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MULTIPLE TEMPERATURE REFRIGERATING APPARATUS

Filed April 2, 1956

2 Sheets-Sheet 1

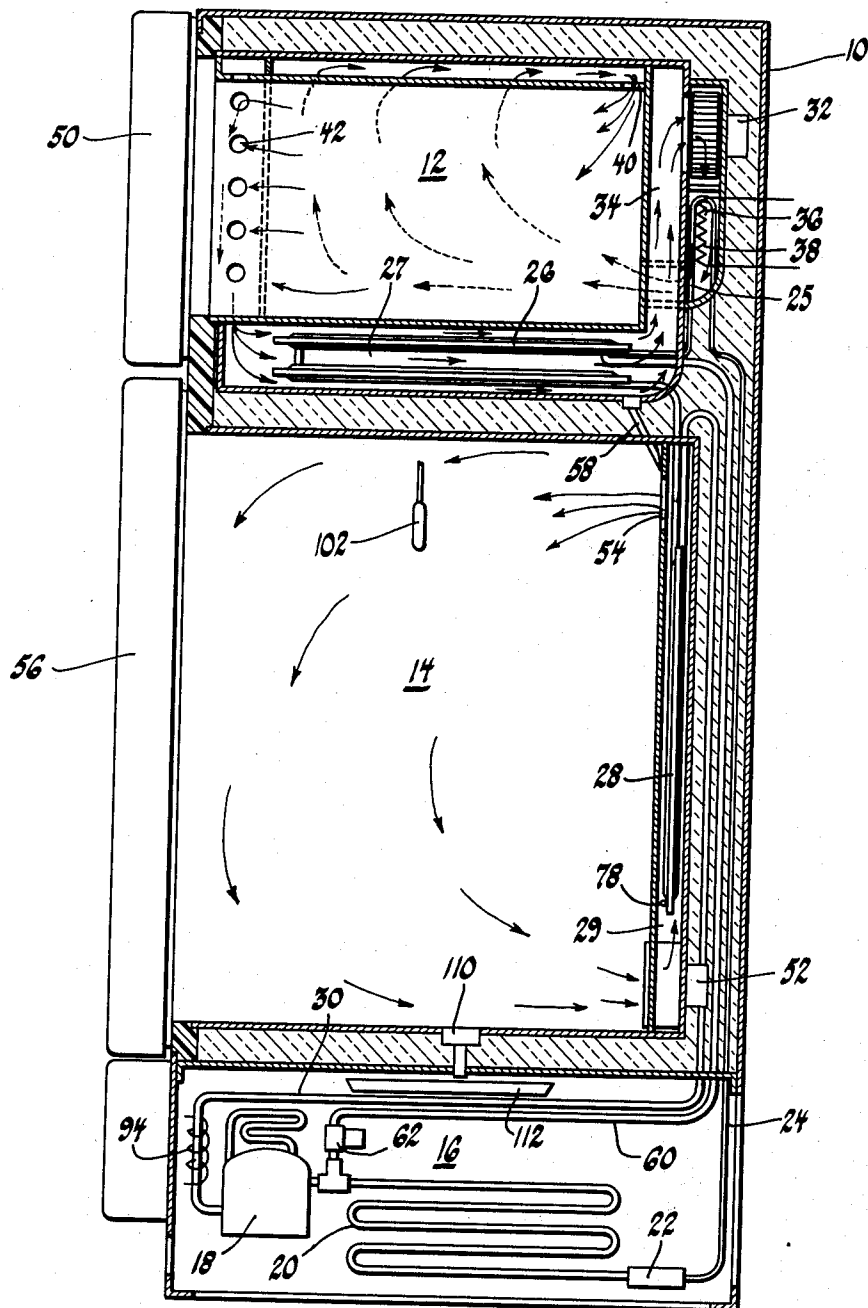


Fig. 1

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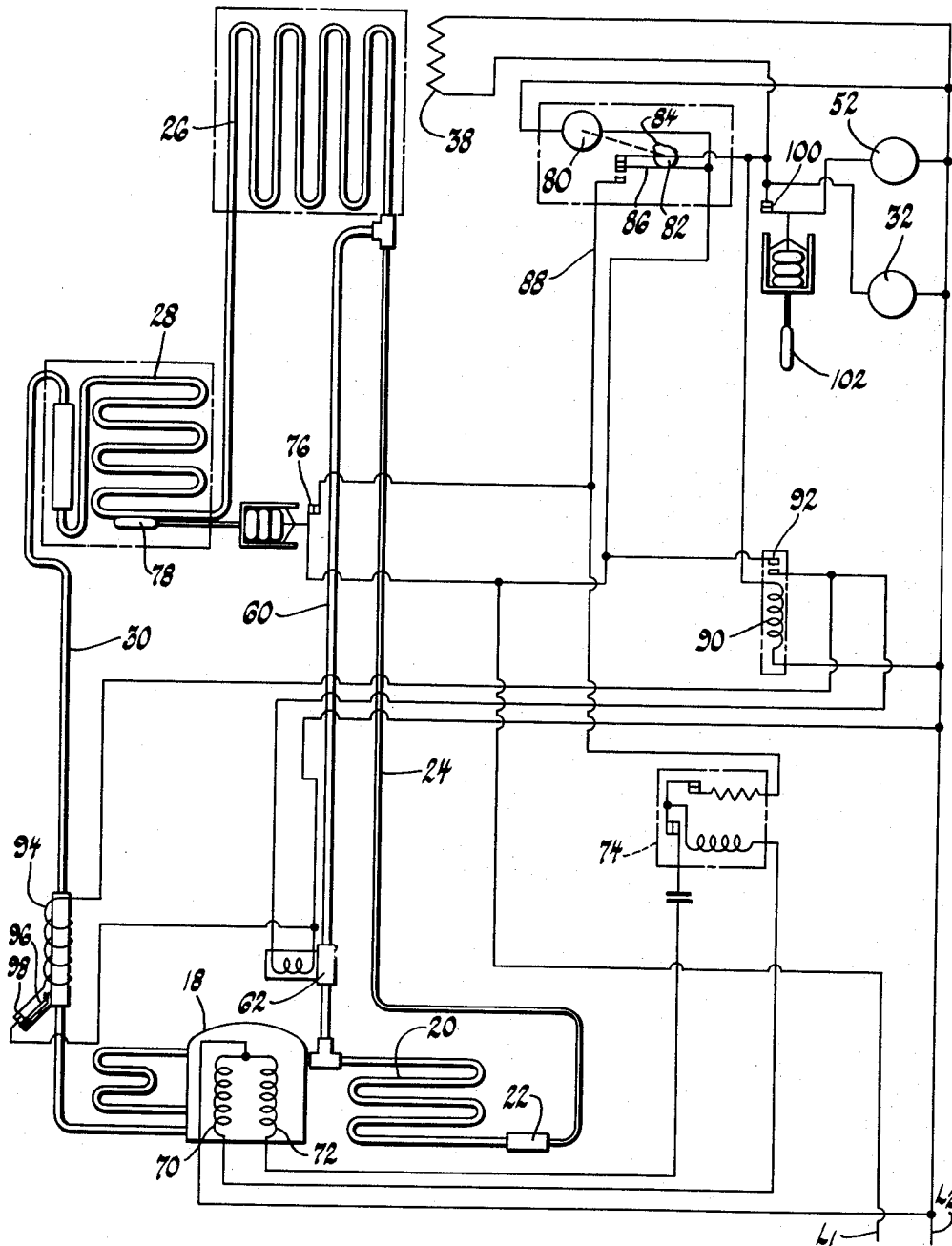


Fig. 2

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MULTIPLE TEMPERATURE REFRIGERATING APPARATUS

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4 Claims. (Cl. 62-196)

This invention relates to refrigerating apparatus and more particularly to a multiple temperature evaporator having means for maintaining the food compartments relatively frost-free at all times.

It is an object of this invention to provide a refrigerator wherein any frost which may momentarily form in the frozen food storage compartment will be removed by the sublimation thereof.

Still another object of this invention is to provide an improved control arrangement for a self-defrosting refrigerating system.

Further objects and advantages of the present invention will become apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figure 1 is a vertical sectional view, somewhat schematic, showing a preferred embodiment of the invention; and

Figure 2 is a schematic view showing diagrammatically the refrigeration circuit and also the electrical controls.

Referring now to the drawing, wherein a preferred embodiment of the invention has been shown, reference numeral 10 generally designates an insulated refrigerator cabinet having a frozen food storage compartment 12, an unfrozen food storage compartment 14 and a machinery compartment 16. The refrigerating system used for cooling the compartments 14 and 16 includes a conventional motor-compressor unit 18 which serves to discharge compressed refrigerant vapor into a conventional condenser 20. The condenser converts the compressed refrigerant vapor into a liquid before discharging the same into the usual drier-filter unit 22 wherein moisture and other impurities are removed from the liquid refrigerant. The liquid refrigerant then flows through a capillary tube type of restrictor 24 which conveys the liquid into a first multiple plate evaporator 26 which serves to cool and dry air for the frozen food storage compartment 12. One portion 25 of the line which feeds liquid refrigerant to the evaporator 26 is arranged in the path of the air leaving the evaporator 26 so as to reheat the air for a purpose explained hereinafter. The evaporator 26 is preferably in the form of a pair of refrigerated plates located in a chamber 27 substantially coextensive with the bottom wall of the frozen food storage compartment 12. The outlet from the evaporator 26 is connected directly to a second plate evaporator 28 located in an air duct 29 adjacent the rear wall of the food storage compartment

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14. In view of the direct unrestricted connection between the evaporators 26 and 28, both will be operated at substantially the same pressure. A suction line 30 connects the outlet of the evaporator 28 to the inlet of the motor compressor unit 18 in accordance with standard refrigeration practice.

Whereas the conventional frozen food storage compartment evaporators completely surround the frozen food storage compartments, the evaporator 26 shown herein is located in an air duct or heat removing chamber 27 located directly beneath the frozen food storage compartment 12 and a fan 32 is used for forcefully circulating air over the evaporator 26 and through the interior of the frozen food storage compartment 12 forming a first air circuit in a manner similar to that disclosed in copending application Ser. No. 555,333, filed December 27, 1955. Thus, as disclosed in Fig. 1 of the drawing, the air leaves the heat removing compartment 27 through a duct 34 which leads directly to the inlet of the fan 32. The outlet of the fan 32 discharges the refrigerated air through a heat acquiring duct 36 in which the cold dehumidified air leaving the evaporator 26 is partially reheated by the liquid refrigerant flowing through the line 25. An electric heater element 38 is also arranged, as shown, to assist in partially reheating the refrigerated air flowing through the duct 36. The air is thus reheated so as to reduce the relative humidity of the air and thereby increase the ability of the air to take on additional moisture for the purpose of sublimating frost from the frozen food compartment 12.

The outlet of the air duct 36 discharges air into the hollow side and top walls of the frozen food storage compartment 12 in the manner indicated by the arrows so as to refrigerate the side and top walls of the compartment 12. After the air has circulated through these hollow walls, it discharges into the main food storage compartment 12 from a point adjacent the upper rear portion of the frozen food storage compartment through the air outlet slot 40. The air then sweeps forwardly through the interior of the compartment 12 and leaves through a plurality of ports 42 located adjacent the front edges of the frozen food storage compartment.

It has been discovered that the relatively cold dry air which is thus circulated through the frozen food storage compartment serves to sublimate any frost which may have formed on the inner walls of the frozen food storage compartment 12 or on the packages stored therein as a result of relatively moist warm room air having entered the frozen food storage compartment while the access door 50 has temporarily been opened. The sublimed moisture is picked up by the cold dry air flowing through the compartment 12 and is thereafter deposited on the cold surfaces of the evaporator 26, in the form of frost. The frost which accumulates on the evaporator 26 during any "on" cycle of the evaporator is not visible to the user and is periodically removed in a manner to be explained more fully hereinafter.

The evaporator 28 which serves to refrigerate the compartment 14 is located in an air duct 29, as shown. A fan 52 serves to withdraw air from the lower rear portion of the compartment 12 and circulates the air throughout this second air circuit upwardly through the air duct 29 in thermal exchange relationship with the evaporator 28

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before discharging the air thus refrigerated through an air outlet 54 located adjacent the upper rear portion of the compartment 14. By virtue of the above-described second air circuit and circulating arrangement, it has been found that substantially uniform temperatures, in the neighborhood of 36°, may be maintained throughout the entire food compartment 14. This is particularly important in refrigerators wherein foods are stored in containers and on door-mounted shelves, not shown, provided on the inner surface of the main door 56.

As best shown in Fig. 1 of the drawing, defrost water from the evaporator 26 drains from the compartment 27 through a drain-pipe 58 which discharges the defrost water onto the rear wall of the compartment 14. Defrost water from the evaporator 28 discharges into the lower part of the compartment 14 and finally drains through the usual drain 110 which directs all of the defrost water which does not reevaporate in the compartment 14 into a vaporizing pan 62 located directly above the condenser 20.

The refrigeration circuit includes a bypass line 60 which leads directly from the outlet of the compressor to the inlet of the frozen food storage compartment evaporator 26, as best shown in Fig. 2 of the drawing. A solenoid operated valve 62 is located in the line 60 and is closed at all times except when it is desired to defrost the evaporator 26.

The motor of the motor-compressor unit 18 includes the usual main winding 70 (see Fig. 2) and starting winding 72 which are controlled by means of a conventional starting relay 74 which in turn is controlled by a compressor cycling switch 76 arranged in the circuit, as shown. This switch 76 is adapted to be operated by means of a thermostat 78 located adjacent the lower end of the plate evaporator 28. The thermostat 78 is preferably so calibrated that the motor-compressor unit 18 is energized when the temperature at the thermostat 78 goes above 6° and is not stopped until the temperature at the thermostat 78 goes below -2°.

When it is desired to defrost the evaporators 26 and 28 the valve 62 in the bypass line 60 is opened so as to relieve the pressure in the condenser and to direct hot gas leaving the motor-compressor unit 18 and the condenser 20 directly into the inlet of the evaporator 26 so as to thereby cause heating of the evaporators 26 and 28. The control for the valve 62 consists of a timing device or clock 80 which drives a rotatable switch operating cam 82, as shown. The cam 82 and the clock 80 are preferably so designed that the cam 82 makes one complete revolution every twenty-four hours. The cam 82 is provided with a projection 84 which moves the switch arm 86 from its upper position, as shown in Fig. 2, to a lower position so as to close the circuit through the line 88. As the switch arm 86 moves down, it serves to bypass the switch 76 so as to cause operation of the motor-compressor unit 18 irrespective of the position of the switch 76. It also serves to open the circuits to the motors for the evaporator blowers 32 and 52 so as to prevent operation of the blower motors during the defrost operation. When the switch contact 86 moves down it de-energizes the solenoid coil 90 and thereby causes closing of the relay contacts 92. Closing of the contacts 92 serves to energize a heater 94 located on the suction line, as shown, so as to cause heating of the suction line during the defrosting operation. The purpose of this is to prevent any liquid refrigerant slugs from entering the motor-compressor unit during the defrost cycle.

A thermostat 96 which responds to the temperature of the suction line serves to open the circuit to the heater 94 through the switch contacts 98 in the event that the temperature of the suction line exceeds a predetermined value. As best shown in Fig. 2 of the drawing, the unfrozen food storage compartment blower 52 is controlled

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by means of a thermostatically operated switch 100 which, in turn, is controlled by the temperature responsive bulb assembly 102 which responds to the temperature of the unfrozen food compartment.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In combination: a refrigerator having a first compartment to be maintained at a temperature below 32° F. and a second compartment to be maintained at a refrigerating temperature above 32° F.; a casing surrounding a major portion of said first compartment and having an air inlet and an air outlet from said first compartment; a refrigerating system having a refrigerant liquefier and refrigerant evaporator means, a first portion of said evaporator means arranged in thermal exchange with said first compartment and another portion of said evaporator means being arranged in thermal exchange with said second compartment; first air circulating means for causing circulation of air from said air outlet past said one portion of said evaporator and then through said air inlet into said first compartment; second air circulating means for recirculating air back and forth between said second compartment and said another portion of said evaporator means, and an electric heater arranged to heat the air leaving said first portion of said evaporator means before said air enters said first compartment.

2. In combination: a refrigerator having a food storage compartment to be maintained at a temperature below 32° F., said refrigerator including a casing surrounding a major portion of said compartment and having an air inlet and an air outlet communicating with said compartment, a refrigerating system having a refrigerant liquefier and a refrigerant evaporator connected in series; means for controlling said refrigerating system to operate said evaporator normally at temperatures substantially below freezing means for supporting said evaporator outside of said food storage compartment; air circulating means causing circulation of air from said air outlet over said evaporator and then through said air inlet into said food storage compartment, and means for adding sufficient heat to the air leaving said evaporator prior to its introduction into said food storage compartment to prevent the deposit of frost therein, said last named means using heat from the refrigerating system.

3. In combination: a refrigerator having a food storage compartment to be maintained at a temperature below 32° F.; means for refrigerating said compartment and for removing frost from said compartment by sublimation comprising a refrigerating system having a refrigerant liquefier and a refrigerant evaporator connected in series; means for controlling said refrigerating system to operate said evaporator normally at temperatures substantially below freezing means for supporting said evaporator outside of said food storage compartment; air circulating means arranged to circulate air from said compartment into thermal exchange relationship with said evaporator and then into said food storage compartment; and means for heating the air leaving said evaporator prior to its introduction into said food storage compartment sufficiently to prevent the deposit of frost therein, said last-named means utilizing heat contained in the refrigerant flowing from said refrigerant liquefier to said evaporator.

4. In combination, a refrigerator having a food storage compartment to be maintained at a temperature below 32° F.; means for refrigerating said compartment and for removing frost from said compartment by sublimation comprising a refrigerating system having a compressor, a condenser, an evaporator, and means connecting said compressor, condenser and evaporator in series refrigerant flow relationship; said last named means including a pressure reducing means between said condenser and said evaporator; air circulating means arranged to circu-

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late air from said compartment into thermal exchange relationship with said evaporator and then into said food storage compartment; means for cyclically removing frost from said evaporator; said last named means comprising a by-pass line connecting the outlet of said compressor to the inlet of said evaporator so as to by-pass said condenser and said pressure reducing means, and means for applying heat for vaporizing liquid refrigerant returning to said compressor during the frost removing cycle, said last named means including a thermostat for preventing the application of heat whenever the temperature of the refrigerant returning to said compressor exceeds a predetermined value.

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