

July 14, 1942.

C. M. REES

2,289,728

REFRIGERATOR WITH HUMIDITY CONTROL

Filed April 25, 1939

3 Sheets-Sheet 1

Fig. 1.

←2

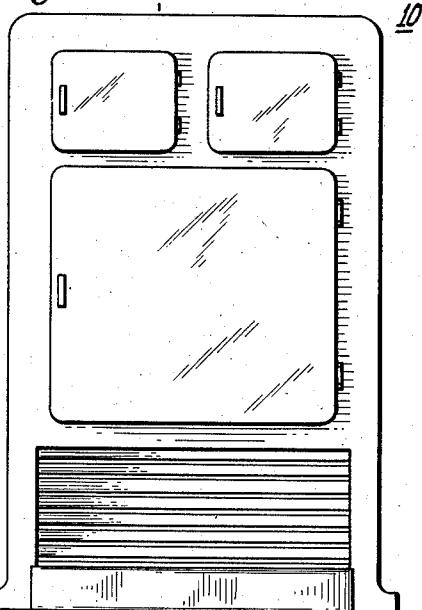
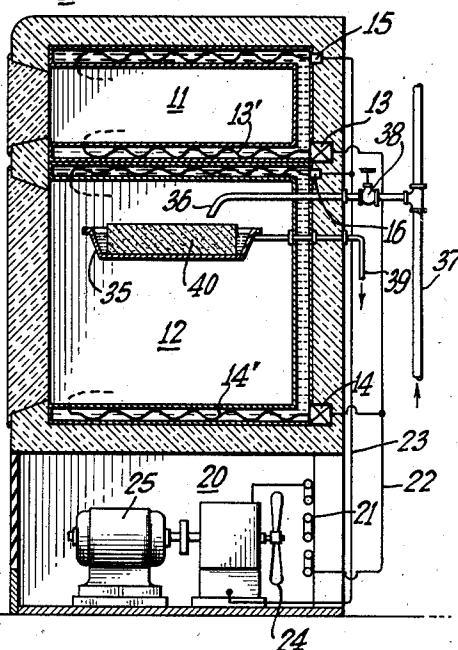


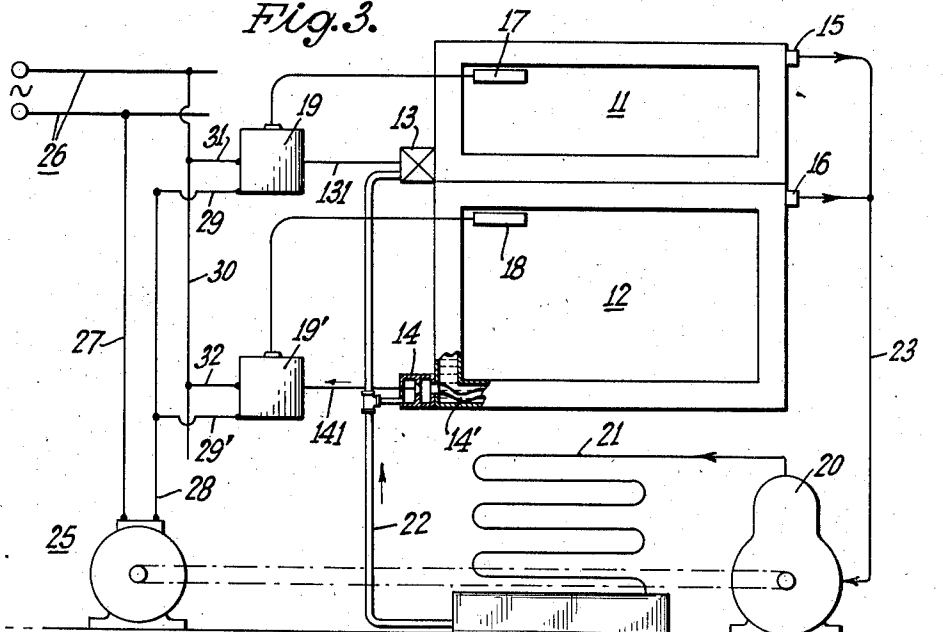
Fig. 2.

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←2

Fig. 3.



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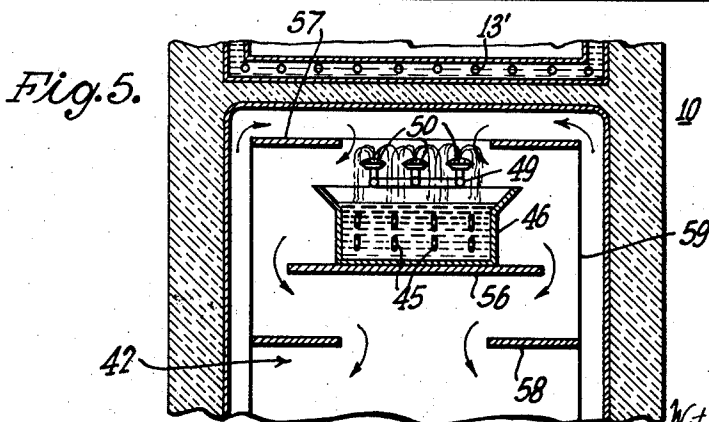
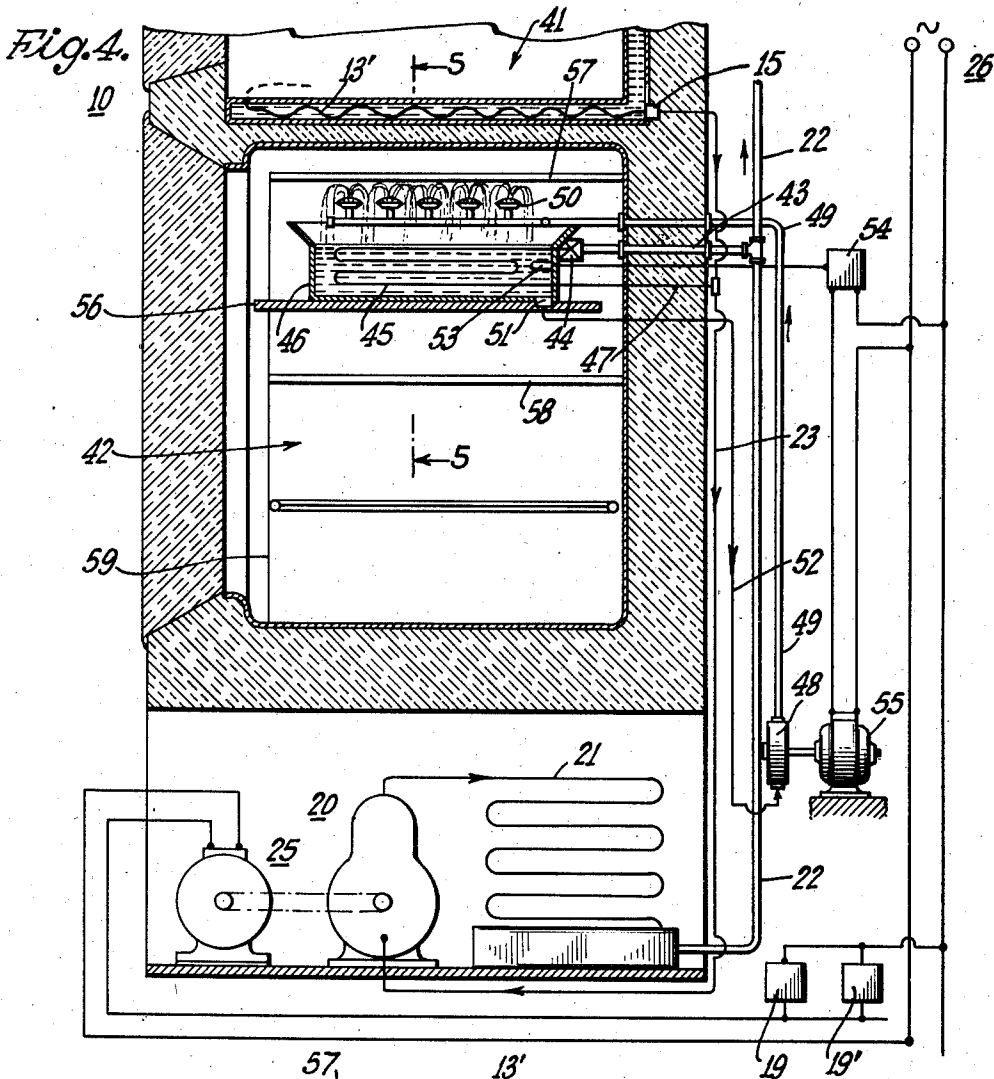
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3 Sheets-Sheet 3

Fig. 6.

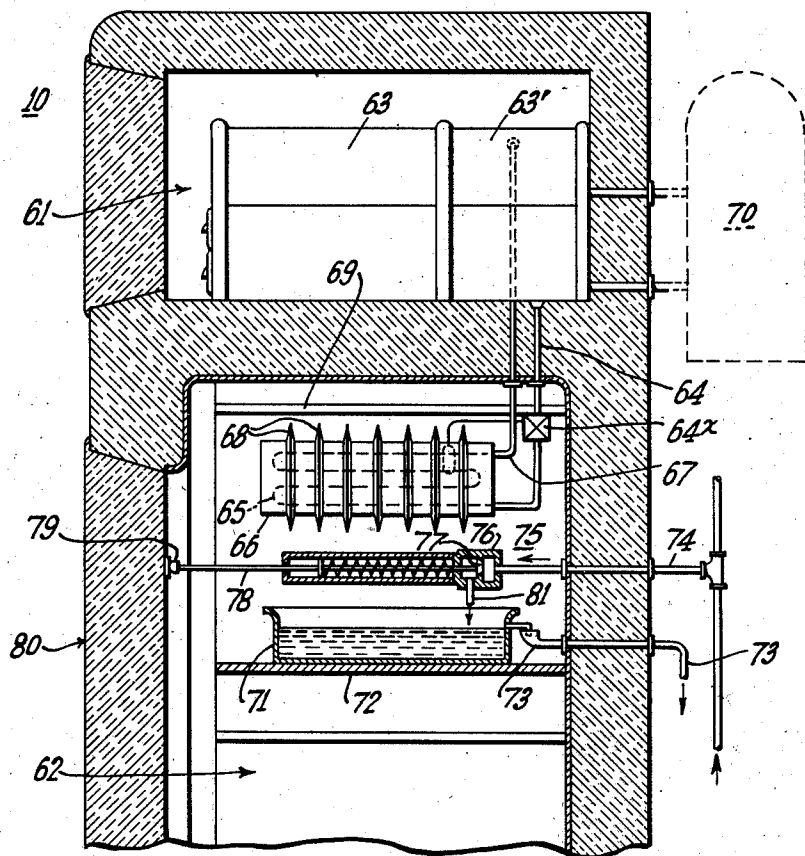
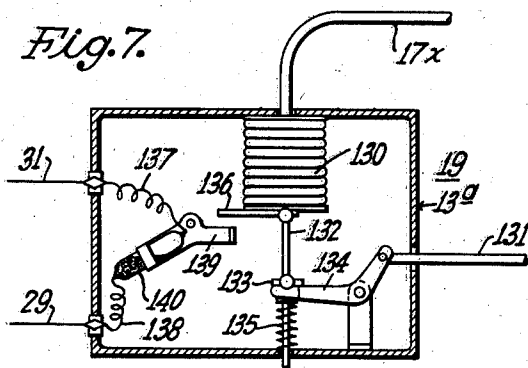


Fig. 7.



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REFRIGERATOR WITH HUMIDITY CONTROL

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Application April 25, 1939, Serial No. 269,831

6 Claims. (Cl. 62—3)

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 with means for positively introducing and 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.

Another object of the invention is to provide a simple and positive means in association with the cooling elements of refrigerators for the controllable introduction of water vapor directly into the refrigerating air.

Another object is to provide humidifying means for refrigerators which is adapted to maintain a relatively large amount of grains of moisture in the air which is circulated in a refrigerating compartment, irrespective of atmospheric conditions.

Still another object is to provide a refrigerator having a plurality of refrigerating compartments cooled by a common system with temperature tempering means associated with the cooling element in a selected compartment in such a way as to modify the temperature gradient of the 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.

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 drawings, in which:

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

Fig. 2 is a vertical section, taken on the line 2—2 of Fig. 1, showing a refrigerating compartment with means for cooling and humidifying the same in accordance with the invention;

Fig. 3 is a schematic diagram showing means

for maintaining automatically desired temperatures in the compartments of the refrigerator shown in Fig. 2;

Fig. 4 is a fragmentary sectional view, similar to Fig. 2, illustrating a modified form of the invention;

Fig. 5 is a fragmentary sectional view, taken on the line 5—5 of Fig. 4, illustrating certain constructional details thereof;

Fig. 6 is a fragmentary vertical sectional view, illustrating still another modified form of the invention; and

Fig. 7 is a fragmentary view showing details of a control element that may be employed in the practice of the invention.

Referring now to the drawings, and particularly to Figs. 1 and 2, a refrigerator of the domestic type is shown generally at 10, provided with upper and lower 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 here shown as of the cold wall type, i. e., they are double-walled vessels in the enclosed space of which a refrigerant is contained or circulated. The refrigerant contained in the enclosed spaces may be a secondary refrigerant or brine that is cooled by a primary refrigerant admitted to the respective enclosed spaces of the compartments by an expansion valve, as shown at 13 and 14 for the compartments 11 and 12 respectively. Such primary refrigerant is arranged to circulate in coils 13' and 14' disposed in the enclosed spaces of the respective compartments and connected to the respective expansion valves. These coils have outlet connections shown respectively at 15 and 16.

The primary refrigerant for compartments 11 and 12 may be any suitable refrigerant, for example, ethyl chloride, which is supplied from a common system having a compressor shown generally at 20, disposed in an uninsulated compartment in the base of the refrigerator 10. Such compressor is arranged to discharge compressed refrigerant into condenser coils indicated symbolically at 21, from the base of which the cooled refrigerant is led by a conduit 22 to the enclosed spaces, in which are located the cooling coils conducting the primary refrigerant. It is to be understood that these cooling coils are immersed in the secondary refrigerant and are tapped into the conduit leading respectively from the expansion valves 13 and 14. 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 wall of the enclosed spaces to the point where the circulating air will be dehumidified. A return conduit 23 is similarly connected to the outlets 15 and 16 of the cooling

coils and led to an inlet of the compressor 20. The system preferably has a power-driven ventilating fan, shown at 24, for cooling the coils 21, the power being advantageously had from that which drives the compressor, here shown as an electric motor 25.

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 refrigerating 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 17 and 18 denote the sensitive elements of the thermostatic means which are disposed respectively in the compartments 11 and 12. These sensitive elements may be of any suitable type, for example, of the expanding fluid type, in which a heat sensitive fluid operates an expansible element for doing the work of operating the primary refrigerant controlling valves and the like, such mechanism being diagrammatically indicated in Fig. 3 by the blocks 19 and 19'.

The control elements 19 and 19' are shown arranged for moving the valves 13 and 14 independently through valve rods 131 and 141. By such means, refrigerant may be admitted selectively whenever the temperatures of the respective compartments rise above predetermined values. These control elements are also preferably arranged to set the compressor 20 into operation whenever an expansion valve is opened. Accordingly, the elements 19 and 19' 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 26. The wiring arrangement connecting this source to motor 25 comprises a main conductor 30 leading from one side of the buses 26 and provided with parallel taps 31 and 32 leading to each of the control elements 19 and 19'. From the other side of the elements 19 and 19' conductors 29 and 29' lead in parallel to the conductor 28 which is connected to a motor terminal. The circuit is completed by another conductor 27 leading from the other motor terminal to the other side of the bus bars. The food compartment 12 of the refrigerator here shown is thus provided through its cold walls with cooling means that lowers the temperature of the air circulated in the compartment to a desired low value, which is preferably above the dew point for the atmospheric conditions to which the refrigerator is subjected.

Positive means for humidifying the compartment are, in accordance with the invention, associated with the refrigerating compartment 12, the means in this instance comprising a pan 35, located in the compartment at a point relatively remote from its side walls in a region of relatively high temperature, into which pan water is discharged from a nozzle 36 that is cooperatively disposed above the pan 35 and connected through the wall of the refrigerator to a water main 37; the latter being advantageously connected with the city water-supply. The water supplied to pan 35 by nozzle 36 is provided with a positive control in the form of a valve 38 introduced in the connection leading from the pipe 37 to the nozzle 36. The pan 35 is also provided

with an overflow connection 39 in order that a predetermined water level may not be exceeded at any time in the pan 35.

The body of water introduced through the nozzle 36 into the pan 35 is invariably at a higher temperature than that desired to be maintained in the refrigerating compartment 12. In consequence, the amount of water admitted is adjusted so that the water in the pan has a desired temperature tempering effect which substantially raises the temperature of the air being circulated by gravity above its dew point and prevents its otherwise being too rapidly cooled. This higher temperature is also seen to be of advantage in accelerating the evaporation of water from the surface of the pan to a point approaching saturation during the period when the walls of the compartment are being cooled.

The evaporation of water into the air circulating in the compartment 12 may be further accelerated by introducing a porous body containing a number of capillary passages, for example, a body of moist clay, hardwood charcoal, or activated carbon. Such block of porous material is indicated at 40 and provides a relatively large upper or exposed surface that is always moist, and quickly humidifies the air circulating in the compartment 12.

The operation of the refrigerator is believed to be sufficiently indicated in the above, it being apparent that the temperatures desired in the compartments 11 and 12 are maintained by properly setting the automatic devices 19 and 19', exemplary details of which are shown in Fig. 7.

Referring to Fig. 7, a valve stem 131 is seen to be extended into an enclosed compartment 13a which may be a small iron receptacle with removable cover, the receptacle being arranged to house an expansible bellows 130 to which is connected a fluid conduit 112 that communicates with the sensitive element 17. By such arrangement, the lower wall of the bellows 130 is free to move up and down, and has an actuating column 132 connected thereto, on which an adjustable follower 133 is secured for engaging with one arm of a lever 134 that actuates the valve rod 131, the lever and the column 132 being resiliently held in operative engagement by means of a spring 135. The column 132 is also provided with an adjustably positioned arm 136 for engaging with one end of a pivoted lever 139 which trips the contact making element 140 of an enclosed arc type of make-and-break device, such as a mercury switch, that is connected at one end with conductor 31 through a pigtail 137, the other end being connected to conductor 29 through a pigtail 138. Thus, by suitably adjusting the follower 133 and the arm 136 on the column 132, a control maintaining substantially any desired operating condition of its associated expansion valve and the motor 25 may be had.

A modified form of the invention is shown in Fig. 4, in which the cooling medium for the refrigerating compartment is a secondary refrigerant such as brine which is preferably under temperature control. Here, the refrigerator has insulated walls and upper and lower compartments 41 and 42, which are similar to the compartments 11 and 12 in the first form of the invention except that here cold walls are not employed or, at least, not in connection with the refrigerating compartment 42. The riser 22 for the primary refrigerant circulated by the compressor 20 is tapped by a connection 43 which has an expansion valve therein at 44 and

leads to a cooling coil 45 in an open tank or pan 46 that contains a suitable temperature tempering liquid, such as brine, and is disposed in the upper part of compartment 42. The coil 45 has an outlet connection 47 that leads to the return connection 23.

In order that the secondary refrigerant or brine in pan 46 may not only lower the temperature in compartment 42 but also humidify it, this brine is itself circulated and sprayed through the air circulating in the compartment. To this end, a separately driven pump 48 is provided, preferably on the exterior of the refrigerator, and has an outlet connection 49 provided with a plurality of nozzles 50 distributed over the top of the pan 46. The arrangement of these nozzles is preferably such as to spray the brine upwardly into the air in the compartment, any unevaporated spray falling back into the body of liquid in the pan 46. In order that this brine may be circulated to an extent which lowers the temperature, the pan 46 is provided with a sump 51 at its bottom from which a pump inlet connection 52 leads to the inlet end of pump 48. Automatic control for the circulation of the brine is also preferably provided. To this end, a temperature controlling means is employed, comprising a sensitive element 53, arranged to actuate a control element 54, which may be similar to that shown in Fig. 7 and arranged to actuate both the expansion valve 44 and a make and break for the circuits supplying power to a motor 55 coupled to drive the pump 48.

The brine thus circulated is seen to serve as a secondary refrigerant at a higher temperature than the primary refrigerant circulated in the coil 45 and is adapted in its circulation to introduce a relatively large number of grains of moisture directly into the air circulated in the compartment 42.

In order to achieve direct impingement by the spray from nozzles 50 of substantially all the air being circulated in compartment 42, baffling means are preferably employed, of a character adapted to direct the impingement and assist in inducing circulation. An arrangement of baffles of this character is shown in Fig. 5, where a main baffle 56 is disposed horizontally across the main space in the upper portion of the compartment 42 but whose ends clear the side walls of the compartment by a substantial distance. Superior auxiliary baffles 57 are disposed above the nozzles and to one side, such baffles clearing the side walls of the compartment by a less distance than the main baffles 56. Inferior baffles 58 are also preferably disposed below the main baffle 56 in substantially the same position as the baffles 57. To assist in inducing circulation, a thin metallic plate 59, which may be described as a vertical baffle, is disposed adjacent each of the side walls but clearing the same in all directions by small distances, the clearances being such that each plate 59 fits snugly against the adjacent edges of baffles 57 and 58. In this manner, the circulation of air which may have been warmed by absorbing heat from an article or articles being refrigerated in compartment 42, rises in the space between the vertical baffles 59 and the side walls of compartment 42, and moves horizontally over the baffles 57 and thence downwardly through the spray from nozzles 50 and then about the sides of the brine pan 45 to descend centrally into the cooling compartment through the space between the baffles 58. Substantially the whole body of air in the compartment 42 partakes of

this motion, and is hence both cooled and humidified by the secondary refrigerant or brine circulated and sprayed in compartment 42. In this manner, the tempered cold wall effect is achieved by the forced circulation of a secondary refrigerant.

A third form of the invention is shown in Fig. 6, in which 61 denotes an upper freezing compartment of the refrigerator, while 62 denotes a lower refrigerating compartment, in which cold walls are not directly employed, but a cold wall effect is achieved by the use of both secondary and tertiary refrigerants. Here, the primary refrigerant circulated achieves its refrigerating effect in accordance with the so-called "absorption principle," the compartment 61 being shown provided with a cooling element 63, the front end of which is adapted to house ice trays for making ice-cubes, while the rear portion 63' is adapted for cooling the secondary refrigerant. The cooled secondary refrigerant is led from this portion of the cooling element through a conduit 64 to a cooling coil 65 in a closed brine tank or vessel 66, the connection 64 advantageously having an automatically controlled expansion valve 64x disposed therein, the secondary refrigerant when warmed by the brine in vessel 66 passing out through the connection 67 back to an upper portion of the cooling element at 63'. Here, the cooling of the air circulating in the compartment 62 is accelerated by the provision of a plurality of cooling fins 68 on the vessel 66, these operating in conjunction with one or more baffles, as shown at 69, which may be similar to those shown in Fig. 5. The circulation of the primary refrigerant for the cooling element 63 is insured by the provision of an exterior element, shown symbolically at 70, the power supply for which may be through gas for heating.

In this form of the invention, the air is humidified by evaporating water from the surface of a water pan 71, which is disposed in the upper part of the compartment 62 on a shelf 72, the pan having a detachable overflow connection 73 leading directly through the wall of the refrigerator for discharge into a sewer or other sink. The supply of water for the pan 71 is had from a connection 74 leading from the city water-supply to a door-actuated valve controlled device, shown generally at 75. To this end, the valve device 75 comprises a valve casing 76 having a spring-lifted valve element 77, the stem of which is prolonged as a valve rod 78 having a button 79 on its outer end in engagement with the inner surface of a door 80 that affords access to the compartment 62.

By this arrangement, the valve element 77 is normally seated when the door 80 is closed, and the air circulating in the compartment 62 passes downwardly over the brine tank 66 where, if it be dehumidified, it is rehumidified by evaporating water from the surface of the pan 71. The air circulating is thus substantially saturated by evaporation at the water surface in pan 71, as long as equilibrium conditions obtain with the door 80 closed. When, however, the door is opened, the door disengages from the button 79, and the valve 77 is lifted by its spring, permitting water to flow into the pan 71 through the nozzle 81 which depends from the valve casing 76. Fresh air from outside also enters the compartment 62 when the door 80 is open.

By the use of the secondary and tertiary refrigerants here employed, a reduction of the temperature gradient between the air circulated

in the compartment 62 and its cooling element is achieved without in any way interfering with the temperature of the primary refrigerant that is supplied for cooling the element 63.

Thus, it is seen that by the practice of the present invention, precipitation of the humidity normally in the air circulating in the refrigerating compartment of a refrigerator is avoided, the introduction of water vapor into the air circulating being positively accomplished in each of the forms of the invention here illustrated. There is thus substantially no tendency for the air circulating to dehydrate food or other hydrated articles stored in the refrigerating compartment.

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 drawings shall be interpreted as illustrative and not in a limiting sense.

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 food storage compartment containing air, a system for circulating primary refrigerant including a cooling element, a vessel in the upper part of said compartment containing a body of liquid adapted to be cooled by said cooling element and to cool the air which is freely circulated substantially solely by gravity, humidity controlling means for introducing water vapor directly into gravity circulated air including a relatively low pressure nozzle associated with the body of liquid in said vessel, said means being located in said compartment at a point remote from the side walls thereof in a region of relatively high temperature, means for circulating primary refrigerant in said system to cool the body of liquid whereby it serves as secondary refrigerant, and thermostatic means controlling the circulation of said primary refrigerant so as to maintain a desired temperature of the liquid.

2. In a refrigerator the combination comprising, a food storage compartment containing air, a system for circulating primary refrigerant including a cooling element, humidity controlling means for introducing water vapor directly into gravity circulated air including a plurality of relatively low pressure spraying nozzles, said means being located in said compartment at a point remote from the side walls thereof in a region of relatively high temperature, a vessel holding a secondary refrigerant comprising a body of brine connected to supply spray to said nozzles and to collect that which issues therefrom, means for forcing the circulation of said brine, said cooling element being arranged for cooling the brine with the latter being adapted for cooling the air which is freely circulated substantially solely by gravity, and thermostatic means for controlling both the circulation and the temperature of the brine.

3. In a refrigerator the combination comprising, a food storage compartment containing air, a system for circulating primary refrigerant including a cooling element, humidity controlling means for introducing water vapor directly into gravity circulated air including a plurality of relatively low pressure spraying nozzles, said means being located in said compartment at a point remote from the side walls thereof in a region of relatively high temperature, means

holding a secondary refrigerant comprising a body of brine associated with said humidity controlling means and adapted for cooling the air which is freely circulated substantially solely by gravity, said cooling element having at least a portion immersed in the body of brine to permit the circulation of primary refrigerant therethrough, thermostatic means for maintaining the temperature of the brine at a desired value, and baffle means for causing the gravity circulated air to be tempered by passage about the body of brine.

4. In a refrigerator having a plurality of compartments one of which contains air to be refrigerated, the combination with a system common to said compartments for circulating primary refrigerant and including cooling elements one for each of said compartments, of means in said air-containing compartment at a point remote from the side walls thereof in a region of relatively high temperature for holding a body of liquid adapted for cooling the air which is freely circulated substantially solely by gravity with the cooling element for said compartment being arranged for cooling the body of liquid, a plurality of spraying nozzles for humidifying air disposed in said compartment, means connected to said liquid holding means to supply spray to said nozzles, means for collecting and returning to said liquid holding means spray which is unevaporated by gravity circulated air, and means for directing gravity circulated air into contact with said spray.

5. In a refrigerator having a plurality of compartments one of which contains air to be refrigerated, the combination with a system common to said compartments for circulating primary refrigerant and including cooling elements one for each of said compartments, of means in said air-containing compartment at a point remote from the side walls thereof in a region of relatively high temperature for holding a body of liquid adapted to be cooled by one of said cooling elements and to cool the air which is freely circulated substantially solely by gravity, baffles for directing gravity circulated air to pass over the body of liquid, means associated with the body of liquid for introducing grains of moisture directly into gravity circulated air and means for controlling the temperature of the body of liquid.

6. In a refrigerator having a plurality of segregated compartments one of which contains air to be refrigerated, the combination with a system common to said compartments for circulating refrigerant and including cooling elements one for each of said compartments connected in parallel with control means separately governing flow of primary refrigerant through said cooling elements, of an open-topped vessel in the upper part of said air-containing compartment containing secondary refrigerant adapted for cooling the air which is freely circulated substantially solely by gravity with one of said cooling elements immersed in the secondary refrigerant, humidity controlling means comprising a relatively low pressure spraying nozzle located above said vessel, means to circulate secondary refrigerant from said vessel to said nozzle, baffles for directing gravity circulated air over said vessel, and thermostatic means for controlling both the circulation of said secondary refrigerant and said primary refrigerant flow control means.

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