May 1, 1956 E. F. HUBACKER 2,743,587

CONTROL FOR REFRIGERATING APPARATUS

Filed Nov. 12, 1954 3 Sheets-Sheet 1

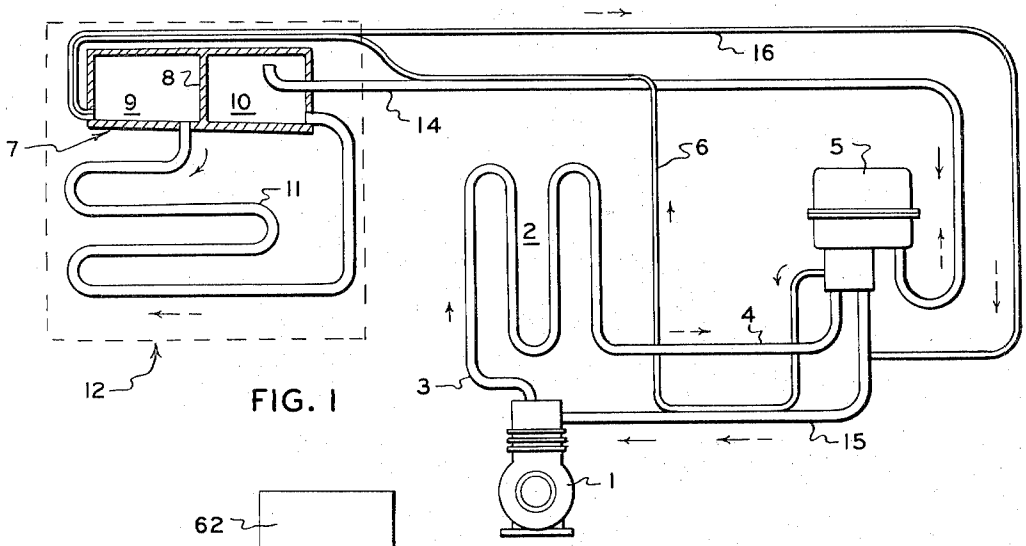
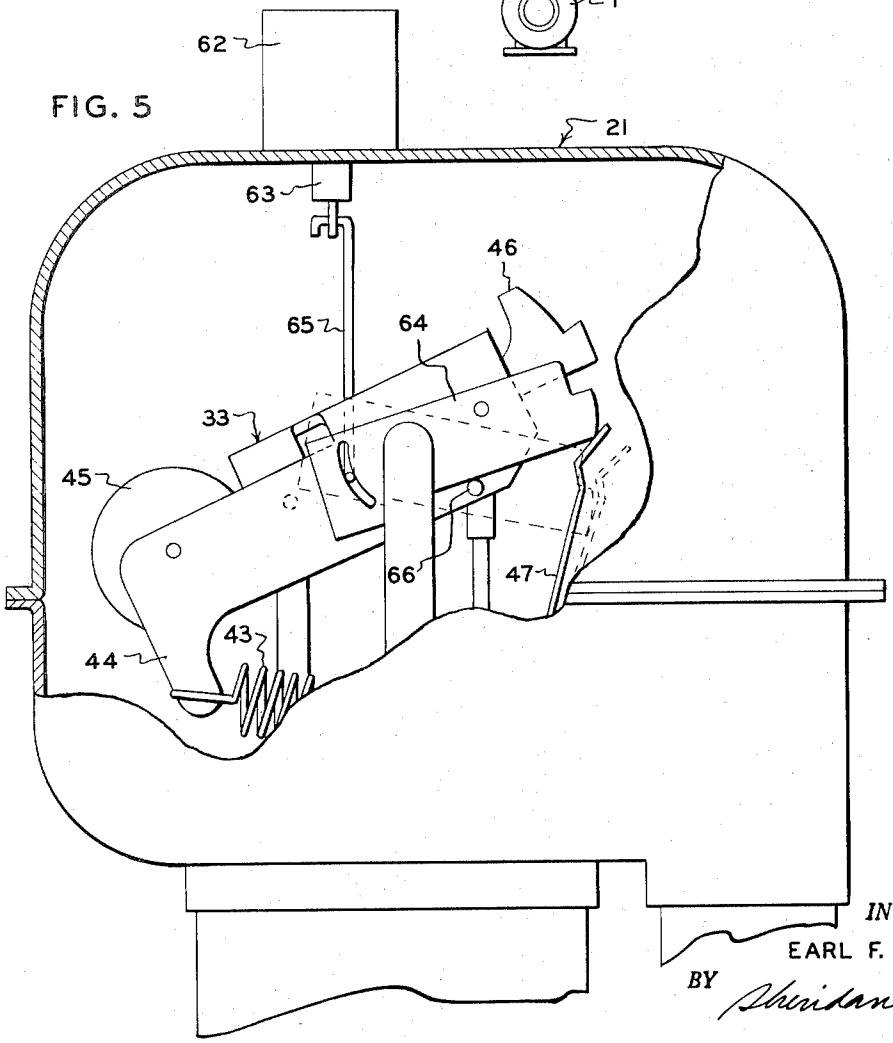


FIG. 1

FIG. 5



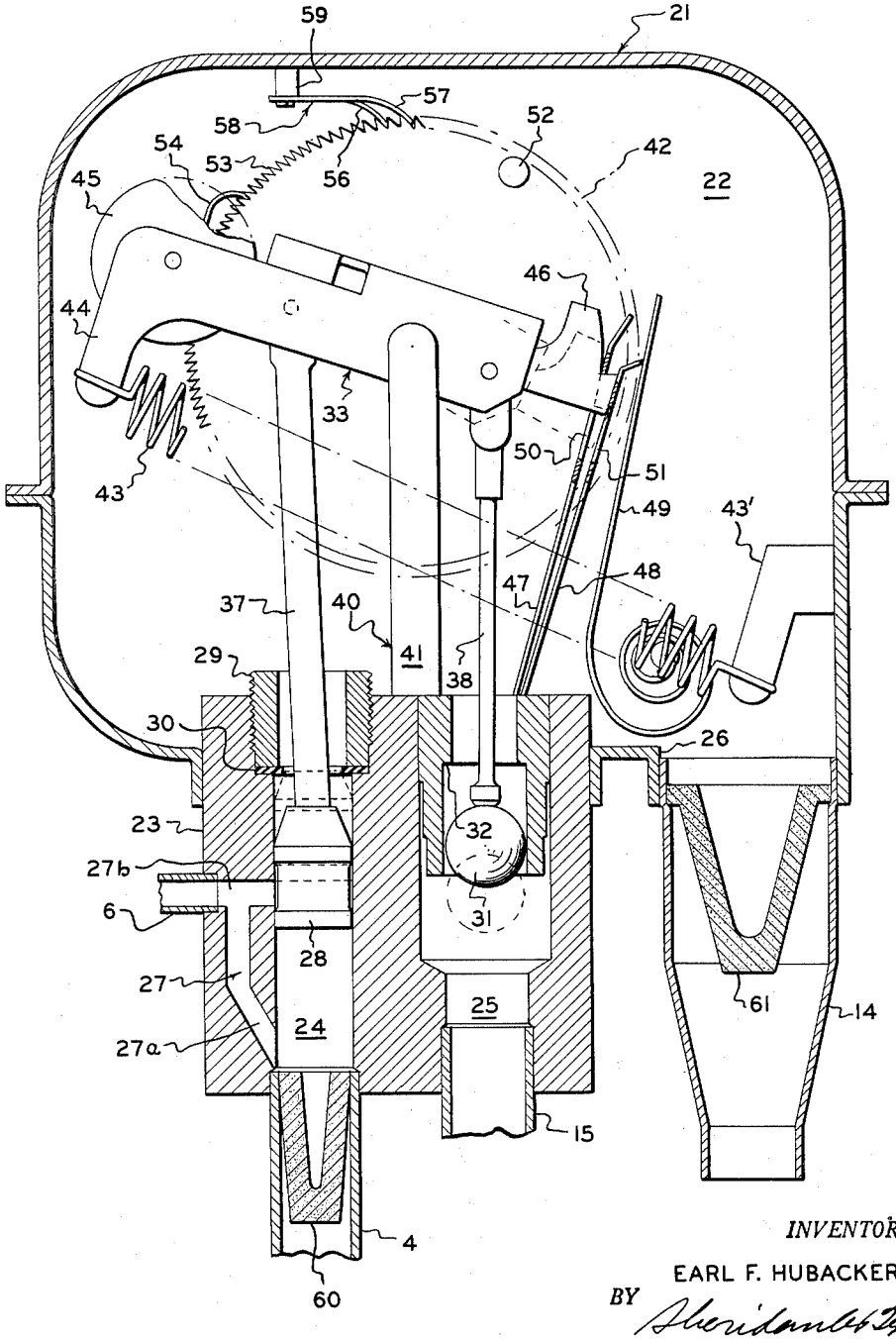
INVENTOR.
EARL F. HUBACKER
BY Sheridan & Boyle
HIS ATTORNEY

May 1, 1956 E. F. HUBACKER 2,743,587

CONTROL FOR REFRIGERATING APPARATUS

Filed Nov. 12, 1954 3 Sheets-Sheet 2

FIG. 2



INVENTOR.

EARL F. HUBACKER

BY Sheridan & Ross

HIS ATTORNEY

May 1, 1956 E. F. HUBACKER 2,743,587

CONTROL FOR REFRIGERATING APPARATUS

Filed Nov. 12, 1954 3 Sheets-Sheet 3

FIG. 3

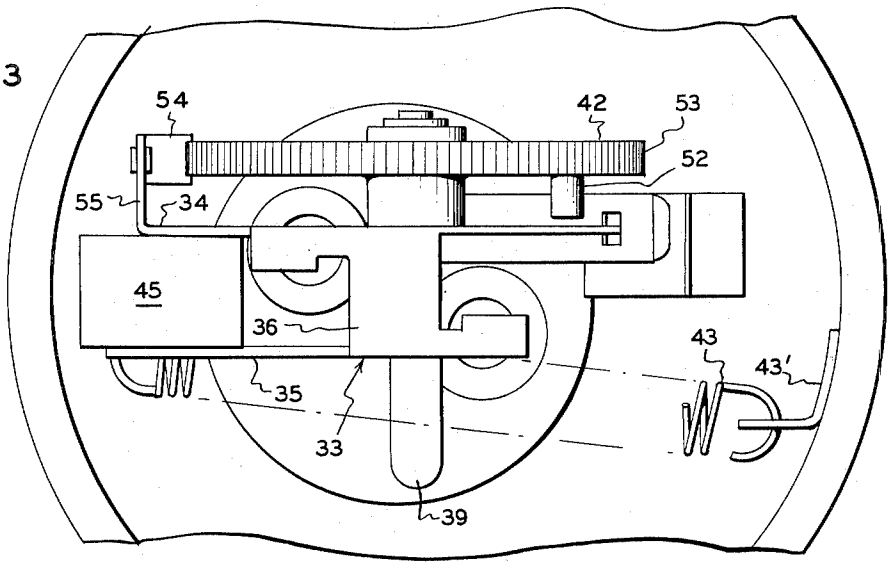
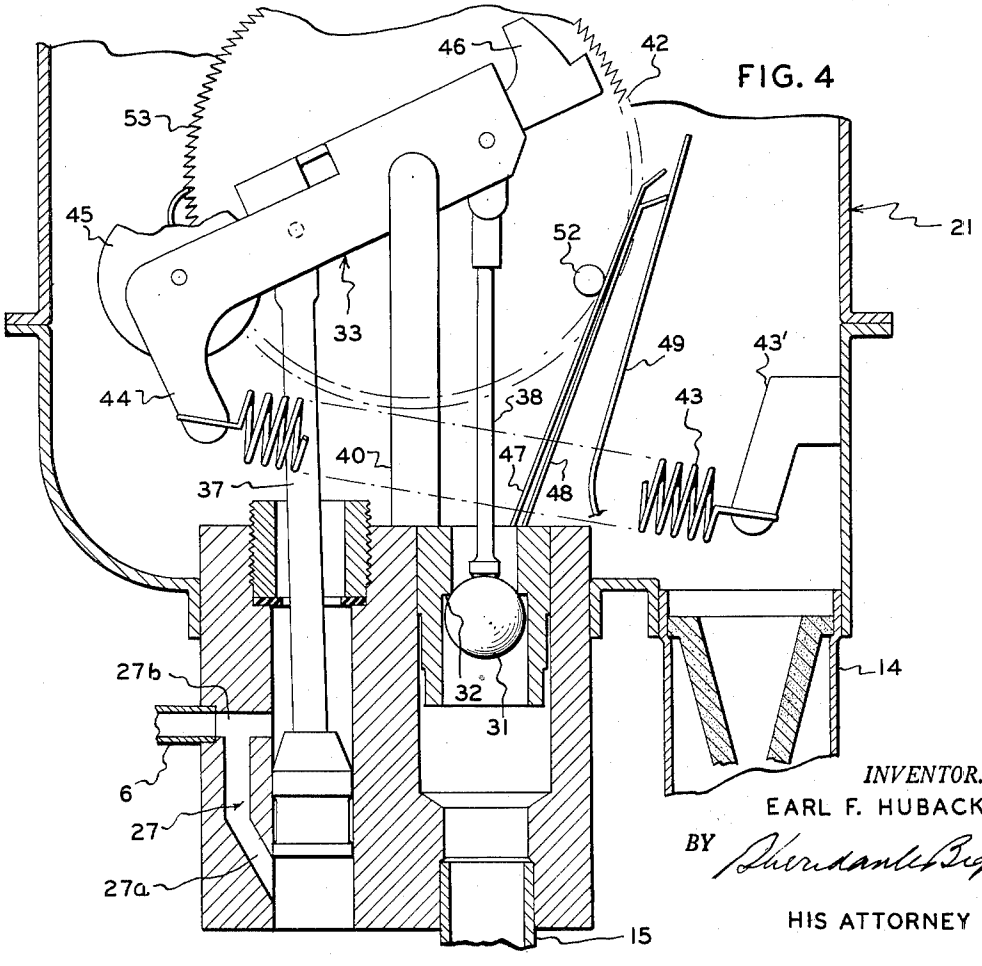


FIG. 4



INVENTOR.
EARL F. HUBACKER
BY Sheridan & Biggs
HIS ATTORNEY

United States Patent Office 2,743,587 Patented May 1, 1956

2,743,587

CONTROL FOR REFRIGERATING APPARATUS

Earl F. Hubacker, Louisville, Ky., assignor to General Electric Company, a corporation of New York

Application November 12, 1954, Serial No. 468,265

19 Claims. (Cl. 62—3)

This invention relates to refrigerating apparatus and, more particularly, to a control device for defrosting the evaporator of refrigerating apparatus.

One system for defrosting an evaporator of a refrigerator supplies hot gas from the compressor to the evaporator to heat the evaporator to defrosting temperature. In one such system, when it is desired to defrost, the flow of refrigerant in the system is fed from the condenser directly to the evaporator so that the evaporator in effect becomes a part of the condenser; that is, the flow bypasses the restrictor or liquid expansion means of the system which in its normal refrigerating cycle is connected between the condenser and the evaporator to convert the compressed liquid into a cooling liquid.

This invention contemplates the provision of an improved system of this character having improved control means for causing the hot gas to flow directly from the condenser to the evaporator when defrosting is desired, and for stopping such flow and re-establishing normal flow of the refrigerant when the defrosting operation has been completed. More specifically, the flow of gas is diverted directly from the condenser to the evaporator for defrosting responsively to a predetermined condition of operation in the system, for example, the number of compressor operations; and automatically the flow of refrigerant is restored for normal refrigerating operation in response to a predetermined condition of operation of the evaporator, more specifically, to the pressure in the evaporator. In a preferred embodiment of this invention, the control means directs the hot gas to flow through the evaporator in a direction reverse to the normal flow of the cooling liquid through the evaporator for refrigeration. The invention also contemplates providing suitable means to vary the frequency of the defrosting operation in response to the ambient temperature outside of the compartment being cooled by the evaporator.

A primary object of the present invention is to provide a control device for starting defrosting by directing hot gaseous refrigerant from the condenser directly to the evaporator after a predetermined condition of operation and for stopping flow of hot gaseous refrigerant and automatically restoring normal refrigerant flow in response to a predetermined pressure in the evaporator.

Another object of this invention is to provide a device for automatically varying the frequency of the defrosting of the evaporator in accordance with the ambient temperature.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with this invention, there is provided refrigerating apparatus including a compressor, a condenser, and an evaporator. A line connects the compressor, the condenser, and the evaporator to convey refrigerant from the compressor through the condenser and to the evaporator during the normal refrigerating

cycle; and a suction conduit connects the evaporator and the compressor to carry the refrigerant from the evaporator to the compressor during this cycle. Suitable means such as a restrictor or expansion means are disposed in the first line between the condenser and the evaporator to regulate the flow of refrigerant to the evaporator thereby to convert the refrigerant to a cooling liquid. Suitable means are provided to bypass the regulating means to cause the high pressure refrigerant to flow from the condenser where it is hot directly to the evaporator to defrost it. This bypass means restores normal flow through the regulating means and the evaporator in response to a predetermined pressure in said evaporator during hot gaseous refrigerant flow therethrough.

For a better understanding of the invention reference may be had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of a refrigerating system embodying the present invention;

Fig. 2 is a sectional view of the control apparatus of the present invention;

Fig. 3 is a fragmentary plan view of the apparatus of Fig. 2;

Fig. 4 is a fragmentary sectional view similar to Fig. 2 showing the control apparatus in another position; and

Fig. 5 is a view partly in section of a modification of the control apparatus.

Referring to the drawing and particularly Fig. 1, there is shown a refrigerating system including a compressor **1**, which supplies high pressure refrigerant vapor to a condenser **2** through a conduit or "line" **3**. The condensed refrigerant then flows through a "line" **4** to a valvular line control device or means **5**. This control means **5** normally permits the condensed refrigerant to flow through a fixed restrictor **6**, preferably a capillary tube, wherein the refrigerant is reduced in pressure.

From the restrictor **6**, the refrigerant passes into a header **7** that is divided by a wall member **8** into two compartments **9** and **10** with the restrictor **6** directing refrigerant into the compartment **9**. It will be understood that the compartments **9** and **10** could be separate rather than unitary, if desired.

When the liquid refrigerant enters the compartment **9** from restrictor **6**, a portion of the liquid refrigerant flashes into vapor in the compartment **9** of the header **7** and the remaining liquid refrigerant evaporates in the evaporator **11** and the compartment **10** of the header **7**. The evaporator **11** provides a cooling effect for a compartment **12** such as a refrigerator cabinet, for example. A line **14** returns the gaseous refrigerant from the compartment **10** to the control means **5** from which it flows through line **15** to the compressor **1** to again be compressed to repeat the cycle. The flow during this normal refrigerating cycle is shown by the full arrows in Fig. 1.

It will be understood that part of the vaporous refrigerant, which evaporates in compartment **9**, will flow through a second restrictor **16**, which provides communication between the compartment **9** and the line **15**, to the line **15** and back to the compressor **1**. Preferably, the second restrictor **16** is a capillary tube and has a fixed orifice of a greater diameter than the fixed orifice of the restrictor **6**. The second restrictor **16** has a high restriction to gas flow therethrough so that sufficient pressure is built up in the compartment **9** to force the liquid refrigerant and most of the vapor through the evaporator and the suction line. This prevents liquid flow through the second restrictor **16** during the normal refrigerating cycle. The bottom of the header **7** is preferably sloped to the right, as shown in Fig. 1, to cause the liquid to collect above the opening to the evaporator, though the pressure in compartment **9** will force the liquid into the

evaporator even though the bottom of the header is horizontal.

In accordance with this invention, after a predetermined number of cycles of the compressor, the control means 5 operates to prevent refrigerant flow through the restrictor 6 and directs the refrigerant through the evaporator 11 in a reverse direction (see dotted arrows in Fig. 1) to initiate and effect defrosting. During defrosting, the refrigerant compressed in the compressor 1 is pumped through the line 3 to the condenser 2 where it is only partially condensed; this is due to the fact that the evaporator 11 is now on the high pressure side of the compressor so that the evaporator 11 functions as part of the condenser system. Thus, if the evaporator and condenser are of the same surface area and exposed to the same temperatures, for example, then the refrigerant condensed in the condenser 2 will be equal to that condensed in the evaporator. Since the evaporator temperature normally will be lower than the condenser temperature whereby if the evaporator and condenser, for example, have the same surface areas a larger portion of the refrigerant will be condensed in the evaporator than will be condensed in the condenser.

This reversal of flow of the refrigerant for defrosting is controlled by the valvular control element 5. Thus, in this operation, the mixture of hot gas and hot liquid refrigerant flows from the compressor to the condenser 3 and thence through the line 4 to the control means 5. As will be described in detail, the valve arrangement in the control means 5 is arranged so that less resistance is offered to passage of refrigerant through the control means 5 than through the restrictor 6 during defrosting whereby the refrigerant flows through the control means 5 into the line 14. This refrigerant then passes into compartment 10 of header 7 and enters the evaporator 11 in a direction reverse to the direction in which the refrigerant flowed during the normal refrigerating cycle. The remainder of the hot gas is condensed within the evaporator 11 and the condensation provides the heat required to defrost the evaporator. The liquid refrigerant next passes into the compartment 9 of the header 7 and through the second restrictor 16. The liquid refrigerant will not flow through the restrictor 6 because both ends are at substantially the same pressure. The line 15 into which the second restrictor 16 is connected is on the low side of the compressor so that refrigerant flows through the restrictor 16 which effects a pressure difference sufficient to vaporize all of the refrigerant either before or after it enters the compressor cylinder to again be compressed.

The control means 5 not only reverses flow of refrigerant after a predetermined number of cycles of the compressor but also stops reverse flow of refrigerant to stop the defrosting operation in response to a predetermined pressure in the evaporator. The pressure on the high side of the reverse cycle increases as the evaporator temperature increases; it being understood that the evaporator temperature increases after the frost melts from the evaporator 11. This pressure in the evaporator is transmitted through the line 14 to the control means 5 where it actuates suitable mechanism to stop defrosting and start the normal refrigerating cycle.

This control means 5, as shown in Figs. 2, 3 and 4, includes a casing 21 that provides a chamber 22 therein through which low pressure gaseous refrigerant flows from the evaporator to the compressor during the normal refrigeration cycle and the high pressure hot gaseous refrigerant flows from the condenser to the evaporator during the reverse defrosting cycle. In order to change the direction of flow of refrigerant through the chamber 22, a valve body 23 is disposed in the lower portion of the casing. This valve body 23 has an inlet passage or duct 24 that permits high pressure hot gaseous refrigerant to flow from the line 4 into the chamber 22 during defrosting. An outlet duct or passage 25 allows low pressure refrigerant vapor from the evaporator 11 to flow through the line 15 into the compressor 1 during the normal cycle.

The casing 21 has a third passage or opening 26 that joins with the line 14 to provide communication between the chamber 22 and the evaporator 11. The opening 26 is preferably located in the lowermost portion of the casing 21 to assure that any liquid refrigerant resulting from condensing in the condenser flows therefrom through the evaporator during the defrosting operation although it could be positioned in the upper portion of casing 21 and the vapor be depended upon to carry the condensed liquid refrigerant through the chamber 22.

A valve member 28 is provided in the inlet passage 24 to prevent gas and liquid refrigerant flowing through the line 4 from entering the chamber 22 during the normal refrigerating cycle. The valve 28 when in its position shown in Fig. 2 directs the refrigerant from the condenser into a third passage 27 in the valve body 23. The condensed refrigerant flows through an angular portion 27*a* of passage 27 and a portion 27*b*, which has its axis substantially perpendicular to the axis of the inlet passage 24, into the restrictor 6. As shown in Fig. 2, the portion 27*b* of the passage 27 is in communication with the passage 24 but communication between passage 24 and chamber 22 is blocked by the valve member 28 during normal refrigerant flow so that the refrigerant must flow through the restrictor 6.

When the compressor 1 is operating, the high pressure of the gas and liquid refrigerant acting on the valve member 28 forces it against the valve seat 29, which is provided at the upper end of the passage 24. The valve seat 29 includes a portion 30 preferably made of polytetrafluoroethylene resin, but any material that is resistant to refrigerant and sufficiently resilient to insure a tight seal by valve member 28 thereagainst may be employed.

A valve member 31 is disposed in the outlet passage 25 to prevent flow through the passage 25 during the defrosting cycle. This valve member 31 cooperates with a valve seat 32 (Fig. 4) in the passage 25 to prevent high pressure refrigerant, which flows through the chamber 22 during the defrost cycle, from returning to the compressor through the line 15 rather than flowing to the evaporator 11 through the line 14.

In order to cause the refrigerant to flow through the chamber 22 in the desired direction, the valve members 28 and 31 are mechanically interlocked. For this purpose, a bracket member 33 having arms 34 and 35 (Fig. 3) united by intermediate portion 36 is employed to interconnect the valve members 28 and 31; a rod 37, which is joined to the valve member 28, is pivoted to the arm 34 of the bracket member 33, while a rod 38, which is secured to the valve member 31, is pivoted to the arm 35. The bracket member 33 is fulcrumed on a transverse arm 39 of a support member 40 for rotation about the transverse arm 39. The support member 40 comprises a portion 41 extending upwardly from the valve body 23 and the transverse arm 39 extending at right angles to the upright portion 41. The transverse arm 39 has a ratchet wheel 42 mounted thereon for rotation thereabout. It will be understood that the member 40 could be secured to other parts of the casing, if desired, provided the bracket member 33 and ratchet wheel 42 rotate independently with respect to each other about the transverse arm 39.

A spring 43 has one end attached to a downwardly depending flange 44 of bracket member 33 to bias the bracket member 33 in a counter-clockwise direction (as shown in Figs. 2 and 4) about the transverse arm 39. The other end of the spring 43 is connected to a fixed bracket member 43', which is joined by suitable means such as welding to the interior of the casing 21. A weight 45 is mounted on the bracket member 33 between the arms 34 and 35 and is disposed on the same end of the bracket member 33 as the depending flange 44, which extends from the arm 35, to aid the spring in rotating the bracket member 33.

The arm 34 has a portion 46 extending beyond the arm

35 to cooperate with a holding means that retains the bracket member 33 in its normal refrigerating position of Fig. 2 and prevents the force of the spring 43 and weight 45 from moving the bracket member 33 to the defrost position of Fig. 4 until desired. This holding means includes a pair of flexible members 47 and 48 and a bimetal member or strip 49. The portion 46 is normally disposed within an opening 50 in the flexible member 47, as shown in Fig. 2, while the flexible member 48 is normally disposed outside the path of the portion 46 so that the portion 46 will not be engaged in an opening 51 of the member 48. The flexible member 48 is moved to the left (Fig. 2) by the bimetal strip 49 when it moves due to a low ambient temperature surrounding the control means 5, which is preferably disposed adjacent the compressor and condenser, into a position where portion 46 will be engaged in the opening 51. The opening 50 is larger than the opening 51 whereby the counter-clockwise rotation of the bracket member 33 is reduced by engagement of the portion 46 in opening 51. It will be understood that the clockwise rotation of the bracket member 33 must reach the same position at all times in order to insure that the valve member 28 sits tightly against portion 30 of valve seat 29; therefore, it is the upper edges of openings 50 and 51 that determine the angular movement of the bracket member 33.

Preferably, the member 47 is made of spring material while the member 48 is made of bimetal. The member 48 is designed to flex with temperature in the same direction as bimetal strip 49. This, of course, markedly reduces the force required for bimetal strip 49 to move member 48 to the position where the portion 46 is disposed in the opening 51. Thus, if member 48 is made of bimetal, a smaller change in the ambient temperature surrounding the control member 5 is needed to engage and disengage the opening 51 of member 48 with portion 46 than if member 48 is made of spring material, for example.

The ratchet wheel 42 has a pin or stud 52 adjacent its periphery to release the portion 46 from the holding means when it is desired to allow the force of the spring 43 and weight 45 to move the bracket member 33 to the position shown in Fig. 4 to start defrosting. Since the pin 52 is mounted on the ratchet wheel 42, it will be seen that the engagement of the pin 52 with the flexible member 47 is dependent upon rotation of the ratchet wheel 42. The ratchet wheel 42 is provided with teeth 53 around its entire periphery that are adapted to be engaged by the pawl 54 of angular portion 55, which extends at a substantially right angle to the arm 34 of the bracket member 33. Thus, the pawl 54 will rotate the ratchet wheel 42 about the depending arm 39 whenever the bracket member 33 moves in a clockwise direction.

In order to prevent reverse rotation of the ratchet wheel 42 after being moved by the pawl 54, pawls 56 and 57 are formed from the resilient strip 58, which is supported from the interior of the casing by a bracket 59. The pawl 56 is preferably punched out of the resilient strip 58. It will be understood that the bracket 59 and the strip 58 can be disposed in any position within the casing 21 provided the strip prevents reverse rotation of the ratchet wheel 42.

A filter 60 is disposed in line 4 adjacent its juncture with the inlet passage 24 in the valve body 23. A filter 61 is positioned in line 14 adjacent its connection with the passage 26 in the casing 21.

Considering the operation of the present invention, refrigerant during the normal refrigerating cycle (full arrows in Fig. 1) flows from the compressor 1 through the condenser 2, the passages 24 and 27 and the first restrictor 6 to the evaporator 11. When the compressor operates, the valve member 28 is moved by the high pressure refrigerant up against the portion 30 of the valve seat 29 as shown by the dotted line position in Fig. 2, and is held there by the high pressure. This movement of the valve member 28 is transmitted through the bracket member 33

to the valve member 31 so that it is moved to its dotted line position of Fig. 2. The force exerted by the high pressure refrigerant against the valve member 28 is sufficient to overcome the force exerted by the weight 45 and the spring 43 that tends to move the valve members 28 and 31 to the solid line position shown in Fig. 2. The disposition of the valve members in the dotted line positions permits the low pressure vapor to return to the compressor from the evaporator through the line 14, the casing 21, and the line 15.

Suitable means (not shown), such as a temperature responsive switch, are employed to start and stop operation of the compressor (which may be motor driven) when the compartment 12 being cooled by the evaporator 11 reaches predetermined high and low temperatures, respectively, so as substantially to hold a selected temperature within the compartment.

It will be understood that the portion 46 of bracket 33 is disposed adjacent the lower edge of opening 50 of member 47 but not in contact therewith when the compressor is operating during the refrigerating cycle. Similarly, if the portion 46 is also disposed in opening 51 of member 48, the portion 46 is disposed adjacent the lower edge of opening 51 but not in contact therewith. When the compressor shuts down, the pressure in the system tends to equalize and the force of the spring 43 and the weight 45 rotates the bracket 33 (counterclockwise in Fig. 2) about the transverse arm 39. This rotation moves the portion 46 of bracket 33 into contact with the upper edge of the opening 50 and the valve members 28 and 31 to their full line positions. When the compressor is again started, the bracket member 33 rotates about the transverse arm 39 (clockwise in Fig. 2) and this rotation is transmitted by the pawl 54 to the ratchet wheel 42 to advance the ratchet wheel. When the compressor stops again, the pawls 56 and 57 prevent the ratchet wheel from being moved in a reverse direction.

When the ratchet wheel has moved a predetermined distance in response to a number of cycles of operation just described, the pin 52 of the ratchet wheel 42 engages the flexible member 47 and releases the portion 46 of the bracket 33 from the opening 50 of the flexible member 47. After the portion 46 of bracket 33 is released, the spring 43 and weight 45 bias the valve member 31 into contact with the seat 32 and the valve member 28 into a position between the connection of the portion 27*a* of the passage 27 with passage 24 and the connection of the portion 27*b* of the passage 27 with passage 24, as shown in Fig. 4. This release occurs after the compressor has stopped.

With the control apparatus in the position shown in Fig. 4, there is provided a new flow path for the refrigerant when the compressor again starts. When the compressor again starts, the refrigerant compressed in the compressor is pumped through line 3 to condenser 2 where it is only partially condensed as previously explained. The mixture of hot gas and hot liquid refrigerant then passes through line 4 into passage 24 from which it flows into passage 27. Since the chamber 22 and the portion of the passage 24 above valve member 28 offer less resistance to refrigerant flow than the restrictor 6, the refrigerant flows into the portion of the passage 24 above the valve member 28 and into the chamber 22. As the valve member 31 is in contact with the valve seat 32, it is obvious that the refrigerant cannot flow from the chamber 22 through outlet passage 25 but must exit through passage 26 and line 14.

This refrigerant then passes into the compartment 10 of header 7 and enters the evaporator 11 in a direction reverse to the direction in which the refrigerant flowed during the normal refrigerating cycle. The remainder of the hot gas is condensed within the evaporator 11 and this condensation provides the heat required to defrost the evaporator. The liquid refrigerant next passes into the compartment 9 of the header 7 and through

the second restrictor 16, which effects a pressure difference sufficient to vaporize all of the refrigerant either before or after entering the compressor cylinder to again be compressed. The liquid refrigerant does not flow through the restrictor 6 because both ends are at substantially the same pressure.

After the frost melts from the evaporator 11, the evaporator temperature increases and, accordingly, the pressure on the high pressure side of the reverse cycle increases. This increase in pressure exerts a force on the valve member 31. As the pressure increases, the force on the valve member 31 increases to finally overcome the force exerted by the spring 43 and weight 45 to move the portion 46 back into the opening 50. It will be seen that the line 15 is exposed to the suction pressure of the compressor so that this reduced pressure on one side of the valve member aids the evaporator pressure, which is exerting a force on the opposite side of the valve member 31, in moving the valve member to overcome the combined spring and weight force.

When the bracket member 33 moves from the defrosting position of Fig. 4 to the normal refrigerating position of Fig. 2, the pawl 54 rotates the ratchet wheel 42 so that the pin 52 moves away from the flexible member 47 to permit the portion 46 to again engage the opening 50 when the force on valve member 31 overcomes the force exerted by spring 43 and weight 45. Since the evaporator temperature is very high due to the defrosting, the compressor will continue to operate resulting in the assembly moving to its dotted line position of Fig. 2; that is, the valve member 28 seats against the portion 30 of the valve seat 29 to direct the high pressure refrigerant into the restrictor 6 and the valve member 31 is moved away from the valve seat 32 so that low pressure vapor may return to the compressor from the evaporator. Refrigeration then continues until the evaporator reaches its predetermined minimum temperature at which the compressor shuts down.

The bimetal strip 49 serves to compensate for the difference in ambient temperature to increase the frequency of defrosting operations when the ambient temperature around the refrigerating system increases, and vice versa to decrease said frequency when the ambient temperature decreases. Thus, when the temperature surrounding the control means 5, which is outside the compartment 12 and preferably disposed adjacent the compressor and condenser is high, the bimetal strip moves to the right (Fig. 2) and permits the flexible member 48 to move away from the portion 46 to its normal position so that the portion 46 will engage in the opening 50 rather than in the opening 51 in the member 48. This, of course, results in the portion 46 advancing the ratchet wheel further during each cycle than when the portion 46 is disposed in the opening 51 since the opening 51 is of a smaller size which reduces the rotary advance of the ratchet wheel on each operation thereof. Movement of the bimetal strip 49 due to a lower ambient temperature causes the bimetal 49 to urge the member 48 into contact with the member 47 so that the portion 46 will engage in the opening 51 of the member 48. When this occurs, the ratchet wheel is rotated fewer teeth for each cycle. Thus, this device permits defrosting at shorter intervals when the ambient temperature is high than when the ambient temperature is low. It will be observed that during a complete rotation of the ratchet wheel that the flexible member 48 may be both in its normal position and in the position whereby it will be engaged by the portion 46. Therefore, the present device compensates for varying temperatures during the rotation of the ratchet wheel so that the ambient temperature governs as to when the defrosting operation begins.

Since both the flexible member 48 and bimetal member 49 are in contact with casing 21, these members are responsive to the ambient temperature surrounding the casing 21 rather than the temperature of the suction gas passing through the casing. This is due to the fact that metal to metal heat transfer is much greater than heat transfer from a gas to metal. In addition, casing 21 is positioned a sufficient distance from the evaporator 11 so that the line 14 may be in heat exchange relation with the restrictor 6 and the line 14 may be exposed to the ambient temperature whereby the temperature of the suction gas passing through the casing is within a few degrees of the ambient or room temperature.

It will be observed that a portion of the restrictor 6 is in heat exchange relation with the line 14, which connects the evaporator 11 with the control means 5, and the line 15, which connects the control means 5 with the compressor 1. This is the normal heat exchange relationship provided in the well-known refrigeration system between the restrictor and the suction line to increase the efficiency of the system; it being understood that the suction line of the present invention consists of lines 14 and 15.

The restrictor 6 is also disposed in heat exchange relationship with that portion of the second restrictor 16 adjacent the header 7. During the normal refrigeration cycle, this permits the hot liquid refrigerant in the restrictor 6 to heat additionally any cold gas that may have entered the second restrictor 16 after vaporizing in compartment 9 to insure that this gas is completely vaporized before entering the compressor 1 by means of line 15. Obviously, the second restrictor 16 is not placed in heat exchange relation with line 14 since this would cause cooling of the hot gas flowing to the evaporator during defrosting by the cold liquid flowing through the second restrictor 16.

While the modification disclosed in Figs. 2 to 4 has shown the defrosting of the evaporator to be initiated in response to the number of refrigerating cycles, it will be understood that other suitable means may be employed for initiating the reverse flow through the evaporator for defrosting the evaporator. For example, Fig. 5 discloses a modification for use when the evaporator is disposed in a household refrigerator, for example, that initiates defrosting after the door has been opened for a predetermined cumulative time while the compressor is operating. Similar parts in Fig. 5 will be identified by the same numerals employed in Figs. 2 to 4. A solenoid is disposed within a box 62 and is energized whenever a timing mechanism has run for the predetermined period. Energization of the solenoid causes its plunger 63 to move upwardly whereby a defrost set arm 64 is pivoted by a member 65 that is connected at one end to the plunger 63 and at its other end to the defrost set arm 64. The upward movement of solenoid plunger 63 results in defrost set arm 64 engaging the member 47 so that the arm 64 and the member 47 move to their dotted line positions of Fig. 5. While only member 47 has been shown, it will be understood that members 48 and 49 may be employed in this modification, if desired.

The movement of member 47 to its dotted line position releases the portion 46 of the bracket member 33 from the opening 50 in member 47. This, of course, permits the bracket member 33 to move to the defrost position of Fig. 5 when the compressor shuts down due to the force of the spring 43 and the weight 45. The bracket member 33 has a stud 66 that serves as a catch or dog to engage the defrost set arm 64 to move it to its full-line position when the bracket member 33 moves to the defrost position. Then, when the defrost period ends, the portion 46 of the member may again engage the opening 50 to permit the normal refrigerating cycle.

The circuit containing the timer that energizes the solenoid is connected in parallel with the motor circuit of the compressor motor. The switch that energizes the motor in response to conditions in the refrigerator compartment being cooled is disposed between the source

of power and the timer so that the timer is de-energized whenever the compressor is not operating. The timer circuit has a switch therein that is normally open but closes whenever the refrigerator door is opened to energize the timer, if the motor is energized. Thus, the timer is energized during the time that the door is opened provided the compressor is operating but is de-energized if the compressor is not operating. Other suitable means may be employed to initiate the defrosting mechanism, if desired.

This invention has the advantage of providing a unitary valve arrangement that starts defrosting after a predetermined condition of operation and stops defrosting when the evaporator reaches a predetermined pressure. A further advantage provided by this invention is that the device is less expensive to manufacture than present defrosting mechanisms.

This invention also has the advantage of permitting defrosting to occur only when needed since heavy frost forms in a higher ambient temperature than in a low ambient temperature. Another advantage is that this invention permits the defrosting arrangement to provide for a change in the ambient temperature.

While the present invention has been described by reference to particular embodiments thereof, it will be understood that modifications may be made by those skilled in the art without actually departing from the invention. Therefore, the appended claims are intended to cover all such variations as come within the true spirit and scope of the invention.

I claim:

1. Refrigerating apparatus including a compressor, a condenser, an evaporator, a line connecting said compressor, said condenser, and said evaporator to permit refrigerant flow from said compressor through said condenser to said evaporator during the normal refrigerating cycle, a suction line connecting said evaporator and said compressor to permit refrigerant flow from said evaporator to said compressor during the normal refrigerating cycle, means in said first line between said condenser and said evaporator to regulate the flow of refrigerant to said evaporator, and means to bypass said regulating means to reverse the flow of refrigerant through said evaporator to defrost said evaporator, said bypass means stopping reverse flow and restoring normal flow through said regulating means and said evaporator in response to a predetermined pressure in said evaporator during reverse flow therethrough.

2. Refrigerating apparatus including a compressor, a condenser, an evaporator, a line connecting said compressor, said condenser, and said evaporator to permit refrigerant flow from said compressor through said condenser to said evaporator during the normal refrigerating cycle, a suction line connecting said evaporator and said compressor to permit refrigerant flow from said evaporator to said compressor during the normal refrigerating cycle, means in said first line between said condenser and said evaporator to regulate the flow of refrigerant to said evaporator, valve means in said first and suction lines arranged when in one position to connect said condenser and evaporator for normal refrigerant flow, and means to move said valve means from said one position to a second position to bypass said regulating means and connect said condenser and evaporator to reverse refrigerant flow through said evaporator to defrost said evaporator, said last mentioned means moving said valve means to said one position in response to a predetermined pressure in said evaporator.

3. Refrigerating apparatus including a compressor, an evaporator, means to supply refrigerant from said compressor to said evaporator at a low pressure to permit said evaporator to provide a cooling effect, and means to control the flow of refrigerant to said evaporator, said control means supplying the refrigerant from said compressor to said evaporator at a high pressure in the reverse direction of the flow of refrigerant at low pressure through said evaporator to defrost said evaporator, said control means stopping high pressure flow to said evaporator to stop defrosting and restoring low pressure flow to said evaporator to start refrigerating when refrigerant in said evaporator exceeds a predetermined pressure.

4. In refrigerating apparatus, the combination of a compressor, a condenser, an evaporator, a flow-restricting passage, a flow-reversing means, tubing connecting said condenser, said flow-reversing means, said flow-restricting passage and said evaporator in series, and additional tubing connecting said flow-reversing means with said compressor and said evaporator whereby said flow-reversing means functions to direct the flow of refrigerant from the compressor selectively in either direction through said evaporator, said flow-reversing means directing refrigerant to bypass said flow-restricting passage and flow through said evaporator in a reverse direction to flow during a normal refrigerating cycle after a predetermined condition of operation, said flow-reversing means restoring flow through said evaporator in a normal direction in response to a predetermined pressure in said evaporator during reverse flow therethrough.

5. Refrigerating apparatus including a compressor, a condenser, an evaporator, a line connecting said condenser and said evaporator for the flow of refrigerant therebetween, means in said line to regulate the flow of refrigerant to said evaporator from said condenser during the normal refrigerating cycle, a suction line connecting said evaporator to said compressor to permit refrigerant flow therebetween, and valve means in said lines to bypass said regulating means and reverse the flow of refrigerant through said evaporator after a predetermined condition of operation to defrost said evaporator and to automatically stop the reverse flow of refrigerant when refrigerant in said evaporator reaches a predetermined pressure.

6. Refrigerating apparatus including a compressor, a condenser, a first line connecting said compressor and said condenser, control means, a second line connecting said condenser and said control means, an evaporator, a restrictor connecting said control means and said evaporator, a third line connecting said evaporator and said control means, a fourth line connecting said control means and said compressor, a second restrictor connecting said evaporator and said fourth line, said control means in one position permitting refrigerant flow from said compressor to said condenser to said first restrictor to said evaporator to said control means and back to said compressor, means to move said control means to a second position after a predetermined condition of operation, said control means in said second position permitting refrigerant flow from said compressor to said condenser to said control means to said evaporator to said second restrictor and back to said compressor to defrost said evaporator, said control means returning to said one position when refrigerant in said evaporator reaches a predetermined pressure.

7. Refrigerating apparatus including a compressor, a condenser, a first line connecting said compressor and said condenser, control means, a second line connecting said condenser and said control means, an evaporator, a compartment, one end of said evaporator connected to said compartment, a second compartment, the other end of said evaporator connected to the second compartment, a restrictor connecting said control means and said first compartment, a third line connecting said second compartment and said control means, a fourth line connecting said control means and said compressor, a second restrictor connecting said first compartment said said fourth line, said control means in one position permitting refrigerant flow from said compressor through said first line to said condenser through said second line to said control means through said first restrictor to said first compartment through said evaporator to said second compart-

ment through said third line to said control means through said fourth line to said compressor, and means to move said control means to a second position after a predetermined condition of operation, said control means in said second position permitting refrigerant flow from said compressor through said first line to said condenser through said second line to said control means through said third line to said second compartment through said evaporator to said first compartment through said second restrictor and said fourth line to said compressor to defrost said evaporator, said control means returning to said one position in response to a predetermined pressure in said evaporator.

8. Refrigerating apparatus including a compressor, a condenser, a first line connecting said compressor and said condenser, control means, said control means including a chamber and three passages communicating with said chamber, a second line connecting said condenser to a first of said passages, an evaporator, a restrictor connecting said evaporator with said first passage, a third line connecting said evaporator with a second of said passages, a fourth line connecting the third of said passages with said compressor, a second restrictor connecting said evaporator and said fourth line, said control means including a valve means in said first passage to regulate communication between said chamber and said second line and a valve means in said third passage to regulate communication between said chamber and said fourth line, means connecting said valve means in said first passage and said valve means in said third passage for simultaneously moving said valve means, and means to actuate said connecting means to one position to move said valve means in said first passage to permit communication between said second line and said chamber and to move said valve means in said third passage to prevent communication between said fourth line and said chamber to defrost said evaporator, said actuating means moving said connecting means to a second position in response to a predetermined pressure in said evaporator to move said valve means in said first passage to prevent communication between said second line and said chamber and to move said valve means in said third passage to permit communication between said fourth line and said chamber to provide a cooling effect for said evaporator.

9. Refrigerating apparatus including a compressor, a condenser, a first line connecting said compressor and said condenser, control means, said control means including a chamber and three passages communicating with said chamber, a second line connecting said condenser to a first of said passages, an evaporator, a restrictor connecting said evaporator with said first passage, a third line connecting said evaporator with a second of said passages, a fourth line connecting the third of said passages with said compressor, a second restrictor connecting said evaporator and said fourth line, said control means including valve means in said first passage to regulate communication between said chamber and said second line and valve means in said third passage to regulate communication between said chamber and said fourth line, means connecting said valve means in said first passage and said valve means in said third passage for simultaneously moving said valve means, and means to actuate said connecting means to one position to move said valve means in said first passage to permit communication between said second line and said chamber and to move said valve means in said third passage to prevent communication between said fourth line and said chamber whereby refrigerant flows from said compressor to said condenser through said first passage to said chamber through said second passage to said evaporator through said second restrictor and back to said compressor to defrost said evaporator, said actuating means moving said connecting means to a second position in response to a predetermined pressure in said evaporator to move said valve means in said first passage to prevent communication between said second line and said chamber and to move said valve means in said third passage to permit communication between said fourth line and said chamber whereby refrigerant flows from said compressor to said condenser through said first restrictor to said evaporator through said second passage to said chamber through said third passage to said compressor to provide a cooling effect for said evaporator.

10. In a defrosting valve for a compressor-condenser-evaporator type refrigerating system in which a fixed orifice controls the flow of refrigerant to the evaporator, the combination of a casing forming a chamber having a plurality of passages in communication therewith, a valve body connected to said casing, said valve body having a pair of said passages therein in communication with said chamber, a third passage in said valve body communicating with one of said passages therein, a valve member in each of said passages in said valve body in communication with said chamber, a member supported by said casing, means connecting said valve members, said connecting means being supported by said member for rotation about said member, means to hold said connecting means in a position to prevent communication between said chamber and one of said passages in said valve body whereby said one of said passages communicates with said third passage in said valve body and to permit communication between said chamber and the other of said passages in said valve body to provide a cooling effect for said evaporator, and means to release said holding means after a predetermined condition of operation to permit communication between said chamber and said one of said passages in said valve body and to prevent communication between said chamber and the other of said passages in said valve body to defrost said evaporator while reversing flow of refrigerant therethrough, said connecting means remaining in said defrosting position until refrigerant in said evaporator reaches a predetermined pressure.

11. Refrigerating apparatus comprising a refrigerating system having a condenser, a compressor, an evaporator and a restrictor, refrigerating lines interconnecting these elements including valve means operable between a plurality of positions and connected in said lines so that when in one position said condenser is connected to said evaporator through said restrictor to supply refrigerant from said compressor as cooling medium to said evaporator, and when in another position said condenser is connected directly to said evaporator exclusive of said restrictor so that hot gases from said compressor are fed directly from said condenser to said evaporator to defrost it, control means responsive to a predetermined condition of operation of said system for moving said valve means to said second position, and pressure responsive control means for returning said valve means to said first position responsive to a predetermined high pressure in said evaporator.

12. Refrigerating apparatus comprising a refrigerating system having a compressor, a condenser, a restrictor and an evaporator, refrigerating lines interconnecting these elements including valve means operable between a plurality of positions and connected in said lines so that in one position said condenser is connected to said evaporator through said restrictor to supply refrigerant from said compressor as a cooling medium to said evaporator and when in another position said condenser is connected directly to said evaporator exclusive of said restrictor so that hot gases from said compressor are fed directly from said condenser to said evaporator to defrost it, control means responsive to a predetermined condition of operation of said system for moving said valve means to said second position, a compartment to be cooled, said evaporator being in heat exchange relation with said compartment to be cooled for cooling said compartment, means

to vary the frequency of movement of the valve means to said second position in response to the ambient temperature outside of said compartment, and pressure responsive control means for returning said valve means to said first position responsive to a predetermined high pressure in said evaporator.

13. Refrigerating apparatus including a compressor, a condenser, an evaporator, a line connecting said compressor, said condenser, and said evaporator for refrigerant flow from said compressor through said condenser to said evaporator during the normal refrigerating cycle, a suction line connecting said evaporator and said compressor for refrigerant flow from said evaporator to said compressor during the normal refrigerating cycle, means in said first line between said condenser and said evaporator to regulate the flow of refrigerant to said evaporator, means to bypass said regulating means to supply hot gaseous refrigerant to said evaporator from said condenser to defrost said evaporator, said bypass means stopping hot gaseous refrigerant flow and restoring normal flow through said regulating means and said evaporator in response to a predetermined pressure in said evaporator during hot gaseous refrigerant flow therethrough.

14. Refrigerating apparatus including a compressor, a condenser, an evaporator, a line connecting said compressor, said condenser, and said evaporator for refrigerant flow from said compressor through said condenser to said evaporator during the normal refrigerating cycle, a suction line connecting said evaporator and said compressor for refrigerant flow from said evaporator to said compressor during the normal refrigerating cycle, means in said first line between said condenser and said evaporator to regulate the flow of refrigerant to said evaporator, valve means in said first and suction lines arranged when in one position to connect said condenser and said evaporator for normal refrigerant flow, means to move said valve means from said one position to a second position to connect said condenser and said evaporator to supply hot gaseous refrigerant to said evaporator from said condenser to defrost said evaporator, said last mentioned means moving said valve means to said one position in response to a predetermined pressure in said evaporator.

15. Refrigerating apparatus including a compartment to be cooled, an evaporator to cool said compartment, compressing and condensing means for supplying medium to said evaporator, means to initiate defrosting of said evaporator, said initiating means including a ratchet wheel and means to move said ratchet wheel a predetermined angle of rotation in response to a predetermined condition, said ratchet wheel initiating defrosting of said evaporator after said ratchet wheel has rotated a greater angle than said predetermined angle of rotation, and means to vary the first predetermined angle of rotation of the ratchet wheel in response to the ambient temperature outside of said compartment.

16. Refrigerating apparatus including a compartment to be cooled, an evaporator to cool said compartment, compressing and condensing means supplying medium to said evaporator, means to initiate defrosting of said evaporator, said initiating means including a ratchet wheel and a pawl to move said ratchet wheel a predetermined angle of rotation in response to a predetermined condition, and means varying the movementt of said pawl in response to the ambient temperature outside of said compartment to vary the frequency of the defrosting operation.

17. Refrigerating apparatus including a compartment to be cooled, an evaporator to cool said compartment, compressing and condensing means for supplying medium to said evaporator, means to initiate defrosting of the evaporator, said initiating means including a ratchet wheel and a pawl to move said ratchet wheel a predetermined angle of rotation in response to a predetermined condition, a pair of flexible members mounted adjacent each other, each of said flexible members having an opening therein, said pawl having an extension to cooperate with said openings in said members, said opening in said member closest to said pawl being larger than said opening in said other member, said other member being normally positioned away from said extension, means responding to a low ambient temperature outside of said compartment to move said other member into a position whereby said extension enters said opening in said other member to limit the angular rotation of said ratchet wheel to reduce the frequency of the defrosting operation, said last mentioned means responding to a high ambient temperature outside said compartment to permit said other member to move to its normal position whereby said extension can enter only said opening in said one member to increase the angle of rotation of said ratchet wheel to increase the frequency of the defrosting operations.

18. Refrigerating apparatus including a compartment to be cooled, an evaporator to cool said compartment, compressing and condensing means for supplying medium to said evaporator, means to initiate defrosting of said evaporator, said initiating means including a ratchet wheel and a pawl to move said ratchet wheel a predetermined angle of rotation in response to a predetermined condition, a pair of flexible members mounted adjacent each other, each of said flexible members having an opening therein, said pawl having an extension to cooperate with said openings in said members, said opening in said member closest to said pawl being larger than said opening in said other member, said other member being normally positioned away from said extension, a bimetal member responding to a low ambient temperature outside of said compartment to move said other member into a position whereby said extension enters said opening in said other member to limit the angular rotation of said ratchet wheel to reduce the frequency of the defrosting operations, said bimetal member responding to a high ambient temperature outside of said compartment to permit said other member to move to its normal position whereby said extension can enter only said opening in said one member to increase the angular rotation of said ratchet wheel to increase the frequency of the defrosting operation.

19. Refrigerating apparatus including a compartment to be cooled, an evaporator to cool said compartment, compressing and condensing means for supplying medium to said evaporator, counting means, means to automatically defrost said evaporator at intervals in accordance with the advancement of said counting means, and means to change the rate of advancement of said counting means in response to the ambient temperature outside of said compartment to vary the frequency of the defrosting operation.

References Cited in the file of this patent

UNITED STATES PATENTS

2,021,087 Pearce ---------- Nov. 12, 1935