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3,133,423

SELF-DEFROSTING REFRIGERATION APPARATUS

Filed July 16, 1962

2 Sheets-Sheet 1

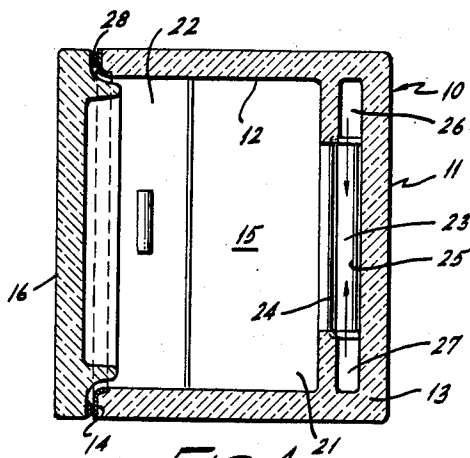


FIG. 4.

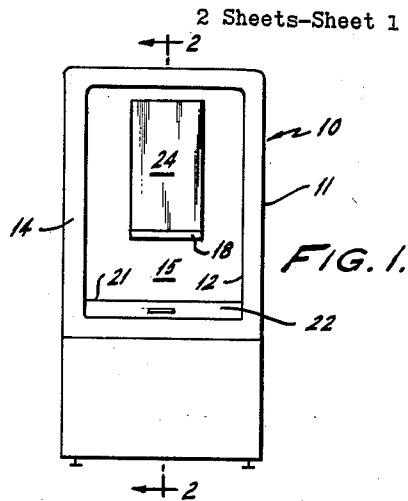


FIG. 1.

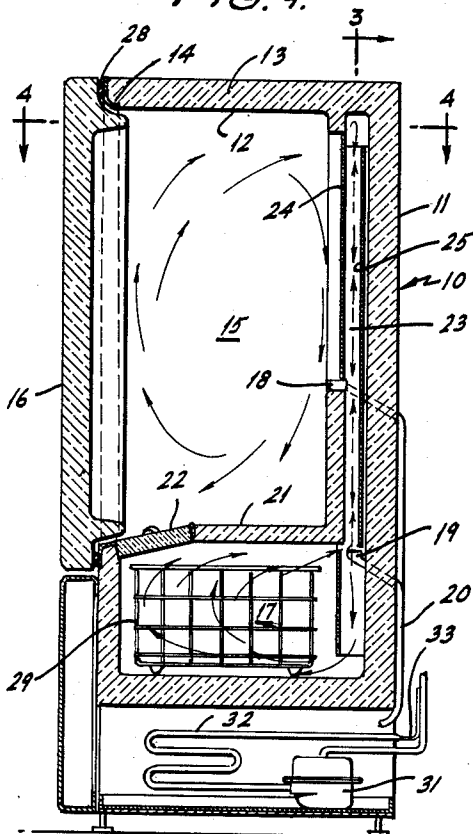


FIG. 2.

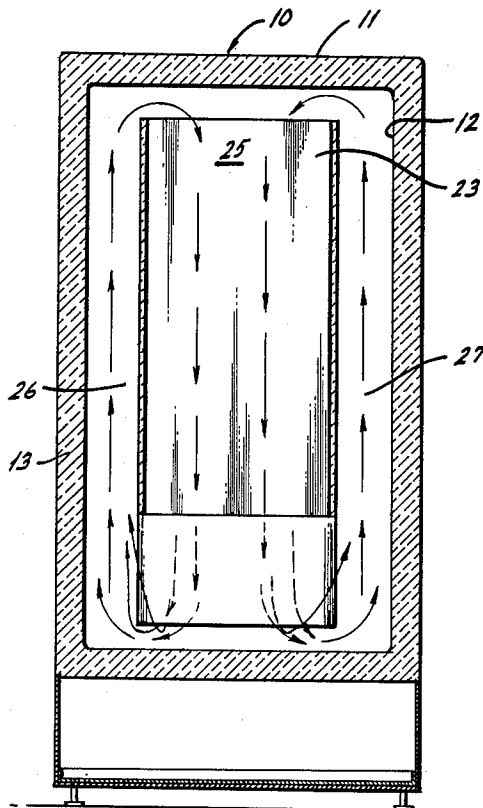


FIG. 3.

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2 Sheets-Sheet 2

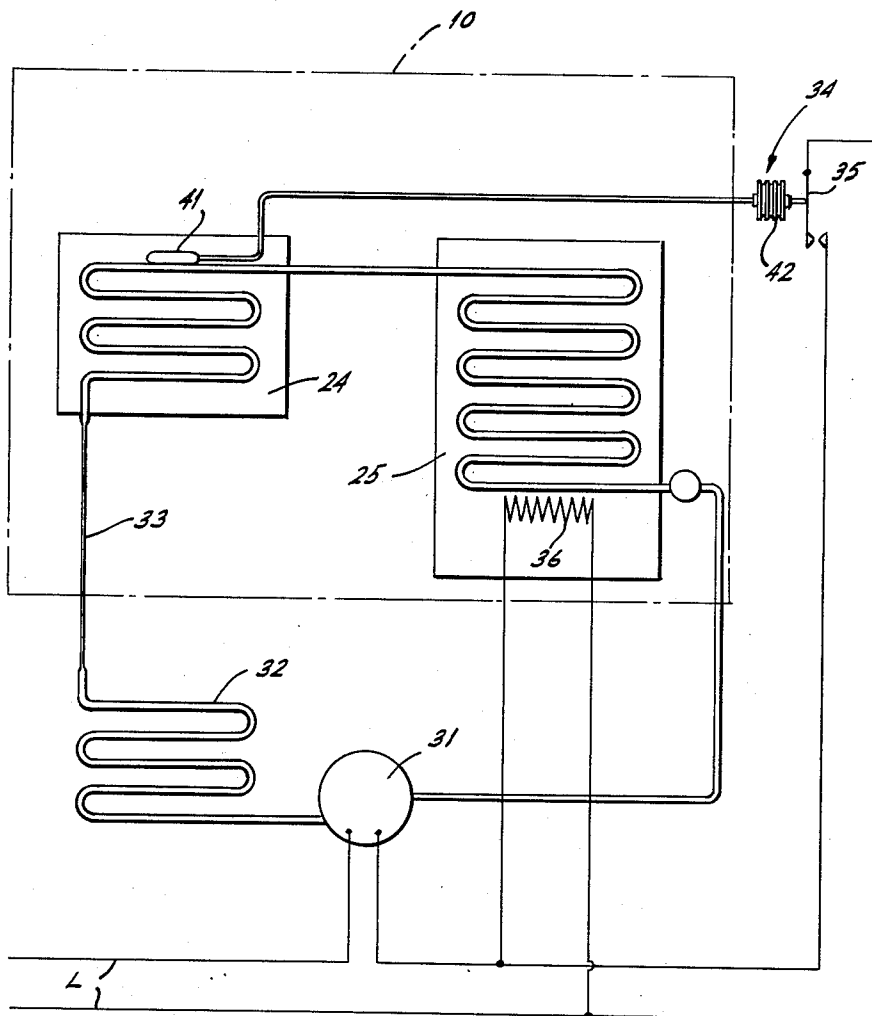


FIG. 5.

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SELF-DEFROSTING REFRIGERATION APPARATUS
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8 Claims. (Cl. 62—156)

This invention relates to refrigeration and more particularly to refrigerated storage cabinets of the type in which there are provided both above-freezing and below-freezing storage compartments.

In order effectively to defrost cooling elements of a refrigerator it has been found helpful to defrost at frequent intervals, inasmuch as lesser amounts of frost are involved. Frequent defrosting of cooling elements adapted to refrigerate above-freezing compartments can normally be effected merely by deenergizing the same and permitting heat arising from normal cabinet heat leakage to melt the frost. However, cooling elements for below-freezing compartments normally are so closely disposed as respects the interior of the compartment and its contents as to require auxiliary heating means to facilitate defrosting. Natural heat-leakage is relatively ineffective to defrost the low temperature cooling element due to the thermal mass of the relatively cold frozen foods disposed in direct heat exchange relation with the latter cooling element. This condition renders natural defrosting so slow, that some thawing of the frozen foods may occur. Moreover, there is some risk of thawing frozen foods in close thermal exchange relation with the cooling element, even when use is made of auxiliary heating means to defrost the latter.

It is therefore a broad objective of the invention to provide simple and effective cooling means for both the above freezing and the below-freezing storage compartments of a refrigerator cabinet, which means may be defrosted periodically without deleteriously affecting stored foods.

It is a specific objective of the invention to provide centralized defrostable cooling means for at least a below-freezing and an above-freezing compartment wherein heat for defrosting may be derived either from natural heat leakage into the above-freezing compartment or from auxiliary heating means applied directly to the cooling means, or from a combination of both means.

It is a further objective of the invention to provide cooling means for at least a pair of storage compartments each to be maintained at a different temperature, which means cools such compartments by thermosyphonic flow of air between the cooling means and said compartments.

To the foregoing general ends the invention contemplates, in a preferred embodiment, the combination comprising: an above-freezing temperature insulated storage compartment; a below-freezing temperature insulated storage compartment disposed below the former; first air flow duct means extending vertically from the lower region of said below-freezing compartment; first and second parallelly disposed cooling plate means spaced from one another, coextensive with said duct means, and disposed for heat exchange with air flowing through the latter, said second plate means including heat exchange surface portions opposite said duct means and disposed to cool air within said above-freezing compartment; and second vertically extending air flow duct means adjacent said first duct means, said second duct means communicating with an upper region of said first duct means and an upper region of said first duct means and an upper region of said below-freezing compartment, the construction and arrangement being such that said above-freezing compartment is cooled by flow of air therein over said heat ex-

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change surface portions of said second plate means, and said below-freezing compartment is cooled by air therein flowing upwardly through said second duct means thence into said first duct means and downwardly therethrough in heat exchange relation with said first cooling plate means.

There is further provided means for periodically defrosting the cooling plate means, the construction and arrangement of the duct means being such as to minimize temperature rise within the below-freezing compartment during such defrosting.

The foregoing and other objectives will best be understood from a consideration of the following description taken in light of the accompanying drawing, in which:

FIGURE 1 is an elevational showing, with parts removed or broken away, of refrigerator cabinet structure embodying the invention;

FIGURE 2 is a sectional view looking in the direction of arrows 2—2 applied to FIGURE 1;

FIGURE 3 is a sectional view looking in the direction of arrows 3—3 applied to FIGURE 2;

FIGURE 4 is a horizontal sectional view looking in the direction of arrows 4—4 applied to FIGURE 2; and

FIGURE 5 is a somewhat diagrammatic showing of electrical and refrigerant circuit elements useful in carrying out the invention.

With more detailed reference to the drawing, and first to FIGURES 1 and 2, a refrigerator cabinet 10 comprises an outer shell 11 and an inner liner 12 spaced therefrom by suitable insulation means 13, and which shell and liner are, for the sake of convenience, represented by single lines in the sectional views. Conventional breaker strip means 14 extends between the outer shell and inner liner, and frames the front access opening of the above-freezing temperature compartment 15. Compartment 15 is closed by an insulated door 16 (not shown in FIGURE 1) hingedly mounted to the cabinet, in accordance with usual practice, and provided with a sealing gasket 28 that seals against a suitably presented face of breaker strip means 14.

A below-freezing temperature compartment 17 is disposed below the above-freezing temperature compartment and is separated therefrom by a thermally insulative partition 21. Partition 21 is provided with a hingedly mounted door 22 that affords access to the compartment 17. A basket-like container 29 for stored foods is disposed within compartment 17 and, as will be more fully appreciated from what follows, accommodates flow of refrigerated air about the stored foods.

An air duct 23 extends vertically from a lower region of below-freezing compartment 17, and first and second cooling plates or evaporators 24 and 25, respectively, are coextensive with the duct 23, each evaporator being disposed for heat exchange with air flowing through duct 23.

The first evaporator 24 includes a heat exchange surface portion presented toward above-freezing compartment 15 and arranged to cool air within the latter compartment. Each of vertically extending ducts 26 and 27 is disposed to opposite sides of central duct 23. Ducts 26 and 27 are defined in part by sections of insulative wall structure also defining said above-freezing compartment, and by outer insulated walls of cabinet 10. Each of ducts 26 and 27 communicates in the region of its upper end with the upper end of central duct 23, and at its lower end with an upper region of below-freezing compartment 17.

With reference also to FIGURE 5, evaporators or cooling plate means 24 and 25 are connected in series refrigerant flow circuit with a motor-compressor 31, a condenser 32, capillary tube 33, and suitable interconnecting conduit means (not identified). Motor-compressor 31 is energizable by line L through suitable thermostatic control means 34 including a switch 35 connected

in series electrical circuit with the line L and the motor-compressor. An electrical resistance heater 36 is disposed in heat exchange relation with evaporator 25 and is connected across the contacts of thermostatic switch 35 in such a manner that when the switch is closed, to energize motor-compressor 31, heater 36 is shunted out of the circuit and deenergized. Conversely, when switch 35 is opened, a circuit is completed from line L through the idle motor-compressor windings to energize heater 36, the heater being so selected as to provide insufficient voltage drop across the said windings to energize the motor compressor.

Thermostatic control means 34 includes a sensing bulb 41 disposed in thermal contact with evaporator 24 and adapted to actuate bellows 42 to open and close switch 35 at above and below freezing temperatures of evaporators 24 and 25.

While the motor-compressor is idle, heat for defrosting first evaporator 24 is derived from natural heat leakage into above-freezing compartment 15, whereas heat for defrosting second evaporator 25 is derived from heater 36.

Defrost water from the evaporators is collected in suitable trough means 18 and 19 disposed below evaporators 24 and 25 respectively (FIGURES 1 and 2), and which trough means empty into a common drain tube 20 adapted to convey the water to suitable disposal means (not shown) in the region of the condenser and the motor compressor.

In operation of the apparatus, and assuming a cooling period is to be initiated, switch 35 is closed at a predetermined above-freezing defrosted evaporator temperature, at which time motor-compressor 31 is energized and heater 36 is deenergized. As the temperatures of evaporators 24 and 25 are reduced, thermosyphonic movement of air is effected in above-freezing compartment 15 in accordance with the directional arrows applied to compartment 15 in FIGURE 2. This pattern of air flow is effected due to the influence of relatively warm air tending to rise in the area of door 16 and its sealing gasket 28, and the tendency to fall by the air made relatively colder in the region of evaporator 24. The air motion is therefore generally circular in a clockwise, or right-hand direction.

Concurrently with the flow of air in compartment 15, air in ducts 26 and 27 tends to rise because it is made relatively warm due to heat leakage through the adjacent cabinet outer walls, and air in central duct 23 tends to fall because it is made relatively cold by virtue of its high heat exchange relation with evaporators 24 and 25. Therefore, the foregoing structural arrangement advantageously comprises means for effecting air flow between the evaporators and the regions to be cooled thereby. These tendencies to relative heating and cooling of the adjacent air columns establish the thermosyphonic air flow patterns indicated by arrows applied to the said ducts and to below-freezing compartment 17. Basket 29, by being spaced from the walls of the compartment 17 accommodates flow of cold air about the stored frozen foods.

When temperatures of the evaporators have been sufficiently reduced to cool the compartment, thermostatic switch 35 is opened to deenergize motor-compressor 31 and energize defrost heater 36 for the defrosting period. By virtue of the arrangement of heater 36 and ducts 23, 26 and 27, above the below-freezing compartment 17, there is little or no flow of warm air into the latter due to the natural tendency of such air to rise. Defrosting continues until such time as temperatures of the evaporators have attained an above-freezing defrosted temperature, following which time switch 35 is closed, the refrigeration period initiated, and the flow of air again takes place in accordance with the hereinabove described patterns.

In the broader aspect of the invention, however, due to the novel structural interrelation between the duct

means, the compartments, and the cooling means therefor, significant advantages can be obtained without resort to the defrost heater.

It will be appreciated that the invention achieves periodic defrost of cooling means for an above-freezing and a below-freezing compartment, economically without need for timers or the like. Moreover, by virtue of isolating the evaporator means from the region in which frozen foods are stored, and by providing the hereinabove described novel combination of air flow ducts with the evaporator means, optimum storage of such foods throughout both the refrigerating and the defrosting periods is achieved.

While but a preferred embodiment of the invention has been shown and described, it will be understood that modifications thereof can be made without departing from the scope of the appended claims.

We claim:

1. In refrigerator cabinet structure, the combination comprising: means defining a higher temperature storage compartment; means defining a lower temperature storage compartment disposed below the former of said compartments; means defining a first air flow duct extending vertically from a lower region of said lower temperature compartment; first and second cooling means disposed for heat exchange with air in said first duct, said first cooling means including a portion disposed to cool air within said higher temperature compartment; means defining a second vertically extending duct disposed adjacent said first duct, said second duct communicating in an upper region thereof with an upper region of said first duct, said upper region corresponding to an upper region of said higher temperature compartment, said second duct communicating in a lower region thereof with an upper region of said lower temperature compartment; and means for effecting air flow upwardly in said second duct, thence downwardly in said first duct and into said lower temperature compartment to cool the latter.

2. Structure according to claim 1 and characterized in that said means for effecting air flow comprises means for introducing heat into air in said second duct to increase its temperature to a relatively higher value than the temperature of air in said first duct, whereby thermosyphonic air flow is effected through said ducts and over said cooling means.

3. Structure according to claim 1, and further characterized in that said first cooling means is defrostible by heat derived from natural heat leakage into said higher temperature compartment, and including means for heating said second cooling means to defrost the same, which means for heating is energizable upon defrosting of said first cooling means.

4. In refrigerator cabinet structure, the combination comprising: an above-freezing temperature insulated storage compartment; a below-freezing temperature insulated storage compartment disposed below the former compartment; first air flow duct means extending generally vertically from a lower region of said below-freezing compartment; first and second generally planar cooling means confronting one another and spaced apart in a transverse direction as respects said first duct means, said cooling means including confronting surface portions disposed and adapted for heat exchange with air flowing through said first duct means, said first cooling means further including a heat exchange surface portion disposed and adapted to cool air within said above-freezing compartment; and second vertically extending duct means disposed adjacent said first duct means communicating in an upper region thereof with an upper region of said first duct means, and communicating in a lower region thereof with an upper region of said below-freezing compartment, the construction and arrangement being such that said above-freezing compartments is cooled by flow of air therein over said heat exchange surface portion of said first cooling means, and said below-freezing compartment is cooled by air therein flowing upwardly through said second duct

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means, thence into said first duct means, and downwardly therethrough between and in heat exchange relation with said confronting surface portions of said first and second cooling means.

5. Cabinet structure according to claim 4 and further characterized by comprising an outer, insulative rear wall and an inner, insulative rear wall spaced from the former wall along the direction of depth of said above-freezing storage compartment, said inner insulative rear wall having an opening over which said first cooling means extends, said second duct means comprising a pair of ducts disposed to opposite sides of said first duct means and defined in part by said insulative inner and outer rear walls.

6. Structure according to claim 4 and further including temperature responsive control means for cycling each of said cooling means between above-freezing and below-freezing temperatures whereby alternately to refrigerate said compartments to provide for defrosting of said cooling means by utilizing the normal heat leakage into the insulated cabinet structure, and auxiliary means for in-

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roducing heat into said second cooling means and energizable through actuation of said control means upon initiation of a defrosting period.

7. Structure according to claim 4 and further characterized in that each of said generally planar cooling means comprises a refrigerant evaporator having the shape of a plate, said plates being parallelly disposed as respects one another.

8. Structure according to claim 7 and characterized in that said first cooling means has less surface area than said second cooling means.

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