June 13, 1967 G. D. JONES 3,324,678

SINGLE EVAPORATOR COMBINATION REFRIGERATOR

Filed May 12, 1965 3 Sheets-Sheet 1

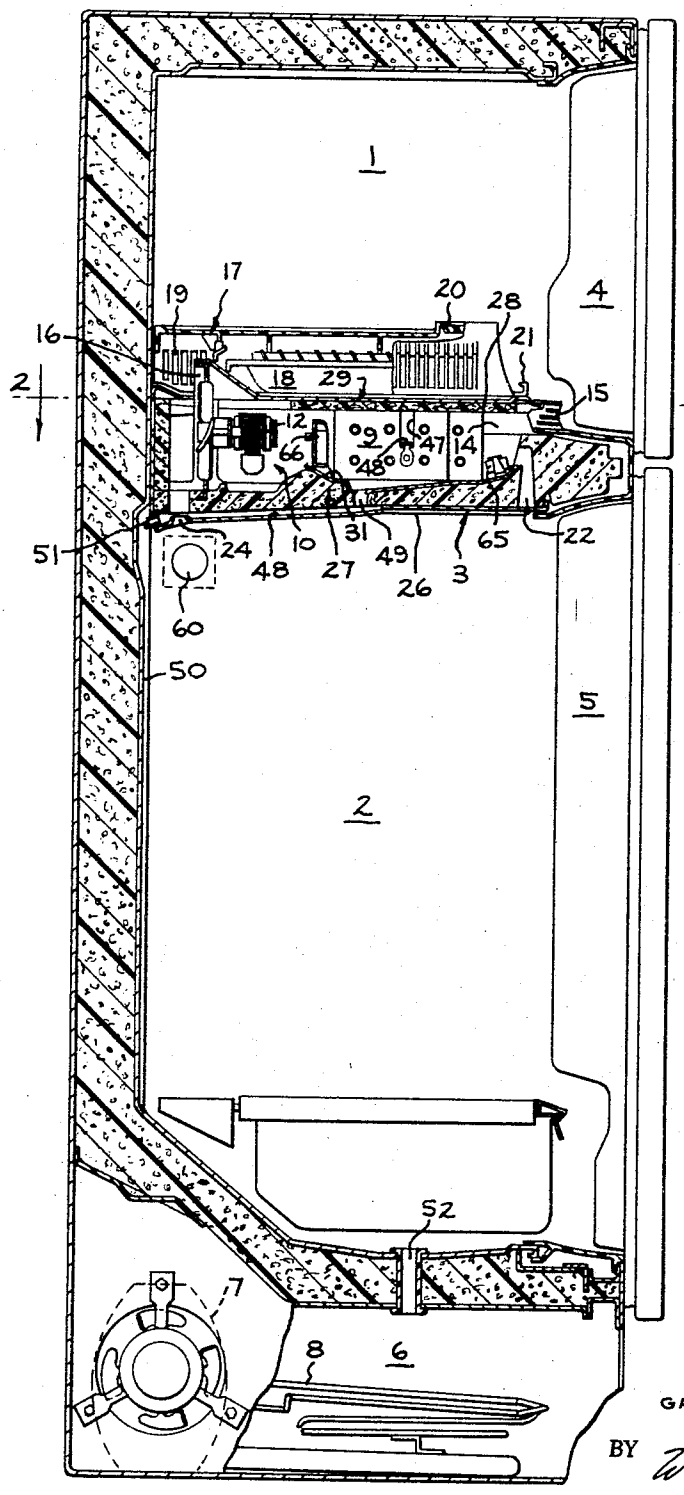

FIG. 1

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SINGLE EVAPORATOR COMBINATION REFRIGERATOR

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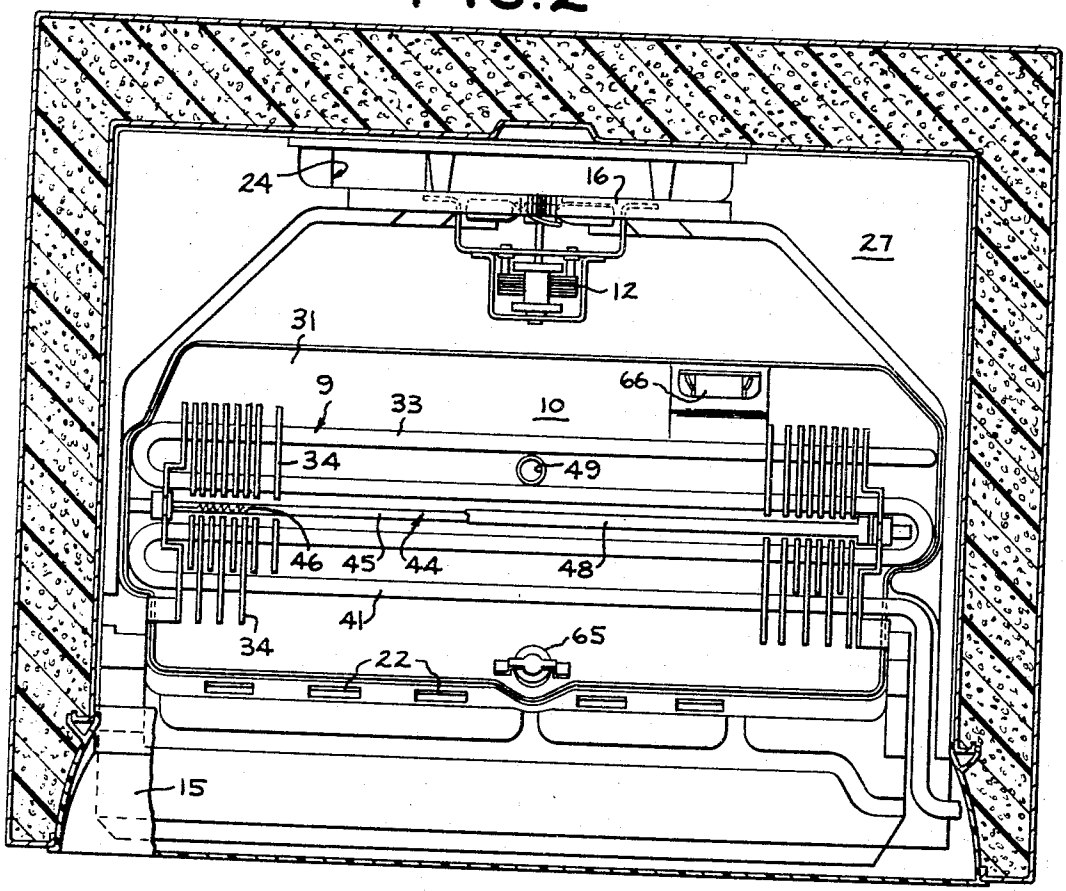
FIG. 2



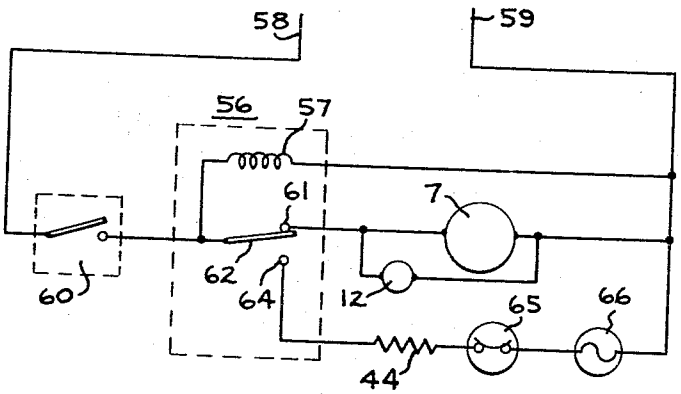


FIG. 5

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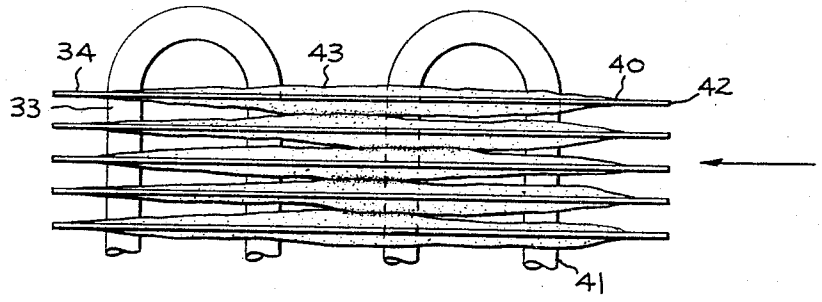

FIG. 3

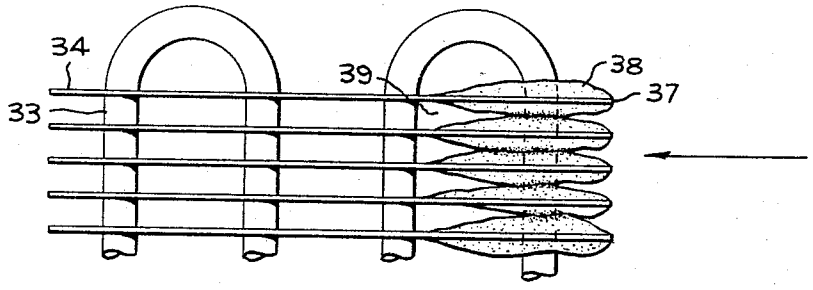

FIG. 4

PRIOR ART

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United States Patent Office 3,324,678
Patented June 13, 1967

3,324,678

SINGLE EVAPORATOR COMBINATION REFRIGERATOR

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Filed May 12, 1965, Ser. No. 455,229
3 Claims. (Cl. 62—276)

The present invention relates to household refrigerators and is particularly concerned with a combination refrigerator comprising a freezing compartment and a fresh food compartment separated by an insulated partition and a single evaporator contained within the partition for supplying refrigerated air to both compartments.

Combination refrigerators including a single evaporator and a single fan for circulating air from the freezer and fresh food compartments over the evaporator are well known. In the operation of such refrigerators, a major portion of the refrigerated air from the evaporator is directed in to the freezer compartment while a smaller portion is directed into the fresh food compartment. In addition to the cost advantages resulting from the employment of a single evaporator and a single fan for refrigerating two separate compartments, such refrigerators have the additional advantage of permitting automatic defrost of the evaporator which is contained within an evaporator housing or compartment outside of or separate from both of the storage compartments without significantly disturbing the temperatures of those compartments during defrost.

The present invention is generally directed to a refrigerator of this type including new and improved means for cooling and circulating the cooled air to the two compartments and for periodically warming the evaporator to defrost temperatures and disposing of the defrost water.

Specific objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In accordance with the illustrated embodiment of the present invention, there is provided a refrigerator cabinet comprising insulated walls and an insulated partition defining a freezer compartment in the upper portion of the cabinet and a fresh food compartment below the freezing compartment and separated therefrom by the partition. Thus the partition forms the bottom wall of the freezer compartment and the top wall of the fresh food compartment. The partition comprises a bottom surface of sheet material forming the top wall of the fresh food compartment and a layer or body of foam insulation supported on this sheet material is shaped to define an evaporator chamber containing a fin-on-tube evaporator comprising spaced parallel fins and transverse tube passes. A single fan supported within the partition draws air from both of the compartments through the chamber and through the evaporator in a path parallel to the fins and discharges the cooled air to the two compartments. The air supplied to the freezer compartment is introduced into that compartment adjacent the rear wall thereof and is received in a tunnel member supported on the partition and including top and side walls defining a chamber for the storage of one or more freezing trays. Air from this tunnel member is introduced into the freezer compartment through a plurality of openings spaced along the sides thereof and additional openings provided in the front portion of the top of the tunnel.

In accordance with a preferred form of the invention, the evaporator is so constructed that the ends of the fins which are initially contacted by the circulating air from the two compartments are of a length sufficient that the edges thereof operate at a more elevated temperature than

the remaining fin structure closer to a tube pass so that frost collects to only a minimum extent on these leading edges. In order to periodically warm the evaporator to defrost temperatures, there is provided radiant heating means comprising a radiant electric heater wire enclosed within a quartz tube, this heating means extending through a center portion of the evaporator transversely of the fins whereby heat from the heater radiates to all surfaces of the fins. Defrost water from the evaporator is collected in the bottom of the evaporator chamber and is drained through a drain hole provided in the foam insulation into a channel formed in the bottom surface of the partition, which channel in turn discharges the defrost water onto a wall of the fresh food compartment. The drain hole which is upstream from the fan is kept open by circulation of relatively warm air from the fresh food compartment upwardly through the channel and drain hole when the fan is operating.

For a better understanding of the invention reference may be had to the accompanying drawings in which:

FIGURE 1 is a vertical side sectional view of a two-temperature refrigerator embodying the present invention;

FIGURE 2 is a horizontal sectional view taken generally along line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view illustrating the frosting operation of the preferred evaporator structure;

FIGURE 4 is a view similar to FIGURE 3 illustrating ing the operation of the usual evaporator during frost formation thereon; and

FIGURE 5 is a wiring diagram of a control circuitry for controlling the operation of the refrigerator.

With reference to the drawing, there is shown a refrigerator comprising insulated walls defining an upper freezer compartment 1 intended to operate at a temperature below freezing and a lower fresh food compartment 2 adapted to operate at an above freezing temperature of about 35 to 40° F. The two compartments are separated by a horizontal insulating partition 3. The access opening to the freezer compartment 1 is closed by means of an insulated door 4 while the access opening to the fresh food compartment 2 is closed by means of an insulated door 5. A machinery compartment 6 in the lower portion of the cabinet contains the refrigerant condensing unit of a refrigeration system including a hermetic motor drive compressor 7 and a condenser 8.

In the illustrated embodiment of the invention, the single evaporator 9 for refrigerating the two compartments 1 and 2 is contained within an evaporator chamber 10 formed within the insulated partition 3. It is understood that the compressor 7, the condenser 8, suitable flow restricting means (not shown) and the evaporator 9 are connected in closed series flow relationship to form the usual closed refrigerant circuit.

For the purpose of maintaining the two storage compartments 1 and 2 at their desired operating temperatures, air streams from these two compartments are passed over the evaporator 9 and refrigerated or cooled air streams are returned to the compartments by means of a single fan generally indicated by the numeral 12. More specifically, the inlet portion or end 14 of the evaporator chamber 10 is connected to the freezer compartment by a relatively large louvered inlet 15 extending across the forward end of the partition 3 within the freezer compartment 1 and the major portion of the air cooled or refrigerated by the evaporator 9 is returned to the freezer compartment through an air passage 16 adjacent the outlet from the fan 12. This air leaving the passage 16 flows into the rear end of a tunnel 17 provided in the bottom of the freezer compartment 1 for the storage of one or more freezing trays 18 and passes from the tunnel into the freezer compartment through a plurality of louvers 19 provided in the side walls of the tunnel and a second set

of louvers 20 provided in the top wall of the tunnel adjacent the front of the tunnel. The access opening at the front of the tunnel 17 is closed by a solid pivoted door 21.

Air from the fresh food compartment 2 enters the inlet end 14 of the evaporator chamber 10 through a plurality of spaced passages or ducts 22 which have a total area that is relatively small as compared with the cross-sectional area of inlet 15. Within the chamber inlet portion 14 this air becomes mixed with the air flowing into the evaporator chamber from the freezer compartment before passing over the evaporator 9. A relatively small portion of the cooled refrigerated air flowing from the rear or outlet end of the chamber 10 is circulated by the fan 12 downwardly through an outlet passage 24 to the fresh food compartment.

The partition 3 comprises a lower horizontal member 26 substantially coextensive with the interior of the cabinet on which is supported a body or layer of insulating material 27 formed to define the evaporator chamber or cavity 10. A cap of insulating material 28 substantially closes the top of this chamber 10 and another member 29 of sheet material positioned over the cap 28 forms the bottom wall of the freezer compartment 1.

The evaporator 9 is positioned within the forward end of the chamber 10 that is adjacent the air inlets 15 and 22 and the concave walls of the chamber in this area are covered by a metal drain pan 31 on which the evaporator 9 is supported and which is designed to receive condensate from the evaporator during the defrost operation. To assure defrosting of the pan portions thereof are in thermal contact with the evaporator.

The evaporator 9, as is more clearly shown in FIGURE 2 of the drawing, comprises a plurality of transversed refrigerant tubular passes 33 and a plurality of fins 34 extending transversely of the passes 33 in a direction generally parallel to the direction of flow of air through the chamber 10 as the air travels from the inlet passages 15 and 22 to the fan 12 positioned in the rear portion of the chamber 10. The evaporator is directly supported on the pan 31.

Also in accordance with the present invention the forward or inlet end of the evaporator, that is the portion of the evaporator first contacted by the air streams from the freezer and fresh food compartments as the air streams enter the evaporator chamber 10 is so constructed as to permit the accumulation of a greater amount of frost on the evaporator without plugging or closing of the spaces between the fins than is possible with the usual fin-on-tube evaporator.

One of the major problems in designing plate-fin-on-tube evaporators for auto-defrost refrigerators is that of keeping them from rapidly blocking with frost and losing their heat transfer ability. Present evaporator designs tend to block rapidly at the inlet leaving the downstream part of the evaporator relatively free of frost. This is illustrated in FIGURE 4 of the drawing showing the usual evaporator structure comprising a plurality of refrigerant passes 33 and a plurality of fins 34 extending transversely of the passes 33. When moisture laden air comes in contact with the inlet or right hand edge of the evaporator as illustrated in FIGURE 4, the forward edges 37 of the fins operating at approximately the same temperature as the passes 33 cause substantially all of the moisture in the air to condense in this area and form layers of frost 38 on and adjacent these forward edges which in a relatively short time bridge the spaces 39 between the fins.

In accordance with the present invention, the evaporator is constructed as shown in FIGURE 3 of the drawing so that the forward or lead end portions 40 of the fins 34, that is the portions extending upstream from the first pass 41 are sufficiently long so that the edges 42 thereof operate at temperatures sufficiently higher than the temperatures of the refrigerant passes 33 as to substantially eliminate or reduce the initial formation of frost thereon.

In other words due to the temperature differential through the fin, a small increase in the length thereof

beyond the first tube pass 41 causes the leading edge 42 of each of the fins to operate at a temperature such that frost does not collect on the immediate edge portion but instead distributes itself fairly evenly along a considerable portion of the remaining length of the fins as indicated by the numeral 43. The amount that the fin length upstream from the pass 41 should be increased to prevent inlet blocking will vary with the application and evaporator construction but in most household refrigerator evaporators an increase in length of about one-half inch over the normal length is usually sufficient. In this connection it should be noted that the usual length of the portion of the fin projecting from the first pass 41 is about one-half the length of the portion of the fin between any two adjacent passes 33 of the evaporator. By lengthening the lead end of the fin as illustrated in FIGURE 3 of the drawing, there in a gradual heat gradient through each fin in this area that provides a more even distribution of frost over a greater length of the fins.

For an even greater frost tolerance, alternate fins may also be shortened or in other words terminated short of the first pass 41 of the evaporator 9 as illustrated in FIGURE 2 of the drawing.

For the purpose of periodically removing the frost layer from the evaporator, there is provided a radiant heater generally indicated by the numeral 44 and comprising a quartz tube 45 enclosing a coiled electric heater 46, the heater 44 extending transversely of the entire fin structure of the evaporator or in other words parallel to the passes 33 as illustrated in FIGURE 2 of the drawing. This radiant heater is positioned within a slot 47 (FIGURE 1) in the fin structure so that it is substantially centrally located within the evaporator and close to the pan 31. It is covered by means of a metallic cap 48 which functions as a reflector to more effectively heat the metal drain pan 31 positioned below the evaporator and prevents overheating of the layer or cap of insulation 28 forming the top surface or wall of the chamber 10. The cap 48 also largely eliminates water dripping on the hot heater during defrost which can cause objectionable noises. The single radiant heater defrosts all of the surfaces within the evaporator largely due to the fact that the radiant heat therefrom reaches the most remote surface areas of the evaporator through the spaces 39.

For the purpose of disposing of the condensate formed during defrosting of the evaporator 9, the pan 31 and the body of insulating material 27 are provided with a drain passage 49 positioned to be directly warmed by heat from the radiant heater and through which condensate drains onto a channel 48 in the sheet member 26. The channel 48 is designed so that the water flowing down through the channel flows onto the back wall 50 of the compartment 2 through a drain tube 51, downwardly along the back wall 50 to the bottom of the compartment 2 and through a second drain opening 52 into a drain pan (not shown) in the machinery compartment 6 in which the defrost water is evaporated by the heat from the condensing unit contained therein.

As is previously indicated, the refrigerator is designed for periodic removal of the frost layer from the evaporator 9 by operation of the heater 44. The control circuitry for this operation is illustrated in FIGURE 5 of the drawing as including a defrost timer 56 including a timer motor 57 connected across the supply lines 58 and 59 through a thermostat 60 positioned at some point within the fresh food compartment 2 so as to be responsive to the temperature therein. The timer 56 includes a double throw switch operated by the timer motor 57 and including a first contact 61 which is normally engaged by the switch arm 62 to complete a circuit energizing both the fan 12 and the compressor 7 when the thermostat 60 calls for cooling. After a predetermined period of operation of the timer, the timer switch operates to move the switch arm 62 out of contact with the contact 61 and into engagement with the contact 64 thereby

opening the circuit to the fan and compressor and closing the circuit including the defrost heater **44** for a period of time sufficient to assure complete defrosting of the evaporator. The energization of the heater **44** is also under the control of a defrost terminating switch **65** illustrated in FIGURE 2 as being in heat exchange relationship with a portion of the pan **31** forwardly from the evaporator **9** and a safety fuse **66** positioned between the evaporator **9** and the fan **12** and designed to open the circuit to the defrost heater in case of abnormal temperatures within the chamber **10**. During the period that the defrost timer calls for defrosting, the switch **65** will open the circuit whenever the temperatures sensed thereby indicate a complete defrosting of the evaporator and surrounding surface areas thereof such as the pan **31**. After a fixed period, the timer motor **57** returns the switch arm **62** into engagement with the contact **61** thereby returning the refrigerator to a normal cooling cycle of operation under the control of the thermostat **60**.

While there has been shown and described a specific embodiment of the present invention it will be obvious that it is not limited thereto and it is intended by the appended claims to cover all such changes and modifications as will occur to one skilled in the art to which the present invention relates.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A refrigerator cabinet comprising insulated walls and an insulated partition defining a freezer compartment in the upper portion of said cabinet and a fresh food compartment below said freezer compartment separated therefrom by said partition forming the bottom wall of said freezer compartment and the top wall of said fresh food compartment,

said partition comprising a bottom surface of sheet material and a layer of foam insulation supported thereon,

an evaporator chamber in said partition above said layer of foam insulation and a fin-on-tube evaporator in said chamber,

said evaporator tube passes normally operating at below freezing temperatures,

air circulating means including a fan for drawing air from both of said compartments through said chamber and through said evaporator and discharging cooled air to said compartments,

radiant heating means for periodically warming said evaporator to defrost temperatures,

means for collecting defrost water and draining said water into said fresh food compartment comprising a drain hole in the body of foam insulation and a channel in said bottom surface of said partition for receiving said water and discharging it onto a wall of said fresh food compartment,

said drain hole being upstream from said fan thereby causing the circulation of relatively warm air from said fresh food compartment through said channel and drain hole when said fan is operating for keeping said drain hole open.

2. A refrigerator cabinet comprising insulated walls including a rear wall and an insulated partition defining a freezer compartment in the upper portion of said cabinet and a fresh food compartment below said freezer compartment separated therefrom by said partition forming the bottom wall of said freezer compartment and the top wall of said fresh food compartment,

said partition comprising a bottom surface of sheet material and a layer of foam insulation supported thereon,

an evaporator chamber in said partition above said layer of foam insulation and a fin-on-tube evaporator comprising spaced parallel fins and transverse tube passes in said chamber,

said evaporator tube passes normally operating at below freezing temperatures,

air circulating means including a fan for drawing air from both of said compartments through said chamber and through said evaporator in a direction parallel to said fins and discharging cooled air to said freezer compartment adjacent the rear wall thereof,

a tunnel member in said freezer compartment and supported on said partition for receiving said cooled air discharged to said freezer compartment,

said tunnel member including top and side walls defining a chamber for the storage of a freezing tray and including a plurality of openings spaced along the sides thereof and in the front portion of the top thereof for the passage of cooled air into said freezer compartment,

the ends of said fins initially contacted by the circulated air being of a length sufficient that the edges thereof operate at a more elevated temperature than the remaining fin structure such that frost does not collect substantially thereon,

radiant heating means for periodically warming said evaporator to defrost temperatures comprising a radiant electric heater wire enclosed within a transparent, heat-resistant tube,

said radiant heater extending through a center portion of said evaporator transversely of said fins whereby heat therefrom radiates through the spaces between said fins,

means for collecting defrost water and draining said water into said fresh food compartment comprising a drain hole in the body of foam insulation and a channel in said bottom surface of said partition for receiving said water and discharging it onto a wall of said fresh food compartment,

said drain hole being upstream from said fan thereby causing the circulation of relatively warm air from said fresh food compartment through said channel and drain hole when said fan is operating for warming said drain channel to above freezing temperatures.

3. A refrigerator cabinet comprising insulated walls including a rear wall and an insulated partition defining a freezer compartment in the upper portion of said cabinet and a fresh food compartment below said freezer compartment and separated therefrom by said partition forming the bottom wall of said freezer compartment and the top wall of said fresh food compartment,

said partition comprising spaced upper and lower sheet metal members and a body of foam insulation therebetween supported thereon,

an evaporator chamber in said body of foam insulation and a fin-on-tube evaporator comprising spaced parallel fins and transverse tube passes in said chamber,

said evaporator tube passes normally operating at below freezing temperatures,

air circulating means including a fan for drawing air from both of said compartments through said chamber and through said evaporator in a direction parallel to said fins and discharging cooled air to said freezer compartment adjacent the rear wall thereof,

a tunnel member in said freezer compartment and supported on said upper sheet metal member of said partition for receiving said cooled air discharged to said freezer compartment,

said tunnel member including top and side walls defining a chamber for the storage of a freezing tray and including a plurality of openings spaced along the sides thereof and in the front portion of the top thereof for the passage of cooled air into said freezer compartment,

the ends of said fins initially contacted by the circulated air being of a length sufficient that the edges thereof operate at a more elevated temperature than the re-

maining fin structure such that frost does not collect thereon,

a metal drain pan below said evaporator,

radiant heating means for periodically warming said evaporator to defrost temperatures comprising a radiant electric heater wire enclosed within a heat resistant, transparent tube,

said radiant heater being removably positioned in a slot in said evaporator and extending through a lower center portion of said evaporator transversely of said fins and adjacent said drain pan whereby heat therefrom radiates through the spaces between said fins for heating said evapoartor and said drain pan,

a reflector above said radiant heater for reflecting the heat therefrom downwardly towards said drain pan and for deflecting defrost water away from said heater,

means for collecting defrost water and draining said water into said fresh food compartment comprising a drain hole in said drain pan and in the body of foam insulation and a channel in said lower sheet

metal member of said partition for receiving said water and discharging it onto a wall of said fresh food compartment,

said drain hole being upstream from said fan thereby causing the circulation of relatively warm air from said fresh food compartment through said channel and drain hole when said fan is operating for warming said drain channel to above freezing temperatures.

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