Sept. 17, 1946. G. MUFFLY 2,407,794

REFRIGERATING MECHANISM

Original Filed Nov. 8, 1933 2 Sheets-Sheet 1

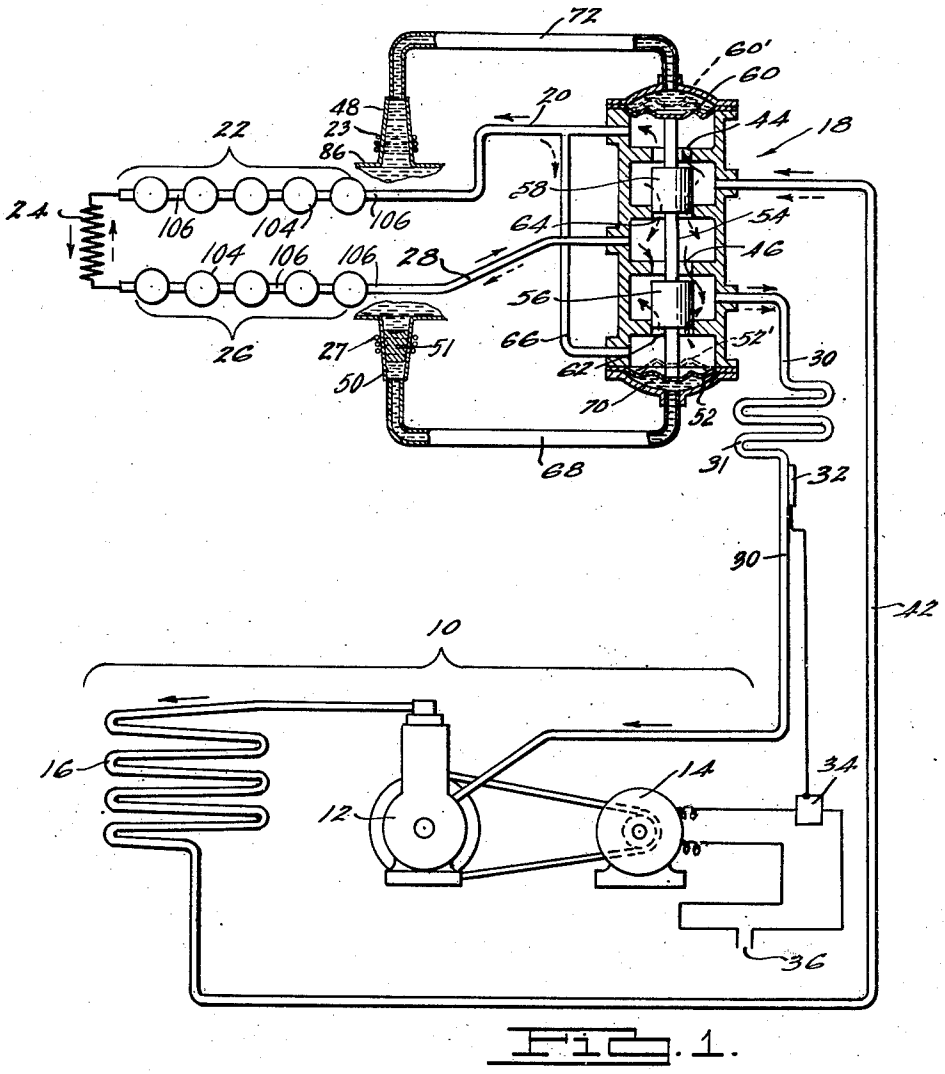


Fig. 1.

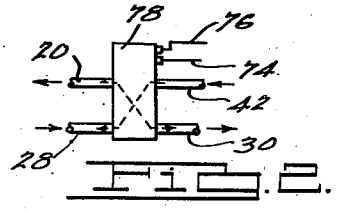


Fig. 2.

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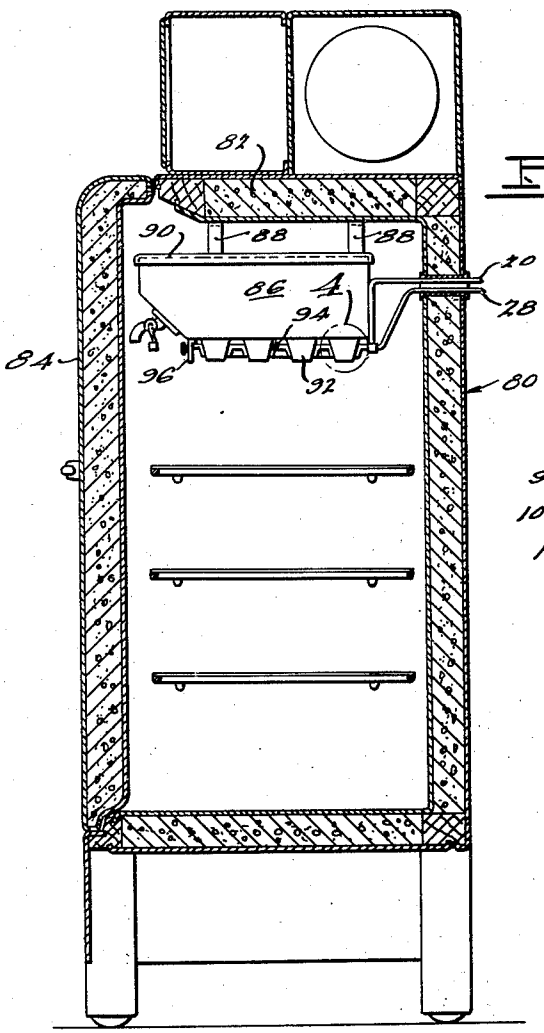


FIG. 3.

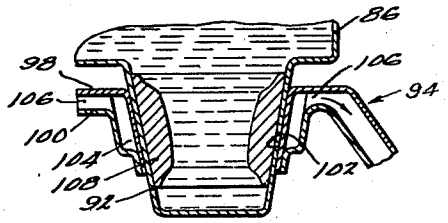


FIG. 4.

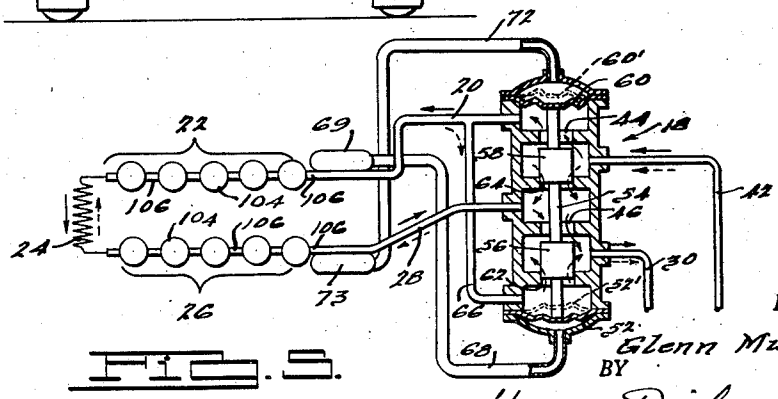


FIG. 5.

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UNITED STATES PATENT OFFICE

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REFRIGERATING MECHANISM

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Original application November 8, 1933, Serial No. 697,124. Divided and this application January 23, 1939, Serial No. 252,291

2 Claims. (Cl. 62—2)

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The invention relates to mechanical refrigeration, and this application is a division of the one which matured into U. S. Patent No. 2,145,773 January 31, 1939.

An important object of this invention is to provide for control of refrigeration systems wherein certain heat exchange elements are required to act sometimes to absorb heat and sometimes to give off heat.

A further object is to improve and simplify the means for controlling flow of refrigerant liquid in such systems.

The above being among the objects of the present invention, the same consists in certain novel features of construction, combinations of parts and steps of operation that will hereinafter be described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a diagrammatic view of a refrigerator system embodying the invention and showing the reversing valve in section for clearness of illustration,

Fig. 2 illustrates an alternative means for operating a valve mechanism equivalent to that shown in Fig. 1,

Fig. 3 is a vertical sectional view through a refrigerator cabinet in which parts of the refrigerating system are mounted,

Fig. 4 is an enlarged sectional view of the portion of Fig. 3 enclosed by the circle 4, and

Fig. 5 is a fragmentary, diagrammatic view showing a modified form of control.

The apparatus embodying the present invention is shown in connection with ice makers for purpose of illustration. Referring first to Fig. 3, a refrigerator cabinet is indicated generally at 80 and as having wall sections including the top 82 suitably insulated as in conventional constructions to reduce the amount of heat transfer through them. As in conventional constructions, the cabinet 80 is provided with a swingable door 84. A water tank 86 is supported from the top 82 through brackets 88 and heat exchanger assembly 94 and has a removable top 90. Formed in or fixed to the lower surface of the water tank 86 and open at their top to the interior thereof are two parallel rows of downwardly projecting cups 92.

Means are provided to refrigerate at least a portion of the surface of the cups 92 so as to

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cause at least a portion of the water from the tank 86 which fills them to be frozen. Such means may comprise an evaporating unit 94 which is supported by hangers 88. The evaporator 94 is made out of two sheets of metal 98 and 100 having downwardly tapered openings 102 in which cups 92 seat and the sheets 98 and 100 are suitably formed and secured as by welding to form an annular chamber 104 of material depth around each of the openings 102. Between the chambers 104 the sheets 98 and 100 are formed to provide passages 106 which connect the chambers in series.

Actually the cups 92 are arranged in two series and, as indicated in Figs. 1 and 5, the chambers 104 for the cups 92 are likewise arranged in two series and indicated in the figures referred to, as 22 and 26, respectively. The series 22 and 26 are connected together at one end by a flow restricting device, here shown more or less diagrammatically as a capillary tube 24. The opposite ends of the series 22 and 26 are connected by tubes 20 and 28, respectively, to a valve 18, which will hereinafter be fully described. These tubes serve in one position of the valve 18 to connect the corresponding end of the series 22 with the condenser 16 and the corresponding end of the series 26 with the suction side of the compressor 12, and in the opposite position of the valve to reverse this connection. Thus, the capillary tube 24 serves alternately to control the expansion of the refrigerant first from one of the series 22 or 26 into the other, and then to control its expansion in the opposite direction.

Any type of refrigerating mechanism having suitable cyclic operation may be adapted for use in connection with the present invention. The particular mechanism shown more or less diagrammatically at 10, Fig. 1, includes a compressor 12 driven by a suitable electric motor 14 and discharging refrigerant therefrom to a condenser 16 from which it is conveyed to the reversing valve 18, which, in the position shown, discharges liquid refrigerant therefrom into the tube 20. The refrigerant, after having passed through the series 22 of heat exchanger passages 104 and 106, flows through the capillary tube 24 and thence through the series 26 of the heat exchanger passages. In the latter passages the refrigerant is gasified and then returns through the tube 28, valve 18, and tube 30 to the suction side of the compressor 12.

Any suitable or conventional type of control mechanism may be provided for controlling the operation of the motor 14. The particular con-

trol indicated diagrammatically is of the thermostatic type including a control bulb 32 secured in contact with the suction tube 30 so as to prevent frosting of the suction line. A control switch indicated diagrammatically at 34 is connected in series with the motor 14 and a suitable source of electrical energy 36. Preferably the switch 34 is of the adjustable type.

In Fig. 1 the valve mechanism is shown with parts in position for refrigerant flow as indicated by the solid arrows. The liquid refrigerant enters the valve through tube 42, passes through valve port 44, and thence through tube 20 to the upper series 22 of the heat-exchanger chambers 104, which is at the moment in the heat-dissipating portion of the cycle. The liquid refrigerant now passes through the capillary tube 24, which retards its flow enough to cause evaporation in the lower series 26 of the heat-exchanger chambers 104. The vapor then goes through the tube 28, the valve port 46, and the tube 30 to the condensing unit 10.

This assembly includes two temperature responsive control elements, in the form shown in Fig. 1, as special ice cups 48 and 50 which may be attached to and open into the water tank 86, and around the cups 48 and 50 are coils 23 and 27, respectively. Coil 23 is connected with the refrigerant passage that serves the upper series 22 of the heat-exchanger chambers 104, while the coil 27 is connected in the circuit for the lower series 26.

The cups 48 and 50 are relatively deep and small in diameter, with each coil 23 and 27 arranged to cause, during its active period of refrigeration, freezing in the upper part of the corresponding cup first. Thus, while rings of ice are forming in the set of cups 92 served by series 26 of the heat-exchanger chambers 104, the ring of ice formed in cup 50 will become a solid plug or cone of ice 51 as shown, and the further, downward freezing of ice below this plug will produce pressure on the water in the bottom of the cup and in the tube 68 and chamber 70, as well as upon the diaphragm 52.

As the formation of ice 51 progresses in cup 50 the pressure upon diaphragm 52 will increase, finally causing the diaphragm 52 to snap into position 52', pushing the valve stem 54 and its valves 56 and 58 along their common axis until the valve 56 closes the port 46 and the valve 58 closes the port 44. At the same time, the stem 54 engaging the diaphragm 60 will cause it to snap into position 60'. It will be seen that the high pressure of liquid refrigerant acting upon diaphragm 60 has been urging it in this direction constantly before this movement occurred, but the diaphragms are so designed that they will not snap into reversed position under the highest possible pressure of the liquid refrigerant. The higher pressure of the expanding ice is, however, ample to snap both of the diaphragms and to move the valve 58 against the pressure of the liquid refrigerant, aided by the liquid pressure that is already exerted upon diaphragm 60.

This movement of the valve stem and its valves has now opened the ports 62 and 64, simultaneously closing ports 44 and 46, which provides new paths for both liquid and gaseous refrigerant, as indicated by the broken line arrows. The inrush of warm liquid refrigerant through port 64 and tube 28 warms up the cup 50 and the series 26 of heat exchanger chambers 104. Its flow is retarded by the capillary tube 24, through which refrigerant now flows in a reversed direction. The refrigerant already in series 22 of the heat exchanger chambers 104 and around cup 48 is now free to evaporate and pass through tube 66 and port 62 to the suction tube 30, thus starting the refrigeration of the cups 92 in the series 22, and cup 48, which is continued with refrigerant which passes through the capillary tube 24.

The result is the melting free of the ice in cups 92 served by series 26 of the heat-exchanger chambers 104, and of ice in cup 50, and a drop of pressure in the tube 68 and chamber 70, while ice is being formed in cups 92 served by series 22, and in cup 48, preparatory to the next reversal of the valve mechanism, which will bring the operation back to the starting point of this description. The ice 51 in cup 50 will free itself and float upwardly out of the cup like the other ice, or will remain in the cup and melt enough to reduce the pressure, according to whether the cup is connected with the bottom of a tank of water, or closed.

The tube 30 may include an additional evaporator 31 for the purpose of cooling cabinet air, in which case no damage will result from a slight leakage of the valves which might allow refrigerant to "short-circuit" and pass from tube 42 through the closed valve port 46 or 64, to tube 30.

As an alternative arrangement, tubes 68 and 72 can be crossed and provided with bulbs 69 and 73 which contact tubes 20 and 28 respectively, as shown in Fig. 5. Bulbs 69 and 73 are fluid-tight and filled with carbon-dioxide or other very volatile fluid which then operates the diaphragms 52 and 60 to effect operation of the valve 18 in the same general manner as in the first described construction.

The valve mechanism of Fig. 1 may optionally be actuated by other means, such as by a controlled electrical circuit supplied through conductors 74 and 76 of Fig. 2 to the valve mechanism 78. In either figure, liquid refrigerant received through the tube 42 is delivered through the tube 20 while suction vapor received through the tube 28 is delivered through the tube 30, as indicated by solid arrows. Then, when the valve mechanism is reversed, liquid refrigerant received through the tube 42 is delivered through the tube 28, and suction vapor received through the tube 20 is delivered through the tube 30.

From the foregoing it will be readily apparent that when the cups 92 associated with either the series 22 or 26 are subjected to refrigerating effect, the water in such cups will be frozen over the area of contact between such cups and the evaporator 94. Such water frozen in the cups will build up as a ring of ice 108, and should the refrigerating effect exist for a sufficiently long time, it will be apparent that the ring 108 will eventually become a disk. Preferably, however, the relative size of the chambers 104 and the diameters of the cups are so proportioned that the ring 108 will not build up into a complete disk during the active period of one cycle of operation of the refrigerating unit for one series of cups.

When the valve mechanism 18 or 78 is actuated to discontinue the active period of refrigeration of one series of cups 92 and begin active refrigeration of the other series of cups, warm refrigerant will be circulated through the chambers 104 associated with that series of cups 92 in which ice has just previously been frozen, and active refrigeration of which has now been stopped, thus warming this last series of cups and releasing the ice therein to float free and up-

wardly in the water in tank 86. Thus, the last mentioned series of cups is conditioned to freeze a new batch of ice as soon as the valve 18 is again reversed.

What is claimed is:

1. In a refrigerating system, a pair of heat exchangers, means including a capillary passage connecting said heat exchanger in series, said capillary passage acting as a refrigerant flow controlling means, and means for causing refrigerant to reverse its direction of flow through said heat exchangers and capillary passage.

2. In a refrigerating system, a pair of heat exchangers, means including a capillary passage of small cross section and considerable length connecting said heat exchangers in series, said capillary passage acting as a refrigerant flow controlling means, and means for causing refrigerant to reverse its direction of flow through said heat exchangers and capillary passage in response to energy resulting from a thermal effect associated with one of said heat exchangers.

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