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REFRIGERATING APPARATUS

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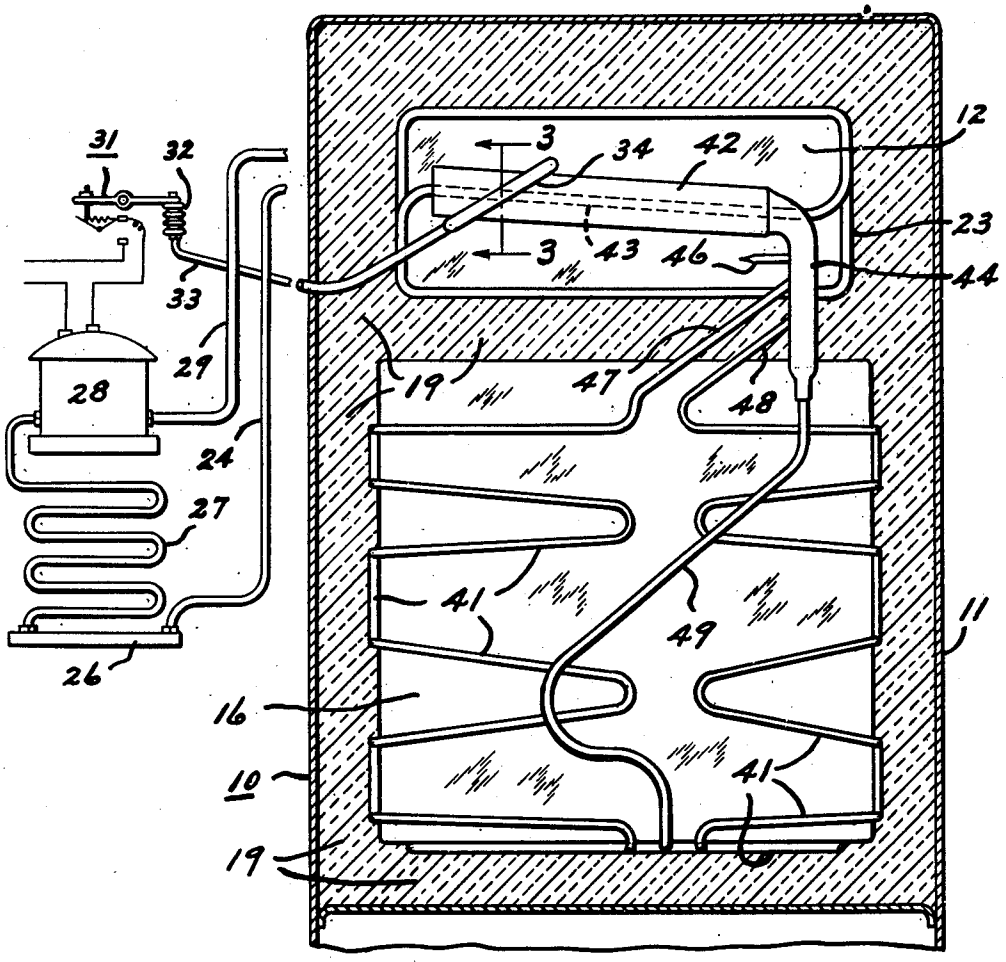


Fig. 2

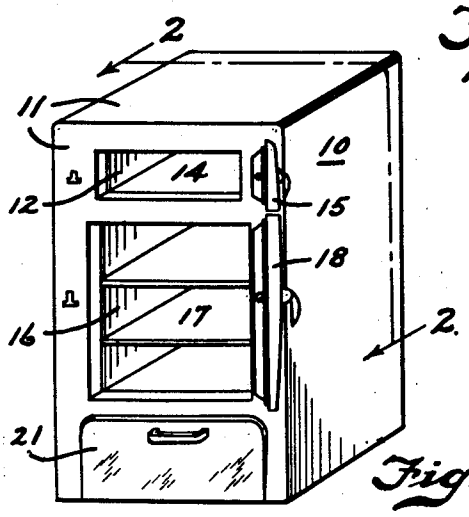


Fig. 1

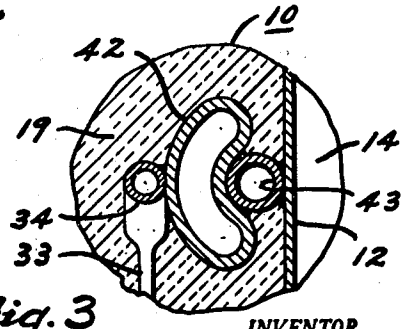


Fig. 3

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REFRIGERATING APPARATUS

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This invention relates to refrigerating apparatus and more particularly to a refrigerator of the two-temperature type in which one compartment is maintained at a low temperature by means of a primary refrigerating system and wherein another compartment is maintained at a higher temperature by means of a closed secondary refrigerating system.

An object of my invention is to provide an improved control of the refrigerant liquefying or translating device in response to the temperature of the evaporators in a two-temperature compartment refrigerator.

A more specific object of my invention is to provide a control for a refrigerating apparatus employing a primary refrigerating system and a secondary refrigerating system for cooling different zones or compartments, which control is directly responsive to the temperature of the secondary system and indirectly responsive to the temperature of the evaporator of the primary system.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a front perspective view of a two-temperature compartment refrigerator showing the doors to the compartments in open position;

Fig. 2 is a vertical sectional view of the refrigerator illustrated in Fig. 1 and taken on the line 2—2 thereof showing a refrigerant translating unit diagrammatically associated therewith; and

Fig. 3 is an enlarged fragmentary sectional view taken on the line 3—3 of Fig. 2 showing a part of the thermal unit of the control switch mounted on a portion of the secondary refrigerating system.

Referring to the drawings, I have shown in Fig. 1 thereof, a refrigerating apparatus comprising a cabinet 10 having outer metal walls or panels 11. A metal line 12 within the walls 11 forms a zone or compartment 14 in the upper portion of cabinet 10, the access opening of which is normally closed by a door 15. Another metal liner 16 within the walls 11 of cabinet 10 forms a zone or compartment 17 in the cabinet below the compartment 14 and the opening to his compartment is normally closed by a door 18. Any suitable insulating material 19 (see Fig. 2) may be interposed between the liners 12 and 16 and the outer walls 11 of cabinet 10 to insulate the

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compartments. Conventional throat or door opening breaker strips of insulating material may be employed to prevent conduction of heat between the inner metal liners 12 and 16 and the outer metal walls 11 of the cabinet. A lower compartment having its open front closed by a door 21, may be provided in cabinet 10 for housing a refrigerant compressing and condensing unit or a refrigerant translating device, diagrammatically shown in Fig. 2 of the drawings, as is conventional in the art.

In order to cool the upper zone or compartment 14 to a low temperature, say for example, to an average of 3° F., for the storage of frozen food products and/or for freezing water or foods placed therein, I wrap a conduit 23 around the compartment 14 and secure the same to the outer wall surface of metal liner 12 in any suitable or desirable manner. This conduit 23 forms the cooling element or evaporator of a primary refrigerating system and refrigerant to be evaporated therein, for removing heat from compartment 14, may be circulated thereto under the control of an expansion valve or restrictor (not shown) as is conventional in the art. The refrigerant inlet end of the conduit evaporator 23 is connected by way of a pipe 24 with a receiver 26 of the refrigerant translating device (see Fig. 2). A condenser 27 receives compressed refrigerant from a motor-compressor unit 28 and this condenser may be cooled in any suitable or desirable manner to liquefy the compressed refrigerant therein. A pipe 29 having its one end connected to the outlet end of the conduit evaporator 23 and having its other end connected to the interior of the motor-compressor unit 28 is adapted to convey evaporated refrigerant from the primary evaporator 23 to the compressor 28. The motor-compressor unit 28 is periodically operated under the control of a snap-acting electric switch of any suitable or conventional design, generally represented by the reference character 31. Switch 31 has a thermal unit associated therewith including a bellows 32, pipe 33 and a bulb 34. This thermal unit is sealed and contains a volatile fluid suitable to cause expansion and/or contraction, in response to temperature changes, of bellows 32 for actuating the switch means 31. The location of the bulb 34 of the thermal unit will be more fully described hereinafter. Operation of the motor-compressor unit 28 of the refrigerant translating device will cause a reduction in pressure in the primary cooling element 23 and refrigerant therein will, upon absorbing heat from compartment

14, vaporize and be withdrawn therefrom by the unit 28. The evaporated refrigerant is compressed by unit 28 and forwarded under pressure to the condenser 27 where it is cooled and liquefied. The liquefied refrigerant flows from condenser 27 into the receiver 26 from where it is directed by pipe 24 to the expansion valve or restrictor (not shown) and into the conduit cooling element 23 for re-evaporation therein as the demand for refrigeration in compartment 14 continues. Thus the primary refrigerating system normally cools and maintains the upper compartment 14 to a temperature between predetermined low limits.

In order to cool the zone or compartment 17 to a temperature higher than the temperature of compartment 14, say for example, to a temperature averaging 40° F. suitable for the cold storage and preservation of foods not required to be stored in a freezing or below freezing temperature, a closed secondary refrigerating system or circuit is associated with the refrigerating apparatus or cabinet 10. This secondary system comprises a refrigerant evaporating portion including loops of pipe 41 clamped or otherwise suitably secured to the outer surface of the bottom, side and back walls of liner 16 of compartment 17. The secondary system also includes an elongated, inclined refrigerant condensing portion 42 of substantially kidney-shape in cross-section (see Fig. 3) secured by solder or any other suitable means, to a portion 43 of one loop of the conduit cooling element 23 of the primary refrigerating system which extends across and is secured to the liner 12 along the back wall of compartment 14. The primary evaporator loop having the portion 43 thereof extending across the back of compartment 14 is preferably a part of the conduit evaporator which is closely adjacent the refrigerant inlet end of the evaporator. A rounded part 44 extends downwardly from the condensing portion 42 of the secondary refrigerating system and is provided with a small tube connection 46, for a purpose to be presently described, and with riser tube connections 47 and 48 leading from the refrigerant evaporating loops 41 of the system. The lower end of the rounded part 44 of the secondary condenser is connected with a feed pipe 49 which extends down under the liner 16 and branches off into the two sets of loops 41. Refrigerant in the evaporating portion 41 of the secondary refrigerating system, upon absorbing heat from compartment 17 through walls of liner 16, vaporizes and rises to the condensing portion 42 of the circuit through the risers 47 and 48. The vaporized refrigerant is cooled and condensed in the portion 42 of the circuit whereupon it flows downwardly through the rounded part 44 and feed pipe 49 to replace the evaporated refrigerant in the evaporating portions 41 to thereby continue to cool the compartment or zone 17. A volatile refrigerant and an inert gas non-condensable under operating conditions of the present refrigerating apparatus such, for example, as nitrogen is charged into the secondary circuit through the tube 46 which tube then has its end mashed and soldered to seal the circuit. Under ordinary operation of the system the presence of the inert gas in the secondary refrigerant circuit insures a certain temperature differential between the primary evaporator 23 and the secondary evaporator 41. It does this by raising the condensing pressure of the secondary refrigerant within the secondary condenser.

According to my invention I provide an improved control of the temperatures in a two-temperature refrigerator. In order to accomplish this I locate the bulb 34 of the thermal unit of control device 31 entirely out of physical contact with the primary evaporator 23 by mounting the same upon the refrigerant condensing portion 42 of the secondary system. By reference to Fig. 3 of the drawings it will be noted that in the present disclosure the thermal bulb 34 is located exteriorly of either food compartment 14 or 17 and within the insulation 19 so as to prevent the bulb 34 from being influenced by temperatures maintained in the compartments. By mounting the element or bulb 34 on the condenser 42 adjacent the left hand or closed end thereof, as viewed in Fig. 2 of the drawings, it is directly and more quickly responsive to an increased load placed on either of the evaporators 23 or 41 to promptly cause starting of the refrigerant translating device in order to meet the increased load placed on either evaporator. By virtue of the presence of inert gas in the secondary condenser the temperature throughout the length of condenser 42 varies between a temperature substantially corresponding to the temperature of the secondary evaporator 41 and a temperature substantially corresponding to the temperature of the primary evaporator 23. This temperature gradient from one end to the other of condenser 42 is utilized to locate the bulb 34 thereon in such a position that any slight change in the pattern of the temperature gradient between one end and the other of the secondary condenser 42, due to an increased load placed on either evaporator 23 or 41, and consequently either compartment 14 or 17, will immediately be transmitted to the thermal bulb 34 which will respond promptly to actuate switch 31 and start operation of the motor-compressor unit 28 of the refrigerant translating device. In other words when a load is placed on the primary evaporator 23 the refrigerant therein tends to warm up and this temperature is first conducted to the coldest end of the secondary condenser 42 and upon warming this end of the condenser also warms the bulb 34. A load placed on the evaporator 41 of the secondary refrigerating system causes more refrigerant to enter the condenser 42 and the heat of this increased work being done by condenser 42 changes the pattern of the temperature gradient from one end to the other of condenser 42 and transmits the heat to bulb 34. Thus bulb 34 quickly responds to an increase in temperature of either of the evarporators 23 or 41 and in this manner I eliminate the lag ordinarily occurring in a two-temperature refrigerating apparatus, where the thermal element is mounted in physical contact with the primary evaporator, between the time the load is placed on either evaporator of the apparatus and the time the thermal element responds to start operation of the refrigerant translating device. Consequently I am enabled to maintain a range of temperature in the low temperature or freezing compartment of say, for example, between 0° and 10° F. and to maintain a range of temperature within the higher temperatured compartment of say, for example, between 35° and 45° F. irrespective of ambient temperatures outside the refrigerator. If it is desired to favor the temperature of one evaporator over the other evaporator the location of the thermal bulb on the condenser may be changed. Locating the bulb to the right (Fig. 2) or in other words, toward the secondary con-

denser inlet favors the secondary evaporator. Locating the bulb to the left (Fig. 2) or in other words, toward the dead end of the secondary condenser favors the primary evaporator.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In a refrigerating apparatus having a first zone and a second zone to be refrigerated comprising in combination, a primary circuit including a refrigerant translating device and an evaporator for cooling one of said zones, a secondary circuit including an evaporator for cooling the other of said zones and a condenser in heat exchange relationship with a part of said primary circuit, said secondary circuit containing a volatile refrigerant and an inert gas, said condenser being elongated and having a closed end wherein a substantial portion of the inert gas is trapped for increasing the refrigerant condensing pressure and for establishing a temperature gradient in the condenser from substantially the temperature of said primary evaporator at one end thereof to substantially the temperature of said secondary evaporator at the other end thereof, and means having a part thereof mounted on said condenser intermediate its ends for controlling operation of said translating device in response to variations in said temperature gradient.

2. In a refrigerating system comprising a primary circuit including an evaporator means and a refrigerant translating device and a secondary circuit including a secondary evaporator and a condenser in heat exchange relationship with the primary evaporator means, the method which consists in evaporating a refrigerant in the secondary evaporator, conducting the refrigerant vapors to the secondary condenser, diffusing the vapors into an inert gas atmosphere trapped within the condenser whereby the refrigerant condensing pressure is raised and a temperature gradient is maintained in the condenser from substantially the temperature of the primary evaporator at one end to substantially the temperature of the secondary evaporator at the other end, and controlling operation of the refrigerant translating device in response to a temperature existing at a point between the two ends of the condenser, whereby the translating device responds to varying load conditions on both of said evaporators.

3. In a refrigerating apparatus including a cabinet provided with a first liner and a second liner having insulating material therebetween and therearound forming a plurality of food storage compartments to be refrigerated comprising in combination, a primary refrigerant circuit including a refrigerant translating device and an evaporator for cooling one of said compartments, a closed secondary refrigerating system including an evaporator for cooling the other of said compartments and a condenser, said primary evaporator being in the form of a conduit traversing walls of said one compartment, said condenser being substantially kidney-shape in cross-sectional contour with the hilum wall portion thereof receiving and thermally contacting a part of said conduit, a thermostat including a bulb located exteriorly of said compartments and disposed in said insulating material, said bulb being disposed in thermal contact with a wall portion of said condenser on the other side of said hilum wall portion thereof for controlling operations of said translating device to maintain said compartments between predetermined temperature limits, the said cross-sectional contour of said condenser together with the thermal contact of said part of said conduit and said bulb therewith being such that said thermal bulb responds through said condenser to an increase in temperature of either of said evaporators for modifying the operation of said translating device.

4. A refrigerating apparatus comprising a first zone and a second zone to be refrigerated, a primary refrigerating system including a refrigerant translating device and an evaporator for cooling one of said zones, a closed secondary refrigerating system including an evaporator for cooling the other of said zones and a refrigerant condenser in heat exchange relationship with a part of said primary evaporator, switch means for controlling operations of said translating device, means for actuating said switch means to cause said device to maintain said zones between predetermined temperature limits including a thermal bulb spaced from and being entirely out of physical contact with said primary evaporator, and said bulb extending along and being secured in physical contact to an exterior wall surface of said condenser so as to be responsive solely through the condenser to an increase in temperature of either of said evaporators.

5. In a refrigerating apparatus including a cabinet provided with a first liner and a second liner having insulating material therebetween and therearound forming a plurality of food storage compartments to be refrigerated comprising in combination, a primary refrigerating system including a refrigerant translating device and an evaporator for cooling one of said compartments, a closed secondary refrigerating system including an evaporator for cooling the other of said compartments and a condenser in heat exchange relationship with a part of said primary evaporator, switch means for controlling operations of said translating device, means for actuating said switch means to cause said device to maintain said compartments between predetermined temperature limits including a thermal bulb disposed in said insulating material entirely out of physical contact with said primary evaporator, and said bulb extending along and being secured in physical contact to an exterior wall surface of said condenser so as to be responsive solely through the condenser to an increase in temperature of either of said evaporators.

6. In a refrigerating apparatus having a first zone and a second zone to be refrigerated comprising in combination, a primary refrigerating system including a refrigerant translating device and an evaporator for cooling one of said zones, a closed secondary refrigerating system including an evaporator for cooling the other of said zones and a condenser in heat exchange relationship with a part of said primary evaporator, said secondary system containing a volatile refrigerant and an inert gas, said condenser being so constructed and arranged as to trap a substantial portion of the inert gas therein for increasing the refrigerant condensing pressure in said secondary system and for establishing a temperature gradient in said condenser from substantially the temperature of said primary evaporator at one portion thereof to substantially the temperature of said secondary evaporator at another portion thereof, and means having a part thereof mounted on said condenser intermediate its said

two portions for controlling operation of said translating device in response to variations in said temperature gradient.

7. In a refrigerating system comprising a primary refrigerating system including an evaporator and a refrigerant translating device and a secondary refrigerating system including a secondary evaporator and a condenser in heat exchange relationship with the evaporator of said primary system, the method which consists in evaporating a refrigerant in the secondary evaporator, conducting the refrigerant vapors to the secondary condenser, diffusing the vapors into an inert gas atmosphere trapped within the condenser whereby the refrigerant condensing pressure in the secondary system is raised and a temperature gradient is maintained in the condenser from substantially the temperature of the primary evaporator at one portion thereof to substantially the temperature of the secondary evaporator at another portion thereof, and controlling operation of the refrigerant translating device in response to a temperature existing at a point intermediate said portions of the condenser, whereby the translating device responds to varying load conditions on both of said evaporators.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,332,327	Eastwood	Mar. 2, 1920
2,310,657	Shively	Feb. 9, 1943
2,314,190	Atchinson	Mar. 16, 1943
2,433,188	Kalisher	Dec. 23, 1947