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EVAPORATOR STRUCTURE FOR HOUSEHOLD REFRIGERATORS

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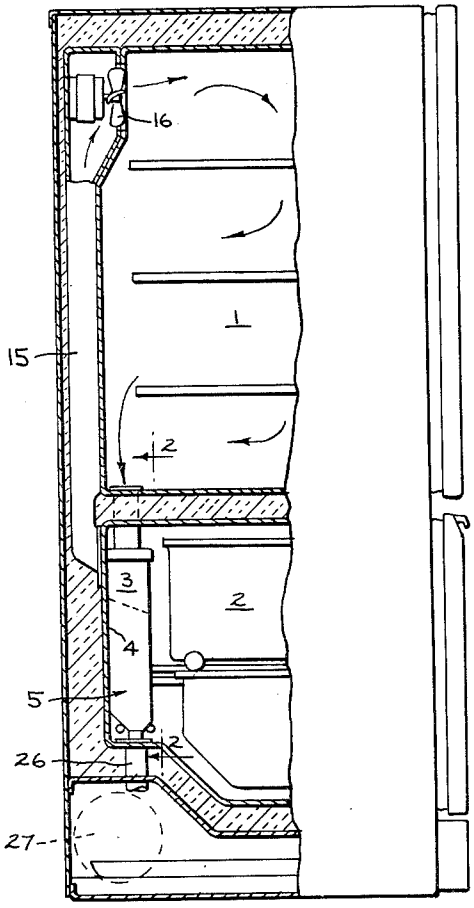


FIG.1

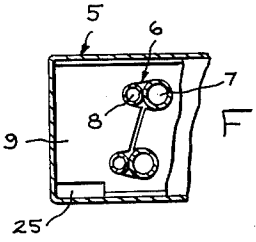


FIG.3

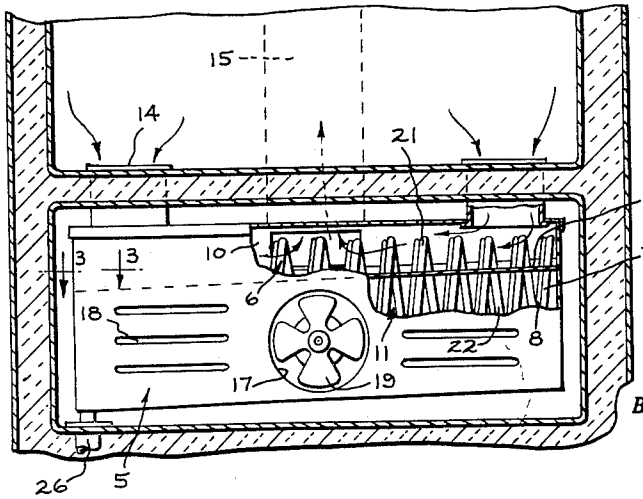


FIG.2

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EVAPORATOR STRUCTURE FOR HOUSEHOLD REFRIGERATORS

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The present invention relates to household refrigerators and is more particularly concerned with an improved evaporator arrangement for cooling the contents of refrigerators provided with separate compartments respectively operating at temperatures above and below freezing.

In one type of household refrigerator provided with a single evaporator for maintaining a frozen food compartment at sub-freezing temperatures and a fresh food storage compartment at temperatures somewhat above freezing, the evaporator is normally operated at a temperature somewhat below that required in the frozen food compartment and both compartments are cooled by circulation of air from the compartments over the evaporator. In such a refrigerator the evaporator may normally be operated at a temperature of for example —20° F. in order to maintain the freezer compartment at a temperature of about —10° F. In known refrigerators of this type, the air streams from the respective compartments are generally intermingled before being passed over the evaporator while the air streams flowing to the compartments from the evaporator are divided and so proportioned as to provide the desired higher temperature of for example 35–40° F. in the fresh food compartment. Since the low temperature evaporator is thereby exposed to both the high moisture content of the air flowing from the higher food storage compartment and the lower moisture content of the air circulating from the freezer compartment, the entire evaporator rather quickly becomes covered with an insulating layer of frost due primarily to the high moisture content of the air from the fresh food compartment. This frost layer causes a deterioration of the heat transfer rate between the evaporator and the air stream. As a result, the temperature of the air leaving the evaporator gradually increases as the frost layer becomes thicker.

Insofar as the fresh food compartment is concerned, a substantial lowering of the heat transfer rate can be tolerated because of the relatively large temperature differential between the evaporator and that compartment. However, as the desired freezer temperatures are relatively close to the normal evaporator temperatures, any substantial accumulation of frost on the evaporator immediately causes higher and less safe freezer compartment temperatures necessitating frequent defrosting of the evaporator to maintain the required evaporator heat transfer rate.

It is an object of the present invention to provide a new and improved evaporator structure so designed that the rapid accumulation of frost due to the high humidity of the fresh food compartment air contacting the evaporator will not interfere with the required refrigeration of the freezer compartment.

Another object of the present invention is to provide a single evaporator for cooling both a frozen food storage compartment and an unfrozen food storage compartment by air circulated over the evaporator and including means for limiting the contact of the air from the unfrozen food storage compartment to selected areas of the evaporator whereby the evaporator can normally be operated for a longer period of time without substantial increase in the temperature of the freezer compartment.

A more specific object of the present invention is to provide an improved low cost evaporator comprising a refrigerant conduit so constructed and arranged that separate air streams from the different refrigerated compartments contact alternate sections of the conduit.

Further objects and advantages of the present invention will become apparent from the following description 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 present invention, there is provided a household refrigerator of the type in which a freezer compartment and an above-freezing or fresh food storage compartment are both refrigerated by means of air circulated over a single evaporator normally operating at temperatures below those desired in the freezer compartment. The evaporator comprises a refrigerant conduit bent to form a plurality of passes. The evaporator is enclosed within an isolating housing and a partition provided within the housing in a plane intersecting the passes divides the housing into two sections one of which contains one end portions of the passes while the other contains the other end portions of the passes or loops. The evaporator structure is connected to the respective compartments by suitable air circulating means in such a manner that all of the air from the freezer compartment flows through one of the sections while all of the air flow from the fresh food compartment is restricted to the other section. As a result the moisture from the fresh food compartment will deposit as frost only on the portions of the evaporator passes in one of the sections. As the amount of frost deposited on the remaining portions of the passes in the other section results only from the relatively low moisture content of the freezer compartment, such frost will collect at a relatively slower rate thereby maintaining a high rate of heat transfer between the freezer portions of the evaporator and the air to maintain lower freezer temperatures for longer periods of time.

For a better understanding of the present invention reference is made to the accompanying drawings in which:

FIG. 1 is an elevation view partly in section of a refrigerator cabinet embodying the present invention;

FIG. 2 is a partial sectional view along line 2—2 of FIG. 1; and

FIG. 3 is a detailed sectional view along line 3—3 of FIG. 2.

With reference to the drawing and particularly FIGS. 1 and 2 thereof, there is shown an insulated refrigeration cabinet comprising an upper fresh food storage compartment operated at temperatures above freezing, such as 35–40° F., and a lower freezer compartment adapted to operate at below freezing temperatures of about —10° F. A single or unitary evaporator structure 3 provides the refrigeration required for both compartments. In the illustrated embodiment of the invention, the evaporator structure 3 is shown as being arranged along the rear wall 4 of the freezer compartment 2 although it is to be understood that it could be positioned outside of both of the compartments 1 and 2.

The evaporator structure comprises a substantially closed housing 5 and a refrigerant or evaporator coil 6 disposed within the housing, the housing serving the purpose of isolating the evaporator coil 6 from the contents of the freezer compartment 2 so that the contents of that compartment will not be damaged during warming and defrosting of the coil 6. In the illustrated embodiment of the invention, the evaporator coil 6 is in the form of a double tube extrusion, one of the tubes indicated by the numeral 7 serving to conduct refrigerant during the normal refrigerating operation of the evaporator and the other tube 8 parallel and heat exchanged with tube 7 providing a circulating path for hot refrigerant gas during the defrost operation. The manner in which hot refrigerant gas may be employed for the periodic defrosting of the evaporator coil 6 is more fully described in Patent 2,928,256—Nonomaque, issued March 15, 1960, and as-

signed to the same assignee as the present invention. It will be understood however that insofar as the present invention is concerned any suitable heating means can be employed for defrost purposes. For example, a suitable electrical resistance heater can be extended through the tube 8 so that upon periodic energization of such a heater the entire length of the refrigerant conduit 7 will be brought to defrosting temperatures. Likewise any suitable defrost control means may be employed for periodically initiating and controlling the frequency of the defrost operations.

In the illustrated embodiment of the invention, the evaporator coil 6 is bent into the form of a plurality of elongated and flattened loops extending from one end to the other of the housing 5 so that there is provided a plurality of vertical passes interconnected at their ends by return bends and extending vertically substantially the full height of the housing 5. A partition 9 extending across the housing in a plane intersecting the passes intermediate the ends thereof divides the housing into an upper or fresh food section 10 and a lower or freezer section 11.

For the purpose of cooling the compartments 1 and 2 by circulation of air from those compartments into heat exchange with the evaporator, the upper section 10 of housing 5 is connected to the fresh food storage compartment 1 by means of two return air ducts 14 and a supply duct 15 and a fan 16 located at the outlet end of the supply duct 15 is provided for effecting air circulation between the evaporator section 10 and compartment 1. The freezer compartment 2 is refrigerated by the circulation of air from that compartment into the lower section 11 of housing through an opening 17 in the lower front wall of housing 5 below partition 9 and back through a plurality of vents 18. A fan 19 is employed to draw air into the housing through the opening 17 in the front of the housing.

The partition 9 causes the air flow from the fresh food compartment 1 to be restricted to the upper or fresh food section 10 of the evaporator structure while the freezer air flow is restricted to the lower or freezer section 11 thereof.

By this partitioning of the housing into upper and lower sections in which all of the end portions 21 at the top of the coil are in section 10 and all of the end portions 22 at the bottom of the coil are in the lower or freezer section 11, there is provided an evaporator structure in which during normal operation of the refrigerating system only the end portions 21 of the refrigerant conduit 6 are exposed to the high moisture content of the fresh food air. An insulating frost layer of substantial thickness can be tolerated on the portions 21 even though that layer causes a significant decrease in the heat transfer rate between the refrigerant tubing 7 and the air in section 10. In other words because of the relatively large differential between the evaporator and the fresh food compartment temperatures, satisfactory fresh food temperatures can be maintained within the compartment 1 for a substantial period of time even though the frost build up on the portions 21 of the refrigerant conduit is such that the effective temperature of the frost layer is above normal freezer compartment temperatures. Since the lower end portions 22 are exposed only to the lower moisture content of the freezer compartment air, frost accumulation thereon occurs at a much slower rate so that the operating efficiency of the surfaces of these portions will remain relatively high to maintain the desired freezer compartment temperatures for a longer period of time. This occurs even though the entire length of the refrigerant conduit 7 within housing 5 is actually operating at substantially the same pressure and hence at the same overall temperature. By thus dividing one continuous evaporator conduit into alternate portions so that some of the portions refrigerate the fresh food compartment and the other or intermediate portions refrigerate the freezer compartment, the frequency of defrost is determined only by the rate of frost formation on the freezer portions.

In order to dispose of the defrost water formed during the defrost operation the partition 9 is preferably sloped both toward one end of the housing as well as to one side and the lowermost corner of the partition is cut away as indicated by the numeral 25 in FIG. 3 of the drawing so that the defrost water can flow from the upper section 10 of the evaporator housing into the lower section from which it is drained through a drain 26 into the machinery compartment 27 at the bottom of the cabinet.

While there has been shown and described a preferred embodiment of the present invention, it is to be understood that the invention is not limited thereto and it is intended to cover by the appended claims all such modifications within the true spirit and scope of the invention.

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

1. A household refrigerator including a freezer compartment for the storage of frozen foods and a fresh food compartment for the storage of foodstuffs at above-freezing temperatures, an evaporator for refrigerating both of said compartments, a housing enclosing said evaporator, said evaporator comprising a refrigerant conduit formed to include a plurality of passes series connected by end loops, a partition positioned in a plane intersecting said passes between the ends thereof dividing said housing and said evaporator into a freezer section and a fresh food section and separate means for circulating air from said fresh food compartment over said fresh food evaporator section and air from said freezer compartment over said fresh food section.

2. A household refrigerator comprising a freezer compartment for the storage of frozen foods and a fresh food compartment for above-freezing storage, means for refrigerating said compartments comprising an evaporator unit including a housing disposed in said freezer compartment and an evaporator coil disposed within said housing, said coil comprising parallel, interconnected refrigerating and defrost tubes formed into a plurality of elongated loops, a partition within said housing in a plane intersecting said loops intermediate the ends thereof for dividing said housing into two sections respectively containing the opposite end portions of said loops, means for circulating air from said fresh food compartment through one of said housing sections and means for circulating air from said freezer compartment through the other housing section.

3. A household refrigerator comprising a freezer compartment for the storage of frozen foods and a fresh food compartment for above-freezing storage, means for refrigerating said compartments comprising an evaporator unit including a housing and an evaporator coil disposed within said housing and comprising a refrigerant conduit formed into a plurality of elongated loops, a partition within said housing in a plane intersecting said loops intermediate the ends thereof for dividing said housing into two sections respectively containing the opposite end portions of said loops, means for circulating air from said fresh food compartment through one of said housing sections and means for circulating air from said freezer compartment through the other housing section.

4. An evaporator unit for refrigerating two separate compartments at respectively above and below freezing temperatures comprising a refrigerant conduit coiled to form a plurality of interconnected passes, a housing at least partially enclosing the coiled conduit, a partition within said housing dividing said housing into two sections, said partition being disposed in a plane intersecting said passes so that a portion of each pass is in one section and the remaining portion in the other section, and separate air circulating means connecting one section with the above freezing compartment and the other section with the below freezing compartment.

5. An evaporator unit for refrigerating two separate

compartments at respectively above and below freezing temperatures comprising a refrigerant conduit coiled to form a plurality of interconnected passes, a housing at least partially enclosing the coiled conduit, a partition within said housing dividing said housing into two sections, said partition being disposed in a plane intersecting said passes, and separate air circulating means connecting one section with the above freezing compartment and the other section with the below freezing compartment.

6. An evaporator unit for cooling separate refrigerated compartments operating respectively at above and below freezing temperatures, said unit comprising a housing, a refrigerant conduit formed into a plurality of elongated loops disposed in said housing and adapted for normal refrigerating operation at a temperature below freezing, defrost means in heat exchange with substantially the entire length of said conduit, a partition in said housing disposed in a plane intersecting said loops intermediate the ends thereof and dividing said housing into separate sections and means for circulating air from the above freezing compartment through one of said sections and air from the below freezing compartment through the other of said sections whereby the frost collecting on said conduit due to the high moisture content of the air from the above freezing compartment will be limited to the portions of said loops in said one of said sections.

7. An evaporator unit for cooling refrigerated compartments operating respectively at above and below freezing temperatures, said unit comprising a housing, a refrigerant conduit formed into a plurality of elongated loops disposed in said housing and adapted for normal refrigerating operation at a temperature below freezing, a partition in said housing disposed in a plane intersecting said loops intermediate the ends thereof and dividing said housing into separate sections so that the sections respectively contain the opposite end portions of each loop, and means for circulating air from the above freezing compartment through one of said sections and air from the below freezing compartment through the other of said sections.

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