July 23, 1940. S. W. E. ANDERSSON 2,208,783

REFRIGERATION

Filed Nov. 28, 1936 4 Sheets-Sheet 1

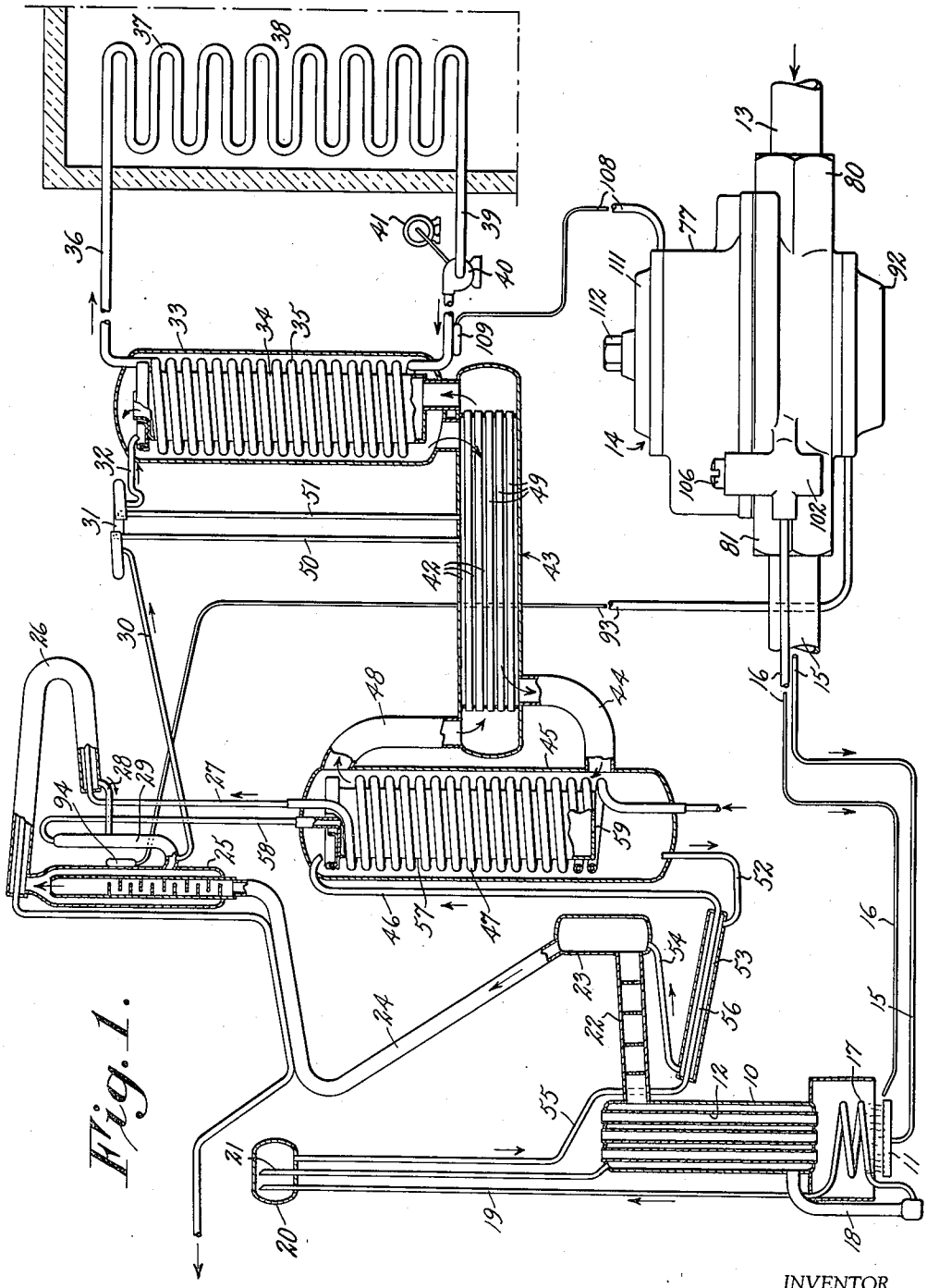


Fig. 1.

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REFRIGERATION

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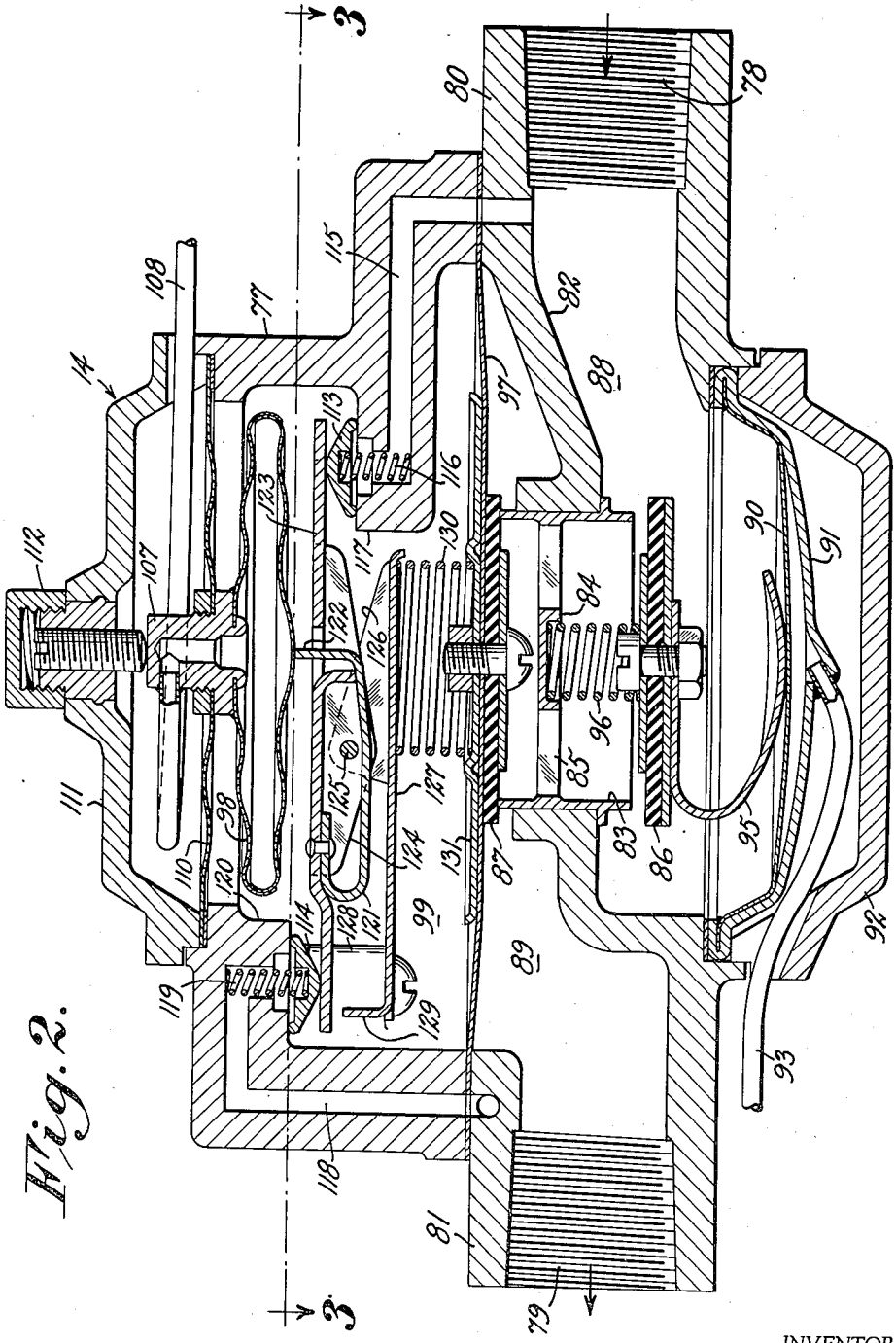


Fig. 2.

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REFRIGERATION

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Fig. 3.

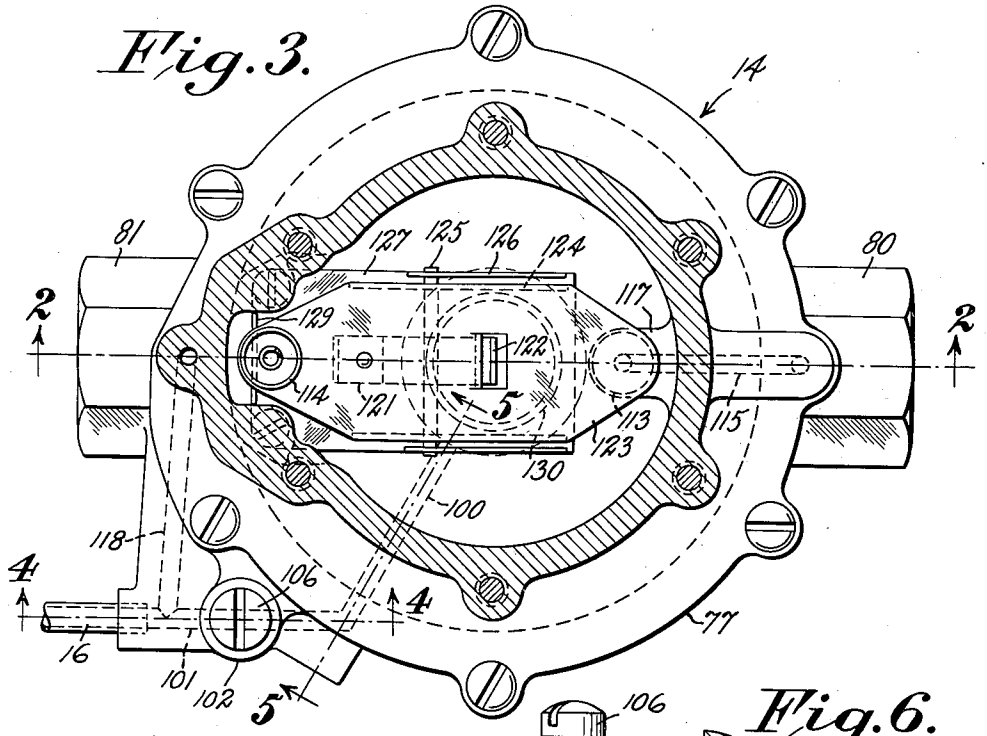


Fig. 6.

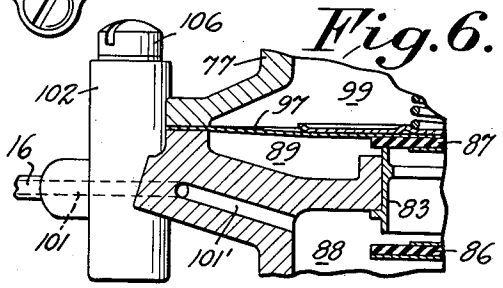


Fig. 4.

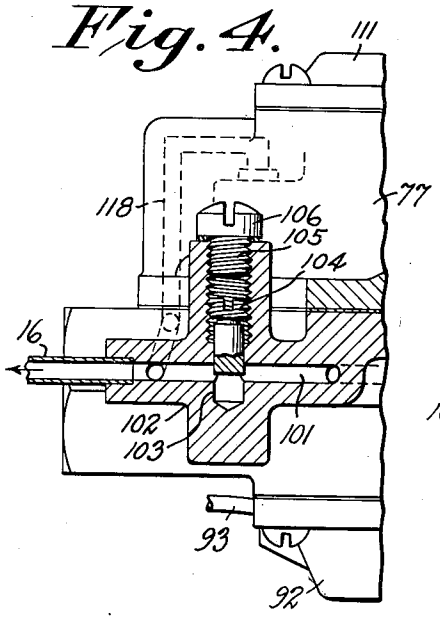
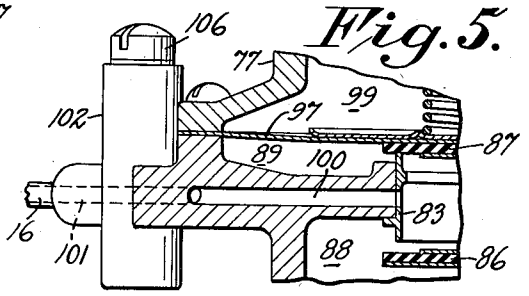


Fig. 5.

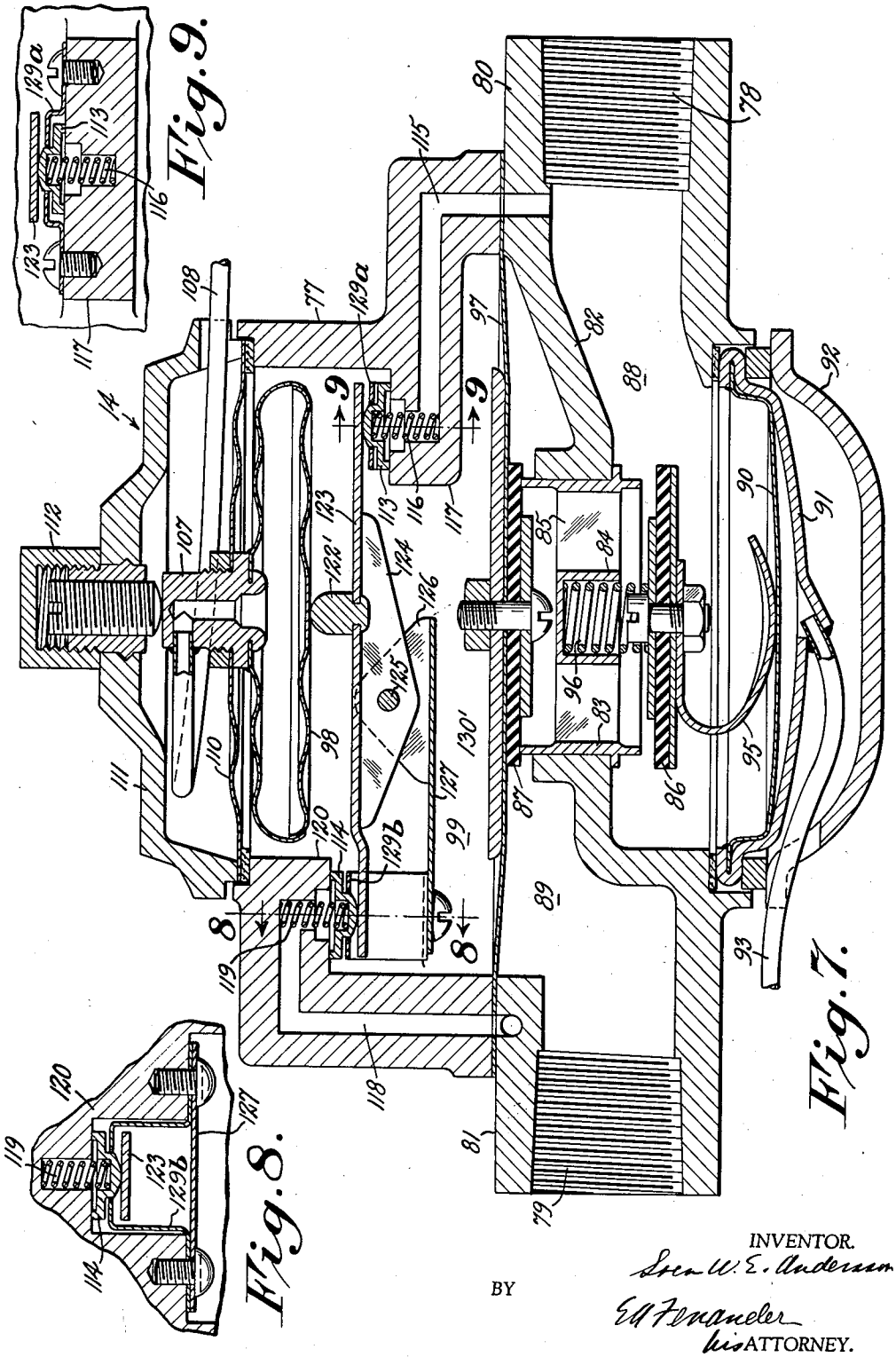


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REFRIGERATION

Filed Nov. 28, 1936 4 Sheets-Sheet 4



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Patented July 23, 1940 2,208,783

UNITED STATES PATENT OFFICE

2,208,783

REFRIGERATION

Sven W. E. Andersson, Evansville, Ind., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application November 28, 1936, Serial No. 113,152

14 Claims. (Cl. 62—5)

My invention relates to refrigeration, and more particularly to control of refrigeration apparatus.

It is an object of my invention to provide a sensitive control mechanism which is reliable in operation for controlling the heat supply of refrigeration apparatus of the absorption type.

Another object of my invention is to provide a control mechanism for refrigeration apparatus of the absorption type wherein the heat is supplied intermittently to the refrigeration apparatus in response to a temperature condition affected by the latter.

A further object of my invention is to provide a control mechanism for refrigeration apparatus of the absorption type wherein the heat is supplied intermittently to the refrigeration apparatus, the control of heat supply being such that defrosting of the apparatus is effected during the periods alternating between the periods of refrigeration when heat is applied to the apparatus.

Further objects and advantages of my invention will become apparent as I next describe control mechanism embodying my invention in connection with absorption refrigeration apparatus like that described in application Serial No. 107,852 of Albert R. Thomas, filed October 27, 1936, and the features of novelty which characterize my invention will be pointed out with particularity in the claims forming a part of this specification.

In the drawings, Fig. 1 diagrammatically illustrates refrigeration apparatus of the absorption type provided with a control mechanism embodying my invention; Fig. 2 is an enlarged vertical sectional view taken on line 2—2 of Fig. 3 to illustrate more clearly the control mechanism shown in Fig. 1; Fig. 3 is an end view of the control mechanism shown in Fig. 2 with the top cover plate removed and some of the internal parts omitted from the casing; Figs. 4 and 5 are fragmentary sectional views taken on lines 4—4 and 5—5, respectively, of Fig. 3; Fig. 6 is a fragmentary sectional view similar to Fig. 5 illustrating a modification of my invention; Fig. 7 is an enlarged vertical sectional view similar to that shown in Fig. 2 illustrating a further modification of my invention; and Figs. 8 and 9 are fragmentary sectional views taken on lines 8—8 and 9—9 of Fig. 7 to illustrate more clearly parts of the control mechanism.

Referring to Fig. 1, I have shown my improved control mechanism in connection with absorption refrigeration apparatus of a uniform pressure type and like that described in the above application of Albert R. Thomas. The refrigeration apparatus comprises a generator 10 containing a refrigerant, such as ammonia, in solution in an absorption liquid, such as water. The generator 10 is heated by a gas burner 11 which is adapted to project its flame into the lower end of a plurality of tubes 12 which extend vertically upward through the generator. A combustible gas is delivered from a source of supply through a conduit 13, a control device 14 hereinafter to be described, and conduit 15 to the burner 11. The open end of a conduit 16 is disposed adjacent to the burner 11 and connected to the control mechanism 14 to provide a pilot flame for the burner 11.

The burner 11 is also adapted to heat a coil 17 which is connected by a conduit 18 to the lower part of the generator 10. Absorption liquid enriched in refrigerant is heated in the coil 17 and is raised by vapor-lift action through a tube 19 into the upper part of a vessel 20 in which the refrigerant vapor and absorption liquid are separated. The liberated refrigerant vapor flows downward through a vertical conduit 21 into the upper part of the generator 10 and this vapor, together with refrigerant vapor expelled from solution in the generator 10, passes through absorption liquid in an inclined conduit 22 and a vessel 23 which together constitute an analyzer.

The refrigerant vapor flows upward from the vessel 23 through a conduit 24 and a liquid-cooled rectifier 25 into a condenser 26. The refrigerant is liquefied in the condenser 26 by a cooling medium, such as water, which circulates through a pipe 27 extending through the condenser. The liquefied refrigerant flows from the condenser 27 through a short conduit 28 and U-shaped conduit 29 to the rectifier 25, so that vaporized absorption liquid accompanying the refrigerant vapor is condensed and drains back to the vessel 23.

From the U-shaped conduit 29 liquid refrigerant flows through a conduit 30, a coil 31, and conduit 32 into an evaporator 33. An inert gas, such as hydrogen, enters the upper part of the evaporator 33 from the upper end of a cylinder 34 arranged within the evaporator. The liquid refrigerant flows downward over the surface of a coil 35 which is arranged about the cylinder 34, and the refrigerant evaporates and diffuses into the inert gas with consequent absorption of heat from the surroundings to produce a refrigerating effect. This refrigerating effect is utilized to cool a fluid, such as brine, for ex-

ample, which flows through the coil 35 and is conducted by a conduit 36 to a cooling coil 37 which is arranged in a thermally insulated storage compartment 38. The cooled fluid in the coil 37 produces cold in the storage compartment 38 and is conducted through a conduit 39 back to the evaporator coil 35, such circulation of the fluid between the coils 35 and 37 being effected by a pump 40 which is connected in the conduit 39 and adapted to be driven by an electric motor 41.

The resulting gas mixture of inert gas and refrigerant that is, gas rich in refrigerant, flows from the evaporator 33 through the outer passage 42 of a gas heat exchanger 43 and a downward extending conduit 44 into the lower part of an absorber 45.

The refrigerant vapor is absorbed out of the gas mixture into absorption liquid which enters the upper part of the absorber 45 through a vertically extending conduit 46, and the heat liberated with such absorption of refrigerant is transferred to the cooling medium, such as water, flowing upward within a coil 47 which is disposed within the absorber and connected at its upper end to the conduit 27. The inert gas, which is practically insoluble and weak in refrigerant vapor, passes from the absorber 45 through conduit 48, a plurality of parallel tubes 49 which form the inner passage of the gas heat exchanger 55 and cylinder 34 into the upper part of the evaporator 33.

The gas rich in refrigerant vapor flows upward from the outer passage 42 of the gas heat exchanger 43 through a vertically extending conduit 50 into the upper part of the coil 31, and, since the partial vapor pressure of refrigerant in the rich gas mixture is less than the vapor pressure of warm liquid refrigerant flowing through the coil 31, liquid refrigerant evaporates and diffuses into the rich gas mixture with consequent absorption of heat from the liquid refrigerant. The rich gas flows downward through conduit 51 into the outer passage 42 of the gas heat exchanger 43. A local circulation of rich gas is set up in the fluid circuit comprising the coil 31 and conduits 50 and 51, so that refrigerant is precooled in the coil 31 before entering the upper part of the evaporator 33.

The absorption liquid flowing downward in the absorber 45 in counter-flow to the gas mixture becomes enriched in refrigerant and flows through conduit 52, outer passage 53 of a liquid heat exchanger, conduit 54, vessel 23, and conduit 22 to the generator 10. The absorption liquid flows from the generator 10 through conduit 18 to the coil 17, as explained above, and in the latter is raised by vapor-lift action through tube 19 into the vessel 20. The absorption liquid is raised to a higher level in the vessel 20 than it is in the absorber 45, and absorption liquid weak in refrigerant flows from the vessel 20 through conduit 55, inner passage 56 of the liquid heat exchanger, and conduit 46 into the upper end of the absorber 57.

In order to vary the total pressure in the refrigeration system just described with changes in temperature of the condenser 26, due to changes in temperature of the cooling medium or the rate at which it flows through the condenser, for example, a cylinder 57 disposed within the absorber 45 is utilized as a storage vessel for gas in the gas circuit with the upper part connected by conduit 58 to the U-shaped conduit 29, and the lower part having an opening 59 to provide communication with the gas circuit. The cylinder 57 and conduit 58 provide a path of flow from the condenser 26 to the gas circuit, so that any inert gas which passes through the condenser can flow to the gas circuit and not be trapped in the condenser. Also, should the temperature of the condenser increase so that refrigerant is not liquefied therein, the refrigerant vapor will flow through conduit 58 to displace gas in the cylinder 57 and force such gas into the gas circuit. This raises the total pressure in the system so that an adequate condensing pressure is obtained for the increased temperature of the condenser.

In accordance with my invention the flow of gas to the burner 11 is controlled by the control mechanism 14. Referring to Fig. 2, the control mechanism 14 comprises a casing 77 having inlet and outlet openings 78 and 79 formed within bosses 80 and 81 to which are connected the conduits 13 and 15, respectively. The casing 77 is provided with a partition 82 having an opening within which is fixed a short cylindrical sleeve 83. The sleeve 83 is formed with a central hub member 84 which is connected to the inner wall of the sleeve by spaced radial arms 85. The spaces between the arms 85 permit the flow of gas through the sleeve 83 which serves as a valve opening, and the lower and upper ends thereof serve as seats for valves 86 and 87 which are disposed in chambers 88 and 89, respectively, formed on opposite sides of the partition 82. The valves 86 and 87 may be formed of artificial rubber material, such as that commercially known as "Duprene" or "Thiokol," or any other suitable material which is not affected by contact with gas.

The valve 86 controls the flow of gas to the burner 11 in response to temperature or pressure by the action of a thermal or pressure element arranged at the lower end of the casing 77. This thermal or pressure element comprises a resilient diaphragm 90 having its peripheral edge secured to the peripheral edge of a plate 91 which in turn is secured between the lower end of the casing 77 and a cover plate 92. At a central opening in the plate 91 is secured one end of a tube 93 which extends through an opening in the cover plate 92 and is connected at its other end to a thermal bulb 94 which is arranged in thermal contact with the liquid-cooled rectifier 25, as shown in Fig. 1.

The resilient diaphragm 90 and plate 91, tube 93, and bulb 94 constitute an expansible fluid thermostat which contains a suitable volatile fluid which increases and decreases in volume with corresponding changes in temperature. The resilient diaphragm 90 moves toward and away from the valve seat with an increase and decrease in volume of the volatile fluid, and these movements of the diaphragm 90 are utilized to regulate the valve 86 and control the flow of gas to the burner 11. As shown, the resilient diaphragm 90 is adapted to bear against the lower end of a C-shaped spring 95 which is secured at its upper end to the valve 86. A spiral spring 96 is retained in position between the valve 86 and the hub member 84 and is adapted to urge the valve 86 to its open position.

The valve 86 may be termed a high-temperature safety valve in that it is normally maintained in its open position by the spiral spring 96. If for any reason the temperature of the liquid-cooled rectifier 25 becomes relatively high, due to failure of the cooling medium to circulate through the condenser 26, for example, the volatile fluid in-

creases in volume and causes the resilient diaphragm 90 to expand and move upward. With such upward movement of the resilient diaphragm 90 the valve 86, through the action of the C-shaped spring 95, is urged toward its closed position against the tension of the spiral spring 96. After the valve 86 is seated at the lower end of the sleeve 83 and in its closed position, any further upward movement of the resilient diaphragm 90 is taken up by the C-shaped spring 95, so that undue straining of the diaphragm is avoided. When the high-temperature safety valve 86 is caused to move to its closed position, the supply of gas to the burner 11 may be shut off completely, whereby heat is no longer applied to the refrigeration apparatus; or the device may be so constructed that gas will still flow to a small burner to provide a pilot flame even when the valve 86 is in its closed position.

The valve 87 is mounted on a diaphragm 97 which, with the partition 82, defines the chamber 89 communicating with the outlet 79. The valve 87 controls the flow of gas to the burner 11 in response to temperature or pressure by the action of a thermal or pressure element 98 which is arranged in the chamber 99 formed above the diaphragm 97, as will be described hereinafter.

In order to provide a pilot flame for the burner 11 when the valve 87 is closed, a by-pass is provided in the casing 77. As shown in Figs. 3, 4, and 5, gas flows from the space between the valves 86 and 87 through a passage 100 and a second passage 101 which is at an angle thereto and terminates at a boss 102 formed on the casing. The conduit 16, which terminates in the vicinity of the burner 11, as shown in Fig. 1, is connected to the passage 101 at the boss 102. The quantity of gas flowing through the by-pass passage and conduit 16 is controlled by valve 103 having a screw 104 at the upper end thereof which is movable in a passage 105 formed in the boss 102 at right angles to the passage 101. By turning the screw 104 from the exterior of the casing after removing an outer screw 106, the valve 103 can be positioned in the passage 101 to regulate the quantity of gas that can flow through the passages 100 and 101 and conduit 16 to the vicinity of the burner.

The valve 87 controls the flow of gas to the burner 11 in response to the action of the thermal or pressure element 98, as stated above. This thermal or pressure element comprises an expansible diaphragm which is secured to and in open communication with a hollow hub member 107 to which is connected one end of a tube 108, the other end of which is connected to a thermal bulb 109 arranged in thermal contact with the conduit 39 of the refrigeration apparatus, as shown in Fig. 1. The hub member 107 is mounted on a resilient diaphragm 110 which is secured at its peripheral edge between the upper end of the casing 77 and a cover plate 111 having an opening through which the tube 108 passes. The cover plate 111 is provided with an adjustment screw 112 for adjusting the position of the resilient diaphragm 110 and hence the position of the expansible diaphragm 98.

The expansible diaphragm 98, tube 108, and bulb 109 also constitute an expansible fluid thermostat which contains a suitable volatile fluid that increases and decreases in volume with corresponding changes of temperature. The expansible diaphragm 98 expands and contracts with an increase and decrease in volume of the volatile fluid, and these movements are transmitted to bleeder valves 113 and 114 to effect control of the valve 87. The valve 113 cooperates with the upper end of a passage 115 which is formed in the casing 77 and permits gas to flow from the chamber 88 into the chamber 99. The valve 113 is guided and urged to its open position by a small spiral spring 116 which is disposed in the vertical portion of the passage 115 formed in an inwardly extending projection 117 of the casing. The valve 114 cooperates with the upper end of a passage 118 which is formed in the casing and permits gas to flow from the chamber 99 to the passage 101, as shown most clearly in Figs. 3 and 4. The valve 114 is guided and urged to its open position by a small spiral spring 119 which is disposed in the vertical portion of the passage 118 formed in the upper inward extending part 120 of the casing 77.

The structure in chamber 99 for transmitting movements of the expansible diaphragm 98 to the valves 113 and 114 to effect regulation of the valve 87 comprises a relatively strong C-shaped flat spring 121 having an upward extending end 122 on the long arm thereof against which the expansible diaphragm 98 is adapted to bear. The short arm of the spring 121 is secured to the under side of a lever 123 having an opening through which the upward extending end 122 of the spring 121 extends. The lever 123, as shown in Fig. 3, is relatively wide and the narrow reduced ends thereof are adapted to bear against the valves 113 and 114. The lever 123 is provided with downward extending sides 124 which are pivotally connected to a pin 125 fixed to the upward extending sides or tabs 126 formed on a flat spring 127 which is secured to a projection 128 of the casing. The inner end of the flat spring 127 is provided with an upturned lip 129 adapted to contact an end of the lever 123 and limit the extent to which the valve 114 can be opened. The flat spring 127 also serves as an abutment for a spiral spring 130 which is disposed and retained between the under side of the flat spring 127 and a washer 131 which is fixed to the upper side of the diaphragm 97 and to the valve 87.

The structure which is disposed in the upper chamber 99 and just described is effective to regulate the bleeder valves 113 and 114 and hence control the valve 87 and the flow of gas to the burner 11, so that the cooling element or evaporator 33 of the refrigeration apparatus will be capable of maintaining the storage compartment 38 at a desired low temperature. When the temperature of the storage compartment 38, and hence the temperature of the cooling fluid in the conduit 39, tends to rise above the desired low temperature, the volatile fluid of the expansible fluid thermostat increases in volume and causes the expansible diaphragm 98 to expand whereby the spring 121 against which it bears is moved downward. With such downward movement of the spring 121, the lever 123 secured thereto pivots at the region which bears against the valve 113 whereby the left-hand part thereof moves downward. The spiral spring 119 cooperating with the valve 114 urges the latter to move to its open position when the left-hand part of the lever 123 moves downward, such movement being limited, of course, by the upturned lip 129 formed on the flat spring 127. Under these conditions the valve 113 is closed and the valve 114 is open whereby the chamber 99, through the passage 118, is in communication with the by-pass passage 101 to which is con-

nected the pilot flame conduit 16. Since the connection of the passage 118 with the passage 101 is between the adjusting valve 103 in the by-pass and the conduit 16, the pressure in the chamber 99 will become relatively low and slightly above atmospheric pressure because the gas flowing through the conduit 16 to provide the pilot flame is adjusted to a low pressure by the valve 103 in the by-pass passage 101.

It will now be understood that the pressure in the upper chamber 99 is relatively low and slightly above atmospheric pressure and that the pressure in the chamber 88 is that of the pressure in the gas supply conduit 13. The spiral spring 130, which may be termed a load spring, is so chosen that the force it exerts on the top of the diaphragm 97 is less than the force exerted against the under side of the valve 87 by the gas under pressure in the chamber 88 and sleeve 83. Since the force exerted on the top of the diaphragm 97 by the load spring 130 is less than the force exerted by the gas in chamber 88 on the under side of the diaphragm 97 at the relatively small portion thereof covering the sleeve 83, the valve 87 will move upward from its seated position shown in Fig. 2. When the valve 87 cracks open, the gas pressure will start building up in the chamber 89 and exert a force on the entire under side of the diaphragm 97, so that the valve 87 will remain in its full open position.

The gas now flows to the burner 11 and is ignited by the pilot flame at the outer end of conduit 16, and heat is applied to the refrigeration apparatus whereby refrigeration is produced in the evaporator 33. By producing refrigeration in the evaporator 33, the cooling fluid in the circuit including the evaporator coil 35 and cooling coil 37 becomes effective to produce cold in the storage compartment 38.

When the temperature of the storage compartment 38, and hence the temperature of the cooling fluid in the conduit 39, tends to fall below the desired temperature, the volatile fluid of the expansible fluid thermostat becomes reduced in volume and causes the expansible diaphragm 98 to contract whereby the flat spring 127 causes the lever 123 and spring 121 secured thereto to move upward. With such upward movement of the lever 123 it first pivots about the region bearing against the valve 113 whereby the lefthand part thereof bears against the valve 114 and moves the latter to its closed position against the tension of the spiral spring 119. The valves 113 and 114 are both closed momentarily, and, with continued upward movement of the lever 123, the lever begins to pivot about the region bearing against the valve 114 whereby the right-hand part thereof moves upward and permits the spiral spring 116 to urge the valve 113 to its open position. Under these conditions the valve 114 is closed and the valve 113 is open so that the upper chamber 99, through the passage 115, is in open communication with the chamber 88 into which gas flows from the supply conduit 13. The gas flows from the chamber 88 through the passage 115 into the upper chamber 99. When the gas pressures in the chambers 99 and 89 are substantially equal, the load spring 130 becomes effective to urge the valve 87 to its closed position. The valve 87 is effectively maintained in its closed position because, after it is seated at the upper end of the sleeve 83, the gas under pressure in the upper chamber 99 exerts a force over the entire area of the diaphragm 97 whereas the gas under pressure in the chamber 88 and sleeve 83 only exerts a force on the part of the diaphragm above the upper end of the sleeve 83.

With the valve 87 in its closed position, heat is no longer applied to the refrigeration apparatus and the refrigerating effect produced by the evaporator 33 is reduced. The valve 87 will remain in its closed position until the temperature of the storage compartment 38 tends to rise above the desired temperature, as described above, whereby the expansible diaphragm 98 will again expand and cause the valve 113 to move to its closed position and the valve 114 to move to its open position. When the valve 114 is moved to its open position the pressure in the upper chamber 99 is relieved and the gas therein flows through the passages 118 and 101 and through the conduit 16 whereby the size of the pilot flame is momentarily increased. This insures a reliable operation of the pilot flame as it coincides with the opening of the valve 87 and thus avoids any tendency of the pilot flame being extinguished by a sudden air draft that may be produced by the gas discharged from the burner 11. Only a relatively small amount of gas flows from the upper chamber 99 during operation of the valve 87, as just described, the amount of gas discharged from the chamber each time the valve 87 opens being equal to the volume of gas in the upper chamber 99. During operation of the control mechanism, the valve 87 takes a few seconds to open which is a distinct advantage because the burner flame would otherwise ignite with a rather loud noise. The closing movement of the valve 87 is, however, very sudden and positive.

When the lever 123 is moved downward, due to expansion of the expansible diaphragm 98, the left-hand part of the lever moves downward until it contacts the upturned end 129 of the flat spring 127. The C-shaped spring 121 does not deflect with such normal expansion of the expansible diaphragm 98. With further expansion of the expansible diaphragm 98, however, the downward movement of the diaphragm is taken up by the C-shaped spring 121, so that any undue straining of the diaphragm is avoided. It will now be understood that the control device is so constructed and arranged that the gas under pressure in the chamber 88 or main gas passage constantly exerts a force on one side of the diaphragm 97, the force being exerted on the diaphragm through the valve 87 when the latter is in its closed position and directly on the diaphragm when the valve 87 is in its open position; and that the gas under presure in the main passage intermittently flows into the chamber 99 and exerts a force on the other side of the diaphragm in response to change of temperature from a predetermined value, whereby the diaphragm is operative to flex and effect control of the valve 87.

It has been previously stated that the by-pass passage to provide gas for the pilot flame at the end of conduit 16 communicates with the space within the sleeve 83, as shown in Fig. 5. With such an arrangement the pilot flame is not extinguished when the valve 87 is closed but is extinguished if for any reason the high temperature safety valve 86 is caused to move to its closed position. If desired, however, the by-pass passage to provide gas for the pilot flame may be so arranged in the casing 77 that the pilot flame will not be extinguished even when the safety valve 86 is caused to move to its closed position. Such an arrangement is shown in Fig. 6 with like

parts indicated by the same reference numerals and wherein the passage 101' corresponding to the passage 101 in Figs. 3, 4, and 5 communicates with the chamber 88. Thus, if for any reason the safety valve 86 should close, the pilot flame would not be extinguished so that the ignition of the burner flame can be effected when the safety valve 86 again opens.

It should be clear that the expansible diaphragm 98 is not mechanically connected to the valve 87 to control the latter, but that the valve 87 is controlled by varying the pressure in the upper chamber 99. This is accomplished by having the expansible diaphragm 98 control the valves 113 and 114, so that the pressure in the chamber 99 will either be relatively small and slightly above atmospheric pressure or substantially equal to the pressure in the chamber 88. The load spring 130 is provided solely to urge the valve 87 to its closed position when the pressures in the chambers 88 and 99 are substantially equal.

If desired, means other than a load spring may be employed to urge the valve 87 to its closed position when the pressures in the chambers 88 and 99 are substantially the same. For example, the valve 87 may be weighted to urge it toward its closed position. Such a modification is shown in Fig. 7 wherein parts corresponding to those shown in Fig. 2 are indicated by the same reference numerals. By comparing Figs. 2 and 7, it will be noted that in the latter the C-shaped spring 121 and load spring 130 are omitted. In Fig. 7 the lever 123 is provided with a knob or protuberance 122' against which the expansible diaphragm 98 is adapted to bear. To limit the extent to which the valves 113 and 114 can be opened, members 129*a* and 129*b*, which may be referred to as valve retainers, are secured within the casing, as shown most clearly in Figs. 8 and 9. The operation of the structure shown in Fig. 7 for transmitting movements of the expansible diaphragm 98 to the valves 113 and 114 is substantially the same as that described above in connection with the embodiment shown in Figs. 2 to 6 inclusive.

If it is assumed that the valve 113 is closed and valve 114 is open, the valve 87 will be in its open position whereby gas is supplied to the burner 11. When the temperature of the storage compartment of the refrigerator tends to fall below the desired temperature, the expansible diaphragm 98 will contract whereby the valve 114 is closed and the valve 113 is opened, thereby permitting gas to flow through the passage 115 into the upper chamber 99. When the pressures in the chambers 88 and 99 are substantially equal, the diaphragm 97 and valve 87 will move downward due to their own weight and the weight 130' which is in the form of a large metal washer fixed to the diaphragm 97 and to the valve 87. After the valve 87 is seated on the upper end of the sleeve 83, it will effectively remain in its closed position because the gas under pressure in the chamber 99 exerts a force over the entire area of the diaphragm 97 whereas the gas under pressure in the chamber 88 and sleeve 83 only exerts a force on the portion of the diaphragm equivalent to the area of the valve 87 covering the upper end of the sleeve 83.

When the expansible diaphragm 98 expands so that the valve 113 is closed and the valve 114 is open, the pressure in the chamber 99 is relieved and the gas therein is discharged into the pilot flame conduit 16. Under these conditions the force exerted by the gas under pressure in the sleeve 83 is effective to move the diaphragm 97 upward and open the valve 87, thereby permitting gas to be supplied to the burner 11. The weight or member 130' is of such size that the combined weight of this member, diaphragm 97, and the valve 87 will exert a force which is less than the force exerted by the gas under pressure in the sleeve 83 when the pressure in the chamber 99 is relatively low, so that the valve 87 will move to its open position, as just described. It will now be understood that the weight or member 130' is equivalent to the load spring 130 and effective to move the valve 87 to its closed position when the pressures in the chambers 88 and 99 are substantially equal.

In view of the foregoing description of the particular embodiments of the control mechanism I have provided, it will be understood that the valve 87 is not a throttle valve and does not assume a number of different positions to vary or change the rate at which gas flows to the burner but only assumes two positions, namely, either a full open position or a closed position. Thus, the expansible fluid thermostat may be likened to an "on" and "off" thermostat which effectively controls the valve 87 whereby gas is intermittently supplied to the burner 11, the periods during which no gas is supplied to the burner alternating with periods during which gas is supplied to the burner and heat is applied to the refrigeration apparatus so that cold is produced in the storage compartment 38. In a control mechanism of the type wherein the thermostat controls the valve to vary or change the rate of flow of gas to the burner in response to a temperature condition affected by an evaporator or cooling unit, the cooling unit will in a relatively short time be covered with a rather heavy layer of frost. In such case, it is necessary to stop the operation of the refrigeration apparatus for a prolonged interval of time to effect defrosting of the cooling unit. In the control mechanism I have provided wherein the gas is supplied intermittently to the burner to maintain a storage compartment at a desired low temperature, the control mechanism may be adjusted to operate with such a temperature differential that the slight layer or coating of frost formed on a cooling unit during the periods heat is applied to the refrigeration apparatus by the burner will melt during the alternate periods when no gas is being supplied to the burner and heat is not applied to the refrigeration apparatus.

Although I have shown my improved control mechanism in connection with a particular type of refrigeration apparatus, I do not wish to be limited to the particular arrangements set forth, and I intend in the following claims to cover all modifications which do not depart from the spirit and scope of my invention.

What is claimed is:

1. Refrigeration apparatus of an absorption type comprising several interconnected parts including a heat receiving part, a burner for heating said last-mentioned part, a device for controlling flow of gas to said burner and comprising a casing having an inlet and an outlet for gas, a partition having an opening and defining two chambers one of which communicates with the inlet and the other with the outlet, a normally open safety valve and a normal control valve disposed at opposite sides of said partition for controlling the opening and hence the flow of gas from the inlet to the outlet, a by-pass passage

communicating with the inlet chamber and extending to the exterior of said casing, a conduit connected to said by-pass passage and terminating in the vicinity of the burner to provide a pilot flame, means operative to cause said normally open safety valve to move to its closed position to shut off the main supply of gas to the burner upon a predetermined rise of temperature of a part of the refrigeration apparatus, and means for operating said normal control valve to control the flow of gas to the burner.

2. A device as defined in claim 1 and including a valve adjustable at the exterior of said casing for regulating flow of gas through said by-pass passage.

3. A device for controlling flow of gas to a burner adapted to heat refrigeration apparatus of an absorption type and comprising a casing having an inlet and an outlet for gas, a movable diaphragm to form a control chamber and a main gas passage, a partition in said main gas passage to form an inlet chamber communicating with the inlet and an outlet chamber communicating with the outlet, said partition having an opening, a main valve connected to said diaphragm and disposed at one side of said partition for controlling the opening, a normally open second main valve disposed at the opposite side of the partition for controlling the opening, a second passage connecting said inlet chamber and said control chamber, a first bleeder valve for controlling flow of gas in said second passage, a by-pass passage communicating with said inlet chamber and extending to the exterior of said casing, a valve in said by-pass passage adjustable from the exterior of said casing, a third passage connecting said control chamber and said by-pass passage at a point between said adjustable valve and the outer end of said by-pass passage, a second bleeder valve for controlling flow of gas in said third passage, a conduit for conducting gas from said by-pass passage and said third passage to the vicinity of the burner, the gas under pressure in said main passage normally exerting a force constantly on one side of said diaphragm, means including a single expansible element operative responsive to temperature or pressure for operating said first and second bleeder valves so that gas under pressure in said main passage intermittently flows into said control chamber and exerts force on the other side of said diaphragm, loading means including said first main valve associated with said diaphragm whereby the latter is capable of flexing and moving said first main valve toward and away from its closed position with changes in force exerted on said diaphragm, and said normally open second main valve being operative to move to its closed position to close the opening upon a predetermined rise of temperature.

4. A device for controlling flow of gas to a burner adapted to heat refrigeration apparatus of an absorption type and comprising a casing having an inlet and an outlet for gas, a movable diaphragm to form a control chamber and a main gas passage, a partition in said main gas passage to form an inlet chamber communicating with the inlet and an outlet chamber communicating with the outlet, said partition having an opening, a main valve connected to said diaphragm and disposed at one side of said partition for controlling the opening, a normally open second main valve disposed at the opposite side of the partition for controlling the opening, a second passage connecting said inlet chamber and said control chamber, a first bleeder valve for controlling flow of gas in said second passage, a by-pass passage communicating with the space between said first and second main valves when the latter are in their closed positions and extending to the exterior of said casing, a valve in said by-pass passage adjustable from the exterior of said casing, a third passage connecting said control chamber and said by-pass passage at a point between said adjustable valve and the outer end of said by-pass passage, a second bleeder valve for controlling flow of gas in said third passage, a conduit for conducting gas from said by-pass passage and said third passage to the vicinity of the burner, the gas under pressure in said main passage normally exerting a force constantly on one side of said diaphragm, means including a single expensible element operative responsive to temperature or pressure for operating said first and second bleeder valves so that gas under pressure in said main passage intermittently flows into said other chamber and exerts a force on the other side of said diaphragm, loading means including said first main valve associated with said diaphragm whereby the latter is capable of flexing and moving said first main valve toward and away from its closed position with changes in force exerted on said diaphragm, and said normally open second main valve being operative to move to its closed position to close the opening upon a predetermined rise of temperature.

5. A device for controlling flow of fluid fuel to a burner adapted to heat refrigeration apparatus of an absorption type and comprising means forming a passage for fluid fuel, a partition in said passage and having an opening, two valves disposed at opposite sides of said partition for controlling the opening, one of said valves normally being open, means including a member arranged at the opening and having spaced radially extending arms supported by said partition for locating and guiding said normally open valve, structure including a movable diaphragm connected to said other valve for controlling the latter, said structure being so constructed and arranged that fuel under pressure normally exerts force constantly on one side of said diaphragm and also exerts force on the other side of said diaphragm in response to temperature or pressure, loading means associated with said diaphragm whereby the latter is capable of flexing and moving said valve connected thereto toward and away from its closed position with changes in force exerted on said diaphragm, and said normally open valve being operative to move to its closed position to shut off flow of fuel upon a predetermined rise of temperature.

6. A device for controlling flow of fluid fuel to a burner adapted to heat refrigeration apparatus of an absorption type and comprising means forming a passage for fluid fuel, a partition in said passage and having an opening, two valves disposed at opposite sides of said partition for controlling the opening, a hub member arranged at the opening and having spaced radially extending arms supported by said partition, resilient means arranged between said hub member and one of said valves for normally maintaining the latter in its open position, means operative upon a predetermined rise of temperature to cause said normally open valve to move to its closed position against the tension of said resilient means, structure including a movable diaphragm connected to said other valve for con-

trolling the latter, said structure being so constructed and arranged that fuel under pressure normally exerts force constantly on one side of said diaphragm and also exerts force on the other side thereof in response to temperature or pressure, and loading means associated with said diaphragm whereby the latter is capable of flexing and moving said valve connected thereto toward and away from its closed position with changes in force exerted thereon.

7. A device for controlling flow of gas to a burner including a main valve, structure including a movable diaphragm to provide first and second chambers, said first and second chambers being connected in first and second gas passages, respectively, said main valve being connected to said diaphragm and arranged to control flow of gas in said first passage, separate inlet and outlet bleeder valves to control flow of gas into and from said second chamber whereby gas under pressure is capable of exerting force on one or both sides of said diaphragm, loading means including said main valve and said diaphragm to cause the latter to flex and close said main valve when said inlet bleeder valve is open and outlet bleeder valve is closed and substantially equal forces are exerted on opposite sides of said diaphragm, said loading means permitting said diaphragm to flex and open said main valve when said inlet bleeder valve is closed and outlet bleeder valve is open and force is only exerted on one side of said diaphragm, and means including an expansible element to simultaneously operate said inlet and outlet bleeder valves.

8. A device for controlling flow of gas to a burner comprising structure including a movable diaphragm defining first and second chambers, said first chamber forming part of a gas passage to the burner, a main valve connected to said diaphragm, a by-pass passage connecting the main passage and said second chamber, said second chamber having an opening to permit gas to flow therefrom, separate inlet and outlet bleeder valves for controlling flow of gas into and from said second chamber whereby gas under pressure is capable of exerting force on one or both sides of said diaphragm, loading means including said main valve and said diaphragm to cause the latter to flex and close said main valve when said inlet bleeder valve is open and outlet bleeder valve is closed and gas exerts force on both sides of said diaphragm, said loading means permitting said diaphragm to flex and open said main valve when said inlet bleeder valve is closed and outlet bleeder valve is open and force is only exerted on one side of said diaphragm, and means including an expansible element to simultaneously operate said inlet and outlet bleeder valves.

9. A device for controlling flow of fluid fuel to a burner adapted to heat refrigeration apparatus of an absorption type and including means forming a passage for fluid fuel, a partition in said passage and having an opening, two valves disposed at opposite sides of said partition for controlling the opening, structure including a movable diaphragm connected to one of said valves for operating the latter, said other valve normally being open, said structure being so constructed and arranged that fuel under pressure normally exerts force constantly on one side of said diaphragm and also exerts force only on the other side of said diaphragm in response to changes in temperature or pressure, loading means associated with said diaphragm whereby the latter is capable of flexing and moving said one valve connected thereto toward and away from its closed position with changes in force exerted on said diaphragm, and means responsive to rise of temperature to cause said normally open valve to move to its closed position.

10. A device for controlling flow of gas to a burner including a partition having an opening, a first valve at one side of said partition to control the opening, structure to operate said valve including a movable diaphragm operatively connected thereto, said structure being so constructed and arranged that both sides of said diaphragm may be subjected to gas under pressure, loading means including said diaphragm to cause the latter to flex and close said valve when both sides of said diaphragm are subjected to gas substantially at the same pressure, valve means to reduce the gas pressure to which one side of said diaphragm is subjected, said loading means permitting said diaphragm to flex and open said first valve when the gas pressure to which said diaphragm is subjected on said one side is reduced, a second normally open valve at the opposite side of said partition to said first valve to control the opening, and means to close said second valve.

11. A device for controlling flow of fluid fuel to a burner adapted to heat refrigeration apparatus of an absorption type and comprising a casing having an inlet and outlet, a valve in said casing for controlling flow of fuel between said inlet and outlet, structure including a first movable diaphragm connected to said valve for operating the latter, and a second diaphragm forming a pressure chamber with said first diaphragm, said structure being so constructed and arranged that one side of said first diaphragm is normally subjected continuously to pressure of fuel and the opposite side is subjected to pressure of fuel within said pressure chamber, means including an expansible and contractible diaphragm within said pressure chamber and mounted on said second diaphragm for controlling fuel pressure in said pressure chamber responsive to temperature or pressure, means adustable from the exterior of said casing for moving said second diaphragm to adjust the position of said expansible and contractible diaphragm within said pressure chamber, and loading means including said first diaphragm to cause the latter to close said valve when both sides of said first diaphragm are subjected to fuel substantially at the same pressure, said loading means permitting said diaphragm to open said valve when the fuel pressure in said pressure chamber is reduced.

12. A device for controlling flow of gas to a burner adapted to heat refrigeration apparatus of an absorption type and comprising a casing having an inlet and outlet for gas, first and second diaphragms in said casing forming a pressure chamber at one side of said first diaphragm and a main passage for gas at the opposite side of the latter between the inlet and outlet, a main valve connected to said first diaphragm for controlling flow of gas in said main passage, said casing having a second passage communicating with the inlet and the pressure chamber and a third passage communicating with the pressure chamber and serving as an outlet to permit gas to flow therefrom, said first diaphragm normally being subjected continuously to pressure of gas on the main gas passage side thereof, valve means to control flow of gas through said second and third passages to control the gas pressure to which said first diaphragm is subjected

on the pressure chamber side thereof, means responsive to temperature or pressure and including an expansible and a contractible diaphragm within said pressure chamber and mounted on said second diaphragm for operating said valve means, means adjustable from the exterior of said casing for moving said second diaphragm to adjust the position of said expansible and contractible diaphragm within said pressure chamber, and loading means including said diaphragm to cause the latter to close said main valve when both sides of said diaphragm are subjected to gas substantially at the same pressure, said loading means permitting said first diaphragm to open said main valve when the pressure of gas within said pressure chamber is reduced.

13. A device for controlling flow of gas to a burner adapted to heat refrigeration apparatus of an absorption type and comprising a casing having an inlet and outlet for gas, first and second diaphragms in said casing forming a pressure chamber at one side of said first diaphragm and a main passage for gas at the opposite side of the latter between the inlet and outlet, a main valve connected to said first diaphragm for controlling flow of gas in said main passage, said casing having a second passage communicating with the inlet and the pressure chamber and a third passage communicating with the pressure chamber and serving as an outlet to permit gas to flow therefrom, said first diaphragm normally being subjected continuously to pressure of gas on the main gas passage side thereof, a first bleeder valve for controlling flow of gas through said second passage and a second bleeder valve for controlling flow of gas through said third passage to control the gas pressure to which said first diaphragm is subjected on the pressure chamber side thereof, means responsive to temperature or pressure and including an expansible and contractible diaphragm within said pressure chamber and mounted on said second diaphragm for simultaneously operating both of said bleeder valves to control the pressure of gas in said pressure chamber, means adjustable from the exterior of said casing for moving said second diaphragm to adjust the position of said expansible and contractible diaphragm within said pressure chamber, and loading means including said diaphragm to cause the latter to close said main valve when both sides of said first diaphragm are subjected to gas substantially at the same pressure, said loading means permitting said first diaphragm to flex and open said main valve when said first bleeder valve is closed and said second bleeder valve is open.

14. A device for controlling flow of fluid fuel to a burner adapted to heat refrigeration apparatus of an absorption type and comprising means forming a passage for fluid fuel, a partition in said passage and having an opening, two valves disposed at opposite sides of said partition for controlling the opening, resilient means for normally urging one of said valves open, means in the opening permitting flow of gas therethrough and forming a mounting for said resilient means, means operative upon rise of temperature and acting against said resilient means to close said one valve, structure including a movable diaphragm connected to said other valve for operating the latter, said structure being so constructed and arranged that one side of said diaphragm is normally subjected continuously to pressure of fuel and the opposite side thereof is subjected to pressure of fuel responsive to change in temperature or pressure, and loading means including said diaphragm whereby the latter will flex to open and close said other valve with changes in the resulting pressure to which said diaphragm is subjected.

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