

Jan. 18, 1949.

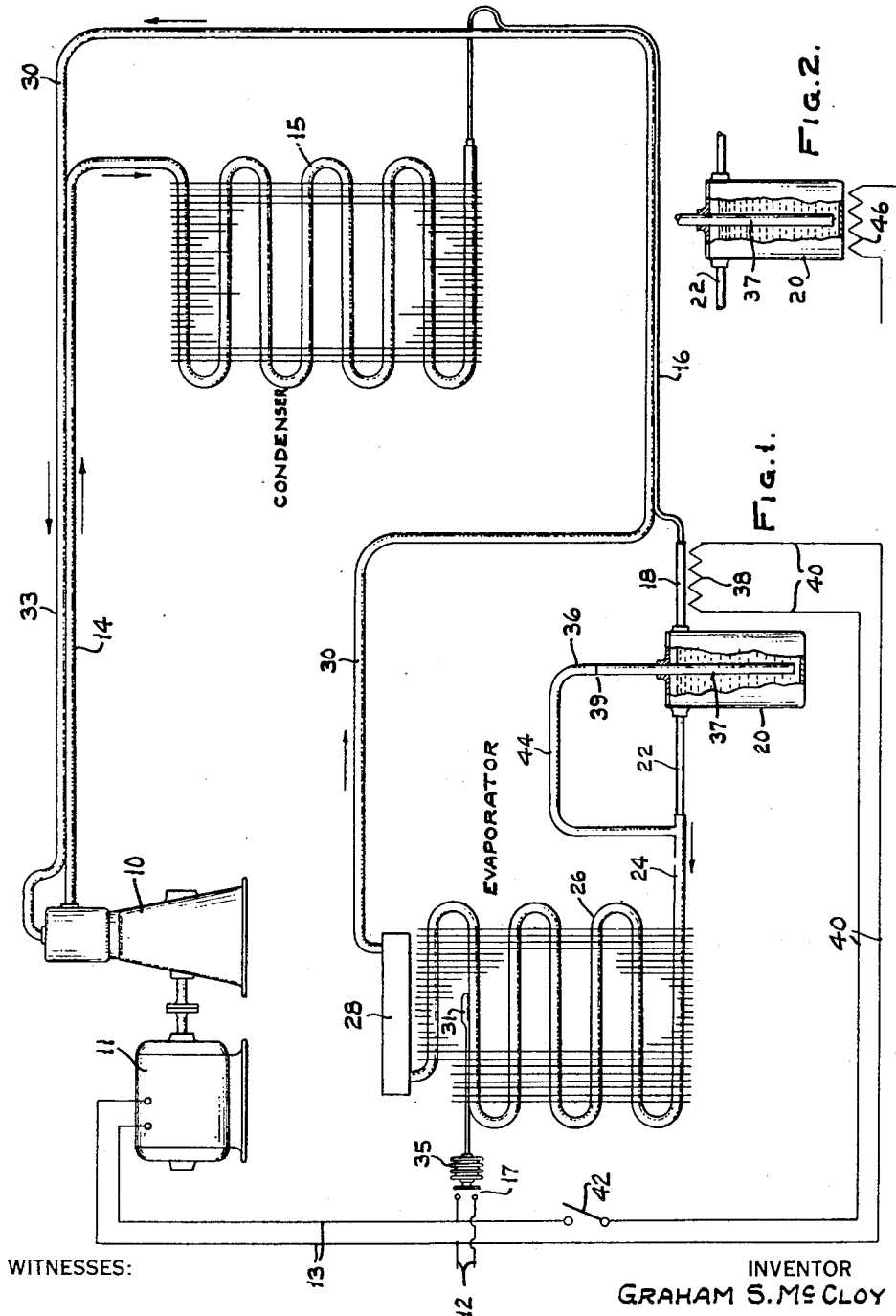
G. S. McCLOY

2,459,173

DEFROSTING MEANS FOR REFRIGERATION APPARATUS

Filed Feb. 5, 1946

2 Sheets-Sheet 1



E. H. Lutz
m/c m. clokey

Jan. 18, 1949.

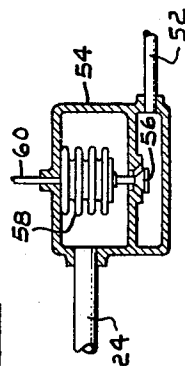
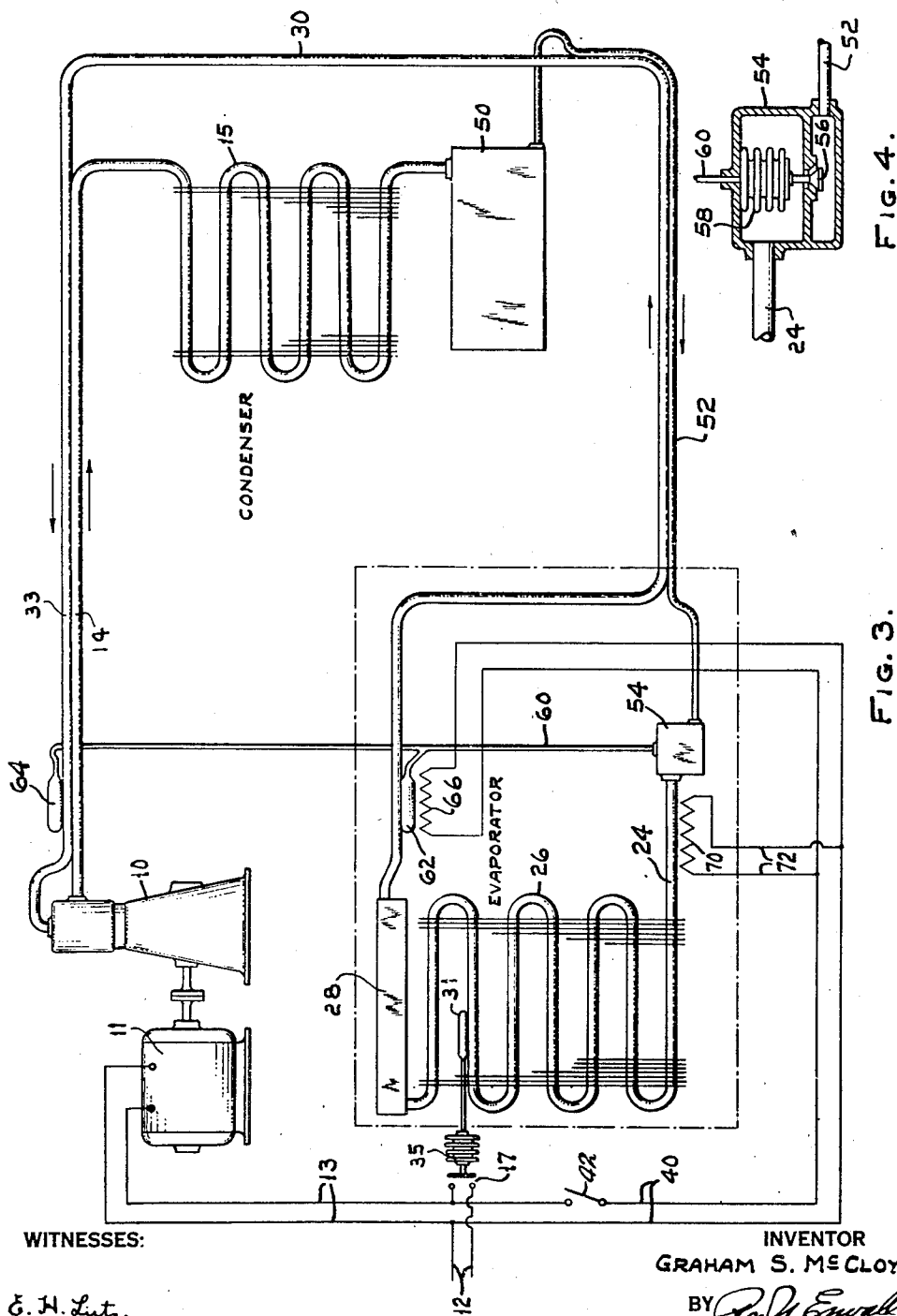
G. S. McCLOY

2,459,173

DEFROSTING MEANS FOR REFRIGERATION APPARATUS

Filed Feb. 5, 1946

2 Sheets-Sheet 2



WITNESSES:

E. H. Luty.
M. E. M. Clackey

INVENTOR
GRAHAM S. McCLOY

BY *J. H. Enwall.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,459,173

DEFROSTING MEANS FOR REFRIGERATION APPARATUS

Graham S. McCloy, Springfield, Mass., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 5, 1946, Serial No. 645,612

12 Claims. (Cl. 62—3)

1

This invention relates to refrigerating apparatus and more especially to a means for rapidly defrosting such apparatus.

It is an object of this invention to provide a novel refrigerating circuit adapted to defrost the evaporator when desired.

It is a further object of the invention to provide novel means for increasing the active quantity of refrigerant flowing in a refrigerating apparatus.

These and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a schematic drawing of refrigerating apparatus and of the defrosting apparatus of this invention;

Fig. 2 is a schematic drawing of a modification of the defrosting apparatus of Fig. 1;

Fig. 3 is a schematic drawing of refrigerating apparatus and of a modification of the defrosting apparatus of this invention; and

Fig. 4 is a schematic drawing of the thermostatic expansion valve of Fig. 3.

Referring now to the drawings for a detailed explanation, the reference numeral 10 designates a compressor driven by an electric motor 11 which receives electrical energy through leads 12 and 13 and is controlled by a switch 17 actuated thermostatically. The refrigerant vapor of the apparatus, when compressed by the compressor 10, flows through the pressure conduit 14 to the condenser 15 wherein it is liquefied and then passes through a capillary tube 16 and through a slightly larger tube 18 into a vessel 20. The refrigerant liquid thereupon flows through a conduit 22 of small diameter and through a second conduit 24 into an evaporator 26 wherein the refrigerant liquid vaporizes and absorbs heat. The vaporized refrigerant thereupon flows to a header 28 and then through a suction tube 30 to the compressor 10. The latter portion 33 of the suction tube 30 is in heat transfer relationship with the pressure conduit 14, and an intermediate portion of the suction tube 30 is in heat transfer relationship with the capillary tube 16.

The switch 17 is actuated by a metal bellows 35 responsive to the vapor pressure of a volatile fluid in a bulb 31 located on the evaporator 26. The switch 17 and its actuating mechanism starts and stops the compressor periodically to maintain the temperature of the evaporator 26 substantially constant during normal operation.

An electric heater 38 is arranged to heat the

2

tube 18. The heater 38 may be energized through leads 40 from the leads 12 and is controlled by an electric switch 42 located in one of the leads 40. The switch 42 is open during normal operation of the apparatus and is closed only when the evaporator 26 is to be defrosted. The vessel 20 is preferably enclosed in heat insulating material so that substantially no evaporation of the refrigerant liquid therein takes place.

An inverted U tube 36 connects through one leg 37 with the lower portion of the vessel 20 and through the other leg with the conduit 24. The inverted U tube 36 comprises a portion 44 which is elevated above the small conduit 22, and the height of this elevation is so proportioned with respect to the resistance of the small conduit 22 to the flow of refrigerant therethrough during normal operation of the apparatus, that the refrigerant will flow through the small conduit 22 in preference to the elevated portion 44 of the U tube 36. During such operation, the refrigerant liquid will rise in the leg 37 of the U tube 36 to such a height 39 that its static head counterbalances the pressure drop in the refrigerant across the small conduit 22. Fig. 1 shows the apparatus in its normal operating position.

To effect defrosting of the evaporator 26, the switch 42 is closed to energize the heater 38 simultaneously with the motor 11. The heat supplied by the heater 38 vaporizes such a quantity of the refrigerant liquid flowing through the tube 18, that the small conduit 22 is incapable of passing the refrigerant at a pressure drop across the conduit 22 which is less than the static head of the liquid refrigerant adapted to be contained in the leg 37 of the inverted U tube 36. As a result, the refrigerant will flow out of the vessel 20 through the U tube 36, and since this tube connects with the bottom of the vessel 20, the liquid refrigerant therein will be forced out. The liquid refrigerant thus forced out of vessel 20 fills the header 28 and flows into the portion 33 of the conduit 30.

The hot refrigerant vapor in conduit 14 vaporizes the refrigerant liquid in the portion 33 of the conduit 30 and thereby raises the suction pressure in the conduit 30 and in the evaporator 26 so that the temperature of the liquid refrigerant in the evaporator 26 rises above the freezing point of water. Switch 17 will remain closed because of the increased temperature of the evaporator, and the compressor 10 will continue to circulate relatively warm liquid refrigerant through the evaporator 26 to defrost it. The heater 38 aids in raising the temperature of the refriger-

3

ant liquid flowing through the evaporator, but its heat is not essential in defrosting the evaporator 26.

The elements comprising the vessel 20, the U tube 36, the conduit 22, and the heater 38 form an apparatus for adding liquid refrigerant to the quantity normally circulating in the refrigerating circuit. Since this liquid refrigerant adding apparatus contains no moving parts, it will be relatively free from mechanical failures. This apparatus, however, may be replaced by any other apparatus for adding liquid refrigerant to the circulating system, such, for example, as shown in Patents Nos. 2,133,948 and 2,133,961 to Buchanan.

A modification of the apparatus is shown in Fig. 2. In this modification, a heater 46, similar to heater 38, is directly applied to the vessel 20 to heat the same and form refrigerant vapor therein. The vapor thus formed in the vessel 20 acts in the same manner as the vapor introduced into it through tube 18 by means of the heater 38 of Fig. 1.

In the embodiment of the invention shown in Figs. 3 and 4, the elements which are identical with the elements shown in Fig. 1 are provided with the same reference numerals. In this embodiment, the reference numeral 50 designates a liquid receiver which receives refrigerant liquid from the condenser 15 and stores a portion of it during the normal operation of the apparatus. The liquid refrigerant flows from the liquid receiver through a liquid line 52 to a thermostatic expansion valve 54, which is of well-known design, being such, for example, as the thermostatic expansion valve shown in Patent No. 1,971,695 to Ploeger. The thermostatic expansion valve 54 connects with the conduit 24.

The essential working elements of the thermostatic expansion valve 54 are shown schematically in Fig. 4 and comprise a valve 56 which controls the flow of liquid refrigerant to the evaporator 26. The valve 56 is actuated by a metal bellows 58 which connects through a tube 60 with a temperature-responsive bulb 62 and which may connect with a second bulb 64 of the same character. The bulb 62 is in heat exchange relationship with the refrigerant issuing from the evaporator 26 and the bulb 64 with the refrigerant entering the compressor 10. The bellows 58, tube 60, and the bulbs 62 and 64 contain a volatile refrigerant which is mainly in the vapor phase, so that the pressure in the bellows corresponds to the temperature of the colder of the two bulbs 62 and 64. An electric heater 66 is located adjacent the bulb 62 and is energized from leads 12 through leads 40 and is controlled by an electric switch 42.

During normal operation of the apparatus, switch 42 is open and the heater 66 consequently is not energized. The bulb 62 will be the coldest part of the control system of the bellows 58 and will actuate the bellows 58 in cooperation with the suction pressure of the evaporator 26 to maintain a substantially constant superheat in the refrigerant vapor issuing from the evaporator 26, as is well understood in the art.

When it is desired to defrost the evaporator 26, switch 42 is closed and the heater 66 is energized simultaneously with the motor 11. The heater 66 warms the control bulb 62 and causes the volatile liquid therein to vaporize so that the valve 56 is opened wide by the bellows 58. When the control valve 56 is opened wide, the refrigerant liquid stored in the liquid receiver 50 will be forced into the evaporator and into the suc-

4

tion tube 30 by the compressor 10, and relatively warm refrigerant liquid will be circulated through the evaporator 26 to defrost the same in the same manner as described in the modification of the invention shown in Fig. 1.

If it is desired to secure a more rapid defrosting of the evaporator 26, a second heater 70 may be placed in heat exchange relationship with the conduit 24 or with any portion of the evaporator 26. The heater 70 may be energized through leads 72 and leads 40, and will then be energized simultaneously with the heater 66.

The function of the bulb 64 is to prevent liquid refrigerant from entering the compressor 10. When the control bulb 62 is warmed to a higher temperature than the bulb 64, the volatile liquid will migrate to bulb 64 so that the temperature of the latter controls the pressure in the metal bellows 58. If liquid refrigerant reaches a point in the conduit 30 adjacent the bulb 64, the partial vaporization of this liquid will cool the bulb 64 and the volatile liquid therein. This decreases the pressure within the bellows 58 and results in a partial closing of the valve 56. When the valve 56 is thus partially closed, less of the liquid refrigerant will enter the suction conduit 30. This liquid will be completely vaporized so that none of it will enter the compressor in the liquid state. The use of the bulb 64 is thus merely a protection for the compressor and its use is not essential.

It will be apparent from the above description that this invention provides several means of defrosting an evaporator, each of which adds liquid refrigerant to the active quantity of refrigerant liquid circulating in a refrigerating apparatus in which the suction tube and the pressure conduit near the compressor are in heat transfer relationship. It will be further apparent that a means has been provided for increasing the active quantity of refrigerant flowing in a refrigerating apparatus, which means is devoid of moving parts.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed is:

1. In refrigerating apparatus, the combination of a compressor, a condenser, a vessel adapted for accumulating and holding refrigerant liquid in an inactive state during the normal operation of said apparatus, an evaporator, a first conduit connecting said compressor with said condenser, a second conduit connecting said condenser with said vessel, a third conduit connecting said vessel with said evaporator, a fourth conduit connecting said evaporator with said compressor, at least a portion of said fourth conduit being in heat exchange relationship with the refrigerant vapor compressed by said compressor, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, and actuating means for producing abnormal operation of said apparatus to defrost said evaporator, said means being adapted to discharge the refrigerant liquid from said vessel through said third conduit, said vessel, when being discharged supplying sufficient refrigerant liquid to flood both said evaporator and said portion of the fourth conduit.

2. In refrigerating apparatus, the combination of a compressor, a condenser, a vessel adapted for accumulating and holding refrigerant liquid

5

in an inactive state during the normal operation of said apparatus, an evaporator, a first conduit connecting said compressor with said condenser, a second conduit connecting said condenser with said vessel, a third conduit connecting said vessel with said evaporator, a fourth conduit connecting said evaporator with said compressor, portions of said first and fourth conduits being in heat exchange relationship, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, and actuating means for producing abnormal operation of said apparatus, said means being adapted to discharge the refrigerant liquid from said vessel through said third conduit, said vessel when being discharged supplying sufficient refrigerant liquid to flood both said evaporator and said portion of the fourth conduit.

3. In refrigerating apparatus, the combination of a compressor, a condenser, a vessel adapted for accumulating and holding refrigerant liquid in an inactive state during the normal operation of said apparatus, an evaporator, a first conduit connecting said compressor with said condenser, a second conduit connecting said condenser with said vessel, a third conduit connecting said vessel with said evaporator, a fourth conduit connecting said evaporator with said compressor, portions of said first and fourth conduits being in heat exchange relationship, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, and actuating means for producing abnormal operation of said apparatus, said means being adapted to heat and discharge the refrigerant liquid from said vessel through said third conduit, said vessel when being discharged supplying sufficient refrigerant liquid to flood both said evaporator and said portion of the fourth conduit.

4. In a mechanical refrigerating circuit comprising an evaporator, a compressor, a condenser, and a flow-impeding device, the combination with said circuit of a vessel connected between said flow-impeding device and said evaporator to trap refrigerant liquid in said vessel, the connection between said vessel and said evaporator comprising a first outlet conduit connected at one end with a lower portion of said vessel and extending above the liquid in said vessel, said first conduit communicating at its other end with said evaporator, and a second outlet conduit connected at one of its ends with an upper portion of said vessel and communicating at its other end with said evaporator, said second conduit being of such constriction that when the ratio of refrigerant vapor to refrigerant liquid in said vessel is below a predetermined value, no refrigerant liquid flows through said first conduit and when said ratio is above said value, the liquid trapped in said vessel will be discharged through said first conduit.

5. In a mechanical refrigerating circuit comprising an evaporator, a compressor, a condenser, and a flow-impeding device, the combination with said circuit of a vessel connected between said flow-impeding device and said evaporator to trap refrigerant liquid in said vessel, the connection between said vessel and said evaporator comprising a first outlet conduit connected at one end with a lower portion of said vessel and extending upwardly and communicating at its other end with said evaporator, and a second outlet conduit connected at one of its ends with an upper

6

portion of said vessel and communicating at its other end with said evaporator, said second conduit having a constricted passage to so impede the refrigerant flowing therethrough, that during normal operation of said circuit, the refrigerant liquid rises in, but does not flow through said first conduit, and actuating means for so increasing the refrigerant vapor in said vessel when said compressor is operating that refrigerant liquid flows through said first conduit.

6. In a mechanical refrigerating circuit comprising an evaporator, a compressor, a condenser, and a flow-impeding device, the combination with said circuit of a vessel connected between said flow-impeding device and said evaporator to trap refrigerant liquid in said vessel, the connection between said vessel and said evaporator comprising a first outlet conduit connected at one end with a lower portion of said vessel and communicating at its other end with said evaporator, said first conduit having an elevated portion to form a siphon in said conduit, and a second outlet conduit connected at one of its ends with an upper portion of said vessel and communicating at its other end with said evaporator, said second conduit having a constricted passage to so impede the refrigerant flowing therethrough, that during normal operation of said circuit, the refrigerant liquid rises in, but does not flow through said first conduit, and actuating means for so increasing the refrigerant vapor in said vessel when said compressor is operating that refrigerant liquid flows through said elevated portion of said first conduit to actuate said siphon.

7. In a mechanical refrigerating circuit comprising an evaporator, a compressor, a condenser, and a flow-impeding device, the combination with said circuit of a vessel connected between said flow-impeding device and said evaporator to trap refrigerant liquid in said vessel, the connection between said vessel and said evaporator comprising a first outlet conduit connected at one end with a lower portion of said vessel and communicating at its other end with said evaporator, said first conduit having an elevated portion to form a siphon in said conduit, and a second outlet conduit connected at one of its ends with an upper portion of said vessel and communicating at its other end with said evaporator, said second conduit having a constricted passage to so impede the refrigerant flowing therethrough, that during normal operation of said circuit the refrigerant liquid rises in, but does not flow through said first conduit, and means for heating the refrigerant liquid after its passage through said flow impeding device and prior to its passage through said constricted passage to increase the refrigerant vapor in said constricted passage when said compressor is operating so that refrigerant liquid flows through said elevated portion of said first conduit to actuate said siphon.

8. A refrigerating system comprising a plurality of refrigerant passages connected in a circuit, pumping means in said circuit for circulating a volatile refrigerant therethrough at a substantially constant rate, and means for varying the effective quantity of refrigerant liquid circulating in said circuit, said means comprising a vessel connected in said circuit through an inlet and an outlet, said vessel having a portion located below said outlet to trap refrigerant liquid in said portion and hold said liquid in an inactive state, a restriction in said circuit between said outlet and said pumping means, a tube connected at one end with said trapping portion of

said vessel and at its other end with said circuit at a point between said restriction and said pumping means, said tube having a portion elevated above the outlet of said vessel, said restriction and the elevation of said portion of the tube being so arranged that the normal proportion of refrigerant vapor and liquid flowing through said restriction is insufficient to cause refrigerant liquid to flow through said tube, and actuating means adapted to so increase the ratio of refrigerant vapor to refrigerant liquid flowing through said restriction that the resistance of said restriction to said flow causes refrigerant liquid to flow from said vessel portion through said tube, said actuating means being adapted to be rendered active and inactive.

9. A refrigerating system comprising a plurality of refrigerant passages connected in a circuit, pumping means in said circuit for circulating a volatile refrigerant therethrough at a substantially constant rate, a flow impeding device in said circuit, said flow impeding device and pumping means dividing said circuit into a low pressure and a high pressure side and means for varying the effective quantity of refrigerant liquid circulating in said circuit, said means comprising a vessel connected in the low pressure side of said circuit through an inlet and an outlet, said vessel having a portion located below said outlet to trap refrigerant liquid in said portion and hold said liquid in an inactive state, a restriction in said circuit between said outlet and said pumping means, a tube connected at one end with said trapping portion of said vessel and at its other end with said low pressure side of said circuit at a point beyond said restriction, said tube having a portion elevated above the outlet of said vessel, said restriction and the elevation of said portion of the tube being so arranged that the normal proportion of refrigerant vapor and liquid flowing through said restriction is insufficient to cause refrigerant liquid to flow through said tube, and actuating means adapted to so increase the ratio of refrigerant vapor to refrigerant liquid flowing through said restriction that the resistance of said restriction to said flow causes refrigerant liquid to flow from said vessel portion through said tube, said actuating means being adapted to be rendered active and inactive.

10. In refrigerating apparatus, the combination of a compressor, a condenser for receiving compressed refrigerant vapor from said compressor, a liquid receiver communicating with said condenser, an expansion valve communicating with said liquid receiver, an evaporator communicating with said expansion valve, a conduit connecting said evaporator with said compressor, said conduit being in heat exchange relationship with the compressed vapor issuing from said compressor, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, said liquid receiver storing such a quantity of refrigerant liquid during normal operation of the apparatus that when said valve is opened wide both said evaporator and said conduit are supplied with refrigerant liquid, and actuating means for producing abnormal operation of said apparatus, said means being adapted for opening said expansion valve wide to admit refrigerant liquid to said evaporator and conduit, said refrigerant liquid being vaporized in said conduit by the heat of the refrigerant vapor issuing from the compressor,

whereby the refrigerating action of said evaporator is reduced so that frost which may have formed thereon is permitted to melt.

11. In refrigerating apparatus, the combination of a compressor, a condenser, a liquid receiver communicating with said condenser, a thermostatic expansion valve communicating with said liquid receiver, an evaporator communicating with said expansion valve, a first conduit connecting said compressor with said condenser, a second conduit connecting said evaporator with said compressor, said first and second conduits being in heat exchange relationship, said expansion valve having a temperature-responsive bulb adapted to open said valve at a predetermined temperature above that of the evaporator, said bulb lying in heat exchange relationship with the refrigerant vapor flowing from said evaporator and with a heating element, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, said liquid receiver storing such a quantity of refrigerant liquid during normal operation of the apparatus that when said valve is opened wide both the evaporator and said second conduit are supplied with refrigerant liquid, and actuating means for producing abnormal operation of said apparatus, said means being adapted for energizing said heating element to open said expansion valve wide to admit refrigerant liquid to said evaporator and second conduit, said refrigerant liquid vaporizing in said second conduit to cool the refrigerant vapor in said first conduit, whereby the refrigerating action of said evaporator is reduced so that frost which may have accumulated thereon is permitted to melt.

12. In refrigerating apparatus, the combination of a compressor, a condenser, a liquid receiver communicating with said condenser, a thermostatic expansion valve, an evaporator, a first conduit connecting said compressor with said condenser, a second conduit connecting said liquid receiver with said expansion valve, a third conduit connecting said expansion valve with said evaporator, a fourth conduit connecting said evaporator with said compressor, said first and fourth conduits being in heat exchange relationship, said expansion valve having two temperature-responsive bulbs adapted to open said valve at a predetermined temperature above that of the evaporator, the first of said bulbs being in heat exchange relationship with the refrigerant vapor flowing from said evaporator and with a heating element, the second of said bulbs being in heat exchange relationship with the refrigerant entering said compressor, said apparatus being arranged to produce refrigeration by means of said evaporator and heat dissipation by means of said condenser during normal operation, said liquid receiver storing such a quantity of refrigerant liquid during normal operation of the apparatus that when said valve is opened wide both the evaporator and said fourth conduit are supplied with refrigerant liquid, and means for producing abnormal operation of said apparatus, said means being adapted for energizing said heating element to open said expansion valve wide to admit refrigerant liquid to said evaporator and fourth conduit, said refrigerant liquid vaporizing therein to cool the refrigerant vapor in said first conduit, whereby the refrigerating action of said evaporator is reduced so that frost which may have accumulated thereon is permitted to melt, the quantity of refrigerant liquid in said two tem-

2,459,173

9

perature-responsive bulbs being limited so that either of said two bulbs can contain said entire quantity, whereby the colder of said two bulbs controls said thermostatic expansion valve, said heating element, when energized and with the compressor operating, heating said first bulb to a temperature higher than that of said second bulb.

GRAHAM S. McCLOY.

10

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,133,961	Buchanan	Oct. 25, 1930
2,385,667	Webber	Sept. 25, 1945