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REFRIGERATING APPARATUS

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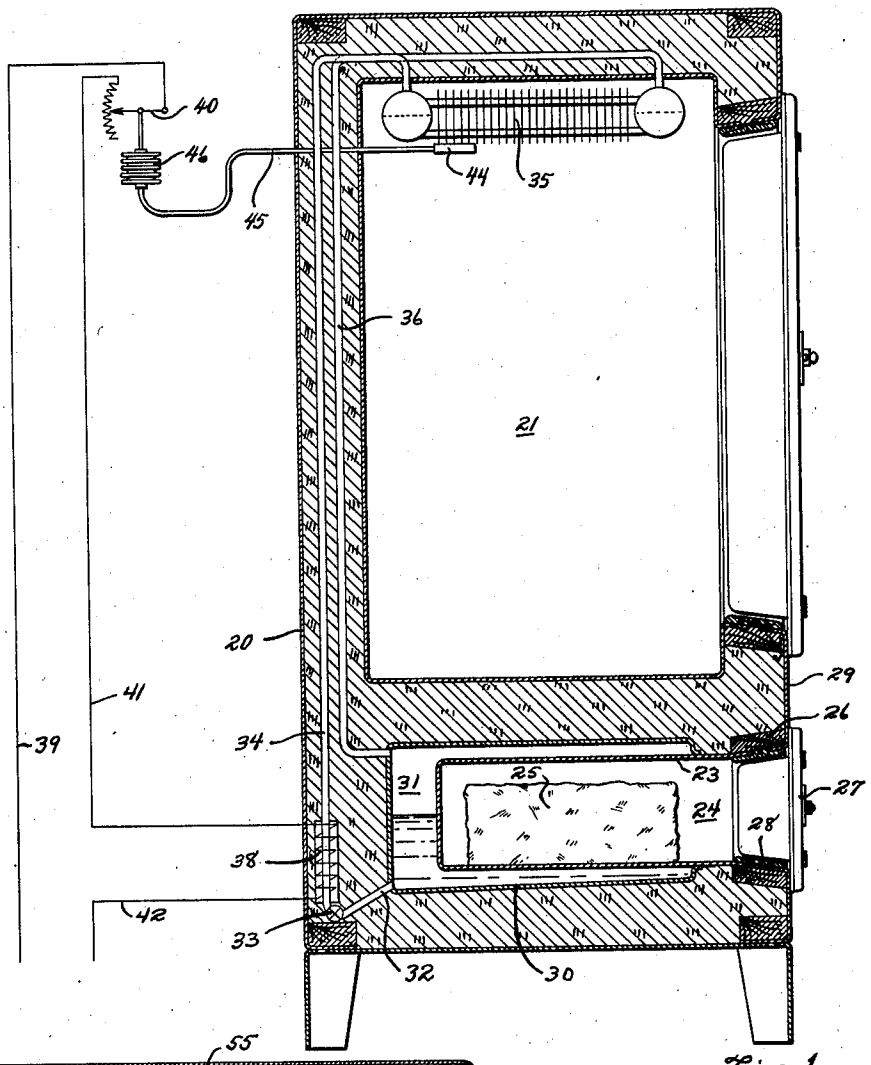


Fig. 1

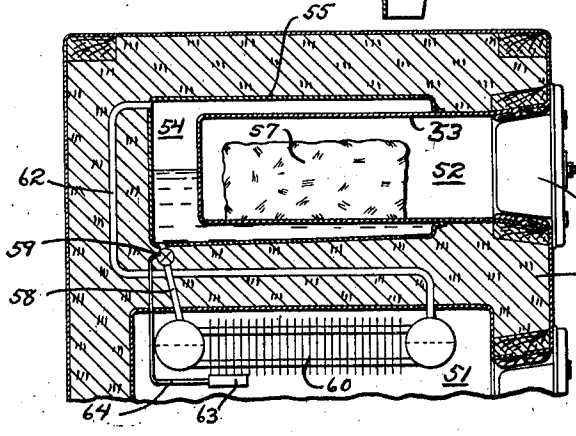


Fig. 2

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REFRIGERATING APPARATUS

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9 Claims. (Cl. 62—91.5)

This invention relates to refrigerating apparatus and more particularly to control means for controlling the refrigerating effect of an evaporator in a secondary refrigerating system.

A principal object of my invention is to provide an automatically and specifically a thermostatically, controlled uniform pressure refrigerating circuit for refrigerator cabinets.

A more specific object of my invention is to provide in a uniform pressure refrigerant system having an evaporator and a condensing means, a means for controlling the supply of refrigerant to the evaporator in accordance with the temperature of the medium to be cooled.

Such a system may be employed to advantage when it is desired to use the refrigeration provided by a change in state of a substance, for example carbon dioxide snow, ice, or liquid air, to cool a compartment or medium which must be kept within certain temperature limits such as a food storage compartment. Such a system may also be employed where it is desired to have two or more evaporators maintained at different temperatures by a single primary refrigerating system.

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

In the drawing:

Fig. 1 is a vertical sectional view of a refrigerator cabinet embodying my invention, and

Fig. 2 is a fragmentary vertical sectional view of a refrigerator cabinet disclosing a modified form of my invention.

Referring to the drawing and more particularly to Fig. 1, there is shown for the purpose of illustrating my invention, a refrigerator cabinet 20 having a food storage compartment 21 in its upper portion surrounded by insulated walls. In the lower part of the cabinet 20 there is provided a primary refrigerating means also surrounded by insulated walls. The primary refrigerating means, which may be of any suitable type, has a casing 23 enclosing a compartment 24 containing a suitable primary refrigerant 25 such as a block of carbon dioxide snow which has been shown to illustrate one example. The casing 23 has its front end fastened to a door jamb 26 which surrounds a door 27 which closes the entrance to the compartment 24. A suitable facing strip 28 on the inside of the door jamb prevents the conduction of heat from the casing 23 to the outer walls 29 of the refrigerator cabinet.

The casing 23 is surrounded by another casing 30 forming a secondary refrigerating compartment 31 between the casing 30 and the casing 23. This secondary chamber 31 forms the condensing means of the secondary system and is adapted to contain some suitable volatile refrigerant such as sulphur dioxide. A refrigerant conduit 32 extends downwardly from the bottom of the compartment 31 to a suitable check valve 33. From the check valve 34 a liquid refrigerant conduit extends upwardly through the insulation in the rear wall of the cabinet 20 and also through a portion of the insulation of the top wall to a refrigerant evaporator 35 of any sutiable type located in the top of the food storage compartment 21. From the evaporator 35 a return conduit 36 for gaseous refrigerant extends through the top and rear walls of the cabinet 20 downwardly to the top of the compartment 31.

According to my invention a vapor lift device is employed for circulating the refrigerant in my secondary refrigerating system. This vapor lift device, preferably takes the form of an electric heater 38 which is located at the lower portion of a liquid conduit 34 just above the check valve 33 which prevents any downward flow in this conduit. This electric heater is supplied with electric current through electrical conductor 39, the rheostat means 40, and the electrical conductors 41 and 42.

The compartment 31 is cooled to a low temperature by the evaporation or sublimation of the carbon dioxide snow 25 in the chamber 24. This low temperature in the chamber 31 causes the volatile refrigerant in the secondary refrigerant to condense in this chamber. The condensed refrigerant floods the lower portions of the chamber 31, the refrigerant conduit 32 and the lower portion of the liquid conduit 34 adjacent the heater 38. The heater 38, by vaporizing a portion of the liquid refrigerant in the lower portion of the liquid conduit 34 causes the remainder of this liquid refrigerant to be carried up the liquid conduit 34 by this vaporized portion of the refrigerant into the evaporator 35 after the manner of a vapor lift pump. This liquid refrigerant, carried to the evaporator 35 in this manner, evaporates in the evaporator 35 because of the absorption of heat from the air in the food storage compartment 21 and this evaporated refrigerant returns to the condensing or liquefying chamber 31 through the return conduit 36.

In order to control the temperature of the food storage compartment I provide, adjacent the lower side of the evaporator 35, a thermostatic bulb

44 which is connected by means of a fluid conduit 45 to a bellows 46 which is connected to a rheostat means 40. A thermostatic bulb 44 is charged with a suitable volatile fluid so that when the temperature in the food storage compartment increases, the resistance of the rheostat means will be lowered so as to permit more current to flow through the electric heater 38 to cause more liquid refrigerant to be pumped up into the evaporator 35 and thus to raise the liquid level therein to provide more refrigeration for the food storage compartment 21. Conversely, when the food storage compartment 21 becomes cool, the volatile fluid within the thermostatic bulb 44 will contract, causing the bellows 46 to collapse and to increase the resistance of the rheostat means 40 to reduce the amount of electric current flowing through the heater 38 to reduce the amount of liquid refrigerant pumped by this vapor lift means into the evaporator 35 and in this way the amount of refrigeration provided by the evaporator 35 will be reduced in accordance with the requirements. The rheostat means 40 is so constructed so that if the food storage compartment 31 should become sufficiently cold, the rheostat means will open the circuit and prevent any refrigeration from being supplied to the evaporator 35 by means of the heater 38. In this event, the check valve 33 will prevent the falling of the liquid refrigerant in the tube 34. Normally, the refrigerating demand on the evaporator 35 is substantially constant so that the rheostat means 40 normally stays in one suitable position to supply just the proper amount of refrigeration to the evaporator 35. However, should there be any change in the refrigerating requirement, the rheostat means 40 will move to the proper position to supply the demand required.

In this system the chamber 31 acts as a hold-over. Inasmuch as the carbon dioxide snow comes in blocks which from their very nature are of a relatively large size to begin with and grow smaller as they produce refrigeration and sublime, the refrigerating effect is greater when a block of carbon dioxide snow is first placed within the compartment 24 and during this time a comparatively large amount of liquid refrigerant may be accumulated within the condensing chamber 31 and the liquid refrigerant level in the evaporator may fall. When the block of carbon dioxide snow becomes smaller, the secondary system will begin to use some of this accumulated condensed refrigerant and thereby maintain an even temperature within the food storage compartment notwithstanding the depletion of the carbon dioxide snow. If desired, an inert gas may be introduced into the secondary system in order to raise the evaporating temperature in the evaporator 35.

In Fig. 2 there is shown a modified form of my invention including a refrigerator cabinet 50 having a food storage compartment 51 therein enclosed within insulated walls as well as a primary refrigerating compartment 52 which is enclosed within a casing 53. This casing 53 is surrounded by a secondary refrigerant compartment 54 formed between the casing 55 and the casing 53. The casing 55 is surrounded by insulated walls. The compartment 52 is closed at its front by a door 56 through which a block of carbon dioxide snow 57 or other suitable primary refrigerating means may be inserted. The sublimation of the carbon dioxide snow within the chamber 52 cools the chamber 54, which serves as a condensing means for a secondary refrigerating system, a liquid supply conduit 58 provided with a thermostatically controlled valve 59 supplies liquid refrigerant from the condensing chamber 54 to an evaporator 60, of any suitable type, located in the food storage compartment 51. A gaseous return conduit 62 is provided for returning the refrigerant evaporated within the evaporator 60 to the condensing chamber 54 where it is recondensed by the action of the carbon dioxide snow.

The refrigerating capacity of the evaporator 60 is controlled in accordance with the requirements of the food storage compartment 51 by means of the valve 59 which is operated through the fluid conduit 64 by means of a thermostatic bulb 63, located within the food storage compartment 51, immediately beneath the evaporator 60. The valve 59 is preferably of a very small capacity so as to be sufficiently sensitive to properly control the flow of refrigerant from the condensing chamber 54 to the evaporator 60. By employing a valve of small capacity only small amounts of liquid refrigerant are supplied from the condensing chamber 54 to the evaporator 60 when the valve is open. In this way a suitable control is provided to maintain the food storage compartment 51 at a proper temperature. Similarly to the first described embodiment, the secondary system may be provided with an inert gas such as an air or nitrogen.

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, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus including a primary refrigerating means, a secondary refrigerating means having a liquefying portion in heat exchange relation with said primary refrigerating means, a compartment to be kept cool, said secondary refrigerating means containing a volatile refrigerant, said secondary means having an evaporating means located in said compartment to be kept cool for evaporating said refrigerant and a reservoir portion for receiving condensed refrigerant, said secondary means also having duct means connecting the upper and lower portions of said reservoir portion with said evaporating means, and vapor lift means for lifting said condensed refrigerant from said reservoir portion to said evaporating means, said vapor lift means including an electric heater in heat exchange relation with the lower portion of said duct means connected to the lower portion of said reservoir portion, and thermostatic means responsive to the temperature of said compartment to be kept cool for controlling the operation of said electric heater.

2. Refrigerating apparatus including a primary refrigerating means, a secondary refrigerating means having a liquefying portion in heat exchange relation with said primary refrigerating means, a compartment to be kept cool, said secondary refrigerating means containing a volatile refrigerant, said secondary means having an evaporating means located in said compartment to be kept cool for evaporating said refrigerant and a reservoir portion for receiving condensed refrigerant, said secondary means also having duct means connecting the upper and lower portions of said reservoir portion with said evaporating means, and vapor lift means for lifting said

condensed refrigerant from said reservoir portion to said evaporating means, said vapor lift means including an electric heater in heat exchange relation with the lower portion of said duct means connected to the lower portion of said reservoir portion, and a rheostat means for controlling the heating action of said electric heater to vary the amount of liquid refrigerant supplied to said evaporating means.

3. Refrigerating apparatus including a cabinet having an insulated compartment to be kept cool, a primary refrigerating means located in entirety beneath the insulated compartment to be kept cool, a secondary refrigerating means having a portion in heat exchange relation with said primary refrigerating means and an evaporating means in the compartment to be kept cool, a pumping means responsive to conditions of said evaporator and located outside of and beneath the compartment to be kept cool for lifting liquid refrigerant in the secondary refrigerating means from the heat exchange portion to the evaporating means.

4. Refrigerating apparatus including a compartment to be cooled, an evaporator for cooling the compartment, a condenser connected to and located below the evaporator, both the evaporator and condenser being at substantially the same pressure and forming a closed secondary refrigerating system, a primary refrigerating means for cooling said condenser, and continuously operating pumping means for returning condensed refrigerant from the condenser to the evaporator, said pumping means being located outside the compartment and controlled by a thermostatic bulb responsive to conditions of said evaporator.

5. Refrigerating apparatus including a primary refrigerating means, a secondary refrigerating means having a portion in heat exchange relation with said primary refrigerating means, a compartment to be kept cool, said secondary refrigerating means having an evaporating means in said compartment and a reservoir portion below said evaporating means, said secondary refrigerating means containing a volatile refrigerant, and vapor lift means located outside the compartment and controlled by a thermostatic bulb responsive to the temperature within said compartment to be kept cool for lifting liquid refrigerant from said reservoir portion to said evaporating means for controlling the temperature within said compartment to be cooled.

6. Refrigerating apparatus including a compartment to be kept cool, a closed secondary system containing a volatile refrigerant including an evaporating means in heat exchange relation with said compartment, said evaporating means forming a liquid trap portion within said closed secondary refrigerant system for trapping liquid refrigerant, a primary refrigerating means located below said evaporating means for condensing refrigerant vapor within said closed secondary refrigerant system and means for controlling the temperature within said compartment including pumping means located outside of said compartment but responsive to temperatures within said compartment for lifting condensed refrigerant vapor within said closed secondary system into the evaporating means according to temperature requirements.

7. Refrigerating apparatus including a compartment to be kept cool, a closed secondary system containing a volatile refrigerant including an evaporating means in heat exchange relation with said compartment, said evaporating means forming a liquid trap portion within said closed secondary refrigerant system for trapping liquid refrigerant, a primary refrigerating means located below said evaporating means for condensing refrigerant vapor within said closed secondary refrigerant system, means for controlling the temperature within said compartment including thermal pumping means for lifting condensed refrigerant within said closed secondary system into the evaporating means, and means for varying the rate of heat supply to said pumping means.

8. Refrigerating apparatus including a compartment to be kept cool, a closed secondary system containing a volatile refrigerant including an evaporating means in heat exchange relation with said compartment, a primary refrigerating means located below said evaporating means for condensing refrigerant vapor within said closed secondary refrigerant system, means for controlling the temperature within said compartment including pumping means for lifting condensed refrigerant within said closed secondary system into the evaporating means and a thermostat for varying the rate of operation of said pumping means.

9. Refrigerating apparatus including a compartment to be kept cool, a closed secondary system containing a volatile refrigerant including an evaporating means in heat exchange relation with said compartment, said evaporating means forming a liquid trap portion within said closed secondary refrigerant system for trapping liquid refrigerant, a primary refrigerating means located below said evaporating means for condensing refrigerant vapor within said closed secondary refrigerant system, an obstructed conduit for transferring liquid refrigerant from the condensing portion to said evaporating means of the closed secondary system, and means for controlling the temperature within said compartment including pumping means located outside of said compartment but responsive to temperatures within said compartment for lifting condensed refrigerant within said closed secondary system into the evaporating means according to temperature requirements.

HARRY B. HULL.