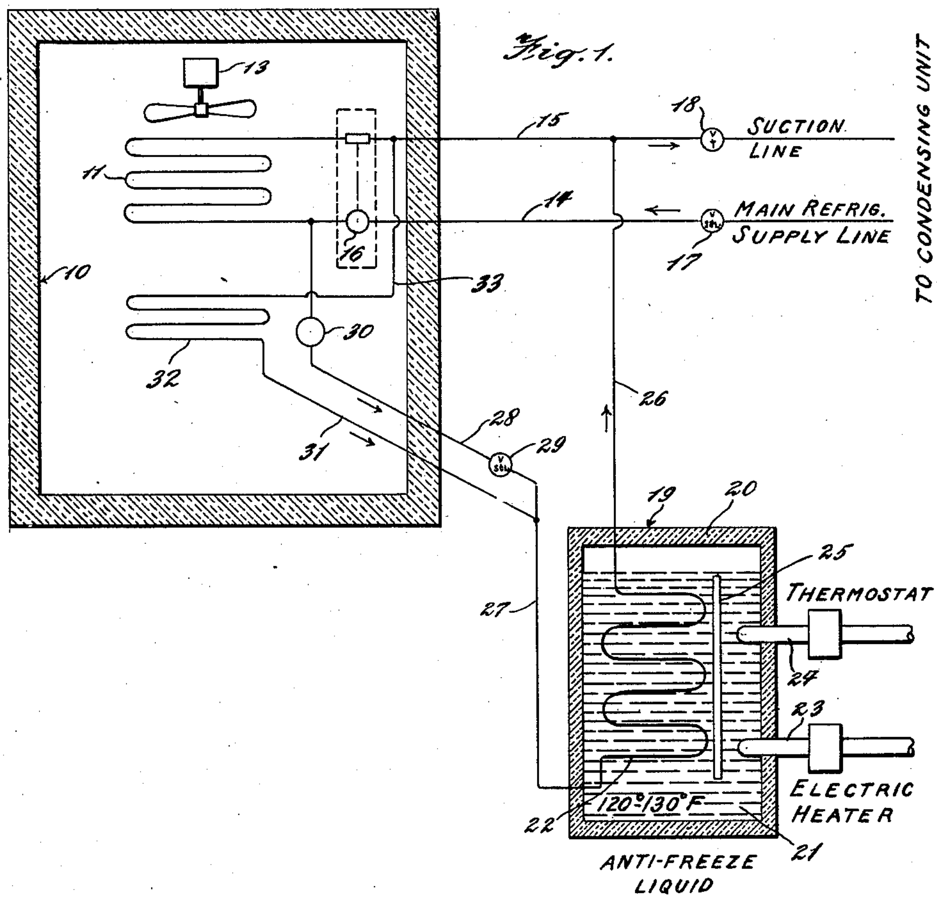
May 29, 1951 T. L. WARREN 2,554,848

METHOD AND APPARATUS FOR AUTOMATICALLY DEFROSTING EVAPORATORS

Filed Feb. 6, 1948 2 Sheets-Sheet 1



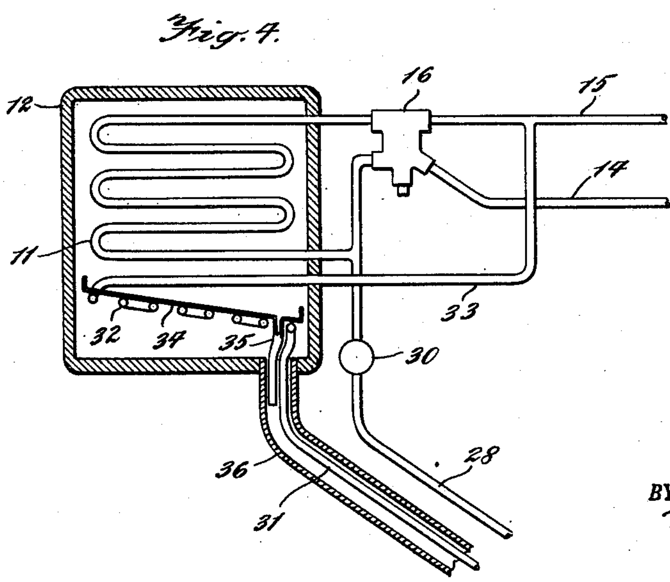


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Fig. 2.

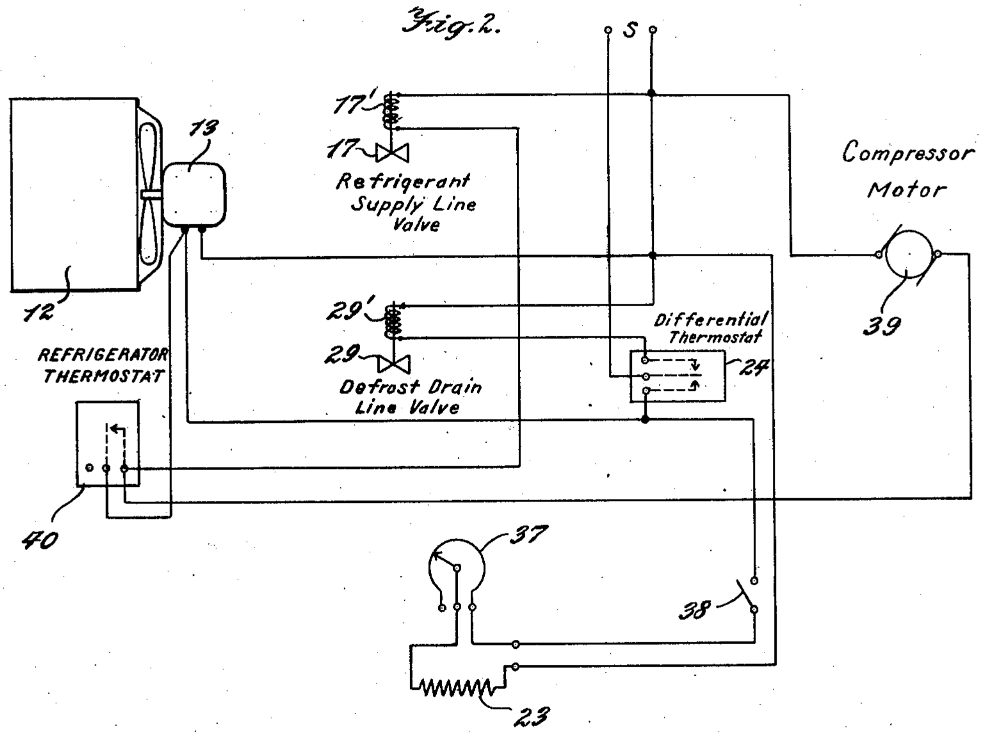


Fig. 3.

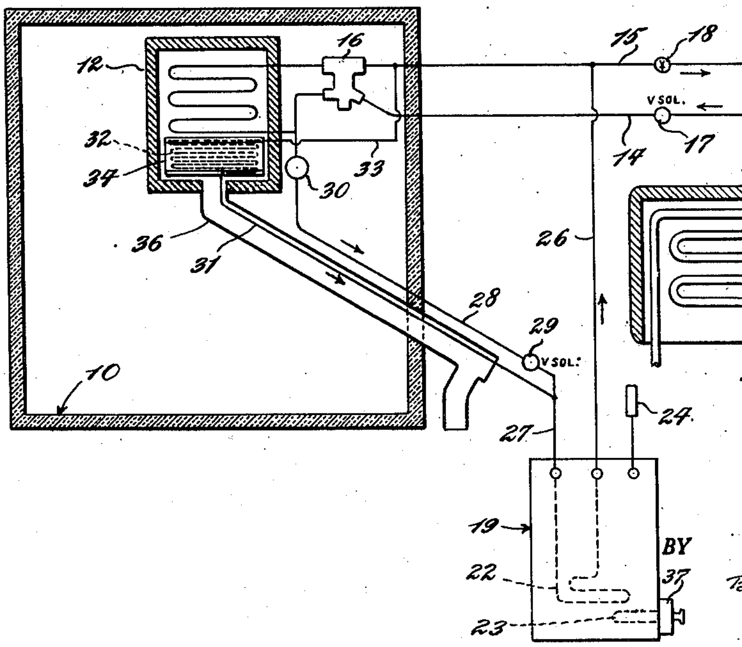
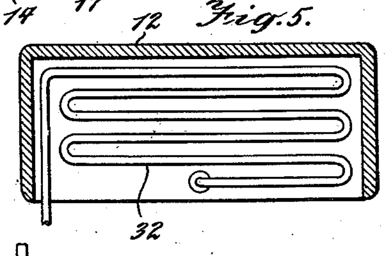


Fig. 5.



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METHOD AND APPARATUS FOR AUTOMATICALLY DEFROSTING EVAPORATORS

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15 Claims. (Cl. 62—4)

1

This invention relates to improvements in a method and an apparatus for defrosting an evaporator; and relates more particularly to a method and an apparatus for automatically defrosting one or more low temperature evaporators such as are used for preserving frozen food products requiring the maintenance of relatively low temperatures. It will be understood that while the present invention may be applied to commercial types of refrigerators, it may also be applied to smaller size domestic refrigerators or to any low temperature evaporator requiring a quick defrost regardless of the particular application of the evaporator.

In the preservation of frozen food products at low temperature (10° F. or less), it is desirable for efficient operation to provide a rapid defrost of the evaporator coil at frequent intervals to remove the ice from the coil without an excessive rise in the refrigerator temperature. Several methods have been used to accomplish this result. In one of these methods hot refrigerant gas from the discharge side of the compressor is pumped through the evaporator coil during the defrost cycle. Such a system melts the ice from the inside and provides a quick defrost without liberating an excessive amount of heat in the refrigerator, but the defrosting capacity of such a system is limited by the amount of hot gas that can be supplied by the compressor of the particular condensing unit and this system also causes an accumulation of liquid refrigerant in the evaporator coil which can pass back to the compressor unless an accumulator or heat exchange unit is used. Furthermore, such a system requires a connection to the discharge side of the compressor which necessitates the removal of the holding charge of refrigerant with which most condensing units are provided. Also, if the refrigerating cycle and the defrost cycle in such a system are automatically controlled by a timing device set for definite intervals of time, there will be a time lag that will shorten the defrost cycle if the refrigerator is down to temperature when the defrost cycle starts as the condensing unit will not be in operation.

The present invention is directed to providing a simplified apparatus and method for automatically defrosting an evaporator coil by circulating a hot refrigerant gas inside of the coil without the objectionable features of the hot gas defrosting systems previously used. The present invention avoids the necessity of using expensive control equipment and the defrosting operation is carried out independently of the condensing unit. The present invention also provides a defrosting method and apparatus in which the defrosting capacity, the length of the refrigerating cycle and the defrost cycle, and the rate of defrosting can each be adjusted as desired in accordance with the requirements for a particular refrigerator.

2

The foregoing and other objects and advantages of the present invention will be best understood from the following description and the accompanying drawings in which:

Fig. 1 is a schematic view illustrating a refrigerating unit with a defrosting system embodying the present invention;

Fig. 2 is a schematic wiring diagram for a refrigerating unit with a defrosting unit embodying the present invention;

Fig. 3 is a section view of a refrigerator with the connections to a defrosting unit embodying the invention being shown diagrammatically;

Fig. 4 is a side view in partial section illustrating a cooling unit in accordance with the invention; and

Fig. 5 is a section view of the evaporator housing showing the defrosting coil located therein.

Referring to the drawings in detail, there is a refrigerator which has a cabinet or box 10. A cooling unit having an evaporator coil 11 is enclosed in a housing 12 that is located within the cabinet 10, as shown in Figs. 3 and 4. A circulating fan 13 is secured to the housing 12 to circulate the air in the box over the evaporator coil 11. The evaporator coil 11 is connected to a condensing unit of the usual type (not shown) through a supply line 14 and a suction line 15 and the flow of liquid refrigerant to the evaporator coil may be controlled by a thermostatic expansion valve 16 of the type shown and described in application Serial No. 538,574, filed June 3, 1944, now Patent No. 2,475,556, issued July 5, 1949. A solenoid controlled valve 17 is located in the refrigerant supply line 14 and a throttling valve 18 is located in the suction line 15.

A separate unit or chamber 19 for effecting defrosting of the evaporator coil 11 and other parts of the cooling unit on which ice may collect is located outside of the refrigerator cabinet 10. The unit 19 consists of an insulated tank 20 containing a fixed quantity of liquid 21 such as a permanent type, anti-freeze solution that is capable of being heated and storing heat without materially changing the quantity of the liquid due to such heating. A heat exchange coil 22 is submerged in the liquid 21 and a low-wattage, immersion type electric heater 23 and an adjustable, differential thermostat 24 are also located in the liquid 21. The thermostat 24 may be of the remote bulb type with its bulb immersed in the liquid 21. A baffle plate 25 located between the heater 23 and the heat exchanger may also be provided in the tank 20 so as to cause circulation of the liquid 21 as it is being heated. The size of the tank 20 and the quantity of the liquid 21 will depend upon the size and type of the refrigerator and the quantity of the liquid 21 provided will have sufficient heat storing capacity to accomplish the defrosting of the evaporator under maximum load conditions.

The high side of the heat exchanger 22 is connected to the evaporator 11 through a line 26 and the suction line 15. The low side of the heat exchanger 22 is connected to the evaporator 11 by lines 27 and 28 and through a solenoid controlled valve 29 and a collector 30 in the line 28. The low side of the heat exchanger 22 is also connected to the suction line 15 through the line 27, a line 31, a defrosting coil 32 and a line 33.

As shown in Figs. 3 and 4, the defrosting coil 32 is located on the under side of a false drain pan 34 that is supported in inclined position in the bottom of the housing 12 beneath the evaporator coil 11. The false drain pan 34 has a drain 35 that extends into a water drain 36 for the housing 12 and the line 31 connecting the coil 32 to the heat exchanger also extends through the water drain 36.

As shown in the wiring diagram, Fig. 2, the low-wattage heater 23 is connected to a source of electrical energy S through a rheostat 37, a manually operable switch 38 and the differential thermostat 24. The connections of the heater 23 to the thermostat 24 are made so that during the refrigerating cycle the circuit to the heater is closed by the thermostat. Circuits connecting the fan 13, a solenoid 17′ for operating the solenoid controlled valve 17 in the refrigerant supply line 14, and a compressor motor 39 for the condensing unit to the source of electrical energy S are also closed by the thermostat 24 during the refrigerating cycle.

The circuits connecting the solenoid 17′ and the compressor motor 39 to the source of energy S also include a refrigerator thermostat of the usual type 40 that controls the operation of the compressor motor 39 and the valve 17 in the supply line in accordance with the temperature requirements of the refrigerator. The solenoid 17′ is arranged to open the valve 17 in the supply line when it is energized so that the valve 17 will be closed when the circuit to its control solenoid 17′ is interrupted by the operation of either the differential thermostat 24 or the refrigerator thermostat 40.

Upon the start of and during a defrost cycle, the operation of the differential thermostat 24 connects a solenoid 29′ for operating the solenoid controlled valve 29 in the defrost line 28 to the source of electrical energy S. The solenoid 29′ is arranged to open the valve 29 when it is energized and to close the valve 29 when the circuit to the solenoid 29′ is interrupted at the completion of the defrost cycle by the operation of the differential thermostat 24.

The time that it takes for the heater 23 to heat the liquid 21 in the unit 19 to a temperature that will cause the differential thermostat to operate for defrosting determines the length of the refrigerating cycle. The rate at which the heating of the liquid 21 takes place may be varied by adjusting the rheostat 37 and in addition, the temperatures at which the differential thermostat 24 operates may be adjusted within limits as desired or a thermostat 24 may be selected with appropriate operating characteristics. The thermostat 24 may be set, for example, to open the circuit to the heater 23 when the temperature of the defrost liquid 21 reaches 130° F. and to close the heater circuit when the temperature of the liquid 21 drops to 120° F. And the rheostat 37 may be set so that the heating of the liquid 21 from 120° F. to 130° F. by the heater 23 will take eight hours if that is the length of the refrigeration cycle desired.

At the start of a defrost cycle, a small amount of liquid refrigerant is contained in the evaporator 11 and in the refrigerant collector 30. When the valve 29 in the defrost line 28 is opened this liquid refrigerant flows under gravity through the defrost lines 28 and 27 to the heat exchanger 22 where, due to the high temperature of the liquid 21 in the unit 19, the liquid refrigerant is vaporized. The liquid head of the liquid refrigerant flowing to the heat exchanger 22 causes the hot refrigerant gas resulting from the vaporizing of the liquid refrigerant to flow through the line 26, the suction line 15 to the evaporator coil 11 and through the line 33 to the defrost coil 32 thus providing a simultaneous defrosting of the evaporator 11 and of any ice collected in drain pan 34.

The cold surfaces of the evaporator 11 and the drain pan 34 cause the hot refrigerant gas to cool and condense as it flows through the evaporator coil 11 and the defrost coil 32, thus, imparting its latent heat to such ice covered surfaces of the evaporator coil and the drain pan which causes the ice to melt and drain from the cooling unit. The condensed refrigerant liquid is continuously being revaporized and recycled as it flows by gravity through the defrost lines 28, 31 and 27 back to the heat exchanger 22 in the unit 19 where it is reheated and vaporized. The defrost drain line 31 from the coil 32 under false drain pan 34 extends inside of the water drain line 36 to a point outside of the refrigerator so that ice will not form in the drain line 36 during the defrost cycle. While the defrosting operation is being carried on the liquid 21 in the unit 19 cools and when it has cooled to a point where the differential thermostat 24 operates to close the circuit to the heater 23, the circuits to the refrigerating apparatus are also re-established in the manner previously described and the refrigerating cycle is started. The throttling valve 18 in the suction line 15 limits the suction that may be pulled through the suction line and prevents an overload on the compressor motor 39 at the start of the refrigerating cycle due to pressures that are built up in the system during the defrosting operation.

From the foregoing it will be seen that the defrosting operation is completely automatic and is entirely independent of the condensing unit so that the defrosting capacity is not limited by the amount of hot gas that can be pumped by the compressor. Also, the compressor is shut down during the defrosting cycle, thus conserving power.

The defrosting capacity, expressed in heat units, depends on the amount the liquid 21 in the defrosting unit is allowed to cool before the refrigerator cycle is repeated. This is controlled by the differential setting of the thermostat 24 and is adjustable over a wide range. Obviously, this can also be varied if necessary by selecting a suitable thermostat for the temperature range desired. The duration of the defrost cycle also depends on the differential setting of the thermostat. The speed of the defrosting depends upon the temperature to which the liquid 21 in the unit 19 for defrosting the evaporator coil is heated and this is controlled by the temperature setting of the thermostat 24, which is also adjustable over a wide range.

It will, thus, be seen that the temperature, the temperature range and the rate of temperature change of the liquid in the unit 19 for defrosting the evaporator coil are utilized in conjunction with the controls to regulate and automatically control the defrosting capacity and the duration of both the defrosting and refrigerating cycles and to provide adjustable means for varying both the capacity and duration of these cycles.

If desired, the duration of the refrigeration cycle and the defrosting cycle may be controlled by a conventional timing device that will initiate the respective cycles at predetermined time intervals. In this case, the thermostat 24 in the liquid 21 of the defrost unit 19 may be connected directly to the immersion heater 23 to control the heating of the liquid and will not control the operation of the valves 17 and 29. In this case the rheostat controlling the rate of heating may also be eliminated. Also, the solenoid controlled valves 17 and 29 may be provided with manual operating stems so that the cooling unit may be manually defrosted if desired.

In addition, a solenoid controlled valve may be located in the line 26 connecting the heat exchanger 22 to the suction line 15 if it is desired to shut the heat exchanger off from the suction line. Such a valve will also be controlled by the operation of the differential thermostat 24, or, if desired, the solenoid controlled valve 29 in the defrost line 28 may be placed in the line 26.

It will also be understood any suitable source of heat such as gas, electricity, steam or the like may be utilized for heating the liquid 21 in the defrosting unit. For example, in a refrigerated truck, the heat from the exhaust gases of the engine that is ordinarily wasted may be utilized for this purpose.

It will be understood that various modifications and variations particularly as to types of material, controls, arrangement of the apparatus and construction may be made in the embodiment of the invention as described and illustrated herein without departing from the scope of the invention as defined by the appended claims.

I claim:

1. An apparatus for automatically defrosting a refrigerator wherein hot refrigerant gas is heated and circulated through an evaporator independently of the refrigerator condensing unit comprising the combination of an evaporator, said evaporator having a suction line and refrigerant supply line connected to a condensing unit, a chamber containing a fixed quanity of a liquid, a heat exchanger submerged in said liquid, said heat exchanger being connected to the evaporator, an electrically operable valve located in the connections between the evaporator and the heat exchanger for controlling the flow of refrigerant through the heat exchanger, a second electrically operable valve located in the refrigerant supply line to the evaporator for controlling the supply of liquid refrigerant from the condensing unit to the evaporator, a differential thermostat operable by the temperature of the liquid in said chamber, circuits controlled by the operation of said thermostat for operating the valves in the connections to the defrosting unit and in the refrigerant supply line upon the temperature of said liquid reaching predetermined values and a heater for heating the liquid in said chamber, said heater being independent of the refrigerator condensing unit and controlled by the operation of the thermostat.

2. An apparatus for automatically defrosting an evaporator for a refrigerator as defined in claim 1 including a collector for collecting liquid refrigerant connected between the evaporator and the heat exchanger.

3. An apparatus for automatically defrosting an evaporator for a refrigerator as defined in claim 1 including a defrosting coil connected to the heat exchanger and located beneath the evaporator.

4. An apparatus for automatically defrosting an evaporator for a refrigerator as defined in claim 1 including a collector for collecting liquid refrigerant connected between the evaporator and the heat exchanger and a defrosting coil connected to the heat exchanger and located beneath the evaporator.

5. An apparatus for automatically defrosting an evaporator of a refrigerator by periodically circulating hot refrigerant gas through the evaporator independently of a condensing unit for the evaporator comprising the combination of a chamber containing a fixed quantity of a liquid, a heat exchanger located submerged in said liquid, a heater for heating said liquid, a collector connected to and located beneath the evaporator for collecting liquid refrigerant from the evaporator, a valve-controlled connection from the collector to the heat exchanger, said connection when open permitting liquid refrigerant to flow from the collector and the evaporator to the heat exchanger whereby the liquid refrigerant flowing from the collector and the evaporator to the heat exchanger will be heated and vaporized in the heat exchanger and the vaporized hot refrigerant gas will flow from the heat exchanger to the evaporator, a solenoid for operating the valve-controlled connection between the collector and the heat exchanger, a differential thermostat operable by the temperature of the liquid in the defrosting unit and circuits controlled by the operation of said thermostat for operating the heater and the valve controlling solenoid when the temperature of the liquid in the defrosting unit reaches predetermined values.

6. In an apparatus for defrosting an evaporator for a refrigerator by circulating hot refrigerant gases through the evaporator independently of its condensing unit comprising the combination of a chamber containing a fixed quantity of a liquid, a heat exchanger submerged in the liquid, a heater for heating said liquid to a

predetermined temperature, a collector connected to and located beneath the evaporator for collecting liquid refrigerant from the evaporator, a valve-controlled connection from the collector to the heat exchanger, said connection when open permitting liquid refrigerant to flow from the collector to the heat exchanger, and a connection from the heat exchanger to the evaporator for permitting hot refrigerant gas resulting from the heating and vaporizing of the liquid refrigerant in the heat exchanger to flow from the heat exchanger to the evaporator.

7. An apparatus as defined in claim 6 including a thermostat operable by the temperature of the liquid in said chamber and a circuit controlled by said thermostat for controlling the operation of the heater for heating the liquid.

8. The method of defrosting an evaporator of a refrigeration unit in which hot refrigerant gas is circulated through the evaporator independently of a condensing unit for the evaporator, which comprises the steps of heating a fixed quantity of a liquid at a constant rate to a predetermined temperature in a zone insulated from the refrigeration unit, said heating being carried out independently of the condensing unit during a refrigerating cycle of the evaporator, then heating and vaporizing a liquid refrigerant from the evaporator in said heated liquid and then circulating the vaporized refrigerant resulting from said heating of the liquid refrigerant through the evaporator, said heating and circulating steps being carried out with the connections between the evaporator and the condensing unit closed.

9. The method of defrosting an evaporator of a refrigeration unit in which hot refrigerant gas is circulated through the evaporator independently of a condensing unit for the evaporator, which comprises the steps of heating a fixed quantity of a liquid at a constant rate to a temperature in the neighborhood of 130° F. in a zone insulated from the refrigeration unit, said heating being carried out independently of the condensing unit during a refrigerating cycle of the evaporator, then heating and vaporizing a liquid refrigerant from the evaporator in said heated liquid and then circulating the vaporized refrigerant resulting from said heating of the liquid refrigerant through the evaporator, said heating and circulating steps being carried out with the connections between the evaporator and the condensing unit closed.

10. The method of defrosting an evaporator of a refrigeration unit in which hot refrigerant gas is circulated through the evaporator independently of a condensing unit for the evaporator, which comprises the steps of heating a fixed quantity of a liquid at a constant rate to a predetermined temperature in a zone insulated from the refrigeration unit, said heating being carried out independently of the condensing unit during a refrigerating cycle of the evaporator, then heating and vaporizing a liquid refrigerant from the evaporator in said heated liquid and then circulating the vaporized refrigerant resulting from said heating of the liquid refrigerant through the evaporator under the head of the liquid refrigerant in the evaporator, said heating and circulating steps being carried out with the connections between the evaporator and the condensing unit closed.

11. The method of automatically defrosting an evaporator of a refrigeration unit periodically wherein a liquid refrigerant is heated and hot refrigerant gas is circulated through the evaporator independently of a condensing unit for the evaporator, which comprises the steps of heating a fixed quantity of a liquid independently of a condensing unit for an evaporator in a zone insulated from the evaporator, said heating being conducted during the refrigeration cycle of the evaporator and at a constant rate, stopping the operation of the condensing unit upon the temperature of said liquid reaching a predetermined value, then heating the liquid refrigerant from the evaporator in said heated liquid and vaporizing the same and then circulating the vaporized refrigerant resulting from said heating of the liquid refrigerant through the evaporator.

12. The method of periodically and automatically defrosting an evaporator of a refrigeration unit where a liquid refrigerant is heated and hot refrigerant gas is circulated through the evaporator independently of a condensing unit for the evaporator, which comprises the steps of heating a fixed quantity of a liquid independently of a condensing unit for an evaporator in a zone insulated from the evaporator, said heating being conducted during the refrigeration cycle of the evaporator and at a constant rate, stopping the operation of the condensing unit upon the temperature of said liquid reaching a predetermined value and then heating the liquid refrigerant from the evaporator in said heated liquid and vaporizing the same and then circulating the vaporized refrigerant resulting from the heating of the liquid refrigerant through the evaporator under the head of the liquid refrigerant in the evaporator.

13. In a system for defrosting an evaporator of a refrigeration unit wherein hot refrigerant gases are circulated through the evaporator independently of a condensing unit for the evaporator, the combination which includes a chamber containing a fixed quantity of a liquid, said chamber being insulated from the evaporator, means for heating the liquid in said chamber at a constant rate, said heating means being independent of the condensing unit for the evaporator, a heat exchanger in said heated liquid, said heat exchanger being connected to the evaporator, a valve located in one of the connections between the heat exchanger and the evaporator, said valve normally being closed during a refrigerating cycle of the evaporator and means for opening said valve, the operation of said valve-opening means being controlled by the temperature of the heated liquid.

14. In a system for defrosting an evaporator of a refrigeration unit wherein hot refrigerant gases are circulated through the evaporator independently of a condensing unit for the evaporator, the combination as defined in claim 13 wherein the means for heating the liquid at a constant rate is adjustable.

15. In a system for defrosting an evaporator of a refrigeration unit wherein hot refrigerant gases are circulated through the evaporator independently of a condensing unit for the evaporator, the combination which includes a chamber containing a fixed quantity of a liquid, said chamber being insulated from the evaporator, means for heating the liquid in said chamber at a constant rate, said heating means being independent of the condensing unit for the evaporator, a heat exchanger in said heated liquid, said heat exchanger being connected to the evap-

orator, a valve located in one of the connections between the heat exchanger and the evaporator, said valve normally being closed during a refrigerating cycle of the evaporator, a second valve located in a supply line connecting the evaporator to the condensing unit, said second valve normally being open during the refrigerating cycle and means for opening the first valve and closing the second valve, the operation of said valve opening and closing means being controlled by the temperature of the heated liquid.

THOMAS L. WARREN.

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