

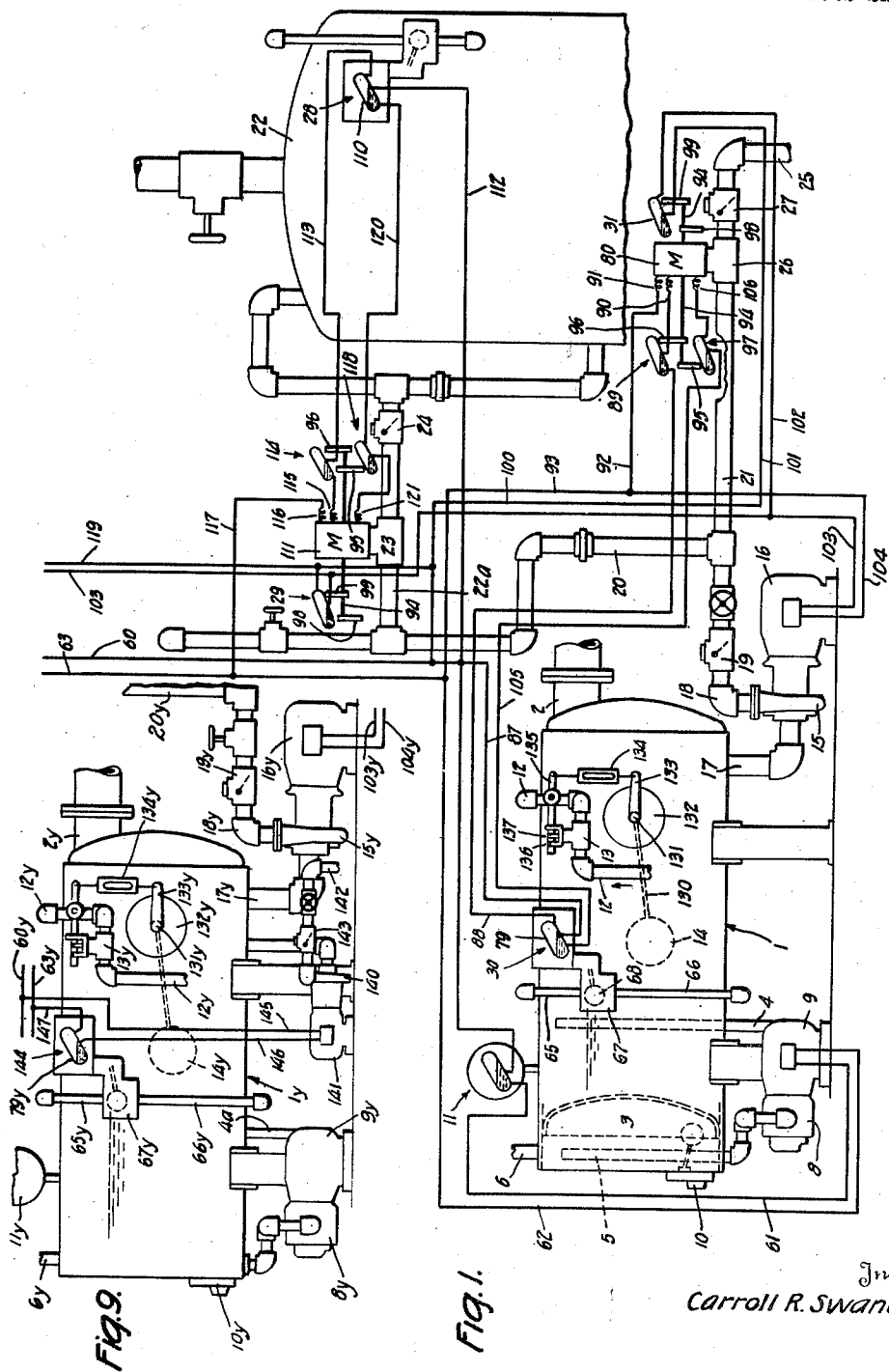
May 3, 1955

C. R. SWANEY
VACUUM HEATING SYSTEMS

2,707,459

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4 Sheets-Sheet 1



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4 Sheets-Sheet 2

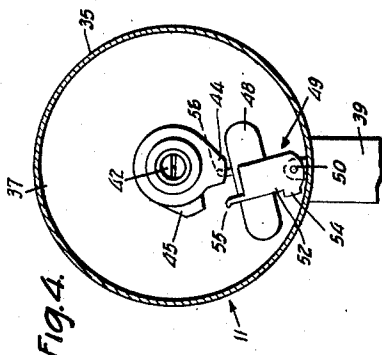


Fig. 4.

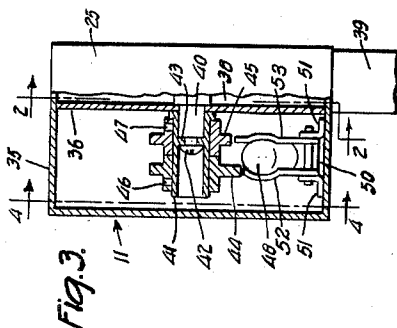


Fig. 3.

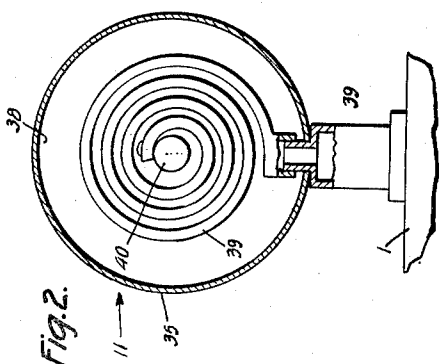


Fig. 2.

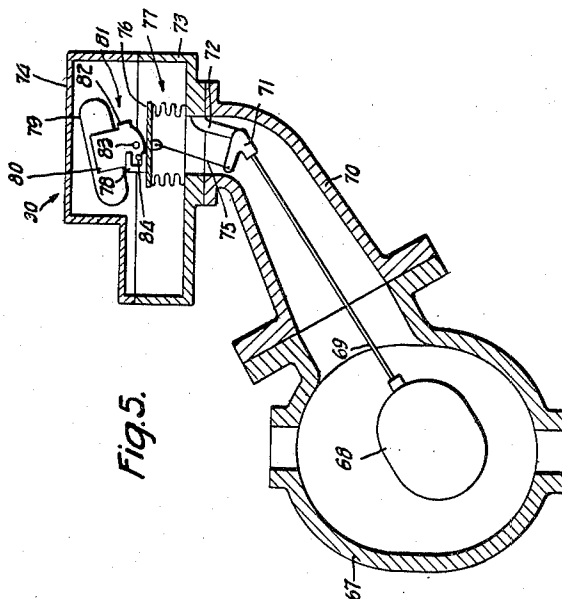


Fig. 5.

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Fig. 7.

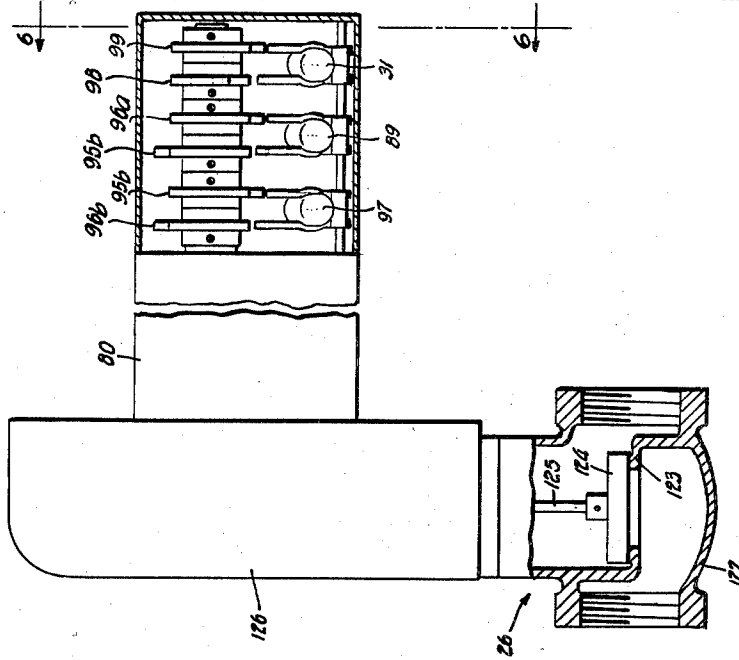
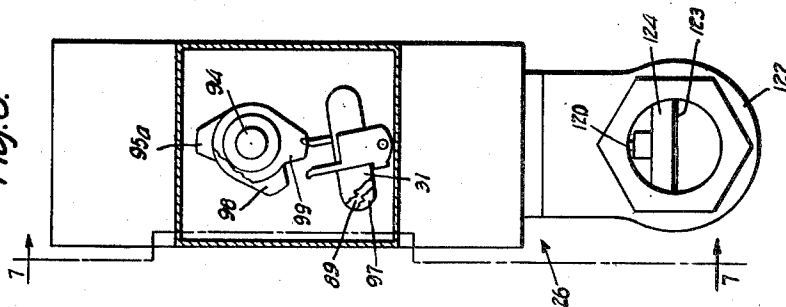


Fig. 6.



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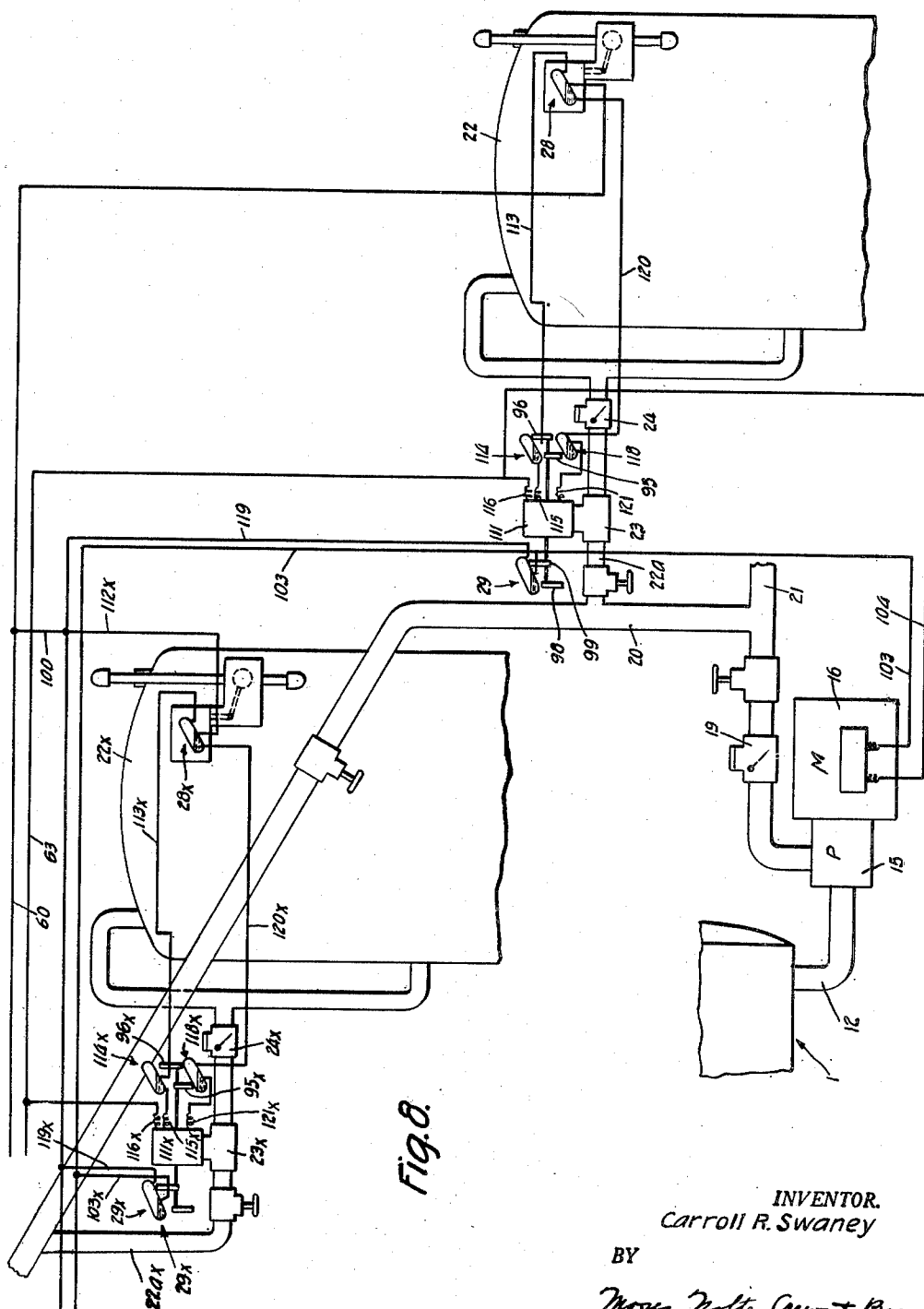
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4 Sheets-Sheet 4



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VACUUM HEATING SYSTEMS

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Application April 10, 1952, Serial No. 281,518

9 Claims. (Cl. 122-451)

This invention relates to vacuum heating systems. In a vacuum heating system steam is delivered from the boiler to distribution pipes and returns as water through return pipes to a receiver. The receiver is a tank maintained automatically under a predetermined vacuum by a vacuum pump which withdraws air and some vapor from the upper part of the receiver and discharges them under atmospheric pressure to a separator. The condensate is pumped from the receiver into the boiler as required.

Ordinarily, the receiver is required to be of large capacity because it must serve as a reservoir for surplus water when the thermal load on the system is light. In the conventional system makeup water is added when the level of the liquid in the receiver is low. This generally occurs when the thermal load is heaviest because the reserve of liquid is then drawn upon for supplying steam under pressure to all parts of the system.

When the thermal load is diminished the condensate accumulates in the receiver and would flood the receiver, if the receiver were not made of large enough capacity to accommodate the accumulation of liquid within a prescribed maximum level. The provision of a large receiver adds considerably to the weight, bulk and expense of the system parts, and to the cost and inconvenience of transportation and installation.

It is an important object of the present invention to obviate the need for a large receiver by making automatic provision both for replenishing the receiver liquid at a predetermined minimum level and for discharging receiver liquid to waste at a predetermined maximum receiver liquid level.

Since this assures ample water at all times, while avoiding all danger of an excess, a small receiver may be provided to serve a large system. The improvement also assures the maintenance of a proper quantity of water at all times without the necessity for manual control and personal supervision.

It is a further feature, in accordance with one embodiment of the invention, that a single pump is provided both for delivering liquid from the receiver to the boiler and for discharging liquid from the receiver to waste. The pump is connected through branch discharge conduits, to the boiler and to waste, and separate valves are provided for controlling the transmission of liquid under pump pressure through the respective conduits. The waste controlling valve is made automatically responsive to the level of the liquid in the receiver, but the boiler supply controlling valve is made automatically responsive to the level of liquid in the boiler. Further automatic mechanism is provided responsive to the valves for causing the pump to operate so long as either valve is open to a prescribed degree.

It is a further feature that a single receiver of moderate capacity may be made to serve two or more boilers. For this purpose a common pump may be made to serve all the boilers through individual boiler liquid level control valves as well as a waste line controlled from the

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receiver liquid level. Separate pumps may however be provided, one for the boilers and one for the discharge to waste, if desired, or a separate pump may be provided for each boiler together with a separate pump for the discharge to waste.

Other objects and advantages will hereinafter appear. In the drawing forming part of this specification,

Fig. 1 is a fragmentary view in elevation, partly diagrammatic, showing the principal parts of an illustrative vacuum heating system which embodies features of the present invention;

Fig. 2 is a vertical sectional view showing a portion of a pressure responsive switch through which the separator pump is controlled, the section being taken upon the line 2-2 of Fig. 3 looking in the direction of the arrows;

Fig. 3 is a view in side elevation, partly broken away, of the switch of Fig. 2;

Fig. 4 is a vertical sectional view of the pressure responsive switch of Figs. 2 and 3, the section being taken upon the line 4-4 of Fig. 3 looking in the direction of the arrows;

Fig. 5 is a vertical sectional view of a liquid level control switch responsive to the receiver liquid level;

Fig. 6 is a view in sectional elevation showing one of the motorized valves and switches responsive to operation of the valve motor, the section being taken upon the line 6-6 of Fig. 7, looking in the direction of the arrows;

Fig. 7 is a view in side elevation, partly broken away, of the structure illustrated in Fig. 6, the view being taken on the line 7-7 of Fig. 6, looking in the direction of the arrows;

Fig. 8 is a fragmentary view, partly diagrammatic, showing the system of Fig. 1 or Fig. 9 extended to include a plurality of boilers served by a common receiver; and

Fig. 9 is a fragmentary view, generally similar to Fig. 1, showing a modified form of embodiment of the invention.

The illustrative system of Figure 1 will first be briefly described without going into detail, for the purpose of affording a comprehensive understanding of the system and its mode of operation.

A receiver 1 is connected to receive the returns from the system through a conduit 2. One end of the receiver 1 is partitioned off to form a separator 3. An air pump 8 of the hydroturbine type, driven by a motor 9, draws air and vapor through a pipe 4 from a point near the top of the receiver, and discharges them compressed to atmospheric pressure, together with seal water and any vapor condensation resulting from compression effected by the pump, into the separator through a pipe 5 which terminates near the top of the separator. The air escapes to the atmosphere through a pipe 6 while the condensate collects in the separator. A liquid level controlled valve 10 regulates the return of the collected liquid in the separator to the receiver, as is usual. A switch 11, responsive to the pressure in the top of the receiver, controls the operation of the pump motor 9, causing the vacuum in the receiver to be maintained automatically between predetermined limits.

Make-up tap water is fed to the receiver 1 through a conduit 12. The conduit includes a valve 13 which is automatically controlled by a float 14 responsive to the level of the liquid in the receiver. The float is arranged to open the valve and thereby permit automatic replenishment of the receiver liquid when the liquid in the receiver falls to a prescribed minimum level.

A condensate removal pump 15, driven by a motor 16, draws liquid from the bottom of the receiver tank 1 through a conduit 17. The pump discharges to a

conduit 18 in which a check-valve 19 is provided. The conduit 18 divides to form branch conduits 20 and 21. The conduit 20 leads to the boiler 22 through a conduit 22a. The conduit 22a includes a motorized valve 23 and a check valve 24. The conduit 21 leads to the waste line 25. Conduit 21 includes a motorized valve 26 and a check valve 27. The motorized valves 23 and 26 are automatically controlled from the boiler water level and from the receiver water level, respectively, and said valves control the operation of the pump motor 16.

When the water in the boiler 22 drops to a prescribed minimum level, a circuit is closed through a float controlled switch 28, for operating the motorized valve 23 to open position. In the course of such operation the valve motor closes a switch 29 through which the motor 16 is energized to drive the pump 15. This causes feed water to be delivered by the pump 15 from the receiver 1 to the boiler 22.

When the water in the receiver 1 rises to a prescribed maximum level, the circuit is closed through a float controlled switch 30 for operating the motorized valve 26 to open position. In the course of such operation the valve motor closes a switch 31 through which the motor 16 is energized to drive the pump 15. This causes water to be delivered by the pump 15 from the receiver 1 to the waste line 25.

It may happen that the boiler water level is low at the same time that the receiver water level is high. In that case the valves 23 and 26 may open simultaneously, and the valves may cause the switches 29 and 31 to be closed simultaneously. Since the closing of either of these switches is effective to cause the pump 15 to be operated, the pump will continue in operation until both the switches have been opened. The valve 23 is operated to closed position by a rise in the boiler water level while the valve 26 is operated to a closed position by a drop in the receiver water level. The switches 29 and 31 are desirably arranged to be opened at prescribed points comparatively early in the closing movements of the valves 23 and 26 by which they are respectively controlled.

The pressure responsive switch 11 through which the motor 9 of the air pump 8 is controlled is illustrated in detail in Figs. 2, 3 and 4. The switch comprises a casing 35 which is divided by a partition 36 into front and rear compartments 37 and 38. A tubular extension and support 39 is connected at its lower end with the upper interior portion of the receiver 1, and extends at its upper end into the rear compartment 38. A Bourdon coil 39 of volute spiral form is supported within the casing upon the upper end of the tube 39 and communicates through the tube with the interior of the receiver 1.

The opposite or inner end of the Bourdon coil 39 is secured to a shaft 40. The shaft 40 is rotatively supported by the rear wall of the casing 45 and the partition 36, and extends forward beyond the partition. A flanged sleeve 41, located in the forward compartment 37, forms an extension of the shaft. The sleeve 41 is secured upon the shaft by means of a headed screw 42, the screw having a shank passed rearward through an internal flange 43 of the sleeve, and being threaded into the forward end of the shaft. Switch actuating cams 44 and 45 are respectively secured upon the sleeve 41 by set screws 46 and 47, the set screws permitting the cams to be secured in any desired angular positions, each independently of the other.

The illustrative switch is a two contact mercury switch comprising a tube 48 which contains a quantity of mercury and which is carried in a rockable carriage or support 49. The support 49 is mounted with capacity for rocking movement upon a shaft 50, the shaft in turn being supported by stationary brackets 51. The support comprises a pair of arms 52 and 53

which embrace the tube 48, the arms being rigidly connected to one another through a connecting bar 54. The arm 52 includes an upstanding finger 55 for cooperating with the cam 44 and the arm 53 includes an upstanding finger 56 for cooperating with the cam 45.

A rise of pressure within the receiver expands the Bourdon coil 39, causing the shaft 40 and the sleeve 51, as viewed in Figs. 2 and 4, to be turned clockwise. In Fig. 4 the cam 44 has just been turned clockwise far enough to cause the center of mass of the switch tube and its support to be moved counterclockwise across the vertical axial plane of the shaft 50. This has caused the switch to snap to its counterclockwise limit of movement as illustrated in Fig. 4, and to close the circuit for operating the motor 9 as illustrated in Fig. 1.

The circuit may be traced from the conductor main 60 through the switch 11, a conductor 61, the motor 9, and a conductor 62, back to conductor main 63. This, of course, sets the pump 8 into operation. As the pump lowers the pressure in the receiver to produce a predetermined degree of vacuum, the Bourdon coil through its contraction turns the shaft 40 counterclockwise until the cam 45, acting through the finger 56, causes the switch to be operated to its open position.

The valve 30 and its control mechanism are shown in detail in Fig. 5. Conduits 65 and 66 (Fig. 1), connected with the interior of the receiver through the top and bottom thereof, are connected respectively to the top and bottom of a bulbous housing member 67 in which a float 68 is contained. The float 68 is carried by a stem 69 which extends upward at an inclination through a complementary housing member 70. The upper end of the stem 69 is secured to one arm of a bell crank lever 71. The lever 71 is pivotally supported upon a bracket 72. The bracket 72 extends downward from a lower switch casing member 73, which casing member is mounted upon the housing member 70. A complementary casing member 74 cooperates with the casing member 73 to enclose the switch mechanism.

The free arm of the bell crank lever 71 is connected to a link 75. The link 75 extends upward through openings provided in the top of the housing member 70 and the bottom of the casing member 73, and is pivotally connected to the lower side of an end plate 76 of a syphon bellows 77. The syphon bellows serves as a mechanical connector between the link 75 and the switch mechanism by sealing the casing against ingress of liquid or vapor from the receiver. A C-shaped switch actuating bracket 78 is secured upon the plate 76.

The switch comprises a three contact mercury tube 79 which is embraced between arms 80 (one shown) of a rockable support 81. The arms 80 are rigidly connected to one another by a connecting bar 82. The support is mounted for rocking movement upon a shaft 83. A pin 84 projects from one of the arms 80 of the support 81 between the upper and lower arms of the switch actuating bracket 78, in position to be engaged and moved by either the upper arm or the lower arm.

As shown in Figs. 1 and 5 the switch 30 is rocked to its left hand position. In this position it is capable of closing one gap in the operating circuit for operating the valve 26 from open to closed position. As shown in Fig. 1, however, the valve 26 has been operated to closed position. A limit switch 97, in series with the switch 30, has been operated to an open position, however, as an incident of the closing of the valve 26, so that the closed condition of the switch 30 does not at the moment cause any current to flow.

When the liquid in the receiver rises to a predetermined maximum level, however, the switch tube 79 is snapped across to its opposite or right-hand limit of movement, in which it closes an operating circuit for opening the valve 26. This circuit may be traced from the main conductor 60 through a conductor 87, the switch tube 79, a conductor 88, a limit mercury switch 89, a field winding 90 of the

motor 80 for driving the motor in valve opening direction, an armature winding 91 of the motor, and conductors 92 and 93, back to the main conductor 63.

A shaft 94, driven from the motor 80 through reduction gearing, acts through cams 95 and 96 to control the limit switch 89 in Fig. 1, the same two cams 95 and 96 being diagrammatically indicated as controlling a similar limit switch 97 in the circuit of the motor 80 through which the valve 26 is to be closed. In reality, separate pairs of cams on the shaft 94 control the respective switches 89 and 97. The operation will be described and explained for the present, however, by reference to the diagrammatic showing of Fig. 1. As the valve 26 is operated to its closed condition, the switch 89 is opened by the cam mechanism and the switch 97 is closed. The opening of the switch 89 arrests the motor 80, but the closing of the switch 97 makes the valve closing circuit ready for operation subject to the return of the valve 30 to its Fig. 1 condition.

The shaft 94 also carries a pair of cams 98 and 99 through which the mercury switch 31 is controlled. As shown in Fig. 1 the switch 31 is in an open condition, but as the motor drives the valve 26 to its open condition, it acts through the cam 98 to close the switch 31. When the switch 31 is closed, an operating circuit for the pump motor 16 can be traced out from conductor main 60 through conductors 100 and 101, switch 31, conductors 102 and 103, motor 16, and conductors 104 and 93 back to conductor main 63. The pump 15 now acts to draw liquid from the receiver and discharge it through valve 26 to the waste conduit 25, causing the level of the liquid in the receiver 1 to fall.

When the level of the liquid has fallen sufficiently to return the switch 30 to the condition shown in Fig. 1, the motor circuit for closing the valve 26 is completed. This circuit may be traced from the main conductor 60 through conductor 87, switch 30, conductor 105, limit switch 97, field winding 106, armature winding 91 and conductors 92 and 93, back to conductor main 63. As an incident of the valve closing operation the switch 31 is returned to an open condition as illustrated in Fig. 1 to arrest operation of the pump motor 16. The switch 97 is also opened to stop the motor 80 at the end of the valve closing movement, and the switch 89 is closed to make ready for the next reversal of the switch 30. At this point, the parts described are all in the conditions illustrated in Fig. 1.

The switch 28, its connection to the boiler, its control, and its housing are like the corresponding elements of the switch 30 and the corresponding associated parts, save that the switch 28 is designed to operate the valve 23 to an open condition in response to a fall of the liquid level in the boiler to a prescribed minimum, whereas the switch 30 is designed to operate the valve 26 to an open condition in response to the rising of the liquid in the receiver to a prescribed maximum level. As shown in Fig. 1 the water level in the boiler is such that the valve 23 is closed and at rest.

When the water level falls to a prescribed minimum level, however, the tube 110 of the switch 28 will be tilted clockwise, causing the operating circuit of the motor 111 to be closed for operating the valve 23 to open condition. This circuit may be traced from conductor main 60 through conductor 112, switch tube 110, conductor 113, a limit switch 114, a field winding 115 of motor 111, armature winding 116 of the motor, and conductor 117 back to conductor main 63. A cam shaft similar to previously described cam shaft 94 and also designated 94 is driven by the motor 111, controls the switch 29, limit switch 114 and a limit switch 118 in the manner already described in connection with the switch 31 and limit switches 89 and 97.

As the valve 23 is operated to an open condition the switch 114 is opened to arrest the motor 111, the limit switch 118 is closed in preparation for the valve closing operation, and the switch 29 is closed. The closing of

the switch 29 is effective to set pump motor 16 into operation, the switch 29 being disposed in parallel relation to the switch 31.

The circuit established by the switch 29 may be traced from main conductor 60 through conductors 100 and 119, switch 29, conductor 103, motor 16 and conductors 104 and 93 back to conductor main 63. When the liquid in the boiler is raised to a predetermined level the switch 110 is tilted back to the Fig. 1 position. This completes a motor circuit for closing the valve 23. The circuit may be traced from conductor main 60 through conductor 112, switch 28, conductor 120, limit switch 118, field winding 121, armature winding 116, and conductor 117 back to main conductor 63. As the valve 23 is returned toward its closed condition, the switches 114, 118 and 29 are all returned to the conditions illustrated in Fig. 1, causing the operating circuits of the motors 111 and 16 to be opened and the circuit for opening the valve 23 to be made ready for operation when the switch 110 is next tilted to the right in response to a fall of water level in the boiler. The valve 29 is caused to open early in the valve closing operation, but the switches 114 and 118 are reversed substantially at the end of the valve closing operation.

In Figs. 6 and 7 the motorized valve 26, its motor 80, and the associated cams and switches controlled by the motor 80 are shown in detail. This showing, however, corresponds equally to any one of the motorized valves and associated parts shown in the drawing. The casing 122 of valve 26 includes a ported partition member 123 toward and from which a valve body 124 is operable. When reference is made to operation of the valve 26 it is to be understood that the body member 124 is the valve member which is really operated. A stem 125 connected to the valve body 124 extends up into a gear casing 126, being driven from the motor 80 through reduction gearing (not shown). The motor 80, through other reduction gearing, drives the shaft 94 through a range of substantially one-half a revolution, first in one direction and then in the other, depending upon the direction of operation of the motor. The shaft 94 has secured to it by set screws, cams 98 and 99 for controlling the switch 31, cams 95a and 96a for controlling the switch 89, and cams 95b and 96b for controlling the switch 97.

The cams 95a and 95b correspond jointly to the cam designated 95 in the diagrammatic showing of Fig. 1, while the cams 96a and 96b correspond jointly to the cam designated 96 in the diagrammatic showing of Fig. 1.

The valve 13 for automatically admitting makeup water to the receiver has its casing interposed in the conduit 12. The float 14 is carried within the receiver on a stem 130, which stem is fast on a horizontal shaft 131. The shaft 131 is mounted with capacity for rocking movement in a plate 132, and extends horizontally through the plate to the exterior of the receiver. The plate 132 covers an opening (not shown) which is formed in the receiver, and is detachably secured to the receiver wall in an air-tight manner by any suitable means, such as bolts (not shown). The shaft 131 has fast upon it an external arm 133. The arm 133 is connected through a turnbuckle link 134 to one end of a valve actuating lever 135. The lever 135 is pivotally supported at its opposite end upon a stationary arm 136, and is pivotally connected intermediate its ends to a valve stem 137. The stem is connected to a valve body (not shown) which is lifted from its seat in response to a lowering of the float 14, and is pressed downward toward its seat in response to a rising of the float.

Fig. 8 partly repeats structure which is common to Figs. 1 and 9, and illustrates additional mechanism which may be regarded as a unitary part of the showing of either of those figures. It will be described first in connection with Fig. 1, and its application to Fig. 9 will later be explained after Fig. 9, itself, has been described.

A second boiler 22x is connected in parallel with the boiler 22 to the pump 15, the conduit 20 being connected to the boiler 22x through a conduit 22ax, just as the conduit 20 is connected to the boiler 22 through the conduit 22a. The physical connections are desirably duplicated and require no detailed description. Corresponding reference numerals have accordingly been applied to corresponding parts with the subscript x added in each instance.

The electrical operating mechanisms and controls are also duplicated with corresponding control and operating circuits arranged in parallel relation to one another. Again there is no need for any detailed description and, therefore, corresponding reference characters have merely been applied to corresponding parts with the subscript x added in each instance.

The principle of arranging the pump 15 to serve two boilers as illustrated in Fig. 8 may obviously be extended to enable the pump 15 and the receiver 1 to serve more than two boilers. The several boilers may be supplied from the pump simultaneously or separately, each boiler having its own liquid level switch, its own motorized valve responsive to the liquid level switch, and its own pump motor operating switch responsive to the motor of the motorized valve.

As thus far described it is assumed that the combination of Figs. 1 and 8 includes every feature illustrated in either figure, so that the pump 15 also serves for discharging liquid from the receiver 1 to the drain as illustrated and described in connection with Fig. 1.

In Fig. 9 the structure is in all respects the same as that shown in Fig. 1 and described in connection with that figure, save that one pump responsive to the level of the liquid in the receiver is provided for discharging the liquid to waste while a separate pump is provided for serving the boiler or boilers. All of the parts which do not have to do with the discharging of liquid from the receiver to waste have the same construction and mode of operation as the corresponding parts of Fig. 1. Corresponding reference characters are accordingly applied to corresponding parts with the subscript y added in each instance and no detailed description will be given. The pump 15, its motor, its boiler level control, and the boiler feed mechanism operated by it, are all retained in Fig. 9, the only difference being that the conduit 18y does not have a branch leading to waste but leads only to the conduit 20y. The motorized valve and the switches associated with the conduit 21 of Fig. 1 are not present in Fig. 9, other provision being made for discharging the receiver liquid to waste. Corresponding reference numerals have been applied to the corresponding boiler feed mechanisms of Fig. 9 with the subscript y added in each instance.

A separate liquid pump 140 is operated by an electric motor 141 to draw liquid from the bottom of the receiver 1y and discharge it through a conduit 142 to waste whenever the liquid in the receiver rises to a predetermined maximum level. The conduit 142 includes a check valve 143 for preventing the sucking of air or liquid back into the receiver when the pump 140 is idle.

The pump motor 141 is controlled by a float operated switch 144, the switch, its casing, and its operating mechanism being identical with the switch 30 of Fig. 1 and the parts associated therewith, save that the switch 144 has only two contacts, being shown in an open condition in Fig. 9. When the liquid in the receiver 1y rises high enough, the tube 79y of switch 144 will be tilted toward the right, causing the switch to be closed. This will directly establish an operating circuit for the pump motor 141. The circuit may be traced from main conductor 60y through a conductor 145, the motor 141, a conductor 146, the switch 144, and a conductor 147 back to main conductor 63y. When the level of the liquid in the receiver has been reduced sufficiently to cause the switch tube 79y to be tilted back to its Fig. 9 position,

the operating circuit of the pump 141 is broken, causing the motor and the pump 140 to come to rest.

As has been previously indicated, the pump 15y of Fig. 9 may be made to serve a plurality of boilers by adding one or more boilers together with feeding and controlling mechanism to the structure of Fig. 9 in the manner illustrated in Fig. 8 and described in connection with that figure.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. In a vacuum heating system, in combination, a receiver, means maintaining the receiver constantly under vacuum within predetermined limits, a boiler, automatic means for supplying makeup water to the receiver from an outside source when the water level in the receiver falls below a prescribed minimum level, a normally idle, motor operated pumping mechanism for withdrawing liquid from the receiver and delivering it either to the boiler or to waste, a liquid supply valve responsive to the liquid level in the boiler, means responsive to said valve for causing the liquid to be pumped by said pumping mechanism to the boiler through said valve when the liquid in the boiler stands below a prescribed level, a waste valve responsive to the liquid level in the receiver, means responsive to said valve for causing the liquid to be pumped through said valve to waste when the waste valve is open, and means to discontinue operation of the pumping mechanism when both valves are closed.

2. In a vacuum heating system, in combination, a receiver, means maintaining the receiver constantly under vacuum within predetermined limits, a boiler, liquid level means responsive automatically to the water level in the receiver, for supplying makeup water to the receiver when the water level in the receiver falls below a prescribed minimum level, a normally idle pump for withdrawing liquid from the receiver, said pump having two outlet branches leading respectively to the boiler and to waste, a pump operating motor, boiler feed and waste controlling valves in the respective branches, means controlling the boiler feed valve from the liquid level in the boiler to open the valve when the boiler level falls to a predetermined level, and to close the valve when the boiler level is raised to a predetermined higher level, means controlling the waste valve from the liquid level in the receiver to open the waste valve when the receiver level rises above a predetermined level and to close the waste valve when the receiver liquid falls to a predetermined lower level, and means responsive impartially to said boiler feed and waste valves to cause the pump to operate only so long as one or the other of the valves, or both valves, are open to a predetermined degree.

3. A vacuum heating system comprising, in combination, a boiler, a receiver for the returns from the system, automatic means for replenishing the liquid supply in the receiver with makeup water when the liquid in the receiver falls below a prescribed minimum level, means, including a pump, automatically responsive to the liquid level in the boiler for causing liquid to be delivered from the receiver to the boiler only when the liquid in the boiler falls below a prescribed minimum level, and means, including the same pump, automatically responsive to the level of the liquid in the receiver for causing liquid to be delivered from the receiver to waste only when the liquid in the receiver rises to a prescribed maximum level the pump thus being maintained inactive so long as the minimum boiler level is maintained and the maximum receiver level is not exceeded.

4. In a vacuum heating system, in combination, a receiver for the system returns, means maintaining the receiver constantly under vacuum within predetermined limits, a mechanism for discharging liquid from the re-

ceiver to diverse destinations comprising, in combination, a pump, an electric motor for operating the pump, a conduit leading from the receiver to the pump, a plurality of branch outlet conduits leading from the pump to the diverse destinations, separate liquid level responsive devices for controlling the delivery of liquid selectively to the individual branch conduits, and means responsive to either of said devices for setting the pump into operation.

5. In boiler means, a vacuum heating system, in combination, a receiver for the system returns, automatic means for replenishing the liquid supply in the receiver with make-up water from an outside source when the liquid in the receiver falls below a prescribed minimum level, means automatically responsive to a high level of the liquid in the receiver for connecting the receiver to waste when the liquid in the receiver rises to a prescribed maximum level, means automatically responsive to low liquid level in at least one boiler for connecting the receiver to such boiler, when the liquid level in the boiler falls to a prescribed minimum level, a pump for delivering water from the receiver to either of said connecting means, and means for maintaining the pump in operation only so long as one or both of said connecting means are open.

6. In a vacuum heating system which includes a plurality of boilers, in combination, a single receiver for the system returns, automatic mechanism for replenishing the liquid supply in the receiver with make-up water from an outside source when the liquid in the receiver falls to a prescribed minimum level, mechanism automatically responsive to a high level of the liquid in the receiver for connecting the receiver to waste when the liquid in the receiver rises to a prescribed maximum level, a plurality of boiler connecting means automatically responsive to low liquid level in the respective boilers, each for connecting the receiver to the associated boiler when the liquid in such boiler falls to a prescribed minimum level, pumping means for delivering water from the receiver through any one or more of said waste and boiler connecting means to the associated boiler or to waste, and means for maintaining the pumping means in operation so long as any one or more of said connecting means are open.

7. In a vacuum heating system which includes a plurality of boilers, in combination, a single receiver for the system returns, means for maintaining the receiver under vacuum at all times, automatic means for replenishing the liquid supply in the receiver with make-up water from an outside source when the liquid in the receiver falls to a prescribed minimum level, a single pump having its intake connected to the receiver and operative to discharge liquid at increased pressure from the receiver, a plurality of discharge conduits leading from said pump, one of them going to waste and the others going to the

respective boilers, valves in the respective conduits controlling the discharge of liquid through them, means automatically responsive to the level of the liquid in the receiver for causing the valve in the waste conduit to be opened when the liquid in the receiver rises to a prescribed maximum level, means automatically responsive to the level of liquid in the respective boilers, each for causing the valve in the pump discharge conduit which serves its boiler to be opened when the liquid level in the boiler falls to a prescribed minimum level, and means for causing the pump to operate only so long as any one of said valves is open to a prescribed degree.

8. In a vacuum heating system which includes a plurality of boilers, in combination, a receiver common to the boilers for the system returns, means for maintaining the receiver under vacuum at all times, automatic means for replenishing the liquid supply in the receiver with makeup water from an outside source, automatic means for connecting the receiver to waste when the liquid in the receiver rises to a prescribed maximum level, and boiler connecting means mechanism automatically responsive to the level of the liquid in the respective boilers for connecting the common receiver to the individual boilers as required by low liquid level in the boilers, pumping means for delivering water from the receiver through any one or more of said waste and boiler connecting means to the associated boiler or to waste, and means for maintaining the pumping means in operation so long as any one or more of said connecting means are open.

9. In a vacuum heating system which includes a plurality of boilers, in combination, a receiver for the system returns, automatic mechanism for replenishing the liquid supply in the receiver with makeup water from an outside source when the liquid in the receiver falls to a prescribed minimum level, automatic mechanism for discharging liquid from the receiver to waste when the liquid in the receiver rises to a prescribed maximum level, a pump for transferring liquid from the receiver to the several boilers, conduits connecting the pump to the respective boilers, valves individually controlling the delivery of the liquid through the conduits, mechanisms automatically responsive to the liquid level in the respective boilers for opening and closing the respective valves as the respective boiler liquid levels fall and rise, and mechanism responsive to the valves for causing the pump to operate so long as any one of the valves is open to a prescribed degree.

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