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2,866,323

FORCED AIR COOLED REFRIGERATOR

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4 Sheets-Sheet 1

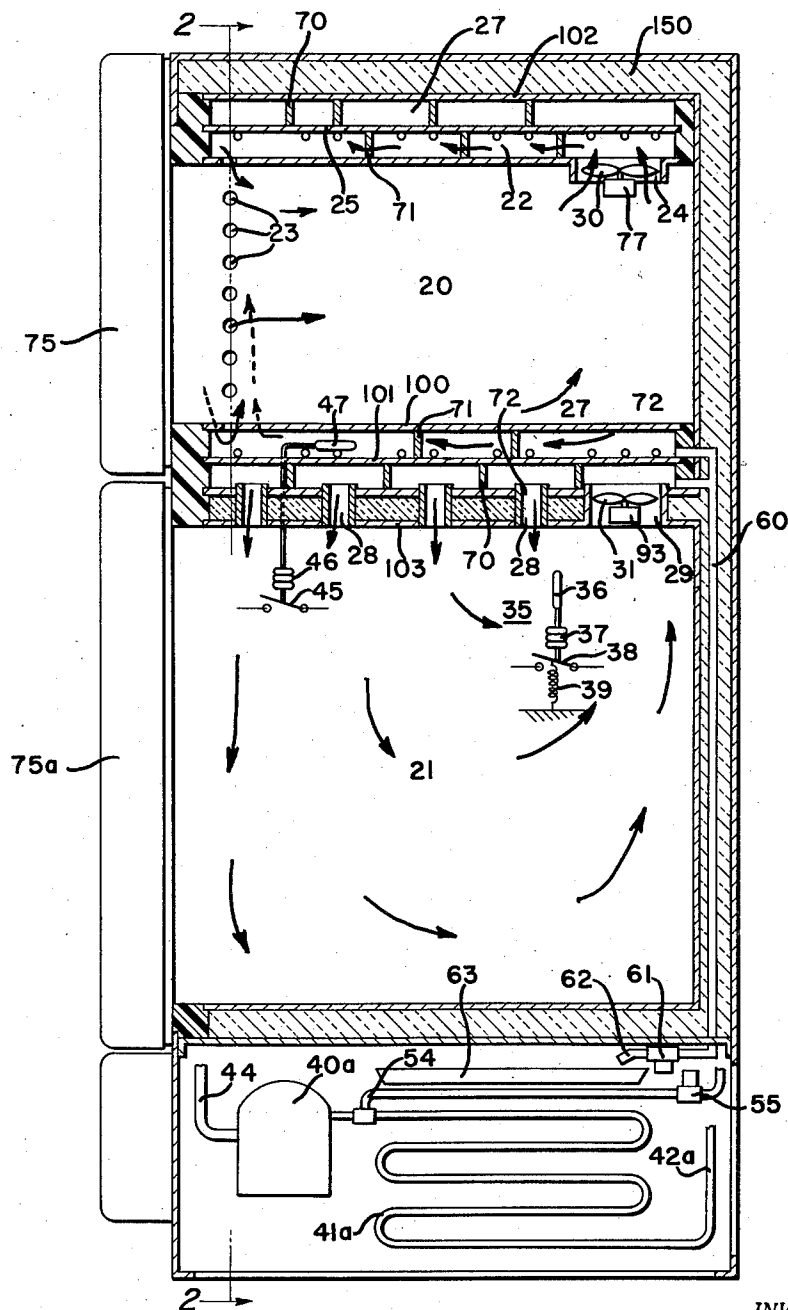


Fig. 1

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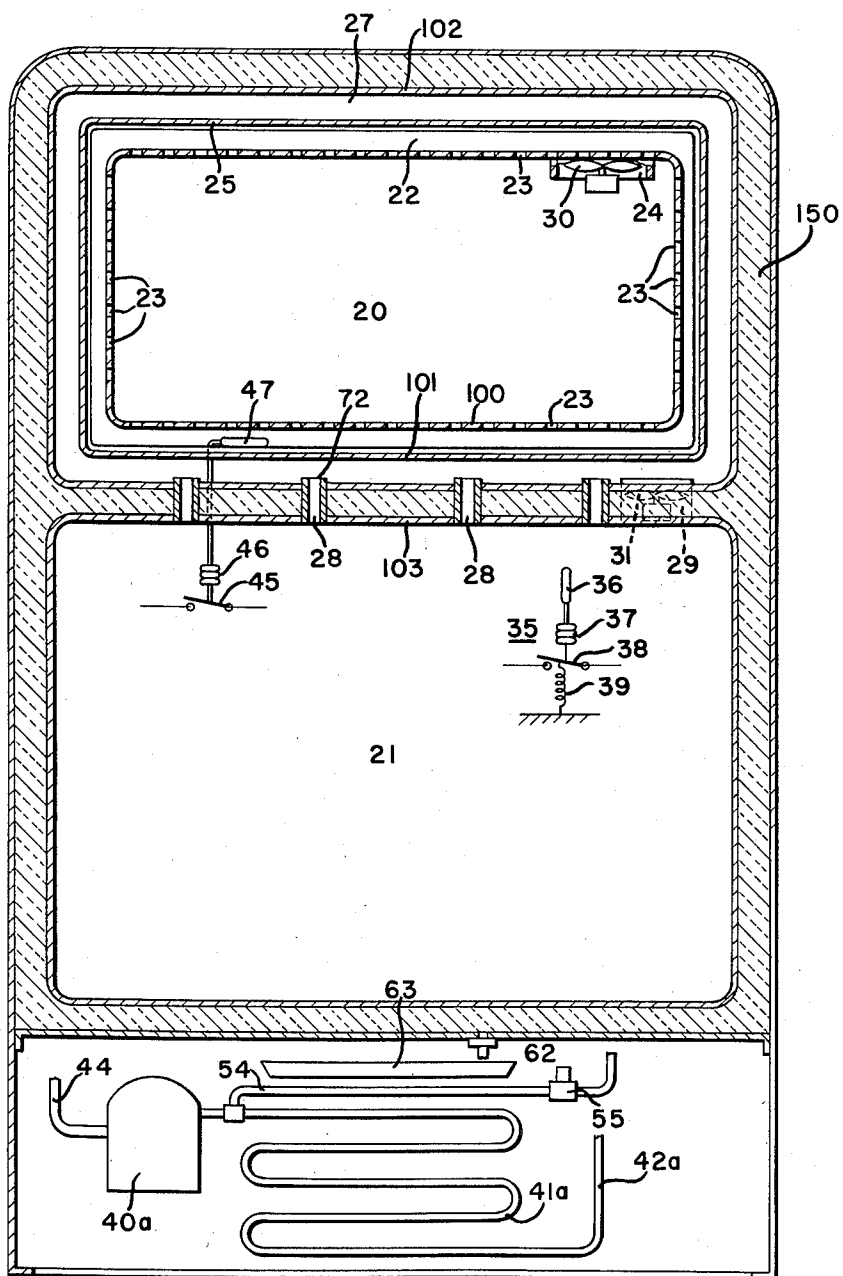


Fig. 2.

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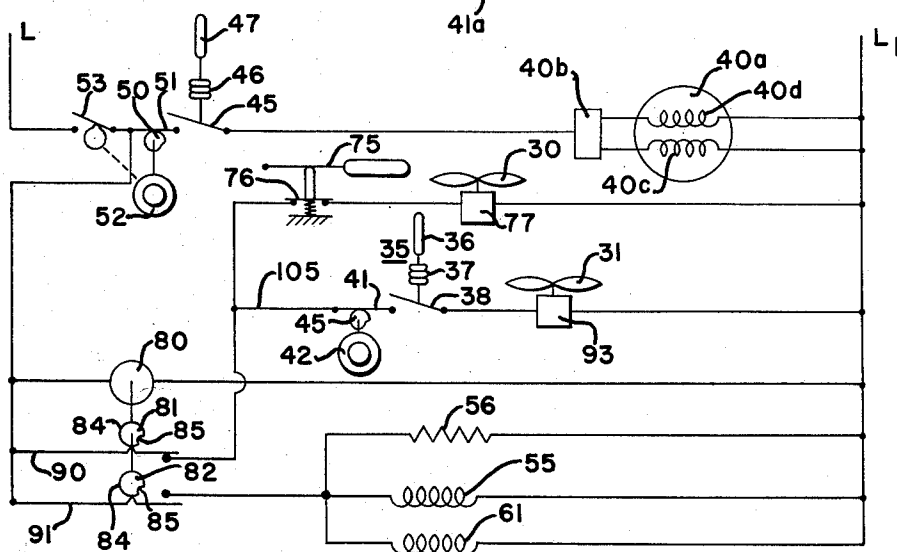


Fig. 4

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4 Sheets-Sheet 4

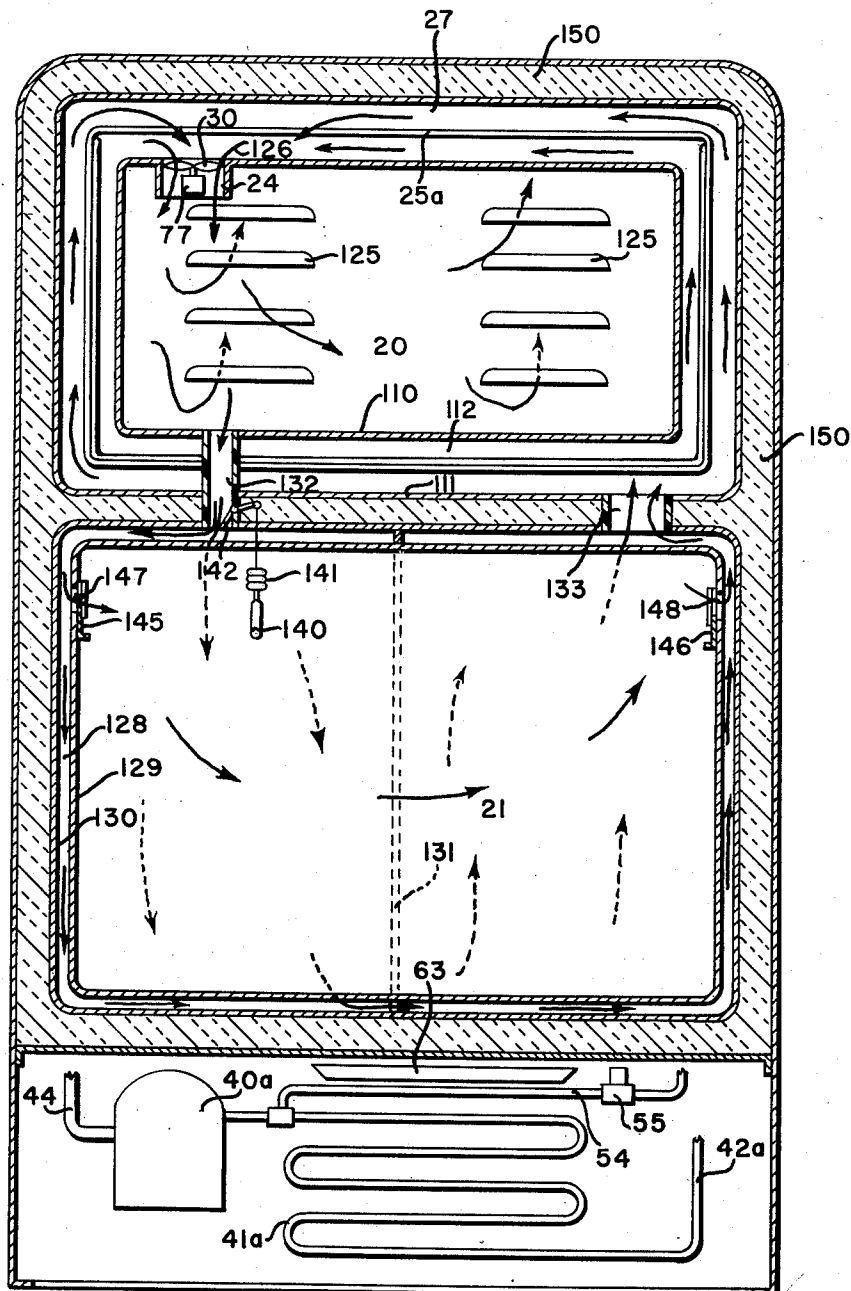


Fig. 5

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FORCED AIR COOLED REFRIGERATOR

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9 Claims. (Cl. 62—187)

This invention relates to refrigerating apparatus and more particularly to a refrigerator in which no frost is deposited in either the freezer or the warmer compartment.

An object of this invention is to provide a refrigerator having a first box or compartment to be maintained at a temperature below 32° F. and which is surrounded by an evaporator, said refrigerator also having a second box or compartment to be maintained at a refrigerating temperature above 32° F. and to which air is circulated from the evaporator to it in a manner to maintain it at a refrigerating temperature above 32° F.

Further objects and advantages of the present invention will be 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 cross section of the refrigerator.

Figure 2 is a vertical cross section taken along the line 2—2 of Figure 1.

Figure 3 is a diagrammatic representation of the refrigerating apparatus to be applied to the refrigerator shown in Figures 1, 2 and 5.

Figure 4 is a wiring diagram for the control of the refrigerating system shown in Figures 1 and 2, and, with modification, the refrigerating system shown in Figure 5.

Figure 5 is a vertical cross-section, somewhat similar to Figure 2, showing a modification of the invention.

The refrigerator, according to this invention, may comprise a first box or compartment 20 to be maintained at a temperature below 32° F. A second box or compartment 21 is to be maintained at a refrigerating temperature above 32° F. such as between 33° F. and 40° F. or 50° F. A first air passageway means 22 surrounds a major portion of the box 20 and has a first air inlet or inlets 23 into, and a first air outlet or outlets 24 from the box 20. Either the inlet or the outlet may comprise a plurality of inlets or outlets, as desired. A refrigerant evaporator 25, to be maintained below 32° F., is in thermal exchange with the first air passageway means 22. A second air passageway means 27 surrounds said evaporator 25 and is in thermal exchange therewith and has a second air inlet or inlets 28 into, and a second air outlet or outlets 29 from said second box 21. A first blower 30 circulates air through and between said box 20 and said air passageway means 22. A second blower 31 circulates air through and between said box 21 and said second air passageway means 27.

Thermostatic means 35 controls the operation of said second blower 31 in response to the temperature in the said box 21 to maintain its temperature at a refrigerating temperature of above 32° F. Such thermostatic means may take the form of a thermostatic bulb 36 located in the box 21 and connected to a bellows 37 which moves the switch blade 38 against the compression spring 39 to open the switch when the temperature in the compartment or box 21 falls below the selected temperature and to close the switch when such temperature rises above

the selected temperature, this opening and closing of the switch being within predetermined limits.

The thermostatic switch may be adjustable by means of a cam 40 which adjusts the otherwise stationary contact blade 41 up or down to adjust the temperature at which the switch blade 38 opens and closes. The cam 40 may be adjusted by means of a knob 42 located at any place which may be accessible to the user.

The blower 31 is started and stopped by the switch 38 in response to the temperature in compartment or box 21, the blower operating whenever the temperature is above the selected temperature and stopping when the temperature in the box is below the selected temperature.

The evaporator 25 may be part of any usual refrigerating system such as that shown diagrammatically in Figure 3. A motor compressor 40a discharges refrigerant into condenser 41a which discharges liquid refrigerant through the line 42a and through the expansion valve or capillary tube 43 into the evaporator 25. From there the evaporated refrigerant returns through the line 44 to the motor compressor 40a.

Means are provided to maintain the temperature in the evaporator 25 at a low temperature below 32° F. Such means may take the form of a thermostatic switch 45 which is actuated by a bellows 46 connected to a thermostatic bulb 47 in thermal exchange with the evaporator 25. The switch 45 is open when the temperature in the evaporator falls below a predetermined selected temperature and closes when the refrigerant temperature rises above such selected temperature. The switch 45 may be made adjustable by means of the cam 50 which moves the stationary adjustable blade 51 up or down to vary and select the temperature at which the switch 45 opens and closes. The cam 50 may be adjusted by the knob 52 placed at any accessible place for the user. If desired, the knob 52 may open the master switch 53 which opens and closes the entire electric system which is connected to the refrigerator. The lines L and L1 may be connected to the usual connector plug which is provided for a domestic refrigerator.

The motor compressor 40a may be provided with the usual starter switch and protector 40b, and the starting winding 40c and running winding 40d.

The evaporator 25 may be defrosted by means of hot gas or the like. For example, a by-pass line 54 may be provided with a solenoid valve 55 which is energized and opened during the defrost cycle and allows hot gas to be fed to the evaporator 25. An electric heater 56 may be placed against the refrigerating system, for example, at the return line 44, to add heat to the refrigerating system while the defrosting operation is being performed. The heater 56 is energized during the defrost cycle at the same time that the solenoid valve 55 is energized and opened.

Means for draining the defrost water may be provided. This may take the form of a drain pipe 60 connected in such a position as to receive all of the water formed by the defrost operation. If desired, it may lead to solenoid valve 61 which is energized and opened during the defrost period and is closed during the refrigeration cycle. The defrost water is discharged through the spout 62 into the pan 63 which is placed over the condenser 41 and from which the water is evaporated during subsequent refrigeration cycles.

The passageway or passageways 27 may be formed by a spiral wall 70 and the passageway or passageways 22 may be formed by a similar spiral wall 71.

The walls of the openings 28 and 29 may be extended slightly above as indicated at 72 to prevent the flow of defrost water through the openings during the defrosting period.

The compartment 20 may be provided with a door 75 while the compartment 21 may be provided with a door

76. The door 75 may be provided with a door switch 76 which is adapted to be opened when the door is also opened and this deenergizes the motor 77 which drives the blower 30 whenever the door is opened.

A timer may be provided which includes a motor timer 80 driving the cams 81 and 82 which have refrigeration surfaces 84 and defrost notches 85. The cams 81 and 82 actuate respectively the blades 90 and 91. During the refrigeration cycle the blade 90 energizes the blower motors 77 and 93 unless such motors are deenergized by the other switches which are in series therewith. During the defrost cycle the blade 91 energizes the heater 56, hot gas solenoid 55, and the water drain 61. The motor compressor 40 is driven at all times except when it is deenergized either by the switch 53 or the switch 45. The switch 53 is open only when the manual control 52 is turned to the "off" position, and the switch 45 is opened and closed in response to evaporator temperatures to maintain the evaporator at a preselected low temperature sufficient to keep the compartment 20 at the desired below freezing temperature.

In more detail, the compartment or box 20 may have a first casing 100 surrounding a major portion of said compartment 20. Casing 101 surrounds the first casing 100 and forms therewith the circuitous air passageway 22 around the first casing 100 and between such casing 100 and the second casing 101. A liner 102 surrounds the second casing 101 and forms therewith the circuitous passageways 27. The casing 100 has the openings 23 and 24 previously described, while the casing 102, in combination with the liner 103 has the openings 28 and 29.

The walls of the openings 28 and 29 may be extended slightly above as indicated at 72 to prevent the flow of defrost water through the openings during the defrosting period. All of the frost is deposited on evaporator 25 or casing 101, outside of the compartments 20 and 21.

In the modification shown in Figure 5 the refrigerating system is substantially the same as the previous figures and the wiring diagram shown in Figure 4 is applicable to Figure 5 with the exception that all of the elements controlled by the line 105 in Figure 4 are omitted when the wiring diagram is applied to Figure 5. Preferably the evaporator 25a of Figure 5 is made of the open tube type, which permits air to flow between the tubes as well as around them, instead of the sheet metal type shown with respect to Figures 1 and 2 and Figure 3. The box or compartment 20 of Figure 5 is surrounded by a first casing 110. The casing 110 is surrounded, in turn, by a second casing 111 which forms between them an air passageway 112. The evaporator 25a is enclosed within the passage 112 and permits the air to flow freely around the entire passageway. If desired suitable baffling means, not shown, may be provided to insure a complete circuitous flow of air throughout this passageway 112. The casing 110 has an opening 24 preferably near the front of compartment 20 for the blower 30 and motor 77 through which air is forced from the passageway 112 into the compartment 20. The casing 110 also has a series of openings 125 preferably at the rear of compartment 20 which permit the air to flow from the compartment 20 back into the passageway 112. With this construction the air which is to chill the compartment 20 flows out through the openings 125 into the passageway 112 where the air circulates around and in contact with the evaporator 25a and has its temperature reduced to its lowest temperature, considerably below the temperature to be maintained in compartment 20. Thereafter this air is forced by the fan 30 back into the compartment 20 as indicated by the arrows 126. The air in compartment 20 has its temperature raised a slight amount due to the heat received from the motor 77 as well as from the door corresponding to 75 of Figure 1. In this manner the air entering and circulating through the compartment 20 has its temperature raised

slightly and its relative humidity reduced sufficiently to insure proper sublimation of all of the frost which might have found its way into compartment 20. All of the frost deposits on the evaporator 25a, outside of compartments 20 and 21. Should any frost be introduced into said compartments it is quickly sublimated and transferred to evaporator 25a.

A second air passageway means 128 is formed around the box or compartment 21 by means of the concentric casings 129 and 130. If desired a divider wall 131 may be provided in the passageway 128 which is open at any desired place in such a manner as to insure proper circulation of air all around the box 21, so as to cool the entire outer surface thereof. The passageway 128 has a conduit 132 connecting the passageway 128 with the interior of the box or compartment 20. The passageway 128 has a second conduit 133 connected to the air passageway 112. The construction is such that the air from compartment 20, which is at a slightly higher pressure, is forced through the conduit 132 into the passageway 128 where the air circulates all around the outer wall of the compartment 21 and then flows through the conduit 133 into the passageway 112, where the pressure is slightly less than inside the box 20 due to the action of the fan 30. A thermostatic bulb 140 operates a bellows 141 which in turn operates the damper 142 to regulate the flow of air around the passageway 128 to maintain the temperature of compartment 121 at the desired temperature above 32° F.

Means to control the relative humidity in compartment 21 of Figure 5 may be provided. This relative humidity regulator may take the form of manually adjustable dampers 145 and 146 which may be operated by the user to regulate the size of the bleed openings 147 and 148 to regulate the flow of a small amount of air from the passageway 128 through the interior of compartment 21. The damper 145 is adjacent a higher air pressure location in passageway 128 than the air pressure adjacent damper 146. This pressure differential produces the air bleed through compartment 21. This bled air is of low relative humidity when it is warmed by the contents of the compartment 21, and hence tends to reduce the relative humidity in compartment 21 as the amount of air bled is increased and vice versa. By this means, the user may regulate any relative humidity desired within the limits of the apparatus.

In all of the modifications proper insulation, as indicated at 150, may be placed within the refrigerator. The compartments 20 and 21 of Figure 5 may be provided with doors similar to 75 and 76 of Figure 1, and the transverse cross section of Figure 5 may be substantially as indicated in Figure 1, modified only so far as the construction is shown to be different in Figure 5.

In the operation of the embodiment shown in Figures 1 through 4, the refrigerating system operates substantially constantly except that the compressor 40 is started and stopped under the control of thermostatic bulb 47 which maintains the refrigerant in evaporator 25 at a temperature below 32° F. sufficiently low to maintain the compartment 20 at the desired freezing temperature below 32° F. The blower 30 circulates air between the compartment 20 and the evaporator 25 constantly during the refrigeration cycle to provide the necessary transfer of heat to the evaporator 25. The air, as it passes in contact with the evaporator 25, is chilled to its lowest temperature and thereafter enters the compartment 20 through the openings 23. This air is then slightly warmed by the heat passing through the door 75 and thus has its relative humidity slightly decreased. Hence it sublimates any frost which may be present in compartment 20. Thereafter the air is repeatedly returned to be circulated in contact with the evaporator 25. At the same time, air from the compartment 21 is forced by the fan or blower 31 into the passageway 27 where it is chilled by thermal exchange through

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the casing 101 with the evaporator 25 and this air then returns into compartment 21 through the openings 28. When the compartment 21 has been chilled below the preselected temperature, the thermostatic bulb 36 opens the switch and stops the fan or blower 31 until such time as the temperature in compartment 21 rises above the selected temperature. Thereafter the switch 38 is closed and the blower 31 is again operated, this cycling continuing in a manner to maintain the temperature of the compartment 21 at the preselected refrigerating temperature above 32° F.

During the defrost cycle the compressor 40a continues to operate, but the blowers 30 and 31 are deenergized and the heater 56 is energized while the valves 55 and 61 are opened. This causes the temperature of the evaporator 25 to be raised sufficiently to defrost all of the frost which may have accumulated on the evaporator 25 or on the wall 101. The water thus formed flows down the pipe 60 and through the solenoid valve 61 and faucet 62 into the drain pan 63, where the water is evaporated by heat from condenser 41 and subsequent refrigeration cycles. The relative sizes of the refrigeration surfaces 84 and the defrost notches 85 are selected to provide desired refrigeration cycle length of time as compared with the defrost length of time.

The operation of the modification shown in Figure 5 is the same insofar as the refrigeration system is concerned. Air is forced by the blower 30 in heat exchange relationship with the evaporator 25a, the air leaving the compartment 20 through the openings 125 into the passageway 112 where the air is chilled to its lowest temperature and has its moisture content reduced to the minimum. Thereafter the air enters the compartment 20 through the opening 24, where the air is slightly heated by heat from the motor 77 as well as from the heat leaking through the door 75 corresponding to the one in Figure 1. This rise in the temperature of the air in compartment 20 insures the sublimation of any frost which may be present in compartment 20 and prevents the deposit of any frost therein, as will be obvious. At the same time, air is forced through the conduit 132 by the slightly higher air pressure in compartment 20 and through the passageway 128 completely surrounding the box or compartment 21 and thus chills the surrounding wall 129 of the box 21 to maintain the temperature in compartment 21 at the desired refrigeration temperature above 32° F. The air from passageway 128 returns through the conduit 133 into the passageway 112 because of the slightly lower pressure within passageway 112 caused by the operation of the blower 30. The amount of air circulated through the passageway 128 is regulated by the thermostatic bulb 140 operating the damper 142 to regulate the amount sufficiently to obtain the desired refrigerating temperature above 32° F. in compartment 21. The relative humidity of the air in compartment 21 is regulated by the opening and closing of the dampers 145 and 146 to regulate the amount of air bled from the passageway 128 through the interior of compartment 21.

The boxes or casings 100 and/or 110 may be made of relatively heat insulating material to prevent melting of the frozen food in compartments 20 during the defrosting operation. This also increases the temperature of the air in compartments 20 in comparison to the temperature of the air in passageways 22 and/or 112 during the refrigerating cycle, and reduces the relative humidity in said compartments 20, thus increasing the frost sublimating effect.

While the forms of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In combination: a refrigerator having first means forming a first compartment to be maintained at a tem-

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perature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F.; said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming first circuitous air passageways around said first casing and between said first and second casings connected to said air inlet and air outlet; a liner surrounding said second casing and forming second circuitous air passageways around said second casing and between said second casing and said liner and having an inlet from an air outlet into said second compartment; and refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said second casing.

2. In combination: a refrigerator having first means forming a first compartment to be maintained at a temperature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F., said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming first circuitous air passageways around said first casing and between said first and second casings connected to said air inlet and air outlet; a liner surrounding said second casing and forming second circuitous air passageways around said second casing and between said second casing and said liners and having an inlet from and air outlet into said second compartment; a first blower for circulating air through said first circuitous air passageways; a second blower for circulating air through said second circuitous air passageways; and refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said second casing.

3. In combination: a refrigerator having first means forming a first compartment to be maintained at a temperature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F., said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming first circuitous air passageways around said first casing and between said first and second casings connected to said air inlet and air outlet, a liner surrounding said second casing and forming second circuitous air passageways around said second casing and between said second casing and said liner and having an inlet from and an air outlet into said second compartment; a blower for circulating air through said second air passageway, thermostatic means for controlling the operation of said blower in response to second compartment temperature; and refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said second casing.

4. In combination: a refrigerator having first means forming a first compartment to be maintained at a temperature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F., said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming a first circuitous air passageway around said first casing and between said first and second casing connected to said air inlet and air outlet; a blower for circulating air through said passageway and said air inlet and air outlet; refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said air passageway; a double liner surrounding a major portion of said second compartment and forming a second circuitous air passage-

way inside said double liner in thermal exchange with said second compartment; a first conduit connecting said first compartment and said second circuitous air passageway; and a second conduit connecting said second circuitous air passageway and said first circuitous air passageway; and thermostatic means controlling the flow of air through said conduits in response to the temperature in said second compartment to maintain it at a refrigerating temperature above 32° F.

5. In combination: a refrigerator having first means forming a first compartment to be maintained at a temperature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F., said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming first circuitous air passageways around said first casing and between said first and second casings connected to said air inlet and an air outlet; a liner surrounding said second casing and forming second circuitous air passageways around said second casing and between said second casing and said liner and having an inlet from and an air outlet into said second compartment; refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said second casing; means to defrost said evaporator means periodically; and a water drain to receive and convey away water produced during the defrosting of said evaporator means.

6. In combination: a refrigerator having first means forming a first compartment to be maintained at a temperature below 32° F. and second means forming a second compartment to be maintained at a refrigerating temperature above 32° F.; said first means including a first casing surrounding a major portion of said first compartment and having an air inlet into and an air outlet from said first compartment; said second means including a second casing surrounding said first casing and forming a first circuitous air passageway around said first casing and between said first and second casing connected to said air inlet and air outlet; a blower for circulating air through said passageway and said air inlet and air outlet; refrigerant evaporator means to be maintained below 32° F. in thermal exchange with said air passageway; a double liner surrounding a major portion of said second compartment and forming a second circuitous air passageway inside said double liner in thermal exchange with said second compartment; a first conduit connecting said first compartment and said second circuitous air passageway; and a second conduit connecting said second circuitous air passageway and said first circuitous air passageway; thermostatic means controlling the flow of air through said conduits in response to the temperature in said second compartment to maintain it at a refrigerating temperature above 32° F.; means to defrost said evaporator means periodically; and a water drain to receive and convey away water produced during the defrosting of said evaporator means.

7. In a refrigerator: a first box forming a first compartment to be maintained at a temperature below 32° F.; a second box forming a second compartment to be maintained at a refrigerating temperature above 32° F.; means forming first air passageway means surrounding

a major portion of said first box and having a first air inlet into and a first air outlet from said first box; a refrigerant evaporator to be maintained below 32° F. in thermal exchange with said first air passageway means; means forming a second air passageway means surrounding said evaporator and in thermal exchange therewith and having a second air inlet into and a second air outlet from said second box; a first blower circulating air through and between said first box and said first air passageway means; a second blower circulating air through and between said second box and said second air passageway means and thermostatic means controlling the operation of said second blower in response to the temperature in said second box to maintain said last named temperature at a refrigerating temperature above 32° F.

8. In a refrigerator: a first box forming a first compartment to be maintained at a temperature below 32° F.; a second box forming a second compartment to be maintained at a refrigerating temperature above 32° F.; means forming first air passageway means surrounding a major portion of said first box and having a first air inlet into and a first air outlet from said first box; a refrigerant evaporator to be maintained below 32° F. in thermal exchange with said first air passageway means; means forming a second air passageway means surrounding said evaporator and in thermal exchange therewith and having a second air inlet and a second air outlet from said second box; a first blower circulating air through and between said first box and said first air passageway means; a second blower circulating air through and between said second box and said second air passageway means; means to defrost said evaporator periodically; and a water drain to receive and convey away water produced during the defrosting of said evaporator.

9. In a refrigerator: a first box forming a first compartment to be maintained at a temperature below 32° F.; a second box forming a second compartment to be maintained at a refrigerating temperature above 32° F.; means forming first air passageway means surrounding a major portion of said first box and having a first air inlet into and a first air outlet from said first box; a refrigerant evaporator to be maintained below 32° F. in thermal exchange with said first air passageway means; means forming a second air passageway means surrounding said evaporator and in thermal exchange therewith and having a second air inlet into and a second air outlet from said second box; a first blower circulating air through and between said first box and said first air passageway means; a second blower circulating air through and between said second box and said second air passageway means; thermostatic means controlling the operation of said second blower in response to the temperature in said second box to maintain said last named temperature at a refrigerating temperature above 32° F.; means to defrost said evaporator periodically; and a water drain to receive and convey away water produced during the defrosting of said evaporator.

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