July 6, 1943. C. M. REES 2,323,354

REFRIGERATOR

Filed Dec. 10, 1941

Fig. 1

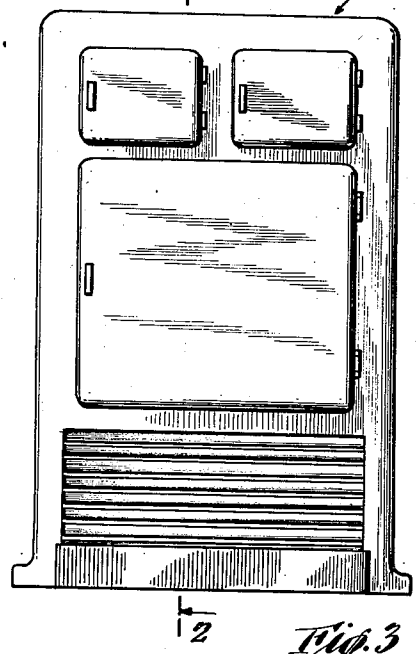


Fig. 2

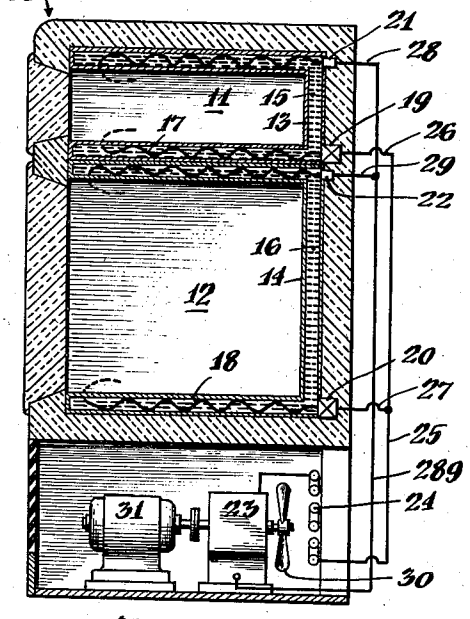


Fig. 3

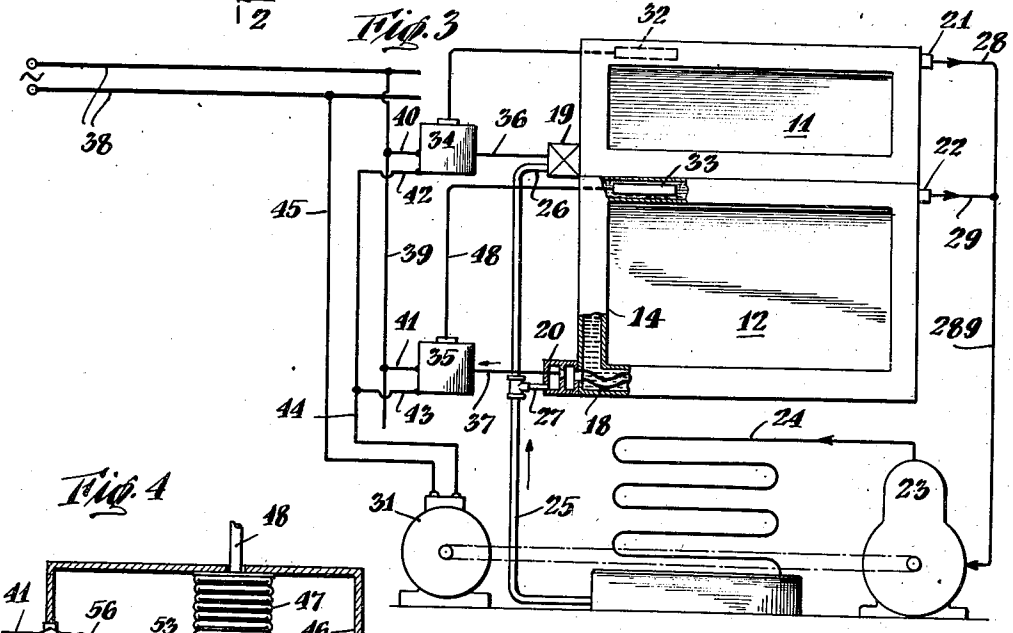
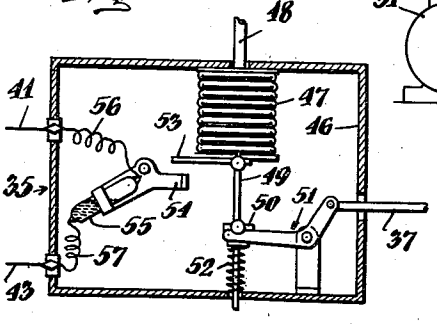


Fig. 4



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REFRIGERATOR

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4 Claims. (Cl. 62—8)

This invention relates to refrigerating apparatus, and more particularly to refrigerators of the domestic type which have a compartment in which hydrated articles of food, and the like, are adapted to be stored.

The invention has for its object generally the provision of refrigerating apparatus with means for controlling the humidity of the refrigerating air in food storage compartments in a positive and efficient manner, simulating the advantages of the ice-boxes already known to the art.

More specifically, the object is to provide refrigerating compartments of refrigerators having systems for circulating refrigerant in a manner controlling the water vapor of the refrigerating air in such compartments, as well as the temperature thereof, so that meats, vegetables, and similar articles will not be dehydrated while being kept therein. It is well understood that there is a definite relationship between air at a given temperature and the quantity of water vapor the air can hold at a given temperature.

Still another object is to provide a refrigerator having a refrigerating food storage compartment cooled by a system that may be common to other segregated compartments such as an ice forming compartment with temperature tempering means in the food storage compartment comprising secondary refrigerant associated with a cooling element carrying primary refrigerant in such a way as to modify the temperature gradient between the primary refrigerant and gravity circulated air to get a desired cooling effect without changing the system, for example, reducing the gradient so as to avoid undue moisture precipitation on the cooling element. This is accomplished by maintaining the secondary refrigerant at a temperature approximately or within a few degrees of that desired to be maintained by the air circulating in said compartment.

A further object of the invention is the provision of such refrigerator structure wherein secondary refrigerant is contained in a hollow air-cooling wall of a food storage compartment and cooled by a primary refrigerant circulated in a system including a cooling element immersed in the secondary refrigerant to a temperature within a few degrees of that at which the air in the food storage compartment advisedly is to be kept, the circulation of the primary refrigerant being controlled by means including a temperature sensitive element immersed in the secondary refrigerant.

A still further object of the invention is the provision of such refrigerating structure particularly adapted for domestic use which avoids undue dehydration of foods in a food storage compartment by avoidance of undue condensation of moisture and maintaining the moisture content of the air in that compartment substantially at or very near saturation without necessitating addition of moisture by auxiliary means such as open pans of water, sprays, etc.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a front elevational view of a typical domestic refrigerator of a type to which the present invention is applicable;

Fig. 2 is a vertical sectional view, taken on the line 2—2 of Fig. 1, showing a refrigerating compartment with means for cooling through the medium of a secondary refrigerant enclosed in the walls of a food compartment in accordance with the invention;

Fig. 3 is a schematic diagrammatic view showing means for maintaining automatically desired temperatures in the compartments of the refrigerator shown in Fig. 2; and

Fig. 4 is a fragmentary view showing details of a control element that may be employed in the practice of the invention.

Referring now to the drawing, and particularly to Figs. 1 and 2, a refrigerator of the domestic type is shown generally at 10, provided with upper and lower insulated compartments denoted respectively 11 and 12, to which access is had by doors opening at the front in the usual manner. The compartments 11 and 12 are formed at least almost wholly by double-walled vessels 13 and 14 formed of some readily heat transferable material such as high heat-conductive metal, in the enclosed spaces of which bodies of secondary refrigerant 15 and 16 are contained or circulated. The refrigerant contained in the enclosed spaces may be a brine that is cooled by a primary refrigerant. Such primary refrigerant is arranged to be circulated through coils or cooling elements 17 and 18 respectively disposed in the enclosed spaces and immersed in the bodies of secondary

refrigerant or brine 15 and 16 therein for cooling the respective compartments, these cooling elements being connected respectively to expansion valves 19 and 20 and outlet connections 21 and 22.

The primary refrigerant for compartments 11 and 12 may be any suitable refrigerant, for example, methyl chloride, which is supplied from a common system having a compressor shown generally at 23, disposed in an uninsulated compartment in the base of the refrigerator 10. Such compressor is arranged to discharge compressed primary refrigeant into condenser coils indicated symbolically at 24, from the base of which the cooled primary refrigerant is led by a common conduit 25 and branch conduits 26 and 27 through the expansion valves 19 and 20 respectively to the cooling coils or elements 17 and 18. These coils 17 and 18, immersed in the bodies of secondary refrigerant 15 and 16, communicate respectively through the outlet connections 21 and 22, branch conduits 28 and 29 and a common return conduit 289 connected to the latter and an inlet of the compressor 23. The advantage of using both primary and secondary refrigerants is readily seen in that it permits the use of a low boiling point refrigerant without lowering the surface temperature of the walls of the vessels 13 and 14 to the point where the circulating air will be excessively dehumidified. The system preferably has a power-driven ventilating fan, shown at 30, for cooling the coils 24, the power being advantageously had from that which drives the compressor, here shown as an electric motor 31.

The compartment 11 may be described as a freezing compartment, inasmuch as it is adapted to have means disposed therein for supporting ice-cube trays and the like. The compartment 12, however, is intended for the preservation of articles of food, and may be described as the food storage compartment. The temperatures desired in these compartments are preferably different and are hence independently controlled. An arrangement for achieving this is shown in Fig. 3 where 32 and 33 denote the temperature sensitive elements of thermostatic means which are immersed respectively in the bodies 15 and 16 of secondary refrigerant in compartments 11 and 12. These elements 32 and 33 may be of any suitable type, for example, of the expanding fluid type, in which a heat sensitive fluid operates an expansible element for operating the expansion valves 19 and 20. For this purpose the elements 32 and 33 may be respectively connected to valve controlling units 34 and 35 diagrammatically indicated in Fig. 3.

The control units 34 and 35 are shown arranged for respectively and independently operating the valves 19 and 20 by valve stems or rods 36 and 37. By such means, primary refrigerant may be admitted to cooling coils 17 and 18 selectively whenever the temperatures of the respective compartments rise above predetermined values. These control elements are also preferably arranged to set the compressor 23 into operation whenever an expansion valve is opened. Accordingly, the units 34 and 35 are arranged to actuate suitable motor control means. To this end, they are connected in parallel to each other but in series with the source of current. This latter is symbolically shown as a pair of alternating current bus bars 38, 38. The wiring arrangement connecting this source to motor 31 comprises a main conductor 39 leading from one side of the buses 38, 38 and provided with parallel electrical connections 40 and 41 each leading to one of two terminal connectors of one of the control units 34 and 35 as shown. From the other terminal connector of each of the units 34 and 35 conductors 42 and 43 respectively lead in parallel to a conductor 44 which is connected to one of the two motor terminals. The circuit is completed by another conductor 45 leading from the other motor terminal to the other side of the bus bars 38, 38. The temperatures desired in the compartments 11 and 12 are maintained by properly setting the automatic units 34 and 35, exemplary details of which are shown in Fig. 4.

Referring to Fig. 4, a valve stem 37 is seen to be extended into casing 46 of the unit 34 which may be a small iron receptacle with removable cover, the receptacle being arranged to house an expansible bellows 47 having one end wall fixedly mounted therein and to which is connected a fluid conduit 48 that communicates with the sensitive element 33. By such arrangement, the other or lower end wall of the bellows 47 is free to move up and down, and has an actuating rod 49 connected thereto, on which an adjustable follower 50 is secured for engaging with one arm of a bell crank or lever 51 that actuates the valve stem or rod 37, the lever and the rod 49 being resiliently held in operative engagement by means of a spring 52. The rod 49 is also provided with an adjustably positioned arm 53 for engaging with one end of a pivoted lever 54 which trips a contact making element 55 of an enclosed arc type of make-and-break device, such as a mercury switch, that is connected at one end with conductor 41 through a pigtail 56, the other end being connected to conductor 43 through a pigtail 57. Thus, by suitably adjusting the follower 50 and the arm 53 on the rod 49, a control maintaining substantially any desired operating condition of its associated expansion valve and the motor 31 may be had.

The spacing of back and front walls of vessel 14 from each other is preferably of substantial dimension, say an inch or more depending on the size of the refrigerator whereby conveniently to accommodate therebetween a cooling element or coil and temperature sensitive element, and the body of secondary refrigerant 16 may extend over a substantial area of the walls of chamber 12, say three walls, so that a relatively large body of secondary refrigerant having an extended heat absorbing surface is provided.

With such construction it will be seen that primary refrigerant may be circulated in the system at a temperature sufficiently low to freeze water for making ice cubes in the freezing compartment 11, say below 32° F., while independently keeping the temperature in the food storage compartment 12 at a much higher temperature, as desired, by the use of an independently controlled expansion valve 20 in a branch conduit parallel to that supplying primary refrigerant to compartment 11 and with the use of a relatively large body of secondary refrigerant 16 which is cooled to a moderate temperature by the primary refrigerant. The temperature of the secondary refrigerant in the compartment wall vessel 14 is kept by periodic flow of primary refrigerant in cooling coil 18 within a few degrees, e. g., one or two, of the temperature best suitable for food storage, say for the latter about 40° F. The control unit 35 may be set, preferably fixedly so that an uninstructed household user cannot change it or tamper with it, whereby when the

body of secondary refrigerant 16 absorbs sufficient heat through the exposed walls of vessel 14 from the air in food compartment 12 to raise its temperature say about 2½° F., the control unit 35 will open the expansion valve 20 to permit primary refrigerant at a relatively low temperature to be circulated through conduits 25 and 27, expansion valve 20, cooling coil 18, and conduits 29 and 289, to cool the body of secondary refrigerant 16 to a predetermined low temperature say about 38° F. This slight lowering of the temperature of the body of secondary refrigerant 16 causes a small amount of heat to be absorbed from the gravity circulated air in food storage compartment 12 and the cycle will eventually repeat, thereby maintaining the temperature of the air in the food storage compartment substantially constant, say within a few degrees. As a result the humidity of the air in the food storage compartment remains at all times near the saturation point with a consequent avoidance of substantial dehydration of food therein.

When the refrigerator door is opened to remove or place articles of food from or in the food compartment some warmer air at atmospheric temperature will take the place of some of the chilled air which flows out of that compartment. The warmer air will contain a relatively high amount of moisture and when the temperature thereof is lowered the air mixture in the compartment will have its humidity automatically adjusted to the saturation point, and there may be sufficient excess moisture for some slight precipitation to occur. The temperature of the walls of the vessel 14 are maintained sufficiently high to prevent freezing of collected condensate and thus there will be no conditions present which will tend to dehydrate foods.

By virtue of the construction and conditions of operation the time of operation cycles of the passage of primary refrigerant through cooling element 18 is minimized and thus excessive wear and tear on mechanical equipment is avoided. By extended tests of working models of the present invention in comparison with well-known and the better makes of mechanical domestic refrigerators on the market it has been found that cyclic operation of the present invention is only about 35% to 50% of that of the other refrigerators and that foods may be kept for extended periods of many weeks in the present device in a fresh, hydrated condition with the refrigerator in normal use, that is, the usual functioning in a household. Operation at no time results in frosting, thus annoyance of periodic defrosting common to refrigerators on the market is entirely eliminated.

As shown the vessel 14 is substantially cup-shaped of rectilinear form to provide the top wall, bottom wall, back wall, and two side walls, of the chamber 12. It is to be understood, however, that similar results may be attained by the use of other forms of such vessel so long as there is provision for exposure of considerable area of heat transfer surface and a relatively large body of contained secondary refrigerant in which the heat sensitive element and the cooling coil or element may be immersed. For example, the vessel 14 may be so shaped as to provide the top wall, or the top and back walls, or the top, back and bottom walls of the compartment 12.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a refrigerator the combination comprising, a refrigerator having a freezing compartment and an air-containing food storage compartment; a system for circulating primary refrigerant including a supply conduit, a return conduit, an expansion valve connected to said supply conduit, a cooling element for said food storage compartment connected between said expansion valve and said return conduit, another expansion valve connected to said supply conduit and another cooling element for said freezing compartment connected between said second-mentioned expansion valve and said return conduit; a vessel of heat transferable material having an exposed surface serving as an inner wall of said food storage compartment and containing a body of secondary refrigerant, said first-mentioned cooling element being located in said vessel and immersed in said body of secondary refrigerant therein to maintain the latter within a relatively small predetermined temperature range whereby air in said compartment to be freely circulated by gravity is cooled and a desired temperature gradient therebetween is maintained; expansion valve controlling means associated with said first mentioned expansion valve including a temperature sensitive element located in said vessel and immersed in said body of secondary refrigerant; and other expansion valve controlling means associated with said second-mentioned expansion valve including a temperature sensitive element associated with said freezing compartment.

2. In a refrigerator the combination comprising, a refrigerator having a freezing compartment and an air-containing food storage compartment; a system for circulating primary refrigerant including a supply conduit, a return conduit, an expansion valve connected to said supply conduit, a cooling element for said food storage compartment connected between said expansion valve and said return conduit, another expansion valve connected to said supply conduit and another cooling element for said freezing compartment connected between said second-mentioned expansion valve and said return conduit; a vessel of heat transferable material shaped to provide an exposed surface serving as at least the top wall of said food storage compartment and containing a body of secondary refrigerant, said first-mentioned cooling element being located in said vessel and immersed in said body of secondary refrigerant therein; a second vessel of heat transferable material shaped to provide an exposed surface serving as at least the bottom wall of said freezing compartment and containing another body of secondary refrigerant, said second-mentioned cooling element being located in said second-mentioned vessel and immersed in said body of secondary refrigerant therein; expansion valve controlling means associated with said first-mentioned expansion valve including a temperature sensitive element

immersed in said first-mentioned body of secondary refrigerant; and another expansion valve controlling means associated with said second-mentioned expansion valve including a temperature sensitive element immersed in said second-mentioned body of secondary refrigerant.

3. In a refrigerator the combination comprising, a refrigerator having an insulated main compartment divided into a freezing compartment and an air-containing food storage compartment segregated therefrom; a relatively thin vessel of heat transferable material shaped to provide an exposed surface serving as at least the top wall of said food storage compartment and containing a body of secondary refrigerant; another relatively thin vessel of heat transferable material shaped to provide an exposed surface serving as at least the bottom wall of said freezing compartment; said vessels cooperating to provide segregating means between said freezing and food storage compartments; a system for circulating primary refrigerant including a supply conduit, a return conduit, an expansion valve connected to said supply conduit, a cooling element for said food storage compartment connected between said expansion valve and said return conduit and located in said first-mentioned vessel and immersed in said body of secondary refrigerant therein, another expansion valve connected to said supply conduit and another cooling element for said freezing compartment connected between said second-mentioned valve and said return conduit and located in said second-mentioned vessel and immersed in said body of secondary refrigerant therein; expansion valve controlling means associated with said first-mentioned expansion valve including a temperature sensitive element immersed in said first-mentioned body of secondary refrigerant; and other expansion valve controlling means associated with said second-mentioned expansion valve including a temperature sensitive element immersed in said second-mentioned body of secondary refrigerant.

4. In a refrigerator the combination comprising, a refrigerator having an insulated main compartment divided into a freezing compartment and an air-containing food storage compartment segregated therefrom; a relatively thin vessel of heat transferable material shaped to provide an exposed surface of considerable area serving as top, bottom, back and side walls of said food storage compartment and containing a relatively large body of secondary refrigerant; another relatively thin vessel of heat transferable material shaped to provide an exposed surface serving as top, bottom, back and side walls of said freezing compartment; the top wall portion of said first-mentioned vessel and the bottom wall portion of the other vessel cooperating to provide a segregating partition between said freezing and food storage compartments; a system for circulating primary refrigerant including a supply conduit, a return conduit, an expansion valve connected to said supply conduit, a cooling element for said food storage compartment connected between said expansion valve and said return conduit and located in said first-mentioned vessel and immersed in said body of secondary refrigerant therein, another expansion valve connected to said supply conduit and another cooling element for said freezing compartment connected between said second-mentioned valve and said return conduit and located in said second-mentioned vessel and immersed in said body of secondary refrigerant therein; expansion valve controlling means associated with said first-mentioned expansion valve including a temperature sensitive element immersed in said first-mentioned body of secondary refrigerant; and other expansion valve controlling means associated with said second-mentioned expansion valve including a temperature sensitive element immersed in said second-mentioned body of secondary refrigerant.

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