Jan. 28, 1964 M. H. DEVERY 3,119,240

REFRIGERATION APPARATUS WITH DEFROST MEANS

Filed June 19, 1962 2 Sheets-Sheet 1

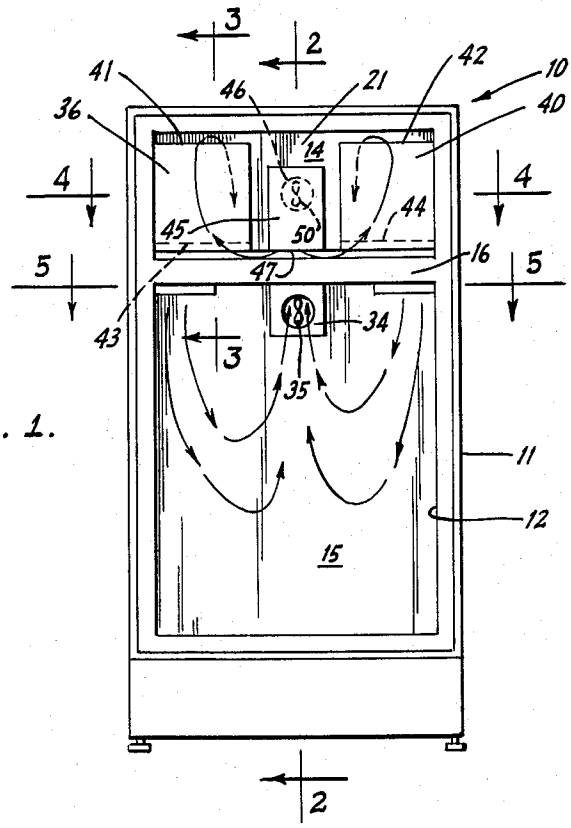


FIG. 1.

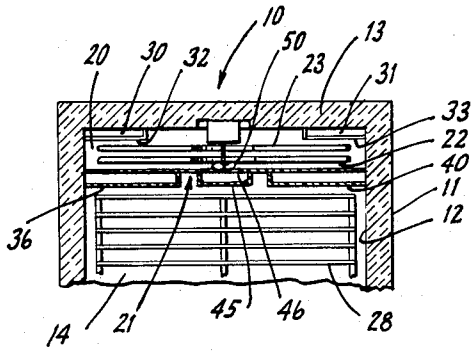


FIG. 4.

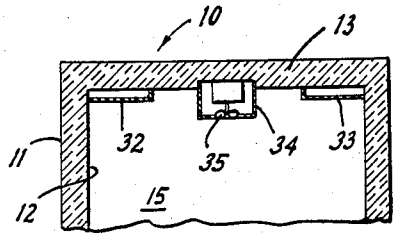


FIG. 5.

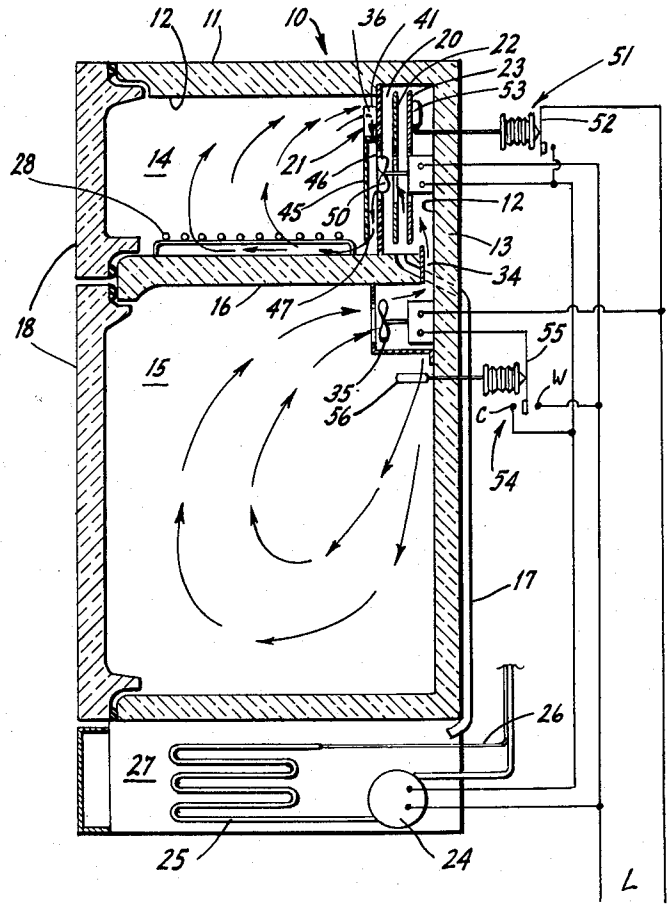
INVENTOR.
MICHAEL H. DEVERY
BY
Harry W. Hargis III
AGENT

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REFRIGERATION APPARATUS WITH DEFROST MEANS

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FIG. 2.



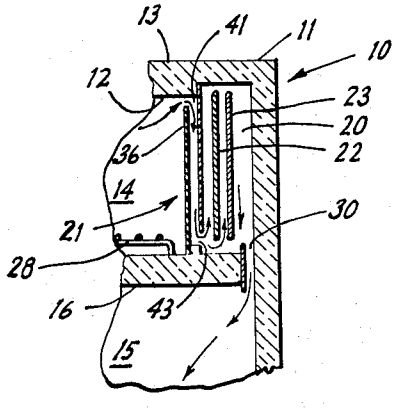


FIG. 3.

INVENTOR.
MICHAEL H. DEVERY
BY
Harry W. Hargis III
AGENT

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REFRIGERATION APPARATUS WITH DEFROST MEANS

Michael H. Devery, Ambler, Pa., assignor to Philco Corporation, Philadelphia, Pa., a corporation of Delaware

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6 Claims. (Cl. 62—156)

This invention relates to refrigeration, and more particularly to means for controlling the automatic defrost and refrigerating cycles of a refrigerator cooling element.

It is a broad objective of the invention to provide a novel combination of temperature responsive control means and air moving means for maintaining temperatures in a refrigerator apparatus within predetermined useful limits to effect both food storage and economical defrosting of a cooling element of the refrigerator.

It is known to defrost the cooling element or evaporator of a refrigerator by applying heat electrically thereto or by causing hot gaseous refrigerant to flow therethrough. Also, it is known merely to deenergize the refrigerating unit to allow the frost to melt from the evaporator over an extended period of time. However, the energy required to defrost by the first two methods is conducive to undesirably increasing operating costs of a refrigerating system, whereas the latter method is time consuming to the detriment of stored frozen food, due to the excessively high temperatures resulting from the relatively long times ordinarily required for defrosting by this method.

It is a particular objective of the invention to provide improved temperature responsive control means operable to control the flow of air through relatively warm zones, and thence over the evaporator of a household refrigerator both to defrost the evaporator and to cool the relatively warm zone.

In achievement of the foregoing and other objectives, the invention proposes, in a refrigeration system including a pair of compartments, a defrostable cooling element adapted for cyclic operation and to be defrosted in the course of deenergization during a period of the cycle, a motor-compressor for energizing said element, and control means for providing the defrosting periods, advantageously for each cycle of operation, comprising: first temperature responsive control means for said cooling element so arranged that when the control means is closed, the cooling element and a first fan are energized to cool a below-freezing storage compartment by causing air to flow sequentially over the energized cooling element and through such compartment; and second temperature responsive control means for maintaining the temperature of an above-freezing storage compartment within predetermined limits independently of the below-freezing compartment temperature, by controlling operation of a second fan disposed and adapted to cause flow of air from within the former compartment and over the cooling element. When the cooling element is deenergized, through deenergizing the motor-compressor by the first control means, the second control means maintains operation of the second fan, irrespective of the temperature in the below-freezing compartment to which the first control means is responsive, which second fan operation causes relatively warm air from the above-freezing storage compartment to flow over the deenergized cooling element and defrost the same. The second fan will continue to run until the cooling element is defrosted, again energized, and the temperature of the above-freezing compartment is reduced, whereupon the second control means will move to position deenergizing the second fan until either cooling of the above-freezing compartment is required or defrosting of the cooling element is to take place.

It is a feature of the invention that in the event the temperature of the above-freezing compartment rises before the cooling element is deenergized by the opening of the first control means, the arrangement of the first and second control means is such that when the first control means opens the second fan will be energized irrespective of the position of the second control means, inasmuch as the second fan is disposed and adapted to operate through the relatively low-impedance windings of the idle motor-compressor.

The foregoing as well as other objects and advantages of the invention will be more clearly understood from a consideration of the following description, taken in light of the accompanying drawing in which:

FIGURE 1 is a front elevational showing of refrigerator cabinet structure with the door removed, and which cabinet structure embodies the invention;

FIGURE 2 is a sectional view of apparatus illustrated in FIGURE 1, looking in the direction of arrows 2—2 applied thereto, and including a somewhat diagrammatic showing of cooling and control circuits embodying the invention;

FIGURE 3 is a fragmentary sectional view similar to FIGURE 2 and looking in the direction of arrows 3—3 applied to FIGURE 1;

FIGURE 4 is a horizontal sectional view looking in the direction of arrows 4—4 applied to FIGURE 1; and

FIGURE 5 is a view similar to FIGURE 4 but looking in the direction of arrows 5—5 applied to FIGURE 1.

With more particular reference to the drawing, and first to FIGURES 1 and 2, a refrigerator cabinet 10 having an outer shell 11 and an inner liner 12 (illustrated by single line surface indication, for the sake of convenience) spaced therefrom by suitable thermal insulation 13 comprises a below-freezing food storage chamber or compartment 14 and an above-freezing food storage chamber or compartment 15 disposed below the former chamber. Door structure 18 for cabinet 10 is provided as shown in FIGURE 2, in accordance with well known practice, but has been omitted from FIGURE 1 for the sake of clarity of illustration. Compartments 14 and 15 are separated, one from the other, by an insulated partition 16 which extends horizontally within the cabinet liner 12.

A plenum or cooling element chamber 20 is defined by the rear wall of liner 12 and a vertically extending partition 21 that spans the width and height of the below-freezing compartment 14 and is spaced forwardly as respects the mentioned rear wall of liner 12. Plenum chamber 20 houses a pair of parallel vertically extending cooling elements or conventional evaporator plates 22 and 23 which comprise a portion of the refrigerator unit including a compressor 24, a condenser 25, and a capillary tube restrictor 26 connected in series flow circuit therewith by suitable conduit means, in accordance with usual practice.

As best seen in FIGURES 3 and 4, lower corner regions of plenum chamber 20 comprise air flow ports 30 and 31

communicating with ducts or passages 32 and 33, respectively, that extend downwardly into air flow communication with upper rear corner regions of above-freezing compartment 15. A centrally located duct 34 communicates with a rear portion of plenum 20 and with compartment 15.

With further reference to FIGURES 1 and 2, and to the air flow arrows applied thereto, a fan 35 is disposed within duct 34, and the construction and arrangement of the above described duct and fan system is such that when fan 35 is energized by control means hereinafter to be more fully described, air is drawn from the storage compartment 15 and forced upwardly through center duct 34 over evaporator plates 22 and 23, thence downwardly through the laterally disposed ducts 32 and 33 and into compartment 15.

With reference also to FIGURES 3 and 4, vertical partition 21 includes a pair of laterally disposed ducts 36 and 40 each including an upper port, 41 and 42 respectively, communicating with below-freezing compartment 14, and lower ports, 43 and 44 respectively, communicating with the region of plenum 20 in front of evaporator plate 22. Vertical partition 21 includes, additionally, a centrally located duct 45 that communicates with the plenum chamber through a port 46 disposed in an upper region thereof and communicates with the freezer compartment through a port 47 disposed in a lower region of the duct.

A fan 50 is disposed within center duct 45 and is adapted to force air through the lower port 47 into the freezer compartment, thence out of the freezer compartment to the upper ports 41 and 42 thence through ducts 36 and 40, over front evaporator plate 22, and back into upper port 46 of the fan duct. A wire trivet 28 (shown in FIGURES 1 and 3) is disposed upon the bottom of compartment 14, and facilitates the circulation of air beneath stored foods.

In further accordance with the invention, and with reference to FIGURE 2, control means 51 includes a single-pole single-throw switch 52 operated by means including a refrigerant filled bellows and a bulb 53, which bulb is disposed in heat exchange relation with evaporator plate 23. Switch 52 is disposed in series electrical circuit with voltage source L and a parallel circuit comprising the motor-compressor 24 and the below-freezing compartment fan 50.

A second control means 54 comprises a single-pole double-throw switch 55 actuatable by means comprising a bellows and a bulb 56, which bulb is in heat exchange relation with air within the above-freezing storage compartment 15. The cold contact C of switch 55 is electrically connected between the first control switch 52 and the parallel circuit comprising freezer fan 50 and compressor 24. The warm contact W of switch 55 is connected to the voltage source L as shown, and the switch arm is connected to one side of the food compartment fan motor, the other side of which fan motor is connected to the source of voltage L.

Turning now to a detailed statement of the operation of apparatus embodying the invention, and for purposes of illustration, the following temperatures will be assumed to prevail at the locations indicated in a 65° F. ambient atmosphere:

	° F.
Below freezing compartment temperature	8
Above freezing compartment temperature	42
Evaporator temperature	38

Starting with the above temperature conditions, which prevail at the completion of a defrost period and just prior to a refrigerating period, operation of motor-compressor 24 will be initiated and maintained by the electrical circuit comprising control switch 55 in its cold position C and control switch 52 in its closed position energizing motor-compressor 24 and freezing compartment fan 50. The controls 54 and 55 are so calibrated

that a complete cycle of the compressor 24 and fan 50 in a 65° F. room temperature need not include operation of the above-freezing compartment fan 35 to provide refrigeration for its compartment, sufficient cooling being derived through natural convectional currents flowing between the evaporator compartment and the above freezing compartment.

The system will remain energized in accordance with the above-described circuit until the following conditions, given by way of example only, are reached:

	° F.
Below-freezing compartment temperature	4
Above-freezing compartment temperature	40
Evaporator temperature	0

Upon attaining these temperature conditions, control switch 52 will open, deenergizing motor-compressor 24, fan 50, and initiating operation of fan 35 through cold contact C of control switch 55 and the motor windings of idle motor-compressor 24. Energization through the motor-compressor windings is made possible by selecting the respective impedances of the motor-compressor windings and the fan motor windings so that there is insufficient voltage applied across the motor compressor windings to operate the same, yet there is enough voltage applied across the fan motor to activate the same. Fan 35 will then circulate the relatively warm air from above-freezing compartment 15 over the evaporator plates 22 and 23 to defrost the same. Defrost water drips from the lower edges of the evaporator plates into a trough-like portion of partition 16, and is drained by a tube 17 that leads to suitable disposal means (not shown) in the motor-compressor compartment 27. Fan 35 will continue to run, until completion of defrosting, when control switch 52 again closes and shunts out the fan to halt its operation.

It will therefore be appreciated that operation of fan 35 is ensured for the defrosting period, irrespective of temperature conditions prevailing in the above-freezing compartment.

Considering operation of the apparatus in a relatively higher room temperature, for example in a 90° F. ambient atmosphere, the following representative temperatures will be assumed to be prevailing following a defrost period and at the locations indicated:

	° F.
Below-freezing compartment temperature	6
Above-freezing compartment temperature	42
Evaporator temperature	38

The balance between the above and the below freezing compartments at this higher room temperature is brought about by periodic cycling of the above-freezing compartment fan 35 during the refrigeration cycle when control switch 52 is closed, which cycling is provided by the control switch 55 operating between its cold position C and its warm position W. This operation cools the above-freezing compartment, and refrigeration will continue in accordance with the above circuit until the following conditions are reached, at which time the defrost cycle will begin when control switch 52 is opened and control switch 55 moves to its warm position W:

	° F.
Below-freezing compartment temperature	4
Above-freezing compartment temperature	40
Evaporator temperature	0

For a given food load, the below-freezing compartment operates at a lower temperature in the higher ambient atmospheric conditions than it does in the lower ambient temperatures. Also it has a smaller temperature differential as between the refrigerating and the defrosting periods, because of the shorter defrost period and higher percent run time of the motor compressor at higher room temperatures.

It will therefore be appreciated that by providing the herein described novel combination of control, air moving, and refrigerating elements in a thermally insulated

cabinet, there is achieved an optimum balance of cabinet heat-leakage and cooling unit capacity to provide adequate cabinet cooling as well as efficient evaporator defrosting. Defrosting is accomplished in the course of each cycle of unit operation, and heat for defrosting is derived from the relatively warm air circulated from the above-freezing compartment over the evaporator means.

Also, by the use of a single evaporator means for both the below and above freezing compartments, in combination with the disclosed novel duct system, relatively cold air is confined in the below-freezing compartment while defrosting of the isolated evaporator takes place, thereby minimizing fluctuations in frozen food temperatures.

I claim:

1. In refrigeration apparatus, in combination: a lower temperature compartment; a higher temperature compartment; means defining a cooling chamber; defrostable evaporator means disposed within said chamber and cyclically deenergizable in the normal function thereof; refrigerant condensing means including a motor compressor operative to energize said evaporator means; first air impeller means disposed and adapted to cause air to flow between said lower temperature compartment and said cooling chamber for heat exchange with said evaporator means, when the latter is energized, to cool such compartment; second air impeller means disposed and adapted to cause air flow between said higher temperature compartment and said cooling chamber for heat exchange with said evaporator means, either when the latter is energized to cool such higher temperature compartment, or when deenergized to defrost the same; first control means responsive to temperatures prevailing in said cooling chamber and operative cyclically to energize and to deenergize said motor compressor; and second control means responsive to temperatures prevailing within said higher temperature compartment when said motor compressor is either energized or deenergized, said last recited control means being operative to maintain operation of said second air impeller means through a circuit completed by windings of said motor compressor, when the latter is deenergized, to raise the temperature of said evaporator means an amount sufficient to defrost the same.

2. Apparatus according to claim 1 and further characterized in that: said first control means comprises a single-pole single-throw switch, and said second control means comprises a single-pole double-throw switch having a cold and a warm contact, said first control switch is connected in series electrical circuit with a source of energy and said first air impeller means, said motor compressor is connected in parallel electrical circuit with said first air impeller means, the cold contact of said second control switch is connected in the circuit between said first control switch and said motor-compressor, and the warm contact is connected in series circuit with the second air impeller means, the construction and arrangement being such that when said first control switch is opened, said second impeller means is energized either directly through the second control switch warm contact, or through its cold contact via the motor compressor windings.

3. In refrigerating apparatus: means defining lower temperature, higher temperature, and evaporator compartments; an evaporator disposed in said evaporator compartment; motor-compressor means for circulating refrigerant through said evaporator; first fan means for circulating air sequentially through said evaporator compartment and said lower temperature compartment to cool the latter; second fan means for circulating air sequentially through said higher temperature compartment and said evaporator compartment; a source of energy; first control switch means operative in response to temperatures prevailing at said evaporator cyclically to provide for energization of said motor-compressor and said first fan means by said source of energy; and second control switch means operative in response to temperatures prevailing in said above freezing compartment and including a cold position adapted to connect said second fan with said source of energy through elements of said motor-compressor when said first control switch means is open, and a warm position adapted to connect said second fan means with said source of energy independently of said motor-compressor, the construction and arrangement being such that higher temperature air impelled by said second fan, when said motor-compressor is deenergized, is effective to defrost said evaporator.

4. Apparatus according to claim 3 and characterized in that said lower and higher temperature compartments comprise below-freezing and above-freezing compartments, respectively, the former disposed at a level above and insulated from the latter, and said evaporator compartment is separated from said below-freezing compartment by vertically extending partition means, duct means providing for the recited circulation of air by said second fan means communicating with an upper region of said above-freezing compartment and a lower region of said evaporator compartment, and duct means for said first fan means comprising a pair of vertically extending passages formed in said partition means, one of said passages communicating with said below-freezing compartment at an upper region thereof and with said evaporator compartment at a lower region thereof, the other of said pair of passages enclosing said first fan means and communicating with said below-freezing compartment at a lower region thereof and with said evaporator compartment at an upper region thereof, the construction and arrangement being such that when said first fan means is idle, said pair of air passages comprise a maze preventing cold air spillage from said below-freezing compartment into said above-freezing compartment.

5. In refrigeration apparatus comprising means defining an above-freezing temperature zone, defrostable evaporator means, and motor-compressor means for circulating refrigerant through said evaporator means, control means for effecting cyclic refrigerating and defrosting periods of said evaporator means comprising: fan means for causing flow of air, from said above-freezing temperature zone, over said evaporator means; a source of energy; first control means responsive to temperatures at said evaporator means cyclically to energize and deenergize said motor compressor means by alternately connecting and disconnecting the latter and said source of energy; and second control means responsive to temperatures prevailing in said above-freezing temperature zone cyclically to energize and deenergize said fan means, while said motor compressor means is energized through said first control means, by alternately connecting and disconnecting said fan means as respects said source of energy, said second control means being operable, upon deenergization of said motor-compressor means by said first control means, to connect said fan means either directly with said source of energy or through a circuit completed by motor windings of said deenergized motor-compressor means to said source of energy, whereby to maintain continuous operation of said fan means while said motor compressor means is deenergized and to effect flow of air from said above-freezing zone over said evaporator means to defrost the same.

6. In a refrigeration system, a pair of compartments to be refrigerated, a cooling element adapted for cyclic energization and to be defrosted in the course of deenergization, a pair of fans for circulating air through said compartments, a motor-compressor for energizing said cooling element, and control apparatus comprising: a source of energy; first temperature responsive control means for said cooling element effective to energize the cooling element and the first one of said fans to cool one of said compartments to a below-freezing storage temperature, by cyclically connecting said motor-compressor and said first one of said fans with said source of energy; and second temperature responsive control means for maintaining the temperature of the other compartment at an above-

freezing temperature by controlling operation of the other fan through cyclically connecting the latter with said source of energy while said motor-compressor is energized through said first control means, and, when the motor-compressor is deenergized, connecting said other fan either directly with the source of energy or through a circuit completed by motor windings of the deenergized motor-compressor means to said source of energy, whereby said second control means maintains operation of said other fan irrespective of the temperature of said below-freezing compartment to cause relatively warm air from the above-freezing compartment to flow over the deenergized cooling element and defrost the same.

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