

May 27, 1952

W. L. BULKLEY

2,598,035

ABSORPTION REFRIGERATION

Filed Aug. 2, 1948

3 Sheets-Sheet 1

Fig. 1.

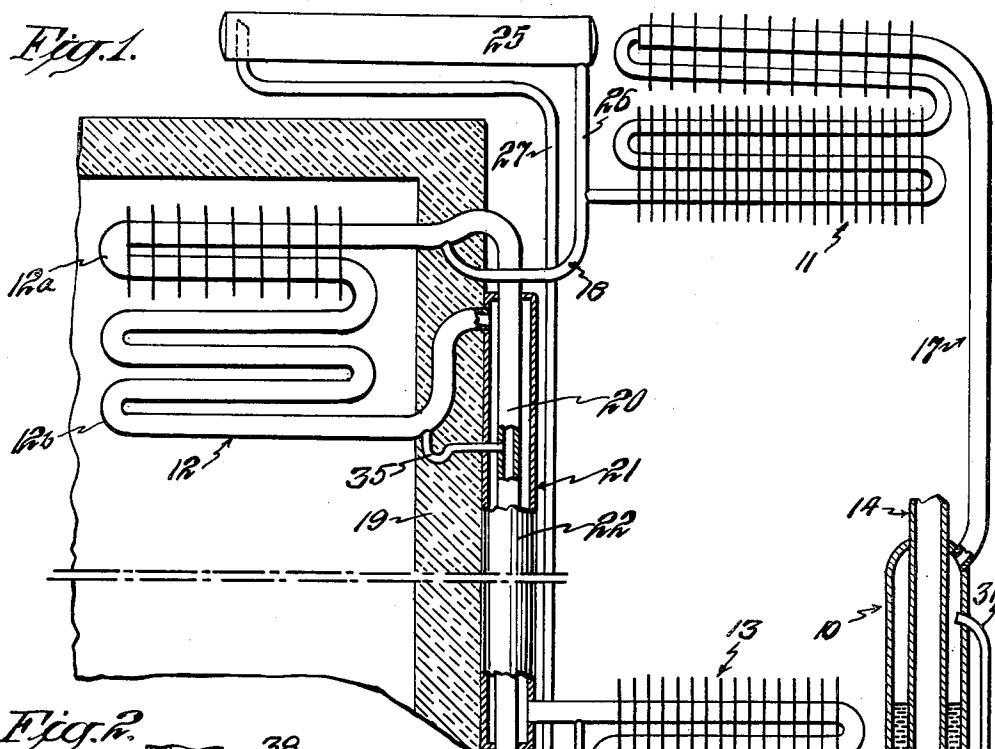
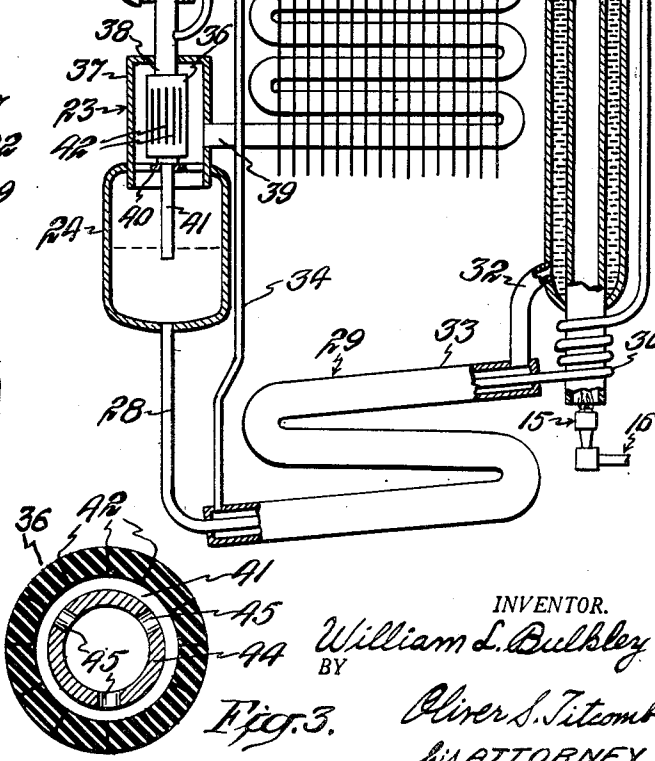
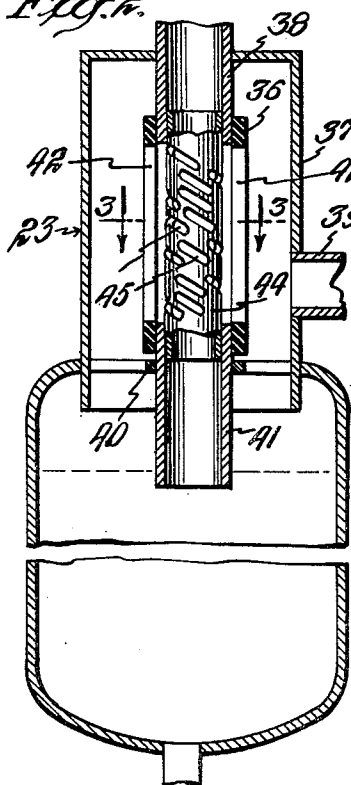


Fig. 2.



INVENTOR.

William L. Bulkley

BY

Fig. 3.

Oliver S. Titcomb
ATTORNEY

May 27, 1952

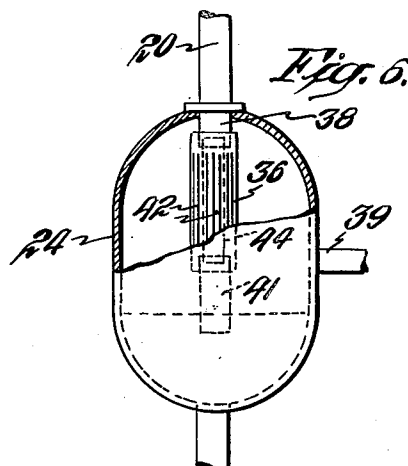
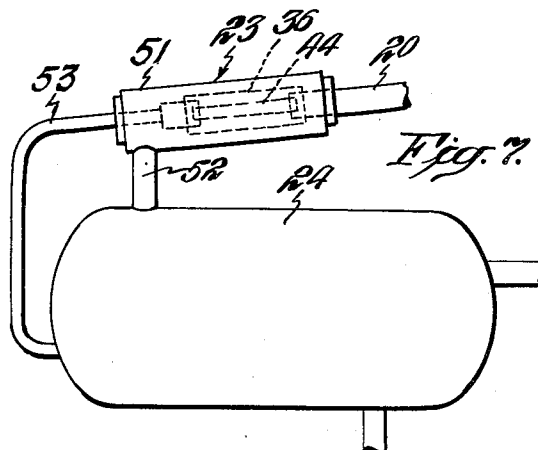
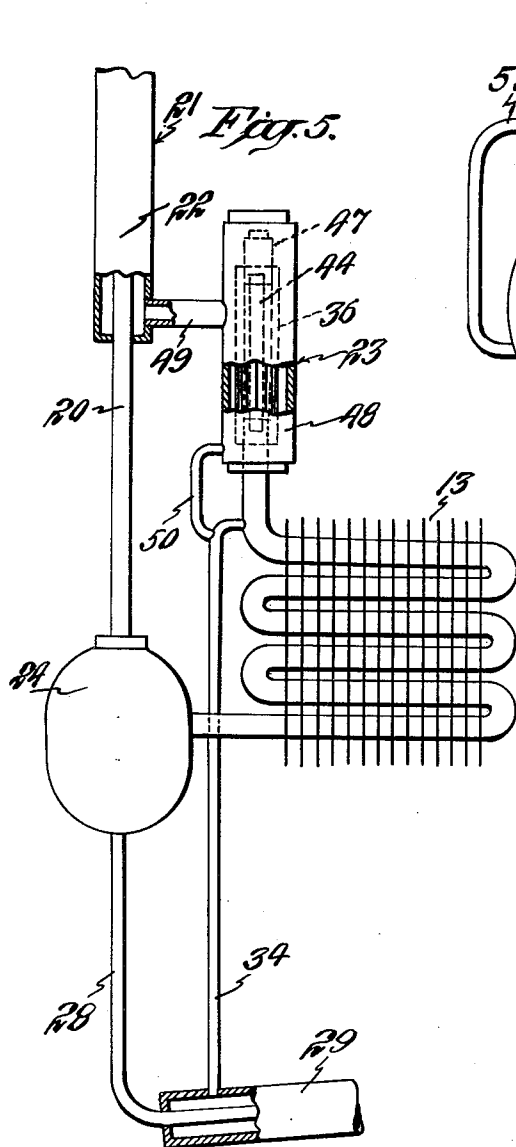
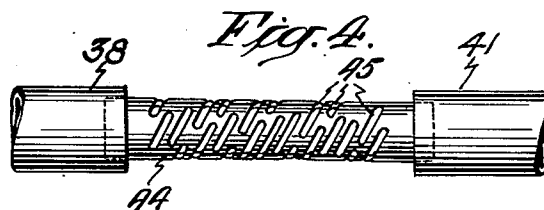
W. L. BULKLEY

2,598,035

ABSORPTION REFRIGERATION

Filed Aug. 2, 1948

3 Sheets-Sheet 2



INVENTOR.
William L. Bulkley
BY
Oliver S. Titcomb
his ATTORNEY

May 27, 1952

W. L. BULKLEY

2,598,035

ABSORPTION REFRIGERATION

Filed Aug. 2, 1948

3 Sheets-Sheet 3

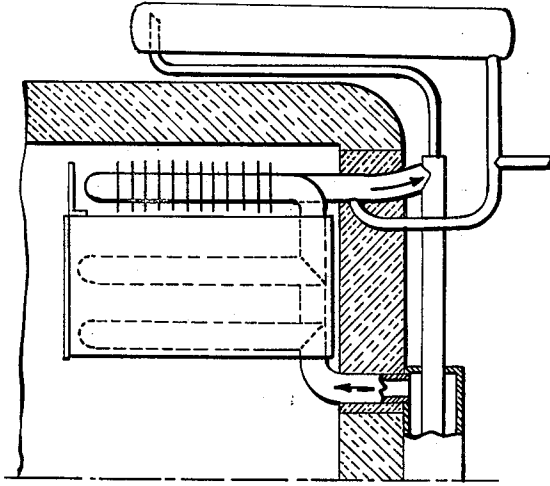


Fig. 8.

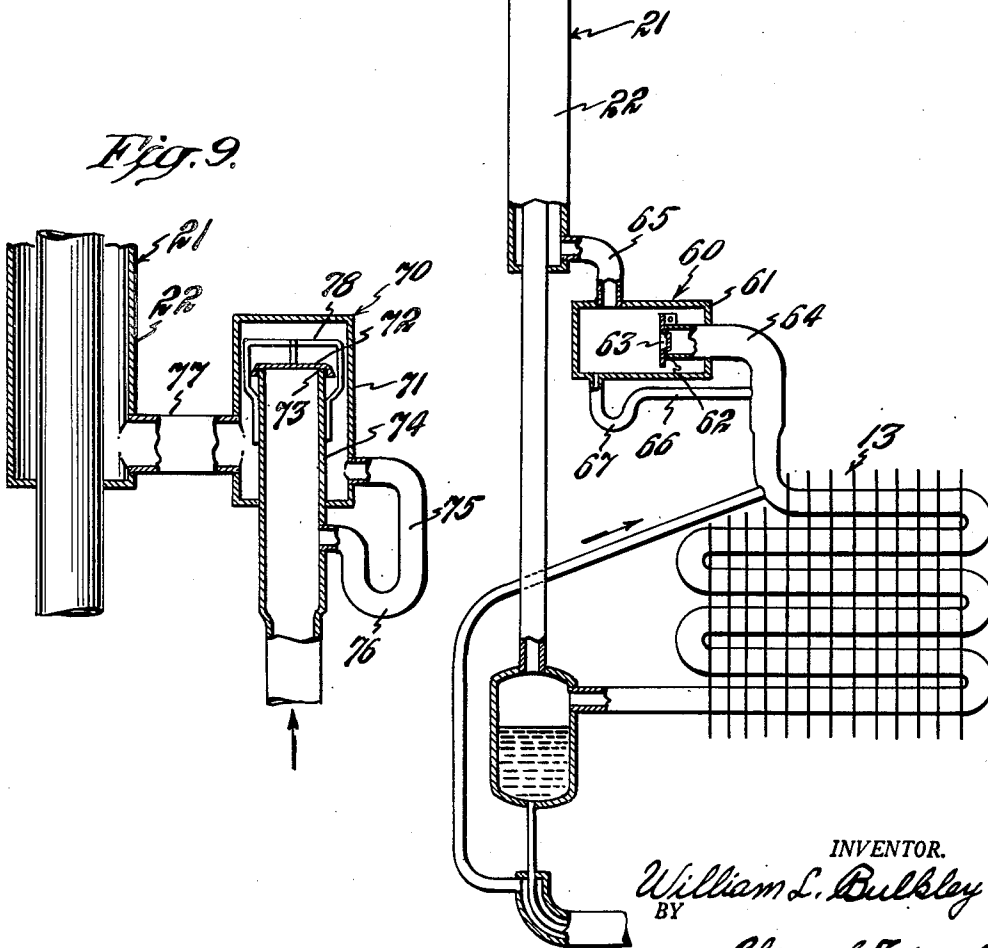


Fig. 9.

INVENTOR.
William L. Bulkley
BY

Oliver S. Titcomb
his ATTORNEY

UNITED STATES PATENT OFFICE

2,598,035

ABSORPTION REFRIGERATION

William L. Bulkley, Munster, Ind., assignor to
Servel, Inc., New York, N. Y., a corporation of
Delaware

Application August 2, 1948, Serial No. 42,014

17 Claims. (Cl. 62—119.5)

1

This invention relates to refrigeration and more particularly to absorption refrigeration systems of the three-fluid type utilizing a refrigerant, an absorbent and a pressure equalizing gas. The present application relates back to my co-pending applications Serial No. 546,635 filed July 26, 1944, now abandoned; Serial No. 737,032 filed March 25, 1947; and Serial No. 742,317 filed April 18, 1947, now abandoned, for common subject matter.

In such three-fluid or unipressure absorption refrigeration systems the refrigerant evaporates in the evaporator and diffuses into the pressure equalizing gas to produce refrigeration. The pressure equalizing gas with refrigerant vapor diffused therein falls by gravity, due to its increased density, to cause a circulation in the gas circuit. Because of the arrangement of the elements in certain particular systems it is possible for the gas to flow in either direction in the gas circuit depending upon the direction in which the circulation is first initiated.

One of the objects of the present invention is to provide an absorption refrigeration system of the type indicated with a check valve in the gas circuit to permit the flow of gas in one direction and prevent the flow of gas in the opposite direction.

Another object is to provide a check valve in the gas circuit of an absorption refrigeration system of the type indicated for limiting flow of gas to one direction only in said circuit while permitting flow of liquid from said circuit.

Another object is to provide check valves operable at the slight difference in pressure prevailing in the gas circuit of an absorption refrigeration system of the type indicated and adapted for installation in systems of usual construction without materially changing the arrangement of its parts.

These and other objects will become more apparent from the following description and drawings in which like reference characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and do not limit the scope of the invention, reference being had for this purpose to the appended claims. In the drawings:

Fig. 1 is a diagrammatic view of an absorption refrigeration system incorporating a check valve for controlling the flow of gas in the gas circuit while permitting the uncontrolled flow of liquid therefrom;

Fig. 2 is an enlarged sectional view of the

2

check valve illustrated in Fig. 1 and showing the flexible slitted tube adapted to open when expanded and close when contracted;

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 2 and showing the arrangement of the slits in the periphery of the flexible tube;

Fig. 4 is a detail view of the inner perforated tube connecting the inlet and drain pipes of the check valve;

Fig. 5 is a diagrammatic view of a portion of the gas circuit showing the check valve arranged in the return line between the absorber and gas heat exchanger;

Fig. 6 is an elevational view showing the check valve enclosed in the absorber pot which constitutes the outer casing thereof;

Fig. 7 is a side elevational view of the check valve arranged horizontally on the absorber pot;

Fig. 8 is a diagrammatic view showing a pivoted type check valve in the gas circuit; and

Fig. 9 is a sectional view of a floating type check valve and its arrangement in the gas circuit.

Referring to the drawings, the present invention is shown applied to an absorption refrigeration system of the three-fluid uniform pressure type as well known in the art. Such a system includes a generator 10, condenser 11, evaporator 12 and absorber 13, which are interconnected in a manner to be briefly described hereinafter. The system contains a solution of refrigerant in absorption liquid such as, for example, ammonia in water and also an auxiliary pressure equalizing gas such as hydrogen.

The generator 10 is in the form of an annular vessel having a central flue 14 and is heated by any suitable means such as a gas burner 15 connected to a gas supply conduit 16. A vapor conduit 17 connects the top of the generator 10 to the upper or inlet end of the condenser 11. The lower or outlet end of the condenser 11 is connected by a conduit 18 to the upper end of a pipe coil constituting the evaporator 12. Evaporator coil 12 is enclosed in an insulated refrigerator cabinet 19 and comprises a high temperature section 12a and a low temperature section 12b. The upper end of the evaporator coil 12 is also connected to the upper end of a descending conduit 20 constituting the inner passage of a gas heat exchanger 21 and the lower end of the evaporator coil is connected to the upper end of a sleeve 22 surrounding the descending conduit 20 and constituting the outer passage of the gas heat exchanger. A drain conduit 23 connects the bottom of the evaporator 12 to the

conduit 20 through which liquid refrigerant overflows from the evaporator and the drain conduit is provided with a depending loop to provide a liquid trap in the conduit.

The absorber 13 comprises a vertically arranged finned coil having its lower end connected to the lower end of descending conduit 20 through a check valve 23, later to be described in detail, and in open communication with an absorber pot 24. The upper end of the absorber coil 13 is connected to the lower end of sleeve 22 of the gas heat exchanger 21. A pressure vessel 25 is connected between the outlet end of the condenser 11 and the lower end of the descending conduit 20 by conduits 26 and 27, respectively. Thus, the gas circuit comprises and gas flows from the upper or outlet end of absorber 13, outer passage 22 of the gas heat exchanger 21, evaporator coil 12, descending conduit 20 of the gas heat exchanger, and check valve 23 to the lower inlet end of absorber 13.

The absorber pot 24 is connected to the generator 10 by means of a conduit 28 constituting the inner passage of a liquid heat exchanger 29, heating coil 30 surrounding the lower end of flue 14 of the generator 10 and vapor liquid-lift tube 31 connected to the side of the generator 10. The lower end of the generator vessel 10 is connected to the upper end of the absorber 13 by a conduit 32, jacket 33 constituting the outer passage of the liquid heat exchanger 29 and conduit 34. Thus, the liquid circuit comprises and absorbent liquid flows from generator 10 through conduit 32, outer passage 33 of the liquid heat exchanger 29, conduit 34, absorber 13, absorber pot 24, and conduit 28 including the inner passage of the liquid heat exchanger, heating coil 30 and lift tube 31 back to the generator.

In accordance with the present invention the flow of pressure equalizing gas is controlled to insure flow in the proper direction through the evaporator while permitting the uncontrolled flow of liquid from the gas circuit. As illustrated in the drawings the gas is permitted to flow in a direction counter-current to the direction of flow of refrigerant through the evaporator but the gas may be controlled to cause it to flow in any direction desired.

In the embodiment of the invention illustrated in Figs. 1 to 4 the flow of gas is controlled by the check valve 23 comprising a wall of an impervious flexible material having an aperture therein which opens and closes automatically. The flexible wall is illustrated in the form of a tube 36 enclosed in a casing 37, see Fig. 1. Casing 37 is mounted in a suitable opening in the top of the absorber pot 24 and is sealed therein as by welding the seam therebetween. The lower end of the conduit 20 extends into the upper end of casing 37 and constitutes an inlet 38 to the check valve 23. The lower end of absorber 13 is connected to a suitable opening in the side of the casing 37 which constitutes an outlet port 39 from the check valve 23. The bottom of casing 37 is in open communication with the absorber pot 24 and has an open frame or spider 40 attached to its sides adjacent the lower end thereof. A drain pipe 41 is supported adjacent its upper end by the spider 40 in alignment with the inlet 38 and has a short section projecting above the spider as illustrated most clearly in Fig. 2.

The flexible tube 36 of the check valve 23 extends between the inlet pipe 38 and drain pipe 41 with its ends surrounding the ends of the

pipes. Tube 36 is provided with one or a plurality of apertures formed as longitudinal slits 42 in its periphery. Preferably, the tube 36 is made of natural or synthetic rubber or a flexible plastic, or may be made of a fabric impregnated with rubber or a flexible plastic. Due to the number and arrangement of the slits 42 the flexible tube 36 is free to expand outwardly upon a slightly greater pressure inside than outside the tube which opens the slits and permits the flow of gas outwardly therefrom. However, a slightly greater outside pressure will contract the tube 36 and upon contraction the adjacent edges of the slits abut to form a comparatively rigid structure which closes the tube to prevent the flow of gases inwardly thereto. The pressure drop may vary considerably with the kind of tubing and the length and number of slits. By way of example, a rubber tube having an outside diameter of seven-eighths of an inch and a wall thickness of one-eighth of an inch with fourteen equally spaced slits one and seven-eighths of an inch long will produce a pressure drop of only forty-three hundredths of an inch of water while passing gas at a rate of 1500 liters per hour.

While non-essential to the operation of the check valve a rigid perforated tube 44 is preferably provided between the ends of the inlet pipe 38 and drain pipe 41 to limit the extent of contraction of the flexible tube 36. As illustrated in Fig. 4, the perforated tube 44 has an outside diameter substantially the same as the inside diameter of the inlet and drain pipes 38 and 41. The ends of perforated tube 44 extend into the ends of the pipes 38 and 41 and are fixedly attached thereto as by welding or the like. The perforations in the tube 44 are in the form of a series of spiral slots 45 to permit the flow of gas therethrough. Thus, the pipes 38 and 41 and tube 44 constitute a continuous conduit with a perforated portion intermediate its ends which may be constructed as a single conduit if desired. The lower end of the drain conduit 41 extends into the absorber pot 24 below the liquid level therein. One form of the invention having now been described in detail the mode of operation is explained as follows.

For purposes of description let it be assumed that the refrigeration system is about to be started initially or after an off cycle phase. To initiate a refrigeration cycle fuel is supplied to the gas burner 15 which heats the generator 10 and expels refrigerant vapor from absorption solution therein. The refrigerant vapor flows from the generator 10 through the conduit 17 to the condenser 11 where it is condensed to a liquid by the transfer of heat to the surrounding ambient. Liquid refrigerant flows from condenser 11 through the conduit 18 into the upper part of evaporator 12. As the liquid refrigerant flows by gravity through the evaporator 12 it evaporates in the presence of pressure equalizing gas. The initial direction of flow in the gas circuit is determined by a number of factors which in turn depend upon the particular operating conditions. It may be stated categorically, however, that the relatively heavy mixture of refrigerant vapor and inert gas normally flows from the evaporator 12 to the absorber 13 through the inner passage 20 of the heat exchanger 21 as well understood by those skilled in the art. After the flow has been initiated in the gas circuit the flow will continue from the upper part 12a of the evaporator into the inner passage of conduit 20 of the gas heat exchanger 21 and will

5

be displaced by inert gas flowing into the lower end of the evaporator section 12b from the outer passage 22 of the gas heat exchanger 21. Due to the slight difference in pressure between the mixture of refrigerant vapor and gas in conduit 20 and the inert gas in casing 37 of the check valve 23, the flexible tube 36 of the check valve will expand to open the slits 42 therein to permit the flow of the mixture outwardly to the casing. The mixture then flows into the lower end of absorber 13 and upwardly therethrough.

Simultaneously, absorption liquid weak in refrigerant flows from the generator 10 through the conduit 32, outer passage 33 of the liquid heat exchanger 29, and conduit 34 to the upper end of the absorber 13 and flows downwardly through the latter by gravity in a direction countercurrent to the direction of flow of refrigerant vapor and pressure equalizing gas therein. The absorption liquid weak in refrigerant absorbs the refrigerant vapor therein which liberates the pressure equalizing gas. The pressure equalizing gas being lighter than the refrigerant vapor tends to flow upwardly and enters the lower end of the outer passage 22 of the gas heat exchanger 21, flows upwardly therethrough and enters the lower end of the evaporator 12 to complete its cycle. The absorption solution enriched with refrigerant flows outwardly from the lower end of the absorber 13 into the casing 37 of the check valve 23 and flows through the spider 40 into the absorber pot 24. The enriched absorption solution in the absorber pot 24 flows through the conduit 28 comprising the inner passage of the liquid heat exchanger 29 and coil 30 surrounding the flue 14 at the base of the generator 10 which vaporizes part of the refrigerant therein to raise the absorption solution in the vapor lift conduit 31 into the generator 10.

From the above it will be apparent that the refrigerant flows through a circuit including the generator 10, condenser 11, evaporator 12 and absorber 13; the absorption solution flows through a liquid circuit including the generator 10, liquid heat exchanger 29, absorber 13 and absorber pot 24; and the pressure equalizing gas flows through the gas circuit including the evaporator 12, inner passage 20 of gas heat exchanger 21, check valve 23, absorber 13 and outer passage 22 of the gas heat exchanger.

Because of the delicate balance in gas columns in gas heat exchanger 21 is sometimes happens that circulation in the gas circuit will be initiated in the wrong direction. The exact reason for such reversal of flow is not fully understood but occasionally occurs in certain installations and may be due to the inert gas being carried along with the absorption solution when the latter is first introduced into the absorber 13 which starts a flow in the wrong direction. When such a condition exists gas flows downwardly through the outer passage 22 of the heat exchanger 21 to the absorber 13 and upwardly through the inner passage 20 to the evaporator 12.

If for any reason the mixture of refrigerant and inert gas should initially flow downwardly through the outer passage 22 of the gas heat exchanger 21 instead of in the passage 20, a greater pressure will exist in the casing 37 of the check valve than in the conduit 20. Such difference in pressure will contract the flexible tube 36 of the check valve 23 to close the slits 42 therein and prevent the flow upwardly through the inner conduit 20. Such closing of the check valve 23 will prevent the introduction of inert pressure.

6

equalizing gas into the evaporator 12 so that the liquid refrigerant will flow through the evaporator and drain conduit 35 into the inner passage 20 of the heat exchanger 21. The liquid refrigerant will then diffuse in the inert gas in the conduit 20 to increase its density until the pressure therein exceeds the pressure in the casing 37, at which time the flexible tube 36 will expand to open the slits 42. The mixture of refrigerant vapor and inert gas will then flow outwardly from the conduit 20 into the casing 37.

The flow downwardly through the conduit 20 of the heat exchanger 21 then will cause a flow from the outer passage 22 of the heat exchanger into the lower end of the evaporator 12 to displace the mixture flowing therefrom whereby to cause the flow to be initiated in the proper direction. It will now be apparent from the above description that the check valve 23 at all times insures flow of gas in the proper direction in the gas circuit.

While the check valve 23 controls the flow of gas in the gas circuit, it is so constructed and arranged as to permit uncontrolled flow of liquid from the gas circuit at both sides of the check valve. Liquid may enter the gas circuit when handling or tipping the unit during transportation or may condense in the gas circuit during operation of the unit. In either case liquid in the gas circuit would interfere with the proper operation of the system and also prevent the operation of the check valve 23 at the low difference in pressures in the gas circuit. With the construction of check valve illustrated in Figs. 1 to 4, liquids may freely flow from the conduit 20 and the interior of the flexible sleeve 36 of the check valve through the drain tube 41 into the absorber pot 24 and any liquid in the casing 37 at the exterior of the flexible sleeve drains through the open spider 40 into the absorber pot. The immersion of the lower end of the drain tube 41 in the liquid in the absorber pot 24 provides a liquid seal which prevents gas from by-passing the check valve.

In Fig. 5 an arrangement is illustrated in which the check valve 23 is connected between the upper end of absorber 13 and the outer passage 22 of the gas heat exchanger 21. The lower end of the conduit 20 of the gas heat exchanger 21 is connected to the top of the absorber pot 24 and the side of the absorber pot is connected to the lower or inlet end of absorber 13. Absorption solution weak in refrigerant is supplied to the upper end of the absorber 13 through the conduit 34 in the same manner as explained with respect to the construction illustrated in Fig. 1.

The upper end of absorber 13 constitutes the inlet to the check valve 23 to adapt the latter to its new location. The rigid perforated tube 44 has its lower end extending into the upper end of the pipe from absorber 13 and its opposite end is sealed by a cap 47. The flexible tube 36 surrounds the perforated tube 44 with its ends overlying the upper end of the absorber pipe and the cap 47. Flexible tube 36 has longitudinal slits 42 in its periphery as previously described and surrounding the flexible tube is a casing 48 mounted on the upper end of the absorber 13. An outlet conduit 49 connects casing 48 to the outer passage 22 of the gas heat exchanger 21 and a drain conduit 50 at the lower end of the casing is connected to the conduit 34 for draining any liquid from the casing.

The check valve 23 in the arrangement illustrated in Fig. 5 operates in substantially the same

way as previously explained to permit flow in the gas circuit in one direction and prevent flow in the opposite direction. The pressure equalizing gas liberated in the absorber 13 flows upwardly into the interior of the flexible tube 36 and expands the latter to open the slits 42 therein through which the gas flows outwardly into the casing 48. The gas then flows from the casing 48 through the conduit 49 to the gas heat exchange 21. However, if the pressure in the casing 48 is greater than the pressure at the interior of the flexible tube 36, the latter will contract to close the slits 42 and prevent the flow of gas inwardly thereto. The flow of liquid refrigerant into conduit 20 then will reverse the direction of flow as previously explained. Any liquid at the interior of the check valve 23 will flow by gravity into the upper end of the absorber 13 and any liquid in the casing 48 will flow by gravity through the drain conduit 50 which, together with the conduit 34, provides a liquid trap between the two sides of the check valve. Thus, the check valve operates to insure the flow of gas in the proper direction in the gas circuit while permitting liquid to flow from the circuit.

Fig. 6 illustrates an arrangement in which the absorber pot 24 constitutes the outer casing of the check valve. The inlet conduit 20 of the gas heat exchanger 21 extends downwardly into the top of the absorber pot 24 to provide an inlet 38. The rigid perforated tube 44 is connected between the end 38 of the conduit 20 and drain pipe 41 arranged in the manner illustrated in Fig. 2. The flexible slitted tube 36 surrounds the perforated tube 44 and the ends of the inlet pipe 38 and drain pipe 41. The side of the absorber pot 24 is connected to the lower end of the absorber 13 above the liquid level in the pot as in Fig. 1. The check valve illustrated in Fig. 6 operates in exactly the same way as the check valve illustrated in Fig. 1. The construction in Fig. 6, however, requires a comparatively larger absorber pot 24, while the construction illustrated in Fig. 1 permits the use of an absorber pot of ordinary size but requires the fabrication of the special casing 37 and its attachment thereto.

In Fig. 7 an arrangement is illustrated in which the check valve 23 is mounted in a substantially horizontal position on an absorber pot 24 in the form of a horizontal cylinder. The casing 51 of the check valve 23 is supported by a conduit 52 extending upwardly from the absorber pot 24 and the casing is inclined slightly from the horizontal to insure proper drainage therefrom. The inlet conduit 20 extends into one end of the casing 51 and a drain conduit 53 extends from the opposite end of the casing with its lower end connected to the absorber pot 24 below the liquid level therein. A perforated tube 44 is provided between the inlet and drain conduits 20 and 53 and a flexible slitted tube 36 surrounds the perforated tube and ends of the inlet and drain conduits in the same way as explained with respect to the check valve in Fig. 1. Although not shown in detail only the upper half of the tube 44 is perforated so that liquid will drain by gravity along the lower imperforated half of the tube and through conduit 53 into the absorber pot 24. Any liquid in the casing 51 of the check valve 23 will drain through the conduit 52 into the absorber pot. The construction illustrated in Fig. 7 operates in the same manner as previously described but because of its mounting in a generally horizontal position it may be used where there is

insufficient height for the vertical type check valve illustrated in the other views.

In Fig. 8 a check valve 60 of modified construction is shown and in the embodiment illustrated is located between the upper end of the absorber 13 and the outer passage 22 of the gas heat exchanger 21. The check valve 60 comprises a housing 61, a valve seat 62 in the housing and a movable valve element 63 adapted to engage the valve seat. The valve seat 62 is formed at the end of a pipe section 64 extending upwardly from the absorber 13 which projects horizontally into the housing 61. The valve element 63 is formed by a slightly cupped sheet metal disk pivotally mounted upon the horizontal end portion 64 of the absorber pipe adjacent the valve seat 62. The arrangement is such that when the refrigeration system is level the weight of the valve element 63 just closes the valve. In other words, the valve element 63 is pivoted in a manner so that the slight pressure of the inert gas flowing upwardly from the absorber 13 toward the heat exchanger 21 will hold the valve open whereas a slight pressure in the opposite direction immediately closes the valve.

As illustrated, the valve housing 61 is connected to the outer passage 22 of the gas heat exchanger 21 by means of a conduit 65. A liquid drain conduit 66 provided with a trap 67 is connected between the bottom of the valve housing 61 and the pipe section 64 from the absorber 13. The check valve 60 permits the flow of gas from the upper end of the absorber 13 to the evaporator 12 by swinging the pivoted valve element 63 away from the valve seat 62 and prevents the flow of gas in the opposite direction by engaging the valve element with the valve seat. Liquid drains from the gas circuit through conduits 64 and 66 at opposite sides of the movable valve element 63 and liquid in trap 67 prevents the gas from bypassing the check valve.

In Fig. 9 a check valve 70 of still further modified construction is illustrated. The check valve 70 illustrated in Fig. 9 comprises a valve housing 71 in which is located what may be termed a floating valve. This floating valve includes a movable valve element 72 adapted to engage a valve seat 73 formed at the upper end of a vertical conduit 74 connected to the upper end of the absorber 13. A conduit 75 connects the lower end of the housing 71 to the upright conduit 74 below the housing and is provided with a depending liquid trap 76 therein. A conduit 77 connects housing 71 with the outer passage 22 of the gas heat exchanger 21. As shown, a plurality of guide members 78 are provided at the upper or outlet end of conduit 74 for guiding and limiting upward movement of the floating valve element 72.

Valve element 72 is made of a light material such as aluminum alloy and is free to move upwardly and downwardly between the guides 78. The movable valve element 72 is preferably of inverted dish shape and merely rests upon the valve seat 73 so that a slight pressure exerted by the inert gas flowing upwardly from the absorber through the conduit 74 lifts the valve element so that the inert gas may flow from the upright conduit into the housing 71 and through the conduit 77 into the outer passage 22 of the gas heat exchanger 21 and from there into the lower end of the evaporator coil 12. A greater pressure of gas in housing 71 than in conduit 74 will hold the valve element 72 against the valve seat 73 at the upper end of conduit 74.

It will now be observed from the foregoing de-

scription that the present invention provides a check valve in the gas circuit of an absorption refrigeration system which controls the flow of gas therein while permitting the uncontrolled flow of liquid from the gas circuit. It will also be observed that the present invention provides several different forms of check valves adapted for operation by the slight difference in pressure occurring in a three-fluid type absorption refrigeration system.

While several forms of the invention are herein illustrated and described, it will be understood by those skilled in the art that further changes may be made in the construction and arrangement of elements without departing from the spirit or scope of the invention. For example, the check valve illustrated in any particular figure of the drawings may be used at any of the locations in the inert gas circuit illustrated in other figures of the drawings. Therefore, without limitation in this respect, the invention is defined by the following claims.

I claim:

1. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure-equalizing gas, a circuit for the pressure-equalizing gas having a construction for producing circulation therein by a differential force of gas strong in refrigerant, a gas weak in refrigerant in said circuit, and a check valve in the gas circuit so constructed and arranged as to be operated to open and closed positions by the flow of gas in said circuit to permit flow of gas in one direction and prevent flow of gas in the opposite direction, and depending passages at opposite sides of the check valve for draining liquid therefrom.

2. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, a liquid absorbent and a pressure-equalizing gas, a circuit for the pressure-equalizing gas having separate paths forming a column of gas strong in refrigerant and a column of gas weak in refrigerant, the gas circulating in said circuit by a differential force of said columns of gas strong in refrigerant and gas weak in refrigerant, a check valve in the gas circuit operated to open and closed positions by the flow of gas in said circuit to permit flow of gas in one direction and prevent the flow of gas in the opposite direction, a circuit for absorbent liquid, and means connecting the gas and liquid circuits to drain liquid from opposite sides of the check valve and providing a liquid seal to prevent the flow of gas therefrom.

3. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas, a check valve in the gas circuit having a movable element operated by the flow of gas in one direction to open the circuit and operated by the flow of gas in the opposite direction to close the circuit, and a construction and arrangement of parts in the gas circuit to provide passages below the movable element of the check valve for draining liquid therefrom.

4. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas including an evaporator and absorber arranged at different levels with conduits connected therebetween, said gas circulating in

said circuit by the differential force of gas strong in refrigerant and gas weak in refrigerant in said conduits, a circuit for absorption liquid interconnected with the gas circuit, a check valve in the gas circuit having a movable element closing the circuit and operated by the flow of gas in one direction to open the circuit for permitting the flow of gas in one direction and preventing the flow of gas in the opposite direction, and said connections between the gas and liquid circuits being so constructed and arranged as to provide passages below the movable valve element at each side thereof to drain liquid from the gas circuit.

5. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas, a circuit for absorption liquid interconnected with the gas circuit, a check valve in the gas circuit having a movable element for closing the circuit and operated to open position by the flow of gas in one direction in said circuit for permitting the flow of gas in one direction and preventing the flow of gas in the opposite direction, connections between the gas and liquid circuits for draining liquid from the gas circuit at opposite sides of the valve, and a liquid trap in at least one of the connections to prevent gas from by-passing the check valve.

6. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas, and a check valve in the gas circuit comprising a tube of an impervious and flexible material having longitudinal slits in its periphery, a conduit connected to one end of the flexible tube to supply gas to the interior thereof, means for sealing the opposite end of the tube while permitting liquid to drain therefrom, a casing surrounding the tube, said flexible tube expanding to open the slits to permit the gas to flow outwardly from the tube into the casing and contracting to close the slits to prevent the flow of gas from the casing to the interior of the tube, an outlet conduit connected to the casing, and means for draining liquid from the casing.

7. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas, and a check valve in the gas circuit comprising a tube having perforations intermediate its ends, a casing surrounding the tube, a tube of an impervious and flexible material surrounding the perforated tube and having longitudinal slits in its periphery, a conduit for supplying gas to the interior of the perforated tube, said flexible tube expanding to open the slits to permit the gas to flow outwardly from the conduit to the casing and contracting to close the slits to prevent the flow of gas from the casing to the conduit, and an outlet conduit connected to the casing.

8. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas including an evaporator and an absorber, a circuit for absorption liquid including the absorber and a generator, a conduit through which gas flows from the evaporator to the absorber, a check valve in said conduit and having a movable element operated by the flow

of gas toward the absorber to open the conduit and operated by the flow of gas in the opposite direction to close the conduit, and means connecting the gas and liquid circuits to provide passages at each side of the check valve below the movable element to drain liquid therefrom.

9. In an absorption refrigeration system of the type utilizing a refrigerant, an absorbent and a pressure equalizing gas, a generator, a condenser, an evaporator, an absorber, an absorber pot, conduits interconnecting the elements to provide circuits for the refrigerant and absorbent, a circuit for the pressure equalizing gas including the evaporator and absorber, a check valve in the gas circuit between the outlet from the evaporator and the inlet to the absorber comprising a casing mounted on the absorber pot, a tube of an impervious and flexible material in the casing and having slits in its periphery, a conduit connecting the evaporator and the interior of the flexible tube, a tube extending from the opposite end of the flexible tube into the absorber pot below the liquid level therein, a conduit connecting the casing to one end of the absorber, and a conduit connecting the opposite end of the absorber to the evaporator to complete the gas circuit, said tube of flexible material expanding to open the slits to permit the flow of gas outwardly to the casing and contracting to prevent the flow of gas from the casing to the interior of the flexible tube.

10. In an absorption refrigeration system having a plurality of interconnected elements and utilizing a refrigerant, an absorbent and a pressure equalizing gas, a circuit for the pressure equalizing gas including an evaporator and absorber, a circuit for absorption liquid including the absorber and a generator, said gas circuit including a conduit through which gas flows from the absorber to the evaporator, a check valve in said conduit and having a movable element operated by the flow of gas toward the evaporator to open the conduit and operated by flow in the opposite direction to close the conduit, and connections between the gas and liquid circuits to provide passages below the movable element of the check valve at opposite sides thereof to drain liquid therefrom.

11. In an absorption refrigeration system of the type utilizing a refrigerant, an absorbent and a pressure equalizing gas, a generator, a condenser, an evaporator, an absorber, a gas heat exchanger having inner and outer conduits with the inner conduit connecting the outlet from the evaporator to the inlet to the absorber, a check valve between the outlet from the absorber and the outer conduit of the heat exchanger, said check valve having a movable element operated to open position by the flow of gas in one direction and operated to closed position by the flow of gas in the opposite direction, a conduit connecting the outer conduit of the heat exchanger to the inlet of the evaporator, and drain connections at opposite sides of the check valve below

the movable element for draining liquid from the check valve.

12. An absorption refrigeration system of the uniform pressure type including a generator, a condenser, an evaporator, an absorber, structure interconnecting said elements providing circuits for flow of a refrigerating medium, an absorption liquid and an inert pressure-equalizing gas, and a flow control in the inert gas circuit, said flow control including a housing, a first conduit having an outlet end thereof opening into said housing and connected at the opposite end thereof to said inert gas circuit, a check valve in said housing having a movable valve head adapted to seat upon the outlet end of said first conduit, said check valve being arranged to be opened by inert gas flowing in one direction only through said inert gas circuit and to be closed by gravity, and a second conduit connected between the flow control housing and the first conduit for flow of liquid from the former to the latter in a direction opposite to the flow of inert gas through said inert gas circuit, said second conduit having a liquid trap therein.

13. An absorption refrigerating system as set forth in claim 12 wherein the head of said check valve comprises a cupped sheet metal disk that seats upon the outlet end of said first conduit.

14. An absorption refrigerating system as set forth in claim 12 wherein the head of said check valve is mounted for pivotal movement upon the outlet end of said first conduit.

15. An absorption refrigerating system as set forth in claim 12 wherein the outlet end of said first conduit projects horizontally into said housing, and the head of said check valve is pivotally mounted upon the top of said first conduit at the outlet end thereof.

16. An absorption refrigerating system as set forth in claim 12 wherein a plurality of guides is formed upon the outlet end of said first conduit for guiding and limiting movement of the head of said check valve.

17. An absorption refrigerating system as set forth in claim 12 wherein the outlet end of said first conduit projects vertically into said housing, and the head of said check valve rests freely upon the outlet end of said first conduit.

WILLIAM L. BULKLEY.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
55,531	Peabody	June 12, 1866
1,212,611	Davis	Jan. 16, 1917
1,442,933	Firpo	Jan. 23, 1923
1,728,643	Von Platen et al.	Sept. 17, 1929
1,854,565	Smith	Apr. 19, 1932
2,229,687	Thomas	Jan. 28, 1941
2,268,381	Brace	Dec. 30, 1941