

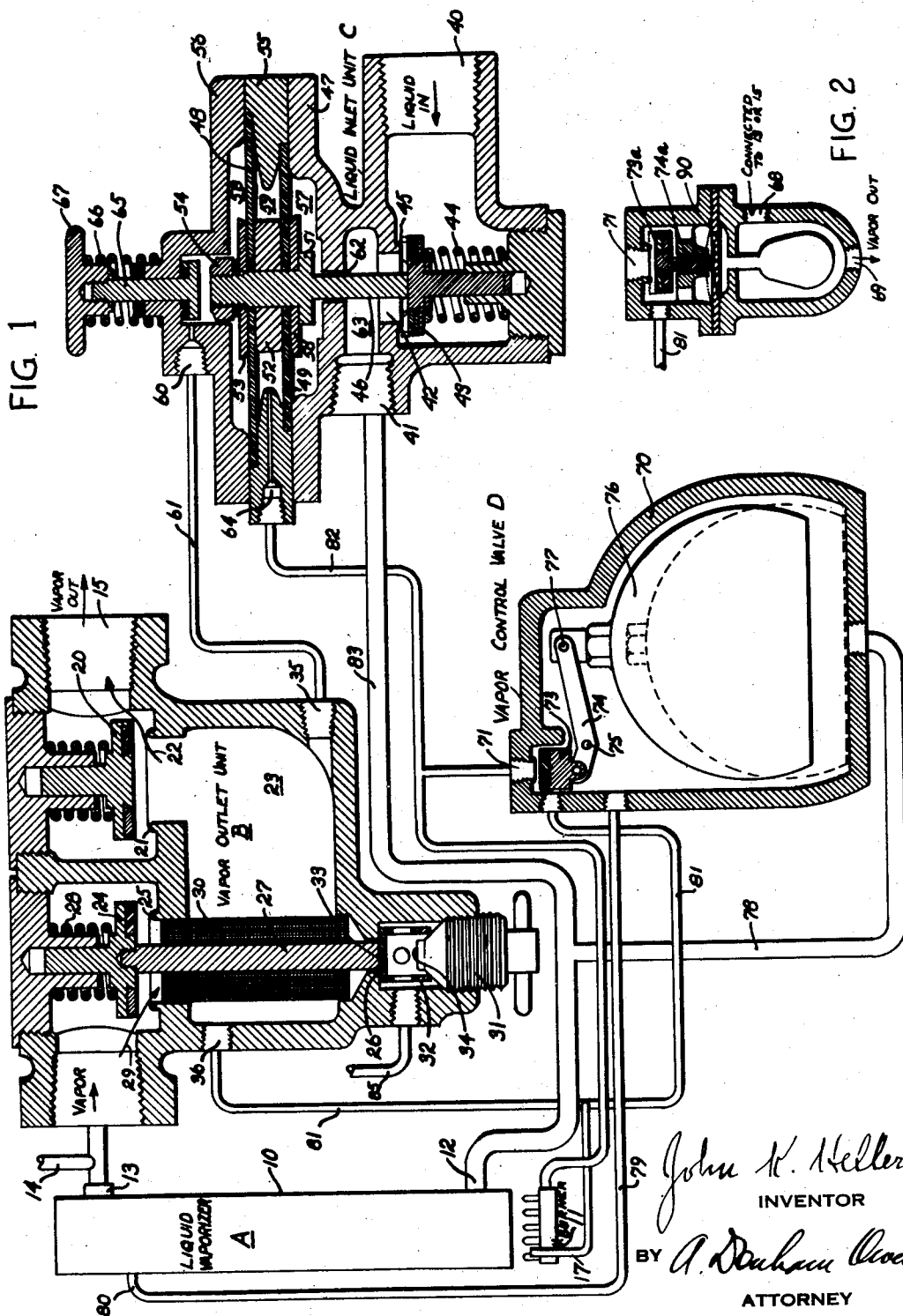
Feb. 14, 1950

J. K. HELLER
FLUID CONTROL SYSTEM

2,497,549

Filed Oct. 29, 1946

3 Sheets-Sheet 1



John K. Heller.
INVENTOR
BY A. Deane Allen
ATTORNEY

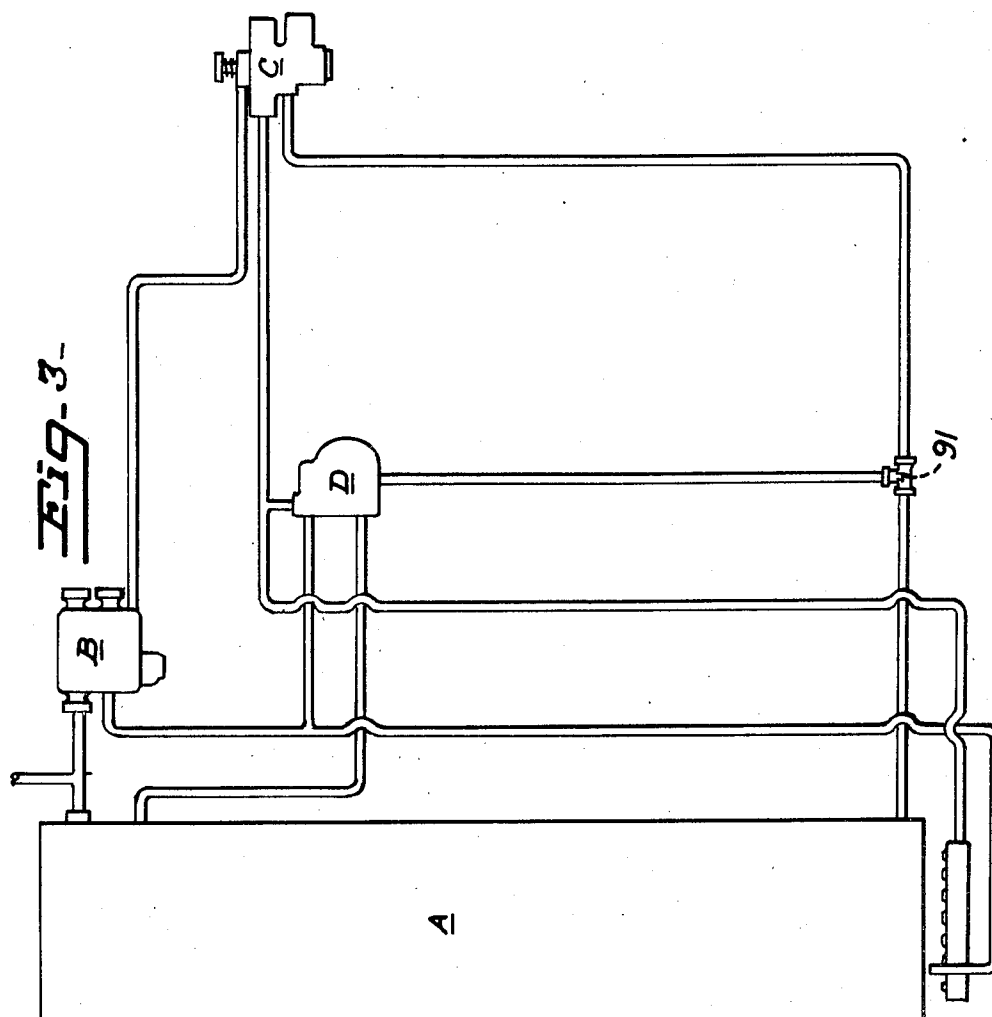
Feb. 14, 1950

J. K. HELLER
FLUID CONTROL SYSTEM

2,497,549

Filed Oct. 29, 1946

3 Sheets-Sheet 2



INVENTOR.
JOHN K. HELLER
BY *P. D. [Signature]*
ATTORNEY.

Feb. 14, 1950

J. K. HELLER
FLUID CONTROL SYSTEM

2,497,549

Filed Oct. 29, 1946

3 Sheets-Sheet 3

Fig. 4.

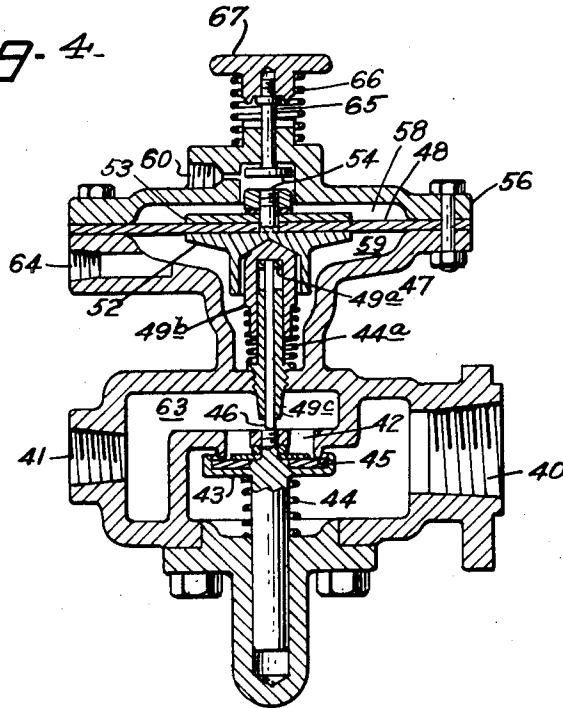
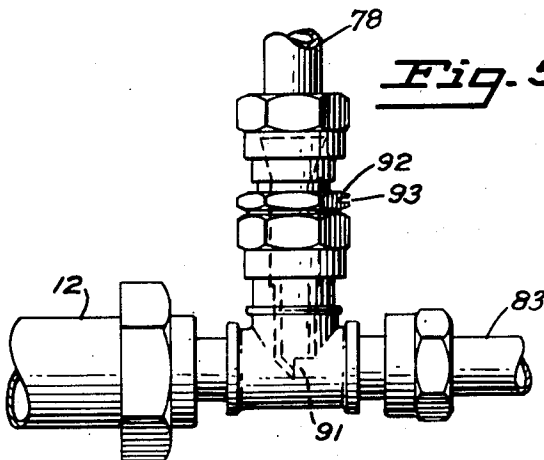


Fig. 5.



INVENTOR.
JOHN K. HELLER
BY *A. Doherty*
ATTORNEY

UNITED STATES PATENT OFFICE

2,497,549

FLUID CONTROL SYSTEM

John K. Heller, San Francisco, Calif., assignor to
Gasair Corporation, San Francisco, Calif., a
corporation of California

Application October 29, 1946, Serial No. 706,330

24 Claims. (Cl. 62-1)

1

This application is a continuation in part of my pending application Serial No. 514,088, filed December 13, 1943, and entitled Fluid control system, now abandoned.

My invention relates to liquid gas vaporizers and particularly to automatic means for controlling the same.

The objects of my invention are to provide a device which is particularly sensitive and quick acting so as to cope with the fast flowing liquefied gas; to provide a control for a liquid gas vaporizer which instead of shutting the vapor line, cuts off the liquid flow at the inlet valve while simultaneously turning on the burner to convert the liquid gas into a vapor; to provide a control which simultaneously turns on the liquid flow when the vaporizer burner is turned off, and turns off the liquid flow when the vaporizer burner is turned on; to provide a particularly sensitive liquid inlet control valve which will allow for the backing up of liquefied gas when expansion takes place in the vaporizer; to provide a completely automatic liquid gas vaporizer which cannot be over-loaded or flooded with liquid gas; to provide a liquid gas vaporizer control which will automatically shut down the whole device in the event of any abnormal withdrawal of vapor beyond the designed capacity for the machine; to provide a safety shut off in a liquid gas vaporizer which in addition to closing the vapor outlet and thereby protecting adjacent valves from injury due to over-heating, also effects a closing of the liquid inlet valve and shutting off the supply of vapor to the burner; and to provide a control which due to its high sensitivity permits a higher liquid level in the vaporizer and thereby increases the effective heating area.

The above are some of the objects accomplished by my invention. Others will be apparent to those skilled in the art from the following description and drawings. In providing this description and drawings pursuant to U. S. Rev. St. Sec. 4888, I do not intend hereby to limit my invention to the specific form or structure of the various parts of the combination, as they may be varied to suit the manufacturer's choice of design, materials, etc. For example, in the drawings the liquid inlet valve, the vapor control valve and the vapor outlet are shown in separate housings, whereas they might as well be placed in a single housing.

In the drawings,

Fig. 1 is a diagrammatic showing of my invention with certain of the parts shown in cross-section and with sufficient detail to present one embodiment of my invention;

2

Fig. 2 shows a modification of the vapor control means to make the device function in response to the temperature of the vapor within the vaporizer;

Fig. 3 shows a preferred spatial relationship of the vapor control valve and the vaporizer, although this may be varied as explained herein;

Fig. 4 shows a modified form of liquid inlet unit adapted for use in the combination; and

Fig. 5 shows a Pitot valve for adjusting relative liquid levels in parts of the combination, as explained herein.

In the drawings A represents the liquid vaporizer, B the vapor outlet unit, C the liquid inlet valve and D the vapor control valve. As already noted, although B, C and D are shown in separate housings, they may be consolidated into one or more housings.

The liquid vaporizer is a well known device and comprises the shell or housing 10 through which the products of combustion of the burner 11 pass in heat transferring contact with the vaporizer tubing (not shown) disposed within the casing 10 and communicating at one end with a liquid inlet 12 and at its opposite end with a vapor outlet 13. The vapor emerging from the tube at 13 may be partly taken off through a branch pipe 14 and part of it passed through to the vapor outlet 15 in the vapor outlet unit B or it may all pass through the outlet 15. A pilot light 17 is connected into pipe 81 in which there is always a supply of gas.

As shown, the vapor outlet unit B, or what might be termed the overheat unit, includes a check valve 20 which is normally raised from its seat 21 to allow free flow of vapor in the direction of the arrow 22. In the event any leakage of the vaporizer tube causes a drop in pressure in the chamber 23, the check valve 20 will drop to its seat and prevent leakage and back flow of the vapor contained in the gas main or in the system which is connected to the vapor outlet 15.

The valve 24 is normally held off its seat 25 in the open position by means of a fusible washer 26 which supports the lower end of a valve stem extension 27. If anything should happen to raise the temperature to the fusing point of the washer 26 the valve stem extension 27 will move downwardly and valve 24 will close on its seat assisted by spring 28. The normal flow of vapor is from the vaporizer outlet 13 through the valve opening 25 in the direction of arrow 29. The screen 30 acts as a strainer to prevent any solid impurities from passing through the vapor outlet 15, or into the other outlets for the vapor, where such im-

purities might interfere with the normal functioning of the various parts.

To replace the fusible washer 26, a plug 31 is threaded into the bottom of the housing B and has a ring 32 which supports the washer 26. If the latter should melt, the valve stem extension 27 will enter the ring 32 and when the valve 24 is seated, the valve stem end 33 will come to rest above and preferably not in contact with the end 34 of the plug 31. Also the melting of washer 26 will open chamber 23 to blow-off pipe 85 which will release the vapor pressure in chamber 23 and upper chamber 58 of unit C. Check valve 20 will stop the back flow of vapor in the gas main. The chamber 23 has an outlet at 35 and an outlet at 36 to which are connected the other elements of the combination about to be described. The overheat fusible link control valve 24 is a useful part of the combination of my device, although it is not absolutely essential and, where economy demands, it can be omitted so long as a port or ports are provided out of the vapor outlet 13 to correspond with the outlets 35 and 36 which carry the vapor and vapor pressure to the other elements of the device.

The liquid inlet valve C has a liquid inlet port 40, an outlet port 41 and a valved port 42 therebetween. A valve 43 is arranged to open and close this port. As shown in the drawings it works in an up and down movement, although it might be mounted to move in a horizontal axis or at any angle in between a vertical and horizontal axis. Preferably the valve 43 is arranged to be closed by a spring 44 which keeps a yielding pressure of about eight pounds lift on the valve. When the valve 43 is on its seat 45 the flow of liquid into the liquid vaporizer A is stopped. When it is opened liquid is supplied to the vaporizer. During operation of the liquid vaporizer an expansion sometimes takes place which tends to force the liquid to flow to the right through the port 41. Because the valve 43 is spring pressed on its seat it will under such circumstances act as a check valve and will allow this backed up liquid to flow backwardly through the port 42 and out through the port 40. In this way it acts as a pressure release or safety valve.

Mounted adjacent the valve 43 is a power actuated rod 46 for moving the valve 43 to open position as shown in the drawings. This rod 46 passes upwardly into a housing 47 and (in the type of liquid inlet valve shown in Fig. 1) to this rod 46 are attached the actuating members 48 and 49, preferably flexible diaphragms, although pistons might be used, and these diaphragms are secured to the rod 46 by means of a shoulder 51, washers 50, 52, 53, and a nut 54. The diaphragms 48 and 49 are securely mounted around the rims in housing members 47, 55 and 56, so as to provide chambers 57 and 58 bordering the diaphragms 49 and 48 respectively and a chamber 59 intermediate the diaphragms 48 and 49. The diaphragms 48 and 49 are of different size. The one which is effective in opening the valve 43 is larger than the other diaphragm. As shown in the drawings this means that the diaphragm 48 is of larger diameter and hence of greater effectiveness than is diaphragm 49, which functions essentially as a packing to seal the lower side of the diaphragm 48 from the fluid pressure in chambers 63 and 57. The chamber 48 bordering the more effective diaphragm 48 is connected through port 60 and passageway 61 with the port 35 of the vapor outlet. The chamber 57 bordering the less effective diaphragm 49

is connected through the port 62 to the liquid inlet passageway 63. The intermediate chamber 59 has an inlet port 64.

Fig. 4 shows another form of liquid inlet valve employing the same basic principles of my invention as described in connection with the form of inlet valve already described. As in Fig. 1, so in Fig. 4 there is a first valve control means—the upper side of the diaphragm 48—and a second valve control means—the lower side of the diaphragm 48. In other words, the diaphragm 49, which functions essentially as a packing in the liquid inlet unit of Fig. 1, is replaced by the close fitting sleeve and valve guide with a packing 49a to effect a positive seal, when the valve 43 is in the open position. This means that when the parts are in the position shown in Fig. 4, and the burner is on, no harm can come from whatever small leakage may occur up past the valve stem 46 and into the chamber 58. However, when the burner is turned off there should be a positive sealing so that the burner will not continue to burn at even a low flame and so overheat the vaporizer. This is cared for in the structure of Fig. 4 by the packing disc 49a which is compressed between the sleeve 49a and the valve guide 49c when the pressure on the top of the diaphragm 48 has pushed the sleeve down on the valve guide.

Arranged in the top of the liquid inlet valve housing 56 is a plunger 65 supported by a spring 66 having a handle 67. The purpose of this device is to allow for manual opening of the valve 43 when the device is first being placed in operation or after a shut-down has removed the liquid from the liquid vaporizer.

The vapor control valve unit D includes in the housing 70 valve port 71, adapted to be closed off by the movable vapor control valve 73 which may be actuated by a lever 74 pivoted to the housing 70 at 75 and moved by means of the float 76 secured loosely to its end at 77. The float 76 moved up and down in the housing 70 as the liquid rises and falls in the liquid vaporizer A.

The valve housing 70 may be located in relation to the liquid vaporizer A at a height where the uppermost position of the float 76 corresponds to the liquid level desired in the vaporizer A, or the valve housing 70 may be located above or below the desired liquid level if means are employed to accelerate or delay the rise of the liquid level in the valve housing 70 in relation to the level in the vaporizer A.

In Fig. 5 one such means is shown. A Pitot tube 91 is installed at the junction of tubes 12, 78 and 83, and held in place there by the adjustable nut 92. A notch 93 or some other indicator shows the position of the Pitot opening 91. With the opening full into the stream, as in Fig. 5, the liquid level in the vapor control valve D will lead that in the liquid vaporizer A on both inward and outward flow. With the opening turned down stream the liquid level in the vapor control valve D will lag that in the liquid vaporizer A on both inward and outward flow. With the opening turned cross stream the liquid level in the vapor control valve D will lag that in the liquid vaporizer A on inward flow and lead it on outward flow. Thus the exact height of the valve D becomes of minor importance.

The liquid out of the vaporizer, or on its way to the vaporizer, is conducted to the valve housing 70 through passageway 78, and a passageway 79 connected to the liquid vaporizer A at 80 provides a compression release as the housing 70 is filled with liquid through passageway 78. Also,

5

if it should happen that liquid would flow through passageway 79 it would go on into the vaporizer A at 80. The vapor controlled by the vapor control valve 73 enters through the passageway 81 from the port 36 in the valve outlet unit. An alternative would be to use a T connection at port 35 where passageway 61 is connected to chamber 23, thereby eliminating port 36. When the liquid level reaches a pre-determined height the opening of the control valve 73 will supply gas to the burner 11, and the vapor pressure supplied through passageway 82 to the chamber 59 of the liquid inlet valve control will allow the liquid inlet valve 43 to be closed by spring 44. If the valve 43 were inverted it could close by gravity if properly weighted.

In the device of Fig. 1 the entry of the vapor pressure into the chamber 59 cancels the downward force being exerted in compression chamber 58 and cancels the upward force produced by the liquid pressure in lower compression chamber 57 so that the rod 46 and its associated parts are moved upwardly by the spring 44 which at the same time closes the valve 43. When the liquid level drops in the housing 70, the float 76 moves downwardly and moves the vapor control valve 73 to close the port 71, with the result that the cancelling vapor pressure in the intermediate chamber 59 is withdrawn and two things happen—the burner 11 shuts off as soon as it burns the vapor collected in the chamber 59 and passageway 82, and the vapor pressure in the upper compression chamber 58 overcomes the smaller force in the compression chamber 57 and the liquid inlet valve 43 is opened.

In the device of Fig. 4, the result is equivalent. The entry of the vapor pressure into the chamber 59 cancels the downward force being exerted in compression chamber 58, and the rod 46 and its associated parts are moved upwardly by the springs 44 and 44a, which at the same time close the valve 43. When, as described in the above paragraph, the vapor control valve 73 closes the port 71, the cancelling vapor pressure in the chamber 59 is withdrawn, the burner 11 shuts off as there described, and the vapor pressure in the upper compression chamber 58 acts on the diaphragm 49 to open the liquid inlet valve 43. The packing disc 49a is then compressed between the valve sleeve 49b and the valve guide 49c and positively seals off any leakage around the valve stem 46 into the chamber 59.

In either case this arrangement for control of the burner and the admission of vapor pressure into the chamber 59 assures a positive and quick action on each turning on and turning off cycle, and makes it possible to maintain a higher liquid level, therefore, a greater heat transferring effect in the liquid vaporizer A.

As shown in Fig. 2 in place of the float-type of control I may substitute a thermostatic actuating member 90. It could be operatively connected to the vaporizer outlet 13 or the vapor outlet 15 to move in response to the temperature of the vapor therein and be operatively connected by the rod 74 to actuate the vapor control valve 73 so that when the vapor temperature in the vaporizer rises to a pre-determined point it will cause the thermostatic actuating member 90 to move upwardly into the dotted line position to close off the port 71, thereby shutting down the burner 11 and relieving the vapor pressure in the intermediate vapor chamber 59 so that the liquid inlet valve 43 will open. Then when enough liquid has flowed into the vaporizer A to lower the vapor tempera-

6

ture to a pre-determined point it will cause the thermostatic actuating member 90 to move into the full line position shown, which in turn will open the vapor control valve 73 and allow vapor to flow through port 71 into passageway 81 to the burner 11 and through passageway 82 to the intermediate pressure chamber 59 which will neutralize the pressures in the chamber 57 and 58 and allow the spring 44 to close the liquid inlet valve. It is important with a thermostatic control that the heat sensitive element be well subjected to the hot vapor gases. In Fig. 2 these enter at 68 and exit at 69, or vice versa. The port 68 is connected to port 13 or 15 and the port 69 is connected back into the vapor outlet line. While Fig. 2 shows the control in a separate housing, it might be mounted right in the vaporizer A.

To avoid needless complication I have omitted from the drawings and the description, the pressure regulators and other usual accessories in vaporizers, because these are well known and do not affect the operative combination of my invention. What I have tried to do is to keep it to the basic elements. The omitted things are well known to the man skilled in this art.

In operation, assuming normal conditions prevail at the vapor outlet 15 and at the liquid inlet 40, namely, that the liquid pressure is anywhere between thirty to sixty pounds and the vapor outlet pressure corresponds, as it would: then with the float 76 on the vapor control valve 73 in the position shown, it means that the liquid entering through the port 40 and the liquid inlet valve 43 has risen to about the desired pre-determined height. The vapor control valve 73 has uncovered the port 71 so that vapor from the vaporizer outlet 13 can pass through the valve 24 into the chamber 23, thence through port 36, passageway 81, and through the port 71 to the burner 11 and to the compression chamber 59. In this state of affairs the liquid inlet valve 43 would have moved up into the dotted line position to close on its seat 45 and would have stopped any further liquid flow. The spring 44 effected this closing and it was possible for it to do it because, with the admission of the vapor pressure into the pressure chamber 59, the downward pressure of the same vapor on the upper side of the diaphragm 48 in chamber 58 was neutralized or cancelled; and the upward pressure of the liquid bearing on the under side of the diaphragm 49, which corresponds to the vapor pressure, was cancelled by the presence of the vapor in the chamber 59, or, in the case of the Fig. 4 device, the liquid has been sealed off by the packing 49a so that it still has no effect on the downward pressure on the upper side of the diaphragm 48. This condition will continue until the float 76 drops into the dotted line position shown, which it will do when the burner 11 has converted the pre-determined amount of liquid into a vapor in the vaporizer A. When this happens, the vapor control valve 73 will close which will extinguish the burner 11 and will remove the pressure in the chamber 59. This means that the vapor pressure in chamber 58 acting downwardly on the diaphragm 48 will overcome the less effective pressure of the liquid in the chamber 57 lifting upwardly on the diaphragm 49 in case the Fig. 1 device is employed, because the latter diaphragm is of smaller area and, therefore, less effective than the larger diaphragm 48. The relative areas of these actuating members 48 and 49 are calculated so that the instant the vapor control valve 73 closes, the vapor

pressure acting downwardly on the diaphragm 48 will be sufficient to overcome the pressure in the chamber 57 as well as the spring 44, and the liquid inlet valve 43 will be opened.

In the case of the Fig. 4 device the action takes place in the same manner, with the close fits between the valve pin 46, valve guide 49c, and valve sleeve 49b holding off any substantial fluid pressure from chamber 63 and enabling the vapor pressure in chamber 58 to act downwardly on the diaphragm 48 to open the liquid inlet valve 43. Under this state of affairs the liquid will flow in through the passageway 83 into the vaporizer at 12 and some of it will flow into the housing 70 and begin to lift the float 76. The float will rise, as the level of the liquid in the vaporizer rises, until the point previously described is reached and then the port 71 will be uncovered, the liquid flow will stop and the burner 11 will go on. This cycle will repeat itself indefinitely and automatically.

As a safeguard against the failure of any part or parts of the device, the fusible link 26 which supports the valve stem extension 27 on the valve 24 will melt and allow the valve 24 to close if the vapor temperature should rise above a safe point. When the valve 24 comes to its seat 25, the vapor pressure in the compression chamber 58 acting downwardly on the diaphragm 48 will diminish, as will the vapor pressure in passageway 81 and 82 connected into the chamber 59 because the chamber 23 will be vented to the atmosphere through blow-off pipe 85. Thus in the Fig. 1 device the liquid pressure acting upwardly on the lower diaphragm 49, plus the pressure of the spring 44, will promptly close the liquid inlet valve 43, and in the Fig. 4 device the pressure of the springs 44 and 44a alone will be sufficient promptly to close the liquid inlet valve 43. The burner 11 will be extinguished because of lack of vapor and the whole device will shut down until the failure leading to the shutdown is corrected.

The operation of the device of Fig. 2 is identical with that of Fig. 1, as described above, except that, instead of relying upon the liquid level in the vaporizer A to open and close the vapor control valve 73, this modification relies upon the temperature of the vapor coming out of the vaporizer at 13 or 15. When this vapor temperature reaches a safe top limit the thermostatic element 90 is designed to move into the position shown in dotted lines in Fig. 2 thereby turning off the burner 11 and removing the vapor pressure from the intermediate chamber 59 which in turn will permit the opening of the vapor inlet valve 43 and more liquid will flow into the liquid vaporizer. This flow will continue until the additional liquid cools down the vapor temperature being emitted at 13, which in turn will cause the thermostatic element 90 to move into the full line position shown in Fig. 2, thereby opening vapor control valve 73 and turning on the burner 11 and allowing the vapor inlet valve 43 to close. The basic elements of the thermostatically controlled device just described are the same as those of the liquid level controlled device, the only difference in the two being in the means for opening and closing the liquid control valve 73 in response to the liquid and vapor conditions in the vaporizer A.

I claim:

1. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a liquid inlet valve operative to open and

to close said liquid inlet passageway, first valve control means at all times responsive to the pressure in said vapor outlet passageway for holding said liquid inlet valve in an open position, second valve control means normally responsive to said pressure in said vapor outlet passageway for opposing said first valve control means to close said liquid inlet valve, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position.

2. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means at all times responsive to the pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means normally responsive to said pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position against said biasing means.

3. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, means for supplying vapor from said vapor outlet passageway to said burner, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for interrupting the supply of pressure to said second valve control means and the supply of vapor to said burner, thereby turning off said burner and rendering said second valve control means inoperative, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means.

4. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve to a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet

passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor under pressure from said vapor valve to said burner and to said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby stopping the flow of vapor to said burner and rendering said second valve control means inoperative to permit said first valve control means to hold said liquid inlet valve in an open position against said biasing means.

5. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve stem, said first valve control means being operative to hold said liquid inlet valve in an open position against said biasing means, said second valve control means being operative to oppose said first valve control means for permitting said biasing means to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first valve control means, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying an actuating vapor pressure from said vapor valve to said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position against said biasing means.

6. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve stem, said first valve control means being operative to hold said liquid inlet valve in an open position against said biasing means, said second valve control means being operative to oppose said first valve control means for permitting said biasing means to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first valve control means, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor from said vapor valve to said burner and for supplying an actuating vapor pressure

from said vapor valve to said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in a closed position against said biasing means.

7. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve stem, said first valve control means including a first pressure compartment and being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position against said biasing means, said second valve control means including a second pressure compartment and being operative in response to pressure in said second pressure compartment to oppose said first valve control means for permitting said biasing means to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said first valve control means, a vapor valve, means for supplying vapor under pressure to said vapor valve, means for supplying an actuating vapor pressure from said vapor valve to said second pressure compartment for actuating said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position against said biasing means.

8. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve stem, said first valve control means including a first pressure compartment and being operative in response to pressure in said first pressure compartment to hold said liquid inlet valve in an open position against said biasing means, said second valve control means including a second pressure compartment and being operative in response to pressure in said second pressure compartment to oppose said first valve control means for permitting said biasing means to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said first valve control means,

a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor from said vapor valve to said burner and for supplying an actuating vapor pressure from said vapor valve to said second pressure compartment for actuating said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby turning off said burner and rendering said second valve control means inoperative whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means.

9. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve stem, said first valve control means including a first pressure compartment and being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means, said second valve control means including second and third pressure compartments, means for maintaining said third pressure compartment constantly in communication with said liquid inlet passageway, said second valve control means being operative in response to liquid pressure in said third pressure compartment partially to oppose said first valve control means by augmenting the action of said biasing means and being operative in response to vapor pressure in said second pressure compartment to render said first valve control means inoperative while permitting said biasing means assisted by liquid pressure in said third pressure compartment to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said first valve control means, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying an actuating vapor pressure from said vapor valve to said second pressure compartment for rendering said first valve control means inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby interrupting the supply of vapor pressure to said second pressure compartment and permitting said first valve control means to hold said liquid inlet valve in an open position.

10. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure actuated valve control means disposed within said pressure chamber and connected to said valve

stem, said first valve control means including a first pressure compartment and being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means, said second valve control means including second and third pressure compartments, means for maintaining said third pressure compartment constantly in communication with said liquid inlet passageway, said second valve control means being operative in response to liquid pressure in said third pressure compartment partially to oppose said first valve control means by augmenting the action of said biasing means and being operative in response to vapor pressure in said second pressure compartment to render said first valve control means inoperative while permitting said biasing means assisted by liquid pressure in said third pressure compartment to hold said liquid inlet valve in a closed position, means for supplying an actuating vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said first valve control means, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor from said vapor valve to said burner and for supplying an actuating vapor pressure from said vapor valve to said second pressure compartment for actuating said second valve control means, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby turning off said burner and interrupting the supply of vapor pressure to said second pressure compartment, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position.

11. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure responsive diaphragms of different effective areas operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second and third pressure compartments, said first diaphragm having the larger effective area and separating said first and second pressure compartments, said second diaphragm separating said second and third pressure compartments, said first diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means, means for maintaining said third pressure compartment constantly in communication with said liquid inlet passageway, said second diaphragm being operative in response to liquid pressure in said third pressure compartment partially to oppose said first diaphragm by augmenting the action of said biasing means and being operative in response to vapor pressure in said second pressure compartment to render said first diaphragm inoperative while permitting said biasing means assisted by liquid pressure in said third pressure compartment to hold said liquid inlet valve in a closed position, means for supplying vapor pressure from said vapor outlet pas-

13

sageway to said first pressure compartment for actuating said first diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor pressure from said vapor valve to said second pressure compartment for rendering said first diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby interrupting the supply of vapor pressure to said second pressure compartment and permitting said first diaphragm to hold said liquid inlet valve in an open position.

12. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, first and second pressure responsive diaphragms of different effective areas operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second and third pressure compartments, said first diaphragm having the larger effective area and separating said first and second pressure compartments, said second diaphragm separating said second and third pressure compartments, said first diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means, means for maintaining said third pressure compartment constantly in communication with said liquid inlet passageway, said second diaphragm being operative in response to liquid pressure in said third pressure compartment partially to oppose said first diaphragm by augmenting the action of said biasing means and being operative in response to vapor pressure in said second pressure compartment to render said first diaphragm inoperative while permitting said biasing means assisted by liquid pressure in said third pressure compartment to hold said liquid inlet valve in a closed position, means for supplying vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said first diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor from said vapor valve to said burner and for supplying vapor pressure from said vapor valve to said second pressure compartment for rendering said first diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby turning off said burner and interrupting the supply of vapor pressure to said second pressure compartment, whereby said first diaphragm is permitted to hold said liquid inlet valve in an open position.

13. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a liquid inlet valve operative to open and to close said liquid inlet passageway, first valve control means at all times responsive to the pressure in said vapor outlet passageway for holding said liquid inlet valve in an open posi-

14

tion, second valve control means normally responsive to said pressure in said vapor outlet passageway for opposing said first valve control means to close said liquid inlet valve, and means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position.

14. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, means for supplying vapor from said vapor outlet passageway to said burner, and means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means and the supply of vapor to said burner, thereby turning off said burner and rendering said second valve control means inoperative, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means.

15. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a liquid inlet valve operative to open and to close said liquid inlet passageway, first valve control means at all times responsive to the pressure in said vapor outlet passageway for holding said liquid inlet valve in an open position, second valve control means normally responsive to said pressure in said vapor outlet passageway for opposing said first valve control means to close said liquid inlet valve, and means operative when the temperature of vapor produced by said vaporizer is above a predetermined value for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position.

16. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, means for supplying vapor from said vapor outlet passageway to said burner, and means operative when the temperature of vapor produced by said vaporizer is above a predetermined value for interrupting

15

the supply of pressure to said second valve control means and the supply of vapor to said burner, thereby turning off said burner and rendering said second valve control means inoperative, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means.

17. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, a pressure responsive diaphragm operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second pressure compartments, said diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means and being responsive to vapor pressure in said second pressure compartment to render the pressure on said diaphragm by said first pressure compartment inoperative while permitting said biasing means to hold said liquid inlet valve in a closed position, means for continuously supplying vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor pressure from said vapor valve to said second pressure compartment for rendering the pressure against said diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby interrupting the supply of vapor pressure to said second pressure compartment and permitting said diaphragm to hold said liquid inlet valve in an open position.

18. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, a pressure responsive diaphragm operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second pressure compartments, said diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means and being responsive to vapor pressure in said second pressure compartment to render the pressure on said diaphragm by said first pressure compartment inoperative while permitting said biasing means to hold said liquid inlet valve in a closed position, means for supplying vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor pressure from said vapor valve to said burner and for

16

supplying vapor pressure from said vapor valve to said second pressure compartment for rendering the pressure against said diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby turning off said burner and interrupting the supply of vapor pressure to said second pressure compartment and permitting said diaphragm to hold said liquid inlet valve in an open position.

19. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, a pressure responsive diaphragm operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second pressure compartments, said diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means and being responsive to vapor pressure in said second pressure compartment to render the pressure on said diaphragm by said first pressure compartment inoperative while permitting said biasing means to hold said liquid inlet valve in a closed position, a packing insulating said second pressure compartment from said liquid inlet passageway, means for continuously supplying vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor pressure from said vapor valve to said second pressure compartment for rendering the pressure against said diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby interrupting the supply of vapor pressure to said second pressure compartment and permitting said diaphragm to hold said liquid inlet valve in an open position.

20. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a housing defining a pressure chamber, a liquid inlet valve operative to open and to close said liquid inlet passageway and having a valve stem projecting into said pressure chamber, means for biasing said liquid inlet valve toward a closed position, a pressure responsive diaphragm operatively connected to said valve stem and cooperating with said housing to divide said pressure chamber into first and second pressure compartments, said diaphragm being operative in response to vapor pressure in said first pressure compartment to hold said liquid inlet valve in an open position with a force exceeding the force exerted by said biasing means and being responsive to vapor pressure in said second pressure compartment to render the pressure on said diaphragm by said first pressure compartment inoperative while permitting said biasing means to hold said liquid inlet valve in a closed position, a packing insulating said second pressure com-

partment from said liquid inlet passageway, means for supplying vapor pressure from said vapor outlet passageway to said first pressure compartment for actuating said diaphragm, a vapor valve, means for supplying vapor under pressure from said vapor outlet passageway to said vapor valve, means for supplying vapor pressure from said vapor valve to said burner and for supplying vapor pressure from said vapor valve to said second pressure compartment for rendering the pressure against said diaphragm inoperative, and means operative in response to a predetermined condition in said vaporizer requiring liquid to be supplied thereto for closing said vapor valve, thereby turning off said burner and interrupting the supply of vapor pressure to said second pressure compartment and permitting said diaphragm to hold said liquid inlet valve in an open position.

21. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet passageway; a liquid inlet valve operative to open and to close said liquid inlet passageway, first valve control means operated by pressure in said vapor outlet passageway for holding said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to close said liquid inlet valve, means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position, and adjustable means whereby the liquid level in said interrupting means may be made to lead or to lag behind the liquid level in said liquid vaporizer.

22. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, means for supplying vapor from said vapor outlet passageway to said burner, means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means and the supply of vapor to said burner, thereby turning off said burner and rendering said second valve control means inoperative, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means, and adjustable means whereby the liquid level in said interrupting means may be made to lead or to lag behind the liquid level in said liquid vaporizer.

23. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway and a vapor outlet pas-

sageway; a liquid inlet valve operative to open and to close said liquid inlet passageway, first valve control means operated by pressure in said vapor outlet passageway for holding said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to close said liquid inlet valve, means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means, thereby rendering said second valve control means inoperative and permitting said first valve control means to hold said liquid inlet valve in an open position, and a Pitot tube in said liquid inlet passageway between said liquid valve and said vaporizer and operatively connected with said interrupting means whereby the liquid level in said interrupting means may be accelerated or delayed in respect to the liquid level of said vaporizer.

24. In a liquid and vapor control system, in combination with a liquid vaporizer including a liquid inlet passageway, a vapor outlet passageway, and a burner heat for supplying heat to said vaporizer; a liquid inlet valve operative to open and to close said liquid inlet passageway, means for biasing said liquid inlet valve toward a closed position, first valve control means operated by pressure in said vapor outlet passageway for opposing said biasing means to hold said liquid inlet valve in an open position, second valve control means operated by pressure in said vapor outlet passageway for opposing said first valve control means to permit said liquid inlet valve to be closed by said biasing means, means for supplying vapor from said vapor outlet passageway to said burner, means operative when liquid in said vaporizer is below a predetermined level for interrupting the supply of pressure to said second valve control means and the supply of vapor to said burner, thereby turning off said burner and rendering said second valve control means inoperative, whereby said first valve control means is permitted to hold said liquid inlet valve in an open position against said biasing means, and a Pitot tube in said liquid inlet passageway between said liquid valve and said vaporizer and operatively connected with said interrupting means whereby the liquid level in said interrupting means may be accelerated or delayed in respect to the liquid level of said vaporizer.

JOHN K. HELLER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
731,191	Learmonth	June 16, 1903
2,094,908	Thrall	Oct. 5, 1937
2,234,407	Hoagland	Mar. 11, 1941
2,319,819	Martin	May 25, 1943
2,329,750	Faucher	Sept. 21, 1943
2,346,112	Melsheimer	Apr. 4, 1944

FOREIGN PATENTS

Number	Country	Date
181,622	Switzerland	Dec. 31, 1935