Feb. 5, 1957 D. E. HILLIKER 2,780,075

FREEZER COMPARTMENT FOR HOUSEHOLD REFRIGERATOR

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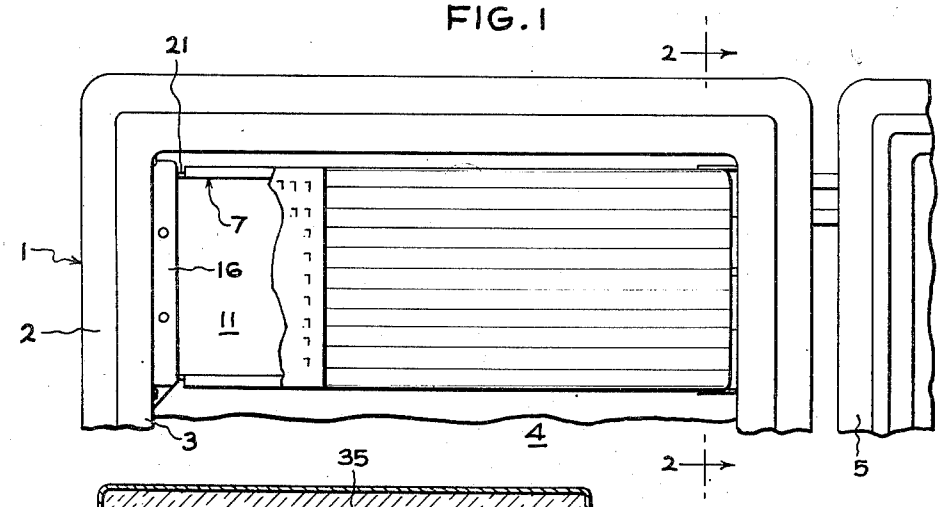
FIG. 1



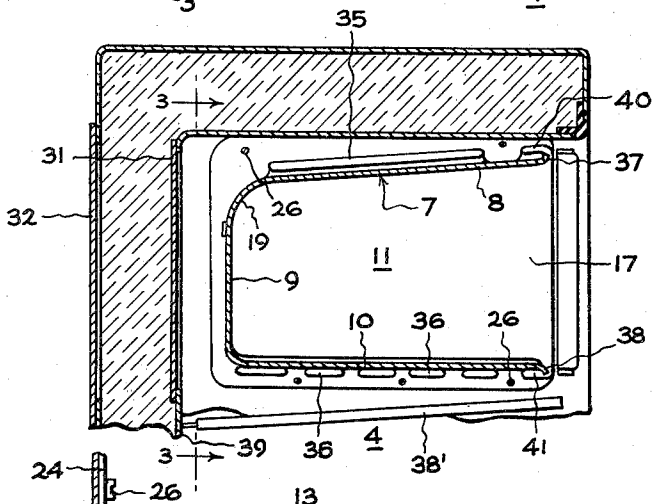


FIG. 2

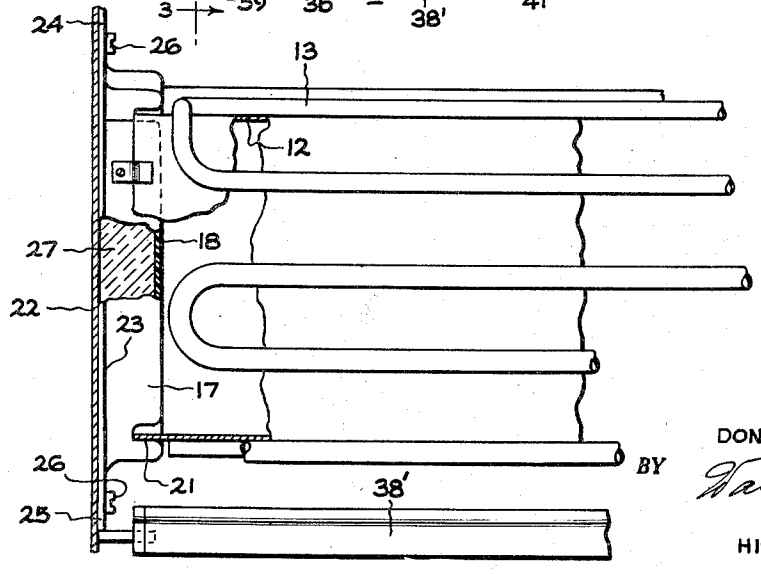


FIG. 3

INVENTOR.
DONALD E. HILLIKER
BY
HIS ATTORNEY

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FREEZER COMPARTMENT FOR HOUSEHOLD REFRIGERATOR

Donald E. Hilliker, Louisville, Ky., assignor to General Electric Company, a corporation of New York

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6 Claims. (Cl. 62—99)

The present invention relates to household refrigerators and is more particularly concerned with an improved freezer compartment for such refrigerators.

In many household refrigerators, there is provided a single evaporator which serves not only to cool the fresh food storage compartment but also forms one or more walls of a freezer compartment. In order to maintain the contents of the freezer compartment at proper preservation temperatures, it is necessary to operate such an evaporator continuously at sub-freezing temperatures. As a result the moisture in the air within the storage compartment condenses on the evaporator surfaces and collects thereon in the form of frost. This frost layer continues to build up during operation of the refrigerator and finally materially decreases the efficiency of the refrigerating unit. It therefore becomes necessary to periodically remove this layer of frost from the evaporator surfaces. To avoid the necessity of the manual defrosting of the evaporator, various automatic arrangements have been developed for defrosting the freezer evaporator. These have generally included various means for supplying sufficient heat to the evaporator so that the frost will melt in a relatively short period of time and before any substantial warming or thawing of the frozen contents of the freezer compartment results. During operation of the evaporator, frost first collects on the refrigerant tubing on the metal freezer walls immediately adjacent the tubing. During continued operation of the evaporator over a relatively long period of time at sub-freezing temperatures there is a gradual expansion of the frosted areas until ultimately substantially all of the metal surfaces of the freezer compartment which are in direct or indirect heat exchange relationship with the refrigerant tubing become covered with frost. This expansion of the frosted area results in part from the fact that during the operating period all of the metal surfaces including those somewhat remote from the refrigerant tubing attain substantially the same sub-freezing temperature so that there is no longer a tendency for moisture or frost collecting on remote surfaces to migrate to the area of refrigerant tubing which at the beginning of the operating period is the coldest area. Since some time is required for the entire freezer compartment metal wall portion to reach this uniform temperature at which frost collects on all of the metal surfaces, it follows that the usual automatic defrosting schemes in which warmed refrigerant is passed through the refrigerant tubing in order to melt the frost collected on the evaporator or freezer surfaces fails to effect sufficient warming of the remote areas to melt the frost in these areas within a period of time which is short enough to avoid thawing of the frozen food contents of the freezer compartment. For that reason, passes of refrigerant tubing are ordinarily provided on all of the metal surfaces of the freezer compartment to assure that all of the metal freezer walls will be quickly defrosted when warm refrigerant is passed through the evaporator tubing. In other words, with the usual freezer evaporator

composed of metal walls, refrigerant tubing passes must be provided on all of the top, bottom, rear and side walls, more for the purpose of effecting satisfactory removal of frost than for the purpose of maintaining the freezer compartment at satisfactory storage temperatures. The provision of the refrigerant tubing on all of the frostable surfaces results in an increased material and manufacturing cost as well as an increase in the total volume of the refrigerating system and hence the amount of refrigerant necessary for an efficient operation of the system.

It is therefore an object of the present invention to provide a relatively inexpensive freezer compartment for a household refrigerator conditioned by means of a single evaporator.

A further object of the invention is to provide a household refrigerator including a freezer compartment and a single evaporator for maintaining the desired temperatures both within the fresh food storage compartment and the freezer compartment, which freezer compartment is characterized by the fact that one or more of the walls thereof need not be provided with refrigerant tubing passes to assure satisfactory automatic defrosting.

Another object of the invention is to provide a freezer compartment for a household refrigerator of simple construction and requiring a minimum number of operations for the mounting thereof within the refrigerator cabinet.

Further 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 carrying out the objects of the present invention, there is provided a freezer compartment having top, rear and bottom walls composed of a material of high heat conductivity such as aluminum and end walls composed of material of low heat conductivity so that under all operating conditions these end walls will maintain a temperature a few degrees warmer than the top, rear and bottom walls to which the evaporator tubing is secured and therefore will operate frost free and require no defrosting. The side walls of the freezer compartment are so formed of a low heat conductivity material, such as a plastic material, that they serve not only to form the side walls of the freezer chamber but also to support the C-shaped evaporator forming the remaining walls of the freezer compartment.

For a better understanding of this invention, reference may be had to the accompanying drawing in which Fig. 1 is an elevation view of a portion of a refrigerator incorporating an embodiment of this invention;

Fig. 2 is a sectional view along line 2—2 of Fig. 1; and,

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2.

Referring to the drawing, there is shown a refrigerator cabinet 1 including an outer wall 2 and a spaced inner wall or liner 3 defining a food storage compartment 4. The access opening to the food compartment is closed by a door 5.

For cooling the food storage compartment, there is provided in the upper portion thereof a C-shaped evaporator 7 including top wall 8, rear wall 9 and the bottom wall 10. As is shown more clearly in Fig. 3 the C-shaped evaporator includes a sheet metal member 12 forming the inner surface of the walls 8, 9 and 10 and a plurality of passes 13 of refrigerant tubing secured in heat exchange relationship with or integral with the sheet metal portion 12.

In order to enclose the space encompassed by the C-shaped evaporator and to provide a closed freezer compartment within the fresh food storage compartment,

there are provided members 16 and 17 composed of a material of low heat conductivity as compared with the metal forming the evaporator 7. These members 16 and 17 not only form the end walls of the freezer compartment 11 but also serve to support the evaporator structure 7 within the upper portion of the food storage compartment 4.

In the modification illustrated, the members 16 and 17 are generally pan-shaped and include, as is more clearly shown in Fig. 3, a central portion 18 defined at its upper, rear, and lower boundaries by a shoulder 19. This shoulder 19 is of the same general shape or configuration as the C-shaped evaporator 7 and is engaged by the side edges 21 of the C-shaped evaporator. To maintain the central portion 18 in spaced relationship with the adjacent side wall 22 of the liner 3, there is provided a flange 23 extending around all four sides of the member 17 with the edges of the flange adjacent at least the top and bottom portions of the member 17 terminating in flat sections 24 and 25 adapted to engage the liner wall 22 and to be secured thereto by means of screws 26. If desired, the space between the liner wall 22 and the central portion 18 of the supporting members may be filled with suitable heat insulation such as Styrafoam as indicated by the numeral 27 in Fig. 3.

As has previously been indicated, the evaporator 7 serves to cool the food storage compartment 4 by direct heat exchange with the air contained in that compartment. In order to maintain a fresh food storage temperature in the food storage compartment 4 and to maintain a temperature within the freezer compartment 11 sufficiently low for the preservation of frozen foods stored therein, the evaporator 7 must be operated normally at a temperature substantially below the freezing point of water. As a result, moisture in the air within the food storage compartment condenses on the evaporator and collects thereon as frost. Since condensation and frosting initially takes place at the coldest areas, the first frost formation is on the refrigerant tubing 13 and in the areas immediately adjacent the refrigerant tube passes.

However, upon continued operation of the refrigerator, the remaining surfaces of the evaporator comprising the sheet metal portion 8 gradually assume approximately the same temperature as the tubing so that there is a gradual migration or expansion of the frosted area until eventually all of the evaporator surfaces are covered with a layer of frost. This frost acts as an insulating medium thus reducing the cooling effect in the evaporator and the efficiency of the refrigerating system. It is desirable therefore to remove this blanket from time to time in order to maintain the operation of the refrigerating system at a reasonably high efficiency.

Since the manual removal of this frost layer is both time-consuming and disagreeable, better schemes have been developed for periodically warming the evaporator to a temperature somewhat above the melting point of ice for a period of time sufficient to melt the frost layer. In a refrigerator of the construction with which the present invention is concerned wherein the evaporator forms the principal wall structure of the freezer compartment, it is essential that any defrosting operation depending upon the warming of the evaporator surfaces be carried out within a relatively short period of time so that the freezer contents are not thawed or otherwise damaged. A simple and effective means of defrosting a refrigerator evaporator known as the "hot gas" method comprises the circulation of warm refrigerant through the evaporator tubing. The warm refrigerant gives up its heat to the tubing for melting the frost therefrom. While this method has as its principal advantages simplicity and relative low-cost as compared for example to complicated electrical heating arrangements, its effectiveness insofar as the entire evaporator surface is concerned depends upon the spacing and positioning of the tube passes 13. In other words while the warmed or gaseous refrigerant quickly removes the frost from the tube passes, the rate of heat transfer through the sheet metal member 8 forming the principal walls of the freezer chamber or compartment, even when this sheet metal member is composed of a high heat conductivity material such as aluminum, is not sufficiently fast to melt the frost on portions of the sheet metal member remote from the tube passes within a period of time sufficiently short so that the freezer compartment contents are not damaged.

For satisfactory hot gas defrosting of the previously known freezer compartments in which all of the walls forming the freezer chamber are composed of metal, it has been necessary to provide refrigerant tubing passes on all of the walls including the end walls. The resultant evaporator or freezer compartment, of course, does not lend itself to manufacture by low-cost methods, as for example by the forming thereof from a flat sheet metal structure in which the refrigerating tubing has already been attached to the sheet metal or formed as an integral part thereof.

In accordance with the present invention, there is provided a freezer compartment adapted for hot gas defrosting of the evaporator characterized by the fact that the side walls or end walls 16 and 17 are formed of a material of relatively low heat conductivity as compared with metal and which because of their low heat conductivity are not given to frost formation thereon. By this arrangement, regardless of the temperature at which the evaporator operates or in other words regardless of the temperature attained by the metal portions of the C-shaped evaporator, the end walls 16 and 17 formed of plastic or other low heat conductivity material continuously operate at temperatures a few degrees above the C-shaped evaporator. Thus any moisture which may collect on the end walls 16 and 17 will migrate to the colder areas of the freezer compartment 11, namely to the C-shaped metal evaporator. In other words, while the end walls of the freezer compartment will normally operate at temperatures well below freezing no frost will collect thereon so that the refrigerant tubing which normally would have to be provided thereon for defrosting purposes can be eliminated. The elimination of this tubing considerably simplifies the evaporator structure as well as the evaporator circuit. In effect a shorter evaporator circuit can be employed so that smaller diameter tubing can be used with a sizeable cost reduction in the evaporator. Likewise, since less evaporator tubing need be supplied, the total volume of the refrigerating system is reduced, therefore permitting a reduction in the total refrigerant charge.

The lower cost of the evaporator of the present invention also results from the manner in which the freezer compartment may be assembled and supported within the storage compartment 4. In the usual method of manufacturing a modern household refrigerator the cabinet is assembled as one unit and the refrigerating system including the evaporator, compressor and condenser are assembled as a separate unit. Thereafter the evaporator is positioned within the cabinet and the condenser and compressor suitably mounted exteriorly thereof. In accordance with the usual practice, openings are provided in the rear walls of the liner and outer cabinet wall or shell and the evaporator is inserted into the storage compartment 4 through this opening. Thereafter the openings in the liner and rear cabinet wall are closed by means of suitable plates such as those indicated by the numerals 31 and 32 in Fig. 2. It is, of course, necessary to provide within the storage compartment 4 suitable supporting means for the freezer compartment, and in the previously known arrangements the freezer compartment must of course be connected to the supports after it is inserted into the storage compartment 4.

The simplified structure of the freezer compartment of the present invention greatly facilitates this assembly operation. Before the evaporator 7 is positioned within the

storage compartment the members **16** and **17** can be fastened to their respective liner side walls by means of the screws or bolts **26** at a time when the bulky evaporator forming the cross-walls of the freezer compartment does not interfere with this operation. Thereafter, the refrigerating system including the evaporator is brought into assembly position with regard to the refrigerator cabinet and the C-shaped evaporator **7** is inserted through the opening provided in the rear cabinet wall until it engages the shoulder **21** of the members **16** and **17**. To facilitate this assembly operation and to support the C-shaped evaporator on the end members **16** and **17**, there may be provided one or more protuberances such as the protuberance **35** adjacent the shoulder at the top of the end members **16** and **17** and the protuberances **36** spaced from the shoulder **21** along the bottom of the end members **16** and **17** which cooperate with the shoulder and form recesses or slots for guiding the forward edges **37** and **38** of the C-shaped evaporator into the proper position with regard to the members **16** and **17**. Preferably the projections **36** at the bottom portions of the side members **16** and **17** are spaced apart to permit drainage of defrost water from the interior of the freezer compartment downwardly between the evaporator **7** and the end members **16** and **17** during a defrosting operation. This defrost water may be collected by means of a baffle **38'** positioned below the freezer compartment from which it drains rearwardly onto the rear wall **39** of the liner. In order to limit the forward movement of the C-shaped evaporator during assembly operation and to provide a more pleasing appearance for the face portions of the freezer compartment, the projections **40** and **41** adjacent the forward portions of the side members **16** and **17** are formed integral with or as continuations of the adjacent flange **23** in order to hide the edges of the C-shaped evaporator structure.

While a specific embodiment of the present invention has been shown and described, it is not intended that the invention be limited to this particular construction, and it is intended by the appended claims to cover all modifications within the spirit and scope of this invention.

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

1. A refrigerator cabinet comprising a liner defining a food storage compartment, a C-shaped refrigerant evaporator positioned in said compartment, said evaporator defining the top, rear and bottom walls of a freezer compartment, the side walls of said freezer compartment being composed of a low heat conductivity material, said side walls being secured to said liner and supporting said C-shaped evaporator in spaced relationship with said liner.

2. The refrigerator of claim 1 in which said side walls of said freezer compartment are composed of plastic material.

3. A refrigerator cabinet comprising a liner defining a food storage compartment and a freezer compartment in said food storage compartment including side, bottom, rear and top walls, said freezer compartment comprising a C-shaped refrigerant evaporator of high heat conductivity material forming the top, rear and bottom walls of said freezer compartment and support members of low heat conductivity material secured to the side walls of said liner, each member including a shoulder defining a vertical section in spaced relation with the adjacent liner side wall, said vertical sections forming the end walls of said freezer compartment, and projecting means spaced from said shoulders and defining with said shoulders recesses for receiving the top and bottom side edges of said evaporator.

4. A household refrigerator having a liner defining a food storage compartment, a freezer compartment in said food storage compartment, said freezer compartment comprising two opposed side wall members of low heat conductivity material and a C-shaped evaporator of high heat conductivity material forming the top, rear and bottom walls of said freezer compartment, means for securing said side wall members to opposed side walls of said liner, each of said members including a shoulder adjacent the top, rear and bottom edges thereof defining a central portion in spaced relationship with the liner wall to which it is secured, the side edges of said C-shaped evaporator substantially engaging said shoulder.

5. A household refrigerator having a liner defining a fresh food storage compartment and including opposed side walls, a freezer compartment disposed in said storage compartment and comprising a C-shaped evaporator of high heat conductivity material for directly cooling said fresh food storage compartment and said freezer compartment, said evaporator forming the top, rear and bottom walls of said freezer compartment and members of low heat conductivity material forming the side walls of said freezer compartment and including sections supporting said evaporator in spaced relationship with the liner side walls.

6. A household refrigerator having a liner defining a fresh food storage compartment and including opposed side walls, a freezer compartment disposed in said storage compartment, a C-shaped aluminum evaporator for cooling both compartments, said evaporator forming the top, rear and bottom walls of said freezer compartment and plastic members of low heat conductivity material forming the side walls of said freezer compartment and including sections supporting said evaporator in spaced relationship with the liner side walls.

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