Nov. 24, 1942. R. E. TOBEY 2,303,182

REFRIGERATION APPARATUS

Filed July 25, 1940 3 Sheets-Sheet 1

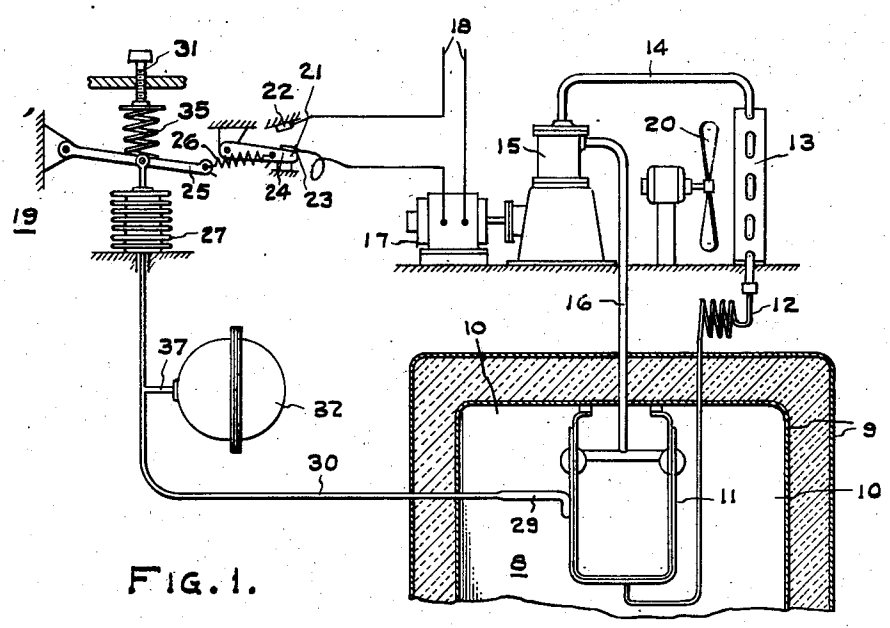


FIG. 1.

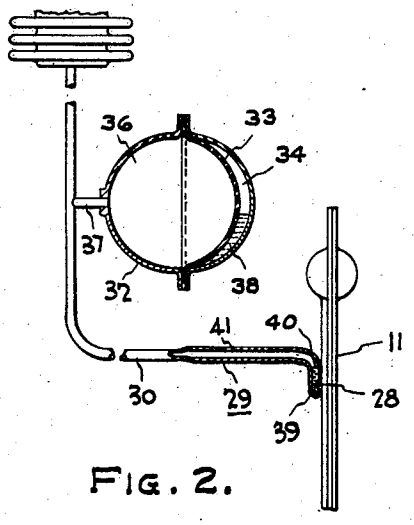


FIG. 2.

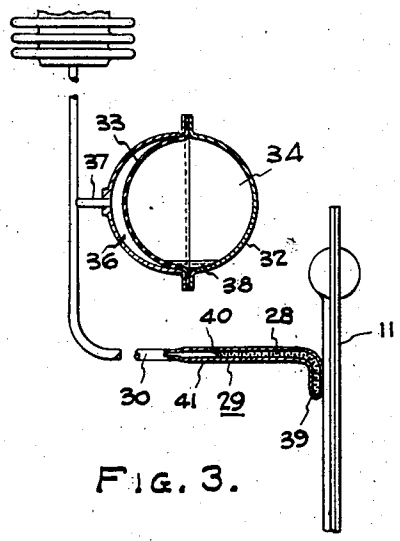


FIG. 3.

WITNESSES:

E. H. Lutz

A. J. Cook

INVENTOR

RAYMOND E. TOBEY.

BY Wakefield

ATTORNEY

Nov. 24, 1942. R. E. TOBEY 2,303,182

REFRIGERATION APPARATUS

Filed July 25, 1940 3 Sheets-Sheet 2

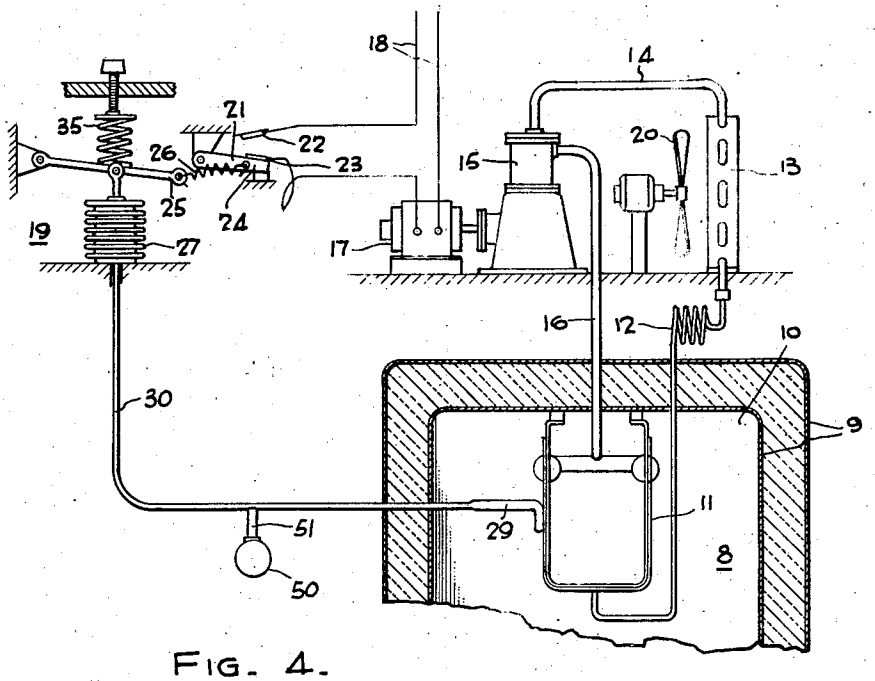


FIG. 4.

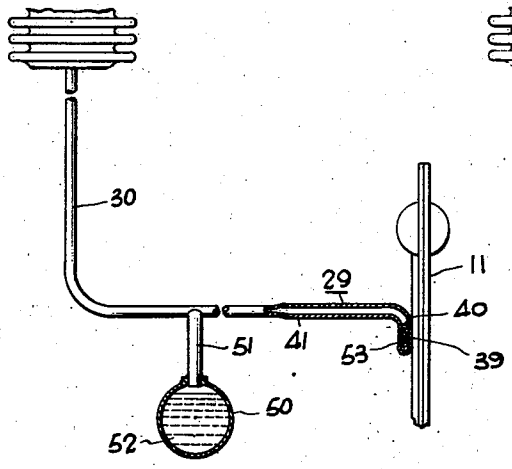


FIG. 5.

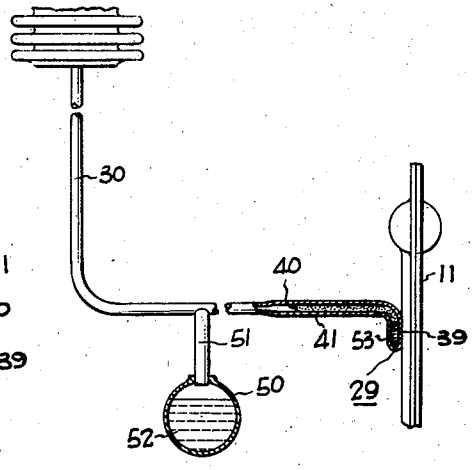


FIG. 6.

WITNESSES:

E. H. Lutz

A. J. Cook

INVENTOR

RAYMOND E. TOBEY

BY

ATTORNEY

Nov. 24, 1942. R. E. TOBEY 2,303,182

REFRIGERATION APPARATUS

Filed July 25, 1940 3 Sheets-Sheet 3

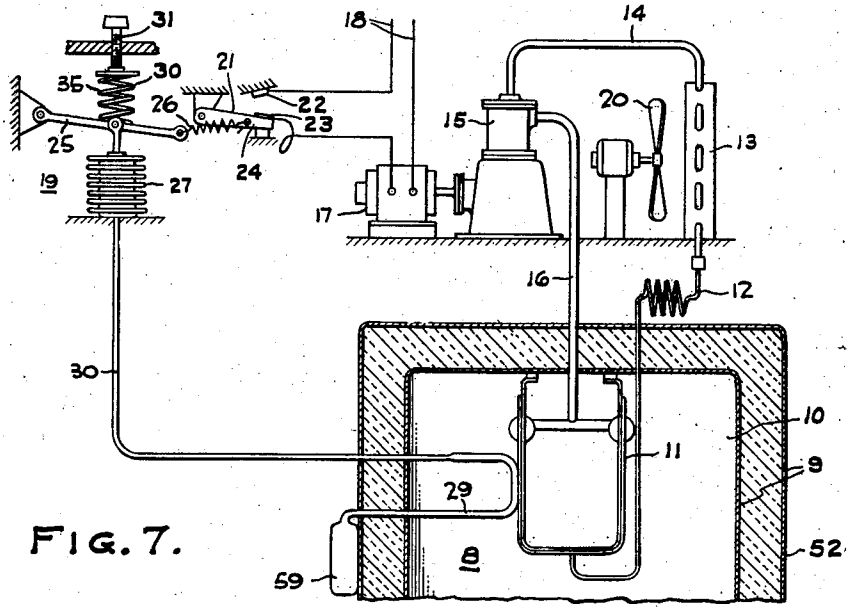


FIG. 7.

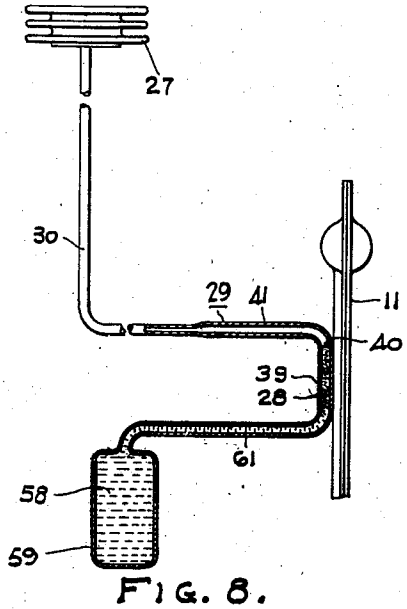


FIG. 8.

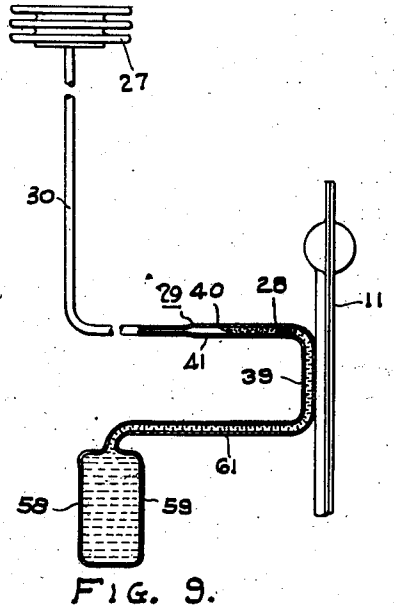


FIG. 9.

WITNESSES:

E. H. Luty

A. J. Cook

INVENTOR

RAYMOND E. TOBEY

BY Whittemore

ATTORNEY

Patented Nov. 24, 1942 2,303,182

UNITED STATES PATENT OFFICE

2,303,182

REFRIGERATION APPARATUS

Raymond E. Tobey, Springfield, Mass., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 25, 1940, Serial No. 347,396

9 Claims. (Cl. 62—4)

This invention relates to refrigeration apparatus and more especially to the thermostatic control of such apparatus.

One object of the invention is to provide a control apparatus for a mechanical refrigerator which maintains the temperature of the media cooled thereby substantially constant in varying room temperatures.

Another object is to provide a control for a mechanical refrigerator which is responsive to the temperatures of both the cooling unit and the media ambient the refrigerator.

A further object is to provide a compensated control of the type described which does not seriously affect the ice freezing capacity of the refrigeration apparatus it is controlling in low room temperatures.

These and other objects are effected by my 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 schematic drawing of the control apparatus of this invention applied to a refrigerator;

Fig. 2 is a detailed view showing the position of the elements of the control apparatus when the temperature of the media ambient the refrigerator is low;

Fig. 3 is a view showing the position of the elements of the control apparatus when the temperature of the media ambient the refrigerator is high;

Fig. 4 illustrates a modification of the control apparatus of this invention applied to a refrigerator;

Fig. 5 is a detailed view of the modification shown in Fig. 4, showing the positions of the elements of the control apparatus when the temperature of the media ambient the refrigerator is low;

Fig. 6 is a detailed view of the modification shown in Fig. 4 showing the position of the elements of the control apparatus when the temperature of the media ambient the refrigerator is high;

Fig. 7 is a schematic drawing of another modification of the invention;

Fig. 8 is a detailed view showing the position of the elements of the control apparatus when the temperature of the media ambient the refrigerator is low; and,

Fig. 9 is another detailed view of the modification shown in Fig. 7 showing the position of the elements of the control apparatus when the temperature of the media ambient the refrigerator is high.

Referring specifically to the drawings for a detailed description of the invention, reference numeral 8 designates a cabinet of a refrigerator having insulated walls 9 forming a food storage compartment 10 with an evaporator or cooling unit 11 therein. The evaporator 11 is supplied with liquid refrigerant through a capillary tube 12 which receives its supply from a condenser 13 into which compressed refrigerant is pumped through a conduit 14 by a compressor 15. The compressor 15 withdraws the vaporized refrigerant from the evaporator 11 through a conduit 16. The compressor 15 is driven by means of an electric motor 17 which receives electrical energy from lines 18. The condenser 13 and the compressor 15 are cooled by a fan 20 which circulates air through the condenser 13 and over the compressor 15.

A thermostatic device 19 controls the current supply to the electric motor 17 by means of a snap-acting switch 21 placed in one of the lines 18. The switch 21 comprises a fixed contact 22 and a movable contact 23 carried on an arm 24 which is actuated by an overcenter linkage comprising a lever 25 and a spring 26. The lever 25 is actuated by a Sylphon bellows 27, which in turn is actuated by the vapor pressure of a volatile liquid 28 in a vessel 29 (see Figs. 2 and 3) adjacent the evaporator 11. A tube 30 connects the Sylphon bellows 27 with the vessel 29. The vapor pressure of the volatile liquid 28 at which the snap-acting switch 21 is actuated may be varied by turning a threaded shaft 31 which adjusts the pressure of a spring 35 on the lever 25.

Vessel 29 is an L-shaped tube with the shorter leg 39 lying in contact with the cooling unit 11 and the longer leg 41 extending away from the cooling unit 11 into the relatively warmer food storage chamber 10. The vessel 29 accordingly varies in temperature, the colder portion being the portion 39 in contact with the cooling unit 11, and the warmer portion being the portion 41, which portion varies in temperature and is progressively warmer, depending on the distance of the various elements thereof from the cooling unit 11. The temperatures of all portions of the vessel 29, however, vary in response to the temperature of the cooling unit 11.

In accordance with the invention, a chamber 32 is located in the ambient air of the refrigerator. The chamber 32 is divided by an elastic diaphragm 33, such as rubber, into two compart-

ments 34 and 36. The compartment 36 communicates through a duct 37 with the tube 30, and the compartment 34 contains a second liquid 38, of lower volatility than the liquid 28 in the vessel 29. The air from the compartments 34 and 36, the bellows 27, the tube 30, and the vessel 29 is exhausted prior to the introduction of the liquids so that the only pressures in the chambers are the pressures of the vapors of the respective liquids.

The liquids 28 and 38 are of such a nature that when the food storage compartment 10 is refrigerated, the vapor pressure of the liquid 38 exceeds that of the liquid 28 when the temperature of the air ambient the refrigerator is high and is below that of the liquid 28 when the temperature of the air ambient the refrigerator is low. Suitable liquids for this purpose are methyl chloride in the vessel 29 and methyl bromide in the compartment 34. Assuming a temperature of the cooling unit 11 such that the warmest portion of the methyl chloride is 20° F., the vapor pressure of the methyl chloride would be 13.8 pounds per square inch. The vapor pressure of the methyl bromide in a 60° F. room would be 8.7 pounds per square inch and in a 90° F. room would be 26.7 pounds per square inch. The pressure of the methyl bromide is less, therefore, than that of the methyl chloride in a cold room and greater than that of the methyl chloride in a hot room so that when the temperature of the ambient air is low, the position of the diaphragm 33 will be towards the right as indicated in Fig. 2, and when the temperature of the ambient air is high, the diaphragm 33 will be moved to the left as shown in Fig. 3.

The movement of the diaphragm 33 to the left forces the vapor of the liquid 28 from the compartment 36, and the increased pressure causes the vapor to condense in the vessel 29. An increase in the quantity of the liquid 28 in the vessel 29 moves the dividing line 40 between the liquid 28 and its vapor farther away from the cooling unit. The dividing line 40 will hereafter be referred to as the liquid line 40 of the liquid 28.

When the temperature of the air ambient the refrigerator is low, the liquid line 40 is close to the cooling unit 11 as shown in Fig. 2 and closely follows the temperature thereof. Under these circumstances the volatile fluid 28 closes the switch 21 when the temperature of the cooling unit 11 rises to the "cut-on" temperature and opens the switch when the temperature of the cooling unit 11 drops to the "cut-off" temperature. However, when the temperature of the air ambient the refrigerator is high, the liquid line 40 of the volatile fluid 28 is moved away from the cooling unit 11 as shown in Fig. 3. The temperature of the cooling unit 11 must now be much lower than formerly to cool the liquid at the liquid line 40 to the "cut-off" temperature and similarly the liquid at the liquid line 40 reaches the "cut-off" temperature only after the cooling unit 11 has been cooled to considerably below this temperature. It will be apparent from the above that the temperature of the cooling unit 11 varies with the temperature of the ambient air and is decreased in temperature when the temperature ambient the refrigerator increases and vice versa. The decrease in the "cut-off" temperature will also be found to be greater than the decrease in the "cut-on" temperature due to the greater temperature difference between the temperature of the air in the cabinet and the "cut-off" temperature of the liquid line 40 as compared to the difference between the temperature of cabinet air and the "cut-on" temperature of the liquid line 40.

The control is preferably so proportioned that it decreases the temperature of the cooling unit 11, just sufficiently to offset the additional heat leakage through the refrigerator walls when the temperature of the ambient air rises. This maintains the average temperature of the air in the refrigerator substantially constant. The control may also be adapted for over-compensation so that the refrigerator temperature drops when the temperature of the ambient air increases. This may be effected by lengthening the vessel 29 and decreasing its diameter.

Applicant's device provides for the freezing of ice cubes and the like by extending the portion 39 of the vessel 29 along the cooling unit. It will be apparent that even though the liquid line 40 drops below the level indicated in Fig. 2 in a very low ambient temperature, the temperature of the liquid at the liquid level 40 will not change relative to that of the cooling unit 11, and the switch will be opened and closed at substantially the same temperatures as for the conditions indicated in Fig. 2, at which a freezing temperature is maintained within the cooling unit 11.

The modification shown in Figs. 4, 5, and 6 produces a similar result as the modifications previously described and like parts are provided with the same reference numerals. In this modification a receptacle 50 connects through a tube 51 with the tube 30. The receptacle 50 is located in the air ambient the refrigerator and contains a mineral oil 52 or other vapor-absorbing material. The volatile fluid in the vessel 29 of this modification comprises a fluid such as dichlorodifluoromethane 53 which is soluble in the mineral oil 52 inversely proportional to the temperature of the oil 52.

When the temperature of the ambient air is cool, a quantity of the dichlorodifluoromethane vapor is absorbed by the mineral oil 52 and some of the dichlorodifluoromethane liquid 53 in the vesesl 29 vaporizes to replace the absorbed vapor. The vaporization of the dichlorodifluoromethane liquid 53 causes the liquid line 40 thereof to move closer to the evaporator 11. When the temperature of the air ambient the refrigerator is high, a certain portion of the vapor absorbed by the mineral oil 52 is driven off and this vapor condenses in the portion 41 of the vessel 29 in the same manner as in the first-described modification. The compensating action of the dichlorodifluoromethane liquid 53 at the liquid line 40 is the same as the volatile liquid 28 in the vessel 29 described in the first modification of the invention.

In the modification shown in Figs. 7, 8, and 9, somewhat similar apparatus is utilized as in the previous modification and like parts are provided with the same reference numerals. The liquid line 40 in this modification is moved back and forth by the expansion and contraction of a fluid, preferably a liquid 58, which is contained in a receptacle 59 secured to the metal of the outer shell 52 of the refrigerator. The receptacle 59 connects to the lower portion 39 of the vessel 29 through a tube 61. The liquid 58 is subject to the temperature of the air ambient the refrigerator, and the expansion and contraction of the liquid 58, caused by the changes of the ambient temperature, moves the liquid line 40 to secure the temperature compensating effects described

in the previous modifications. The outer metal shell 52 of the refrigerator to which the receptacle 59 is secured acts as a heat conducting fin for the receptacle 59 to maintain the temperature of the same in close relationship with the ambient temperature. The liquid 28 in the vessel 29 in this modification may comprise methyl chloride, and the liquid 58, a solution of sodium chloride in which the methyl chloride is insoluble or nearly so. As shown in Figs. 8 and 9 the liquid 58 is arranged to lie below the volatile fluid 28 because the former is heavier than the latter.

It will be aparent from the above that this invention provides a control for a mechanical refrigerator which compensates for room temperature and is responsive to both the temperature of the evaporator and to that of the room in which the refrigerator is operated. The control also provides for the proper evaporator temperature for forming ice even at low room temperatures.

While I have shown my invention 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, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In a mechanical refrigerator, the combination of an insulated cabinet containing a medium to be cooled, a cooling unit for cooling the medium in said cabinet, apparatus for supplying refrigerant to said cooling unit, a vessel having portions thereof in different degrees of heat exchange relationship with said cooling unit, a volatile fluid in said vessel, said volatile fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, and means responsive to the ambient temperature of said cabinet for effecting the disposition of volatile liquid in at least some of said portions of the vessel to vary the mean temperature of the cooling unit.

2. In a mechanical refrigerator, the combination of an insulated cabinet containing a medium to be cooled, a heat absorbing unit for cooling said medium, apparatus for supplying a heat absorbing material to said unit, a vessel having at least a part thereof lying in a medium warmer than said heat absorbing unit, said part having portions in different degrees of heat exchanging relationship with said heat absorbing unit to maintain said portions at different temperatures, a volatile fluid in at least the coldest portions of said vessel, means responsive to the vapor pressure of said volatile fluid for controlling said apparatus, and means responsive to the temperature ambient said cabinet for effecting condensation of a portion of said vapor in the coldest available portion of said vessel as said temperature increases to increase the vapor pressure of said volatile fluid.

3. In a mechanical refrigerator, the combination of an insulated cabinet containing a medium to be cooled, a cooling unit for cooling the medium in said cabinet, apparatus for supplying refrigerant to the cooling unit, a vessel having portions thereof in different degrees of heat exchange relationship with said cooling unit, a volatile fluid in said vessel, said fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, and means responsive to the ambient temperature of said cabinet for moving the liquid portion of the fluid in said vessel from one of said portions of the vessel to another in a different heat exchange relationship to vary the mean temperature of the cooling unit.

4. In a mechanical refrigerator, the combination of an insulated cabinet containing a medium to be cooled, a cooling unit for cooling the medium in said cabinet, apparatus for supplying refrigerant to the cooling unit, a vessel having portions thereof in different degrees of heat exchange relationship with said cooling unit, a volatile fluid in said vessel, said volatile fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, and means responsive to the ambient temperature of said cabinet for effecting the disposition of liquid portions of said volatile fluid in at least some of said various portions of said vessel to vary the mean temperature of the cooling unit, the portion of said vessel in the most intimate heat exchange relationship with the cooling unit being of relatively large capacity to maintain the temperature of the cooling unit below a predetermined limit.

5. In a mechanical refrigerator, the combination of an insulated cabinet, a cooling unit for said cabinet, apparatus for supplying refrigerant to the cooling unit, and a vessel having a portion thereof in intimate heat exchange relationship with the cooling unit and a second portion thereof in heat exchange relationship with the cooling unit and with a medium warmer than said cooling unit to raise the temperature of said second portion above that of the cooling unit, a volatile fluid in said vessel, said fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, and means responsive to an increase in the temperature of the atmosphere ambient said cabinet for condensing quantities of the vapor of said volatile fluid in said vessel to extend the liquid therein to the second portion of said vessel to lower the mean temperature of the cooling unit.

6. In a mechanical refrigerator, the combination of an insulated cabinet, a cooling unit for said cabinet, apparatus for supplying refrigerant to the cooling unit, and a vessel having a portion thereof in heat exchange relationship with the cooling unit and another portion thereof extending from the cooling unit into a zone of higher temperature, a chamber exterior of said insulated cabinet, a movable partition in said chamber dividing the same into two compartments, one of said compartments communicating with said vessel, a volatile liquid in the portion of said vessel in heat exchange relationship with the cooling unit and vapors of said liquid in the compartment communicating with said vessel, means responsive to the vapor pressure of said liquid for controlling the refrigerant-supplying apparatus, and a second volatile liquid in the other compartment of said chamber, said second volatile liquid being in heat exchange relationship with the ambient air of said cabinet, the vapor pressures of the first-named and the second-named liquid being such that the differential between their vapor pressures moves said partition to decrease the volume of the compartment communicating with the vessel when the temperature of the air ambient of said cabinet increases be-

yond predetermined limits thereby condensing the vapors in said first-named compartment in the portion of said vessel extending away from the cooling unit.

7. In a control mechanism for a mechanical refrigerator comprising an insulated cabinet, a cooling unit therein, and refrigerant-supplying apparatus exterior of said cabinet, the combination of a vessel having a portion thereof in heat exchange relationship with the cooling unit and another portion thereof extending away from the cooling unit, a chamber, a movable partition therein dividing said chamber into two compartments, one of said compartments communicating with said vessel, a volatile liquid at least in the portion of said vessel in heat exchange with the cooling unit and vapors of said liquid in the compartment communicating with said vessel thus providing a liquid line in said vessel, a second volatile liquid in the other compartment of said chamber, said second volatile liquid being in heat exchange relationship with the ambient air of said cabinet, and means responsive to the vapor pressure of said first-named liquid for controlling the refrigerant-supplying apparatus, the vapor pressure of the first-named and the second liquid being such that the differential between their vapor pressures moves said partition to decrease the volume of the compartment communicating with the vessel when the temperature of the air ambient of said cabinet increases, thereby condensing some of the vapor of the last-named compartment to supply additional liquid in the vessel to bring the liquid line therein farther away from the evaporator into a warmer area of the insulated chamber.

8. In a mechanical refrigerator, the combination of an insulated cabinet containing a medium to be cooled, a cooling unit for cooling the medium in said cabinet, apparatus for supplying refrigerant to the cooling unit, a vessel having portions thereof in varying degrees of heat exchange relationship with said cooling unit, a volatile fluid in said vessel, said fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, a vapor-absorbing material located exterior of said cabinet and in communication with said vapor, the vapor-absorbing quality of said material varying inversely with its temperature, said material absorbing some of said vapor when the material is at low temperatures and expelling some of said vapor when at high temperatures, said expelled vapor condensing in the coldest portions of said vessel available to said vapor to effect a variation of the average temperature of the cooling unit.

9. In a mechanical refrigerator, the combination of an insulated cabinet, a cooling unit for said cabinet providing a plurality of refrigerated zones of different temperatures therein, apparatus for supplying refrigerant to the cooling unit, a vessel having portions thereof in several of said zones, a volatile fluid in said vessel, said fluid having portions in the liquid and in the vapor phase, means responsive to the pressure of said vapor for controlling said refrigerant-supplying apparatus, and a second fluid located exterior of said insulated cabinet communicating with a portion of said vessel located in one of the colder zones, said fluid expanding with increase in temperature to move the liquid portion of said volatile fluid to a portion of the vessel located in a warmer zone, to effect a decrease of the average temperature of the cooling unit.

RAYMOND E. TOBEY.