May 17, 1955 L. A. PHILIPP 2,708,348

DEFROSTING MEANS FOR REFRIGERATING APPARATUS

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Fig-1

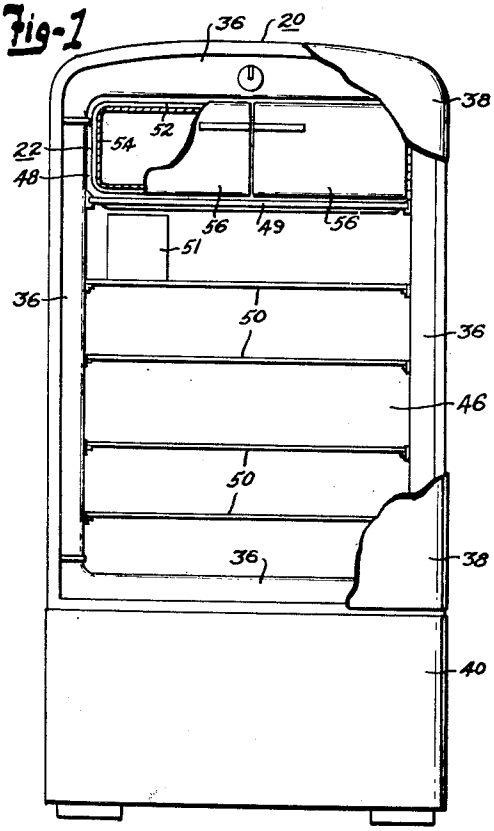


Fig-2

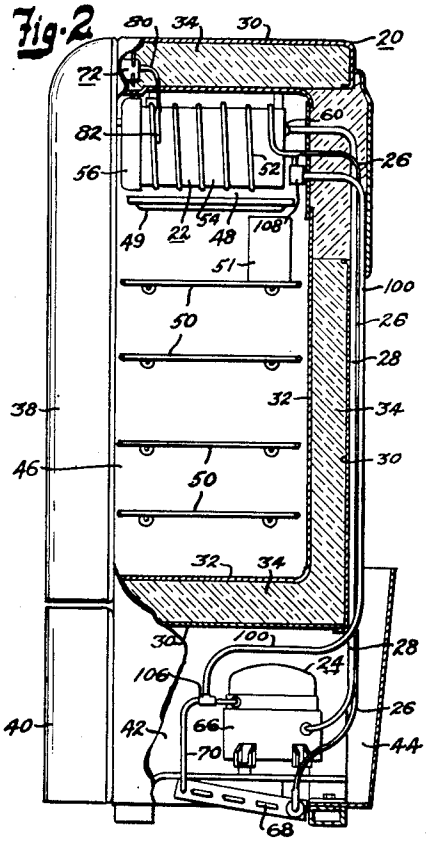
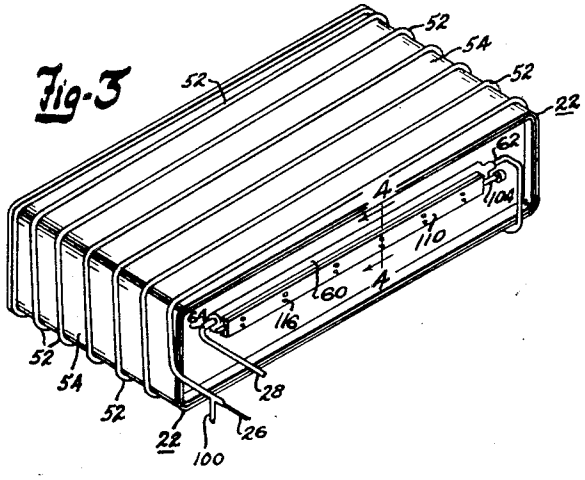


Fig-3



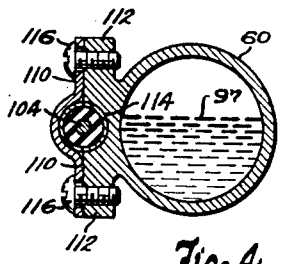


Fig-4

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DEFROSTING MEANS FOR REFRIGERATING APPARATUS

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Fig-5

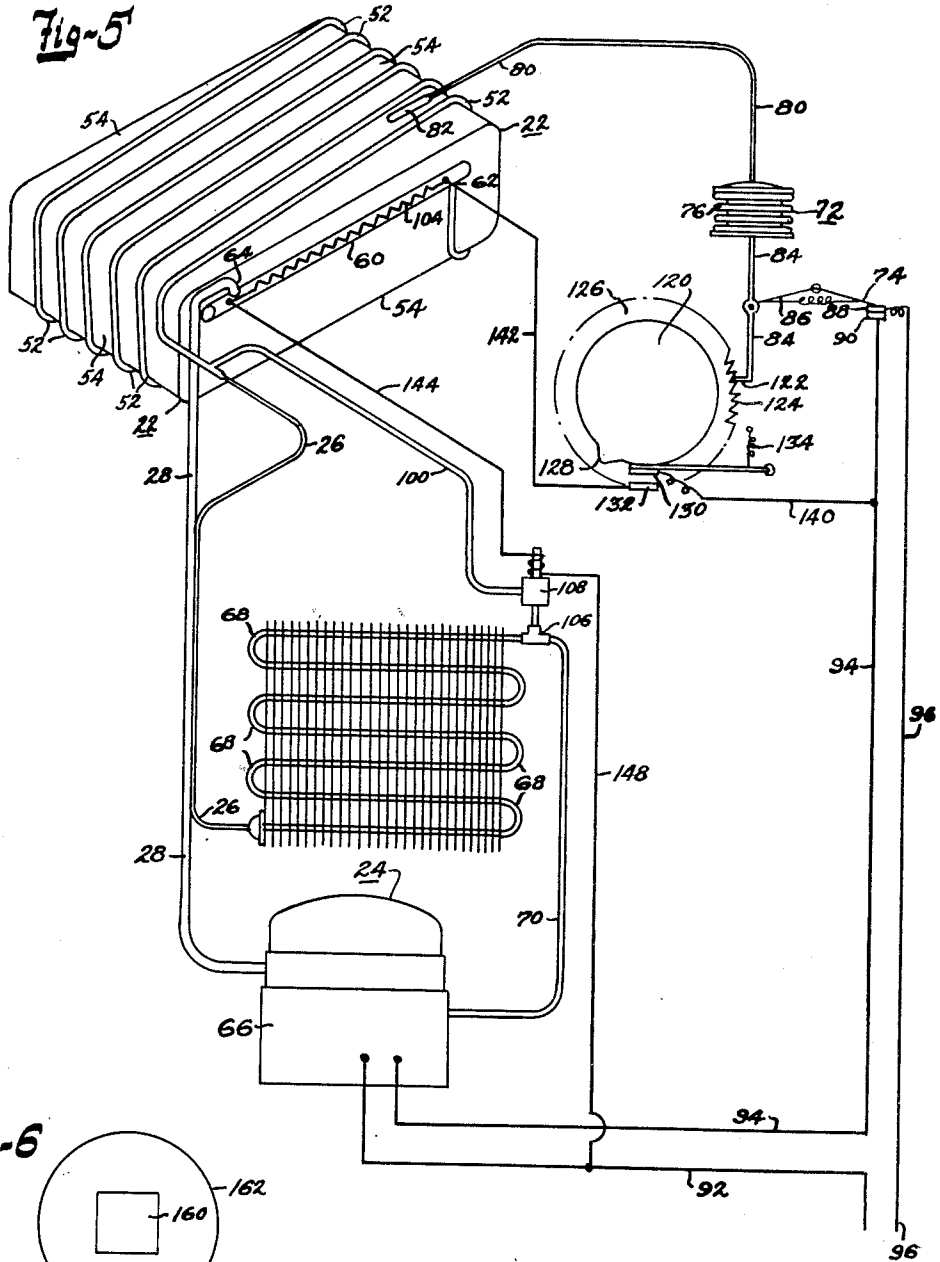
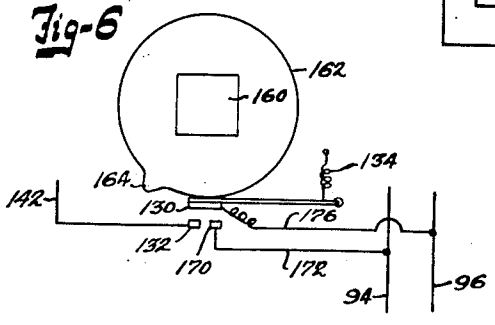


Fig-6



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United States Patent Office 2,708,348 Patented May 17, 1955

2,708,348

DEFROSTING MEANS FOR REFRIGERATING APPARATUS

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Application November 2, 1951, Serial No. 254,466

4 Claims. (Cl. 62—4)

This invention relates to refrigerating apparatus and more particularly to an arrangement for defrosting a refrigerant evaporator thereof.

One of the objects of the present invention is to provide for refrigerating systems an improved arrangement for rapidly defrosting a refrigerant evaporator of said system by applying extraneous heat to the liquid refrigerant in the evaporator and at the same time by-passing the refrigerant condenser of said system to conduct the hot gaseous refrigerant from the refrigerant circulating element or compressor directly into the evaporator and to limit the application of such heat and the flow of said gaseous refrigerant to periods when said refrigerant circulating element or compressor of said system is in operation.

In carrying out the aforesaid object, it is a further object to initiate the application of heat and the flow of such gaseous refrigerant in response to a predetermined number of cycles of the refrigerant circulating element or by a timing device, and to further control such application of heat and flow of refrigerant so that such application and flow takes place only during periods when the refrigerant circulating element is in operation.

Another object of my invention is to provide a new method for defrosting a refrigerating system by utilizing the hot gases leaving the compressor and at the same time using extraneous heat by applying same to the liquid refrigerant in the evaporator of said system.

Another object of my invention is to provide an improved arrangement for defrosting a refrigerant evaporator by passing hot gases from the motor-compressor unit of a refrigerating system directly into the evaporator thereof wherein said gases are condensed, and to apply extraneous heat to the condensed liquid in said evaporator to aid in defrosting the evaporator.

Another object of my invention is to provide an improved arrangement for defrosting a refrigerant evaporator by passing hot refrigerant gases from the motor-compressor unit of a refrigerating system directly into the evaporator thereof wherein said gases are condensed, and to apply extraneous heat to the condensed liquid in said evaporator to aid in defrosting the evaporator, and to limit the flow of said hot gases into the evaporator and such application of extraneous heat to periods when the motor-compressor unit is in operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred forms of the present invention are clearly shown.

In the drawings:

Fig. 1 is a front view of a refrigerator embodying features of my invention and showing a portion thereof broken away;

Fig. 2 is a side view of the refrigerator showing a portion thereof broken away;

Fig. 3 is an isometric illustration of a refrigerant evaporator embodying features of my invention and shown removed from the refrigerator shown in Figs. 1 and 2;

Fig. 4 is a view of part of the evaporator taken along the line 4—4 of Fig. 3;

Fig. 5 is a diagrammatic illustration of the system embodying features of my invention, with an isometric illustration of the evaporator; and

Fig. 6 is a diagrammatic illustration of a portion of the system shown in Fig. 5 and showing a modified arrangement of control embodying features of my invention.

In accordance with my invention, I provide an arrangement for a refrigerating system for rapidly defrosting the refrigerant evaporator thereof. The refrigerating system includes a motor-compressor unit, a condenser and evaporator operatively connected together so that during normal operation the system cycles in response to changes of temperature in the refrigerant evaporator. This type of system is well known and used extensively at the present time. In such system, a small diameter capillary tube is used to control the flow of liquid refrigerant from the condenser to the evaporator. The gaseous refrigerant is evaporated in said evaporator and conducted from the evaporator to the motor-compressor unit through a vapor return conduit. The motor-compressor unit compresses the gaseous refrigerant and delivers the hot gaseous refrigerant to the condenser wherein it is liquefied and from which it is delivered to the small diameter or capillary tube. In the arrangement for defrosting, I utilize the hot gaseous refrigerant flowing from the motor-compressor unit by conducting same directly into the evaporator and by-passing the condenser of the refrigerating system. This is accomplished by means of a by-pass conduit which is normally closed by a solenoid valve but open during the period of defrosting to permit the refrigerant to by-pass the condenser and capillary tube so that the hot gaseous refrigerant flows directly into the evaporator. This hot gaseous refrigerant, when coming into contact with the interior of the refrigerant evaporator, condenses, due to the temperature of the walls of the evaporator which walls collect frost and ice thereon during normal operation of the system. The condensed refrigerant is at this time forced ahead of the gaseous refrigerant into the accumulator of the evaporator. Furthermore, I provide for applying extraneous heat to the liquid refrigerant condensed in the evaporator and confined in the accumulator therein at the time the hot gases are being sent directly into the evaporator. With the combination of hot gaseous refrigerant being passed directly into the evaporator, wherein such condenses, and by applying extraneous heat to such condensed refrigerant to evaporate the condensed refrigerant and to further raise the temperature of the evaporator and pressure therein, defrosting rapidly takes place so that frozen foods and the like stored therein do not have an opportunity to warm up sufficiently to melt before the defrosting phase has been completed and the refrigerating system is back in normal operation. In addition, I have provided for controlling the flow of hot gaseous refrigerant through the by-pass conduit and the operation of the heating element so that the same only come into operation after a predetermined number of cycles of the refrigerating system or by a timing device so as to provide automatic operation. When defrosting takes place after a predetermined number of cycles I have arranged to further control such application of heat and flow of hot gases in accordance with changes in temperatures of the evaporator so that such application and flow take place only during periods when the temperature of the evaporator is above a certain value and when the motor-compressor unit is in operation.

Referring to the drawings, the numeral 20 designates, in general, a refrigerator cabinet. Within the upper portion of the cabinet there is positioned a refrigerant evaporator 22 and in the lower portion of the cabinet there is positioned a refrigerant condensing or circulating element 24. Refrigerant supply and return conduits 26 and 28 respectively operatively connect the evaporator and the condensing element together.

The cabinet 20 comprises, in general, an outer casing 30 and an inner liner 32. These are made in box-like formation of sheet metal such, for example, as sheet steel, and are spaced apart allowing for suitable space for insulation 34 between the casing and liner walls. At the front of the cabinet, heat breaker strips 36 span the edges of the liner and casing and also serve as a finish strip around an access opening to the cabinet. A suitably constructed door 38 is provided to close the access opening and may be hinged to one side wall of the cabinet. Immediately below the door 38, a second door 40 is provided which closes the front of a machinery compartment 42 wherein the condensing element 24 is housed. This compartment 42 is in open communication at the rear thereof with a flue 44 which induces upward draft of air through the compartment to aid cooling of the condensing element 24.

The liner 32 forms walls of a food storage compartment 46 and of a freezing compartment 48 which are separated by a horizontal partition or air baffle 49. Arranged immediately below the evaporator 22, the baffle 49 is spaced from the cabinet door and rear wall to allow for limited air circulation between the evaporator and food storage compartment to cool the latter. Below the baffle 49, a number of shelves 50 may be suitably arranged and be supported on the liner sides. The baffle 49 also functions as a drip baffle for the defrosting operation and may be provided with a drain aperture to discharge into a removable container 51 which may be supported in the uppermost of the shelves 50.

Preferably, the evaporator 22 is of the so-called dry expansion type comprising, a refrigerant coil or conduit 52 and a heat absorbing member 54 in the form of a box-shaped container. The container 54 extends substantially from the door 38 to the liner rear wall and substantially to the liner side walls to provide a large heat absorbing surface and also to provide a large storage space for ice cubes, foods to be frozen, etc. A door 56 preferably closes the front of the container 54 to avoid loss of cold air therefrom when the outer door 38 of the refrigerator is opened.

As shown in Fig. 3, the evaporator coil 52 is wrapped in helical formation crosswise about the container 54 to extend along the top, bottom and sides thereof. Any suitable securing means, such as bituminous cement, may be used to secure the coil 52 in intimate contact with the container walls to obtain efficient transfer of heat from the container to the refrigerant or the same may be secured together by fusion.

On the rear wall of the container 54 is a refrigerant accumulator 60 which may be of tubular form and may extend longitudinally between the sides of the container or crosswise thereof. One end, as at 62, of the accumulator 60 is connected to the discharge end of the evaporator coil 52, and the other end, as at 64, of the accumulator is connected to the gaseous refrigerant return conduit 28.

The refrigerant condensing element 24 may be of conventional type having a motor-compressor unit 66 which generates heat and a finned condenser 68 which dissipates heat. The return conduit 28 is connected to the motor-compressor unit 66, and the refrigerant supply conduit 26 is connected to the condenser 68. A conduit 70 connects the motor-compressor outlet to the inlet of the condenser 68. As illustrated, the refrigerant supply conduit 26 is preferably a small diameter

or capillary tube arranged to control the flow of liquid refrigerant to the evaporator coil 52.

A thermostat 72 is provided for controlling cycling operation of the system in response to changes in temperature of the evaporator 22 to maintain desired evaporator 22 and compartment 46 temperatures. The thermostat 72 may be of the well-known type comprising, in general, a snap-acting switch 74 and a switch actuator or bellows 76, a conduit 80 and bulb 82. These form a closed system which may be charged with any of the well-known temperature responsive, expansible-contractable fluids. A connecting rod 84 operatively connects a movable end of the bellows 76 and the switch 74 together. The switch 74 comprises the usual movable switch mechanism 86, movable contact 88 and fixed contact 90.

The electric motor of the motor-compressor unit 66 and thermostatic switch 74 are electrically connected by lead wires 92, 94 and 96. The circuit through the thermostatic switch and motor is wires 92, 94, contacts 90, 88, and wire 96. Lead wires 92 and 96 may be connected to any suitable source of electrical energy.

During normal operation, the thermostat controls the cycling of the refrigerating system. When there is a demand for refrigeration the thermostat closes contacts 88 and 90 of switch 74 to close the circuit to the motor-compressor unit. This demand occurs when the temperature of the evaporator 22 reaches a predetermined high value to thus cause bellows 76 to expand and close contacts 88 and 90 and said circuit. When the temperature of the evaporator 22 reaches a predetermined low value the bellows 76 contracts to actuate switch 74 to open the said contacts and circuit to the motor-compressor. During such normal operation, liquid refrigerant is delivered from the condenser 68 to the evaporator 22 under the control of the small diameter or capillary tube 26. Within the evaporator the liquid is evaporated and from which it is conducted to the compressor through the vapor return conduit 28. The compressor compresses the refrigerant and delivers the same to the condenser wherein it is liquefied and from which it is delivered to the tube 26. During operation some liquid refrigerant is conducted into the refrigerant accumulator 60 as shown at 97, which is large enough to prevent any refrigerant passing into the return conduit 28. In charging the system with refrigerant, the proper amount is introduced thereinto so that some liquid will go into the accumulator during operation but none will flow therefrom. During operation, gaseous refrigerant is withdrawn from the upper region of the accumulator 60 and returned to the motor-compressor unit through the return conduit 28.

To provide for rapidly defrosting the evaporator 22 from ice and frost which collects thereon during normal operation, I provide a refrigerant by-pass conduit 100 to deliver hot gaseous refrigerant directly from the motor-compressor unit into the evaporator 22 during defrosting operation, and I provide an extraneous source of heat or electric heater 104 to heat the accumulator 60 and liquid contained therein during such period of defrosting.

The by-passed conduit 100 by-passes the refrigerant condenser and is illustrated as being connected at one end, as at 106, to the conduit 70 ahead of the inlet to the condenser. The other end of the by-passed conduit 100 is connected to the refrigerant evaporator coil 52. As shown, the by-passed conduit is much larger than the capillary tube which normally controls the flow of liquid refrigerant to the evaporator so that on defrosting, gaseous refrigerant is free to flow directly through the by-passed conduit into the evaporator without any reduction in pressure to the extent which would result in expansion upon the admission of such refrigerant into the evaporator 22. A valve 108 is positioned in conduit 100 and maintains said conduit closed to the flow of refrigerant therethrough during normal operation and is moved to open position

during defrosting of the evaporator to allow the flow of gaseous refrigerant through said conduit **100**. This valve is preferably an electrically operated solenoid valve but may be of any other suitable type or otherwise suitably controlled.

The heater **104** may be held by a clamp **110** to a flange **112** of the accumulator **60** as shown in detail in Fig. 4. The accumulator flange **112** may be formed with a groove **114** to receive the heating element **104** so as to obtain large surface contact therewith to provide high heat transfer therebetween. Screws **116** or other suitable securing means may be used to secure the clamp **110** to the accumulator flange and hold the heating element in heat conducting relationship therewith.

In order to provide for automatic defrosting any suitable counting or timing device now in use or known in the art may be used in order to control the energization of the heating element **104** and the operation of the valve **108**. In Fig. 5 I have shown a counting device **120** which is actuated by the connecting rod **84** of the thermostatic switch **72**. On the lower part of the connecting rod **84** is provided a pawl or finger **122** which engages teeth **124** of ratchet wheel **126**. The counting member is provided with an arcuate or cam portion **128** which when moved to engagement with a movable contact **130** will cause said contact to engage a stationary contact **132** to complete the circuit through the electric heater **104** and energizes the solenoid valve **108** to move same into open position to allow the by-pass of refrigerant around the condenser **68** and capillary tube **26**. The movable contact **130** is normally held in upper or open position by spring **134**. However, when the bellows **76** expands and causes connecting rod **84** to move downwardly, the pawl **122** will engage a tooth **124** of wheel **126** to move the wheel a certain distance and after the bellows is contracted the connecting rod **84** will move upwardly until there is again a demand for refrigeration which causes expansion of the bellows to move downwardly again to cause another movement of the ratchet wheel **126**. Accordingly, after a predetermined number of movements, the cam **128** engages the movable contact **130** to engage contact **132** to complete the circuit to the heater **104** and valve **108**. It will be noted that when the bellows expands and moves downwardly to cause connecting rod **84** to rotate the ratchet wheel, the circuit to the electric motor through contacts **88** and **90** is in closed position to permit the motor-compressor unit to operate. At the time contact **130** engages contact **132** the circuit through the electric heater is through wire **96**, contacts **88** and **90**, wire **140**, contacts **130** and **132**, wire **142**, heater **104**, wire **144**, valve **108**, and wires **148** and **92**. Consequently when the heater becomes energized the valve is simultaneously moved to open position and only during periods when the motor-compressor unit circuit is closed so that the compressor is in operation during the time the heater is energized and by-pass **108** is in open position. While the ratchet wheel and operating mechanism herein shown is diagrammatic, any suitable type of those well known may be utilized for closing a circuit in response to either thermostatically operated switch or pressure operated switch as is well understood in the art. In addition, the counting mechanism may be of any suitable type that may be closed upon predetermined movement thereof and opened by any means such as a spring **134** or other device which would tend to keep the circuit open to the heating element and solenoid valve except when the predetermined movement of the ratchet wheel causes the closing of the circuit to enable defrosting. In this connection, the arrangement is such that when the bellows expands, the connecting rod **84** not only causes the circuit through the motor-compressor unit to become closed but engages a tooth of the ratchet wheel to close the circuit through the heater and hold it in closed position until the bellows causes the connecting rod to rotate the ratchet wheel **126** sufficiently so that the cam **128** moves free of the contact **130** to allow the spring **134** to raise the contact **130** to open the circuit to the heater and valve winding.

In Fig. 6 I have shown a modified form of automatic control for defrosting wherein there is shown diagrammatically a clock or timer **160** used for actuating a wheel **162** having a cammed portion **164** which timer may be set so that the cam surface **164** will engage the movable contact **130** once every 24 hours to retain the contact **130** in engagement with contact **132** for a predetermined length of time after which the timer will move the cammed portion **164** away from contact **130** to allow the spring **134** to move the contact **130** away from contact **132** to interrupt the circuit to the heater and the solenoid valve. In this arrangement the timer **160** operates entirely independent of the thermostat control **72** which is utilized solely for making and breaking the circuit through the motor-compressor unit. It will be noted, however, that when the contact **130** is moved into engagement with contact **132**, contact **130** also engages a contact **170** which is connected by wire **172** with wire **94** and contact **130** is connected to wire **96** by wire **176** to complete the circuit through the motor-compressor unit so that the motor-compressor unit will be assured of operation during the period when the heater **104** is energized and the solenoid valve winding is energized. This takes place regardless of whether there is a demand for refrigeration by the thermostat **72** at the time when the clock or timer completes the circuit through the heating device and by-pass valve. When the cammed portion **164** moves past contact **130**, the spring **134** will cause contact **130** to move away from contact **170** at the same time it moves away from contact **132** to interrupt the circuit through the motor-compressor unit at this point. However, the motor-compressor unit may continue to operate in the event that the thermostat has the contacts **88** and **90** in closed position.

From the foregoing it will be readily understood that I have provided a system for defrosting a refrigerant evaporator by conducting hot gaseous refrigerant thereinto wherein it is condensed and the latent heat of condensation aids in melting the frost from the evaporator and the electric heating element vaporizes the condensed refrigerant to cause further melting of the frost by the heat of evaporation. In this type of arrangement the evaporator is defrosted in sufficient time to enable frozen foods stored therein to retain their frozen condition as the defrosting takes place before such frozen foods begin to thaw. Furthermore, the system is entirely automatic and is arranged so that the heating element and the solenoid valve cannot come into operation except when the defrosting period takes place and during that period the motor-compressor unit is assured of operation throughout the entire period when the heating element and solenoid valve are energized.

Although preferred and modified forms have been illustrated, and described in detail, it will be apparent to those skilled in the art that various other modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. Refrigerating apparatus comprising a motor-compressor unit, a condenser, a refrigerant avaporator having a liquid accumulator vessel at its outlet that contains liquid refrigerant during normal operation, supply means for conducting liquid refrigerant from said condenser to said evaporator, by-pass conduit means between the compressor and evaporator for conducting hot gaseous refrigerant directly from the compressor-unit into the inlet of said evaporator during operation of said unit, heating means adjacent said vessel for applying extraneous heat to the liquid refrigerant in said vessel of said evaporator only during the operation of said unit and the flow of hot gaseous refrigerant directly to said evaporator, and conduit means for conducting gaseous refrigerant from said evaporator to said unit.

2. Refrigerating apparatus comprising a motor-com-

pressor unit, a condenser, an evaporator having a liquid accumulator vessel at its outlet that contains liquid refrigerant during normal operation, a conduit connecting said unit with said condenser, a supply conduit connecting said condenser with said evaporator, a vapor return pipe connecting the outlet of said evaporator with said unit, means for by-passing said condenser and supply conduit to permit direct flow of gaseous refrigerant into the inlet of said evaporator from said unit, a valve for controlling said means for by-passing, a heating element arranged in the vicinity of said vessel and in heat exchange relation with liquid refrigerant in said vessel of said evaporator, and means for controlling said valve and said heating element to limit operation thereof during periods of operation of said unit.

3. Refrigerating apparatus comprising a motor-compressor unit, a condenser, an evaporator having a liquid accumulator vessel at its outlet that contains liquid refrigerant during normal operation, supply means for conducting liquid refrigerant from said condenser to said evaporator, conduit means between the evaporator and said unit for bypassing said condenser, a heating element in the vicinity of said vessel and in heat exchange relation with the liquid refrigerant in said vessel of said evaporator, and means for initiating the flow of refrigerant through said conduit means, the operation of said heating element and the operation of said motor-compressor unit at approximately the same time.

4. Refrigerating apparatus comprising a motor-compressor unit, a condenser, an evaporator having a liquid accumulator vessel at its outlet that contains liquid refrigerant during normal operation, a conduit connecting said unit with said condenser, a supply conduit connecting said condenser with said evaporator, a vapor return pipe connecting the outlet of said evaporator with said unit, means for by-passing said condenser and supply conduit to permit direct flow of gaseous refrigerant into said evaporator from said unit, a valve for controlling said means for by-passing, a solenoid for said valve, a heating element arranged in the vicinity of said vessel and in heat exchange relation with liquid refrigerant in said liquid collecting vessel of said evaporator, and means for causing energization of said solenoid and said heating element to limit operation thereof during periods of operation of said unit.

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