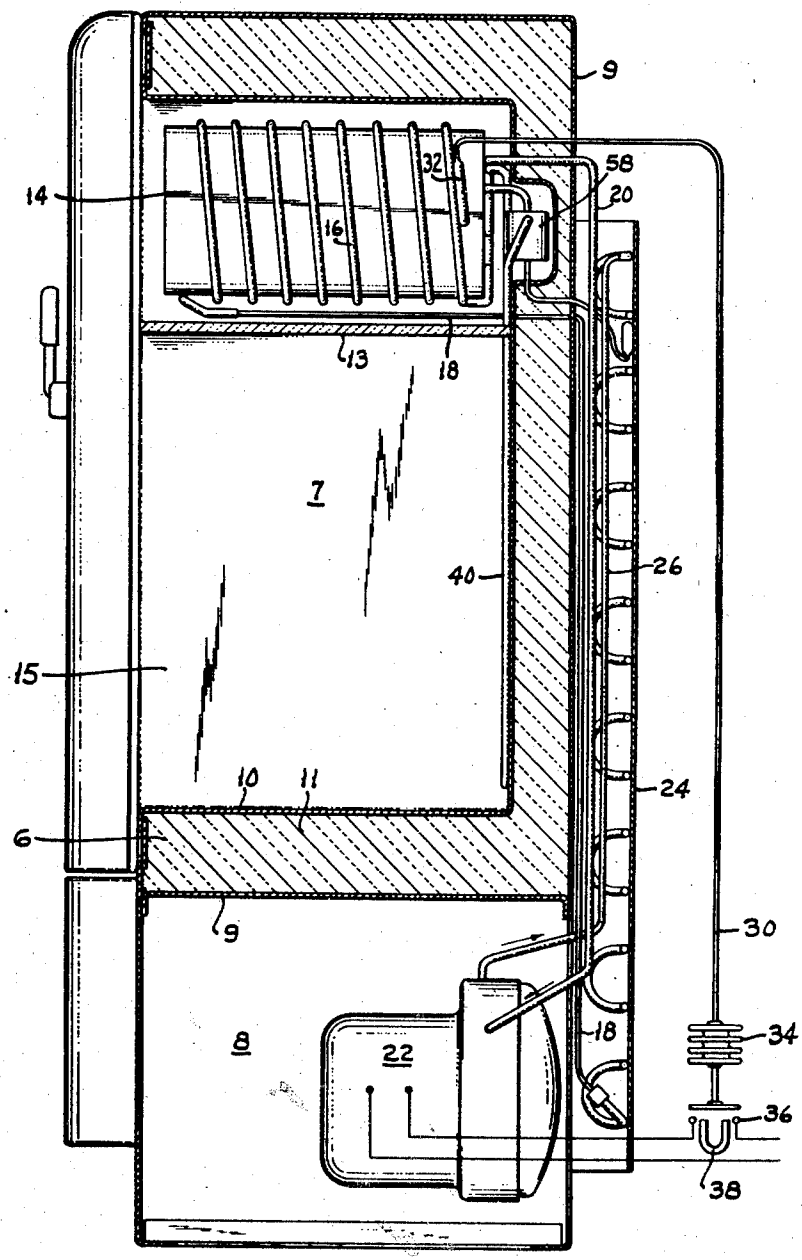
Dec. 23, 1947. C. F. ALSING 2,433,187

CONTROLLED REFRIGERATING APPARATUS WITH SECONDARY REFRIGERATING CIRCUIT

Filed May 25, 1945 2 Sheets-Sheet 1

FIG. 1.



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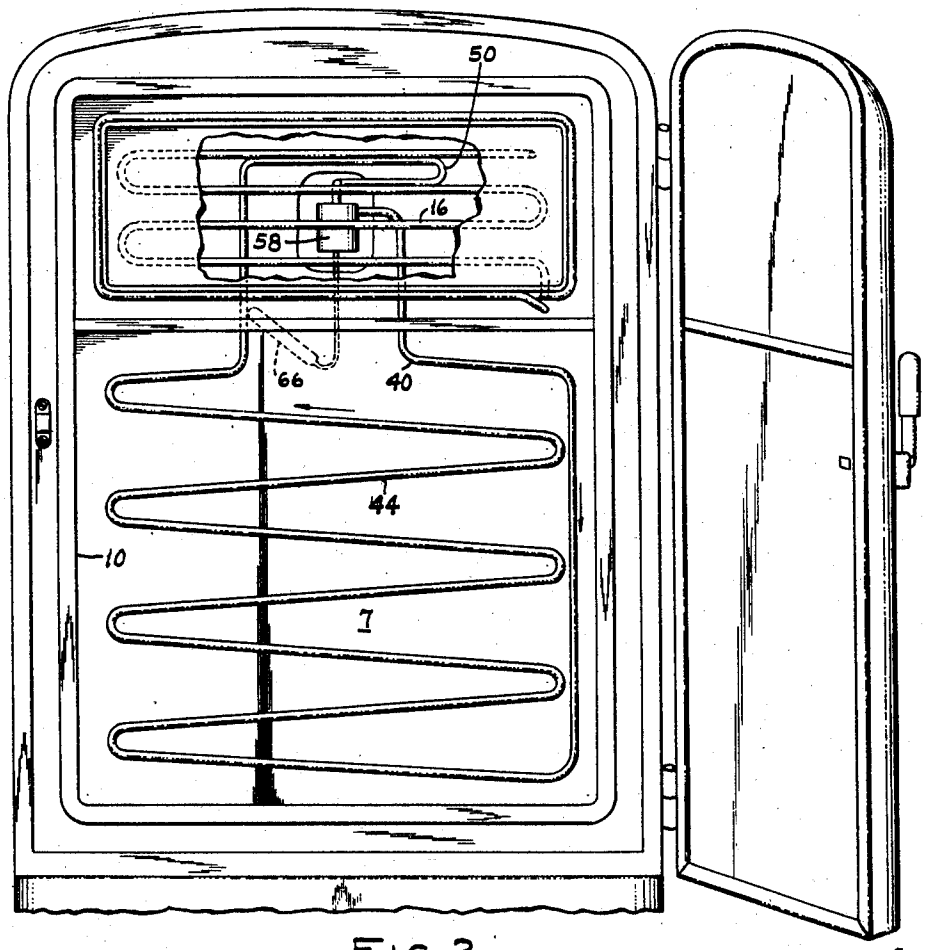


FIG. 2.

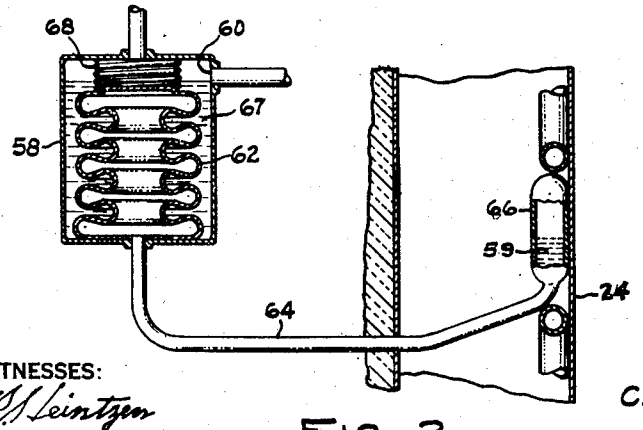


FIG. 3.

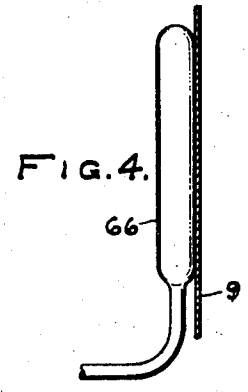


FIG. 4.

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2,433,187

CONTROLLED REFRIGERATING APPARATUS WITH SECONDARY REFRIGERATING CIRCUIT

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11 Claims. (Cl. 62—2)

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This invention relates to refrigerating apparatus comprising a secondary volatile refrigerant circuit and more especially to a means for controlling the secondary circuit.

Modern domestic refrigerators provide a compartment for storing frozen foods and a second compartment for ordinary refrigerated storage. Each of these compartments is preferably maintained at a constant temperature in spite of variations in the room temperature.

It is, accordingly, an object of this invention to provide novel and simple means for maintaining two refrigerated compartments at different but relatively constant temperatures in spite of variations in the room temperature in which the compartments are located.

A further object of the invention is to provide novel means for controlling a secondary volatile refrigerant circuit to provide predetermined temperatures in a chamber in response to changes in the ambient temperature of the chamber.

These and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawings forming a part of this application, in which:

Fig. 1 is a vertical section of a mechanically-cooled refrigerator embodying the invention;

Fig. 2 is a front elevation of the food storage chamber of the refrigerator with the door open;

Fig. 3 is a sectional view of the controlling vessel of this invention; and

Fig. 4 shows a modification of the invention in which the temperature-sensitive tube is located on the outer metal shell of the cabinet.

Referring now to the drawings for a detailed description of the invention, the reference numeral 6 designates a refrigerator cabinet having an insulated food storage chamber 7 in the upper portion thereof and a machinery compartment 8 below the food storage chamber 7. The food storage chamber 7 comprises an outer metal shell 9, a metal food liner 10 therein, and heat-insulating material 11 packed between the outer shell 9 and the food liner 10. A partition 13 divides the food chamber into two compartments, the upper compartment 14 being devoted to the storage of frozen foods and maintained at a temperature of about 5° F. and the lower compartment 15 being devoted to the storage of comestibles at about 40° F.

The upper compartment 14 is refrigerated by a mechanical refrigerating apparatus which hereafter will be designated as the primary apparatus.

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It comprises a primary evaporator 16 which is supplied through a capillary tube 18 with a volatile liquid refrigerant and the refrigerant vapor is withdrawn from the evaporator 16 by a suction tube 20. The suction tube 20 connects with a sealed housing 22 containing a refrigerator compressor and a motor for driving the same. The motor and the compressor are not shown in the drawings. Compressed refrigerant is conducted from the compressor to a primary condenser 24 through a tube 26. The lower end of the condenser 24 connects with the capillary tube 18.

The temperature of the primary evaporator 16 is controlled by a thermostat 30 shown diagrammatically in the drawings. The thermostat 30 comprises a bulb 32 containing a volatile liquid, the vapor pressure of which is transmitted to a metal bellows 34 which actuates a switch 36. The switch 36 controls the operation of the motor in the sealed casing 22. A permanent magnet 38, associated with the switch 36, provides a snap-acting opening and closing movement to the switch 36 and is adjusted so that the switch 36 opens when the evaporator 16 is cooled to a predetermined temperature and closes when the evaporator 16 warms up to another predetermined temperature. The thermostat 30 thus provides that the evaporator 16 is maintained between predetermined temperature limits so that its average temperature remains constant in spite of variations in the temperature of the room in which the cabinet 10 is located. The foods stored in the compartment 14 will be at a substantially constant temperature because of the thermal storage capacity of the foods.

The lower compartment 7 is cooled by a volatile refrigerant circuit 40 which hereafter will be referred to as the secondary refrigerant circuit. The secondary refrigerant circuit 40 comprises a secondary evaporator consisting of a tube 44 located in heat-exchange relationship with the metal food liner 10 of the lower compartment 15. The secondary refrigerant circuit 40 also comprises a secondary condenser comprising a tube 50 located in heat-exchange relationship with the evaporator 16. The tubes 44 and 50 are interconnected.

The refrigerating apparatus, as thus far described, is well known in the art but has the disadvantage that the temperature of the lower compartment 7 varies with the temperature of the room in which the refrigerator is located. The refrigerator of this invention corrects this defect by rendering the secondary refrigerant system

less effective when the room temperature is low than when it is high, by varying the quantity of refrigerant which circulates in the secondary circuit.

To accomplish this result, a vessel 58 is located in the secondary circuit 40 below the condenser 50 to receive the condensate therefrom. Spaced from the bottom of the vessel 58 is an opening 60 which communicates with the secondary evaporator 44 so that the refrigerant liquid will drain into the evaporator 44 after the vessel 58 is filled to the level of the opening 60. The opening 60 thus constitutes a spillway.

A metal bellows 62 is located in the vessel 58 below the level of the opening 60 and communicates through a tube 64 with a bulb 66 located in heat-transfer relationship with the condenser 24. The space between the walls of the vessel 58 and the bellows 62 forms a storage tank 67 of variable capacity for the refrigerant liquid. A coiled spring 68 in the vessel 58 biases the bellows 62 to its contracted position. The bellows 62, tube 64, and a portion of the bulb 66 are filled with a volatile liquid 59 so that, during operation of the refrigerator, the pressure of the fluid is dependent on the temperature of the bulb 66.

The refrigerant charge in the secondary circuit 40 is such that when the bellows 62 is contracted, substantially all of the refrigerant liquid will accumulate in the tank 67 during operation.

Operation

The operation of the device is as follows: When the room temperature increases and also when warm foods are placed in the storage chamber 7, the refrigerating apparatus will operate for a larger portion of the total time than previously and the condenser will assume a higher temperature. This temperature is transmitted to the bulb 66, and the vapor pressure of the liquid 59 therein will increase and expand the bellows 62. The bellows, on expanding, drives more of the refrigerant liquid into the secondary circuit 40 and increases its effectiveness in transferring heat from the inner liner 10 of the food storage compartment 7 to the primary cooling unit 16.

As the temperature ambient the refrigerator decreases, the opposite action occurs, namely, the condenser 24 will run at a lower temperature and for less time, the bellows 62 will contract so that a larger portion, or in an extreme case, the entire secondary refrigerant charge will be located in the tank 67 and little or none will be available for transferring heat from the liner 10 of food storage compartment 7 to the primary evaporator 16.

The quantity of the liquid displaced in the vessel 58 is preferably so proportioned to the heat leakage of the lower compartment 7 that the temperature of the latter remains constant in varying room temperatures. However, it may also be proportioned to vary the temperature of the compartment 7 with changes in the ambient temperature of the refrigerator. Thus, the temperature of the compartment 7 can be made to rise or to fall in response to a rise in the ambient temperature.

Modification

A modification of the invention is shown in Fig. 4 in which the bulb 66 is located on the inner surface of the outer metal shell 9 of the refrigerator and thus responds mainly to room temperature. The action is similar to that of the previously described modification with the exception that placing warm foods in the storage chamber 7 only remotely affects the action of the secondary circuit 40. In this modification, the temperature variations to which the bulb is subjected are not as great as in the previously described modification, so that a more sensitive spring 68 is required. In either modification, the spring 68 may be eliminated if the bellows 62 has an inherent tendency to contract.

It will be apparent from the above that this invention provides a simple means for maintaining two refrigerating compartments at different but relatively constant temperatures in varying room temperatures. It also provides a novel means for controlling a secondary volatile refrigerant circuit without introducing valves or other movable parts in the circuit.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed is:

1. In a refrigerator comprising a thermally-insulated food storage chamber, a cooling means, a volatile refrigerant circuit for cooling said food storage chamber, said refrigerant circuit including a condenser in heat-transfer relationship with said cooling means, a tank for receiving liquid refrigerant from said condenser, said tank having an opening spaced from the bottom thereof, an evaporator in heat-transfer relationship with said storage chamber and communicating with said opening to receive liquid refrigerant from said tank, and thermostatic means in heat-transfer relationship with an element which varies in temperature in response to the ambient temperature of said chamber for decreasing the refrigerant volume of said tank below the level of said opening when said ambient temperature increases and for increasing said volume when said ambient temperature decreases.

2. In a refrigerator comprising a thermally-insulated food storage chamber, a primary cooling means maintained at a constant average temperature for cooling a portion of said chamber, a secondary volatile refrigerant circuit having an evaporative portion for cooling another portion of said food storage chamber and a condensing portion in heat-transfer relationship with said primary cooling means, the combination with said refrigerator of a control for said secondary circuit, said control comprising a tank in said circuit located below the condensing portion to receive liquid refrigerant therefrom, an opening in said tank spaced from the bottom thereof and communicating with said evaporative portion to drain liquid refrigerant into said portion, said control including a thermostat in heat-transfer relationship with an element which varies in temperature responsive to the ambient temperature of said chamber for decreasing the volume of said tank below the level of said opening when said ambient temperature increases and for increasing said volume when said ambient temperature decreases.

3. In a refrigerator comprising a thermally-insulated food chamber, a cooling means, a volatile refrigerant circuit for cooling said food storage chamber, said refrigerant circuit including a condensing portion in heat-transfer relationship with said cooling means, a tank adapted to receive liquid refrigerant from said condensing portion, said tank having an opening spaced

from the bottom thereof, an evaporative portion communicating with said opening to receive liquid refrigerant from said tank and thermostatic means responsive to the ambient temperature of the refrigerator for decreasing the volume of said tank below the level of said opening when said temperature increases and for increasing said volume when said temperature decreases.

4. In a refrigerating system, comprising a cooling means, a volatile refrigerant circuit for cooling an insulated storage chamber, said refrigerant circuit including an evaporative portion in heat-transfer relationship with said food chamber, and a condensing portion in heat transfer relationship with said cooling means, the combination with said circuit of a tank adapted to receive liquid refrigerant from said condensing portion, said tank having an opening spaced from the bottom thereof and communicating with said evaporative portion to transmit liquid refrigerant to the same, said tank having a movable wall to vary the volume of the portion of the vessel below the level of said opening, and a thermostatic element responsive to the ambient temperature of the storage chamber to move said wall to decrease the volume of said portion of said tank when said temperature increases and for increasing said volume when said temperature decreases.

5. In a refrigerating system, comprising a cooling means, a volatile refrigerant circuit for cooling an insulated storage chamber, said refrigerant circuit including an evaporative portion in heat-transfer relationship with said food chamber, and a condensing portion in heat-transfer relationship with said cooling means, the combination with said circuit of a tank adapted to receive liquid refrigerant from said condensing portion, said tank having an opening spaced from the bottom thereof and communicating with said evaporative portion to transmit liquid refrigerant to the same, said tank having a movable wall to vary the volume of the portion of the tank below said opening, refrigerant liquid in said secondary circuit equal in volume to the maximum volume of said portion of said tank, and a thermostatic element responsive to the ambient temperature of the storage chamber to move said wall to decrease the volume of said portion of said tank when said temperature increases and for increasing said volume when said temperature decreases.

6. In a refrigerator comprising a thermally-insulated food storage chamber, a cooling means, a volatile refrigerant circuit having an evaporative portion for cooling said food storage chamber and a condensing portion in heat-transfer relationship with said cooling means, the combination with said refrigerator of a control for said secondary circuit, said control comprising a tank in said circuit adapted to receive liquid refrigerant from said condensing portion, an opening in said tank spaced from the bottom thereof and communicating with said evaporative portion to drain liquid refrigerant into said evaporative portion, said control including a thermostatic element comprising a bellows in said tank positioned at least in part below the level of said opening, a bulb responsive to the temperature ambient the refrigerator, a conduit connecting said bulb and bellows, and a volatile fluid in said thermostatic element to expand and contract said bellows in response to the temperature of said bulb.

7. In a refrigerator comprising a thermally-

insulated food chamber, a primary cooling means maintained at a constant average temperature for cooling a portion of said chamber, a secondary volatile refrigerant circuit for cooling another portion of said food storage chamber, said circuit including a condensing portion in heat-transfer relationship with said cooling means, a tank communicating with said condensing portion to receive liquid refrigerant therefrom, said tank having an opening spaced from the bottom thereof, an evaporative portion communicating with said opening to receive liquid refrigerant from said tank and a thermal element associated with said tank, said element comprising an expansible bellows located in said tank below the level of said opening, a bulb responsive to the temperature ambient the food chamber, a tube connecting said bulb and bellows, and a quantity of volatile liquid in said thermal element to effect expansion and contraction of said bellows in response to the temperature of said bulb.

8. In a refrigerator comprising a thermally-insulated food chamber, a primary mechanical refrigerating unit including a primary evaporator, a condenser cooled by the ambient air of the food chamber, and means for maintaining said primary evaporator at a constant average temperature, a secondary volatile refrigerant circuit for cooling another portion of said food storage chamber, said circuit including a condensing portion in heat-transfer relationship with said primary evaporator, a tank communicating with said condensing portion to receive liquid refrigerant therefrom, said tank having an opening spaced from the bottom thereof, an evaporative portion communicating with said opening to receive liquid refrigerant from said tank and a thermostatic element responsive to the temperature of said primary condenser for decreasing the volume of said tank below the level of said opening when said temperature increases and for increasing said volume when said temperature decreases.

9. In a refrigerator comprising a food storage chamber having a metal plate forming at least a portion of the outer wall of said chamber and located in heat-transfer relationship with the air ambient the chamber, an inner liner spaced from said outer plate, and heat insulation between said liner and plate, a cooling means, a volatile refrigerant circuit for cooling said food storage chamber, said refrigerant circuit including a condensing portion in heat-transfer relationship with said cooling means, a tank communicating with said condensing portion to receive liquid refrigerant therefrom, said tank having an opening spaced from the bottom thereof, an evaporative portion communicating with said opening to receive liquid refrigerant from said tank and a thermostatic element responsive to the temperature of said plate for decreasing the volume of said tank below the level of said opening when said temperature increases and for increasing said volume when said temperature decreases.

10. A refrigerator comprising a thermally insulated food storage cabinet, a cooling means, a volatile refrigerant circuit having substantially the same pressure throughout, said circuit including a condenser in heat-transfer relationship with said cooling means, a storage tank for receiving liquid refrigerant condensed by said condenser, an evaporator for cooling said cabinet, means for conducting refrigerant liquid from said tank to said evaporator, said means including a spillway elevated above the bottom of said tank,

and thermostatic means responsive to the ambient temperature of said cabinet for decreasing the liquid storage capacity of said tank below said spillway when said ambient temperature increases and for increasing said liquid storage capacity when said ambient temperature decreases.

11. A refrigerator comprising a thermally insulated food storage cabinet, a cooling means, a volatile refrigerant circuit having substantially the same pressure throughout, said circuit including a condenser in heat-transfer relationship with said cooling means, a storage tank for receiving liquid refrigerant condensed by said condenser, an evaporator for cooling said cabinet, means for conducting refrigerant liquid from said tank to said evaporator, said means including a spillway elevated above the bottom of said tank, thermostatic means responsive to the ambient

temperature of said cabinet for decreasing the liquid storage capacity of said tank below said spillway when said ambient temperature increases and for increasing said liquid storage capacity when said ambient temperature decreases, and a quantity of refrigerant in said system such that all of the refrigerant liquid will accumulate in said tank when said circuit is in operation and said volume is at its maximum.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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