured, a inlet liquid manifold connected to one set of ends of the set of tubes, a outlet liquid manifold connected to the other set of ends of the set of tubes, a set of vapor tubes, each vapor tube being nested within a different liquid tube, an inlet vapor manifold connected to the inlet ends of the vapor tubes, an outlet vapor manifold connected to the outlet ends of the vapor tubes, the inlet manifolds being higher than the generator, the outlet liquid manifold being lower than the inlet liquid manifold, a vapor expansion tank, a liquid balancing tank, a Venturi tube having two open ends and an opening at its throat, conduit means connecting the inlet vapor manifold to the first opening, conduit means connecting the inlet liquid manifold to the third opening, conduit means connecting the outlet vapor manifold to the vapor expansion tank, conduit means connecting the outlet liquid manifold to the throat of the Venturi tube, conduit means connecting one of the ends of the Venturi tube to the liquid balancing tank, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tubes returning to the generator exclusively through the vapor containing portion of the system, and means to heat liquid in the generator.

16. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator comprising a plurality of fins pierced by a set of liquid tubes to which the fins are secured, a inlet liquid manifold connected to one set of ends of the set of tubes, a outlet liquid manifold connected to the other set of ends of the set of tubes, a set of vapor tubes, each vapor tube being nested within a different liquid tube, an inlet vapor manifold connected to the inlet ends of the vapor tubes, an outlet vapor manifold connected to the outlet ends of the vapor tubes, the inlet manifolds being higher than the generator, the outlet liquid manifold being lower than the inlet liquid manifold, a vapor expansion tank, a liquid balancing tank, a Venturi tube having two open ends and an opening at its throat, conduit means connecting the inlet vapor manifold to the first opening, conduit means connecting the inlet liquid manifold to the third opening, conduit means connecting the outlet vapor manifold to the vapor expansion tank, conduit means connecting the outlet liquid manifold to the throat of the Venturi tube, conduit means connecting one of the ends of the Venturi tube to the liquid balancing tank, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tubes returning to the generator exclusively through the vapor containing portion of the system, means to prevent an airlock in the radiator, and means to heat liquid in the generator.

17. A self-circulatory heating system comprising a generator in which a vaporizable liquid is adapted to be disposed, said generator having three openings, the first opening being at a high point in the generator, the second opening being at a low point in the generator and the third opening being intermediate said first two openings, a radiator comprising a plurality of fins pierced by a set of liquid tubes to which the fins are secured, a liquid inlet manifold connected to one set of ends of the set of tubes, a outlet liquid manifold connected to the other set of ends of the set of tubes, a set of vapor tubes, each vapor tube being nested within a different liquid tube, an inlet vapor manifold connected to the inlet ends of the vapor tubes, an outlet

vapor manifold connected to the outlet ends of the vapor tubes, the inlet manifolds being higher than the generator, the outlet liquid manifold being lower than the inlet liquid manifold, a vapor expansion tank, a liquid balancing tank, a Venturi tube having two open ends and an opening at its throat, conduit means connecting the inlet vapor manifold to the first opening, conduit means connecting the inlet liquid manifold to the third opening, conduit means connecting the outlet vapor manifold to the vapor expansion tank, conduit means connecting the outlet liquid manifold to the throat of the Venturi tube, conduit means connecting one of the ends of the Venturi tube to the liquid balancing tank, conduit means connecting the other end of the Venturi tube to the second opening, the volume of the liquid containing portion of the system external to and above the generator being less than the volume of the generator above the third opening, the condensate from the vapor tubes returning to the

generator exclusively through the vapor containing portion of the system, means to prevent an airlock in the radiator, said last named means comprising an air relief conduit connecting the top of the inlet liquid manifold to the conduit means connecting one of the ends of the Venturi tube to the liquid balancing tank, and means to heat liquid in the generator.

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