June 6, 1939. A. A. KUCHER 2,161,420

REFRIGERATING APPARATUS

Filed Dec. 29, 1934 2 Sheets-Sheet 1

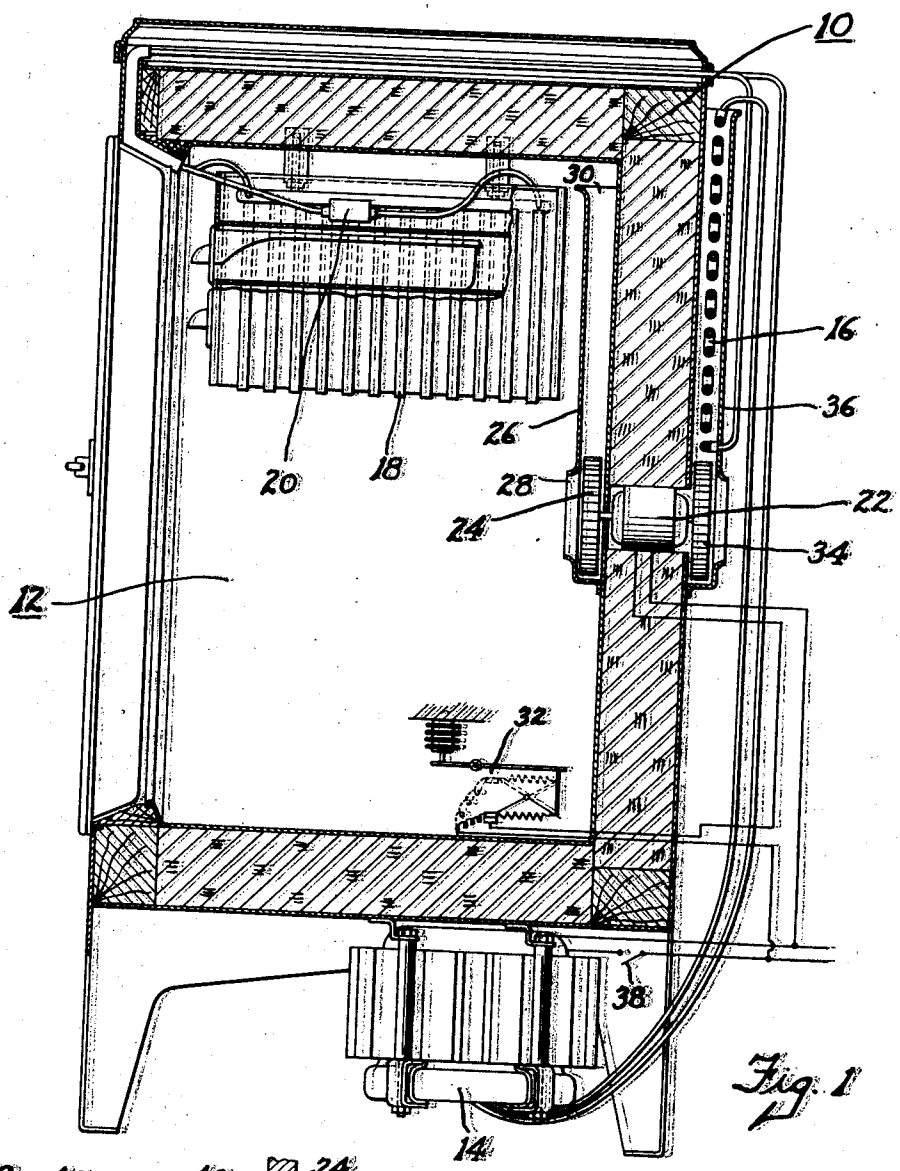


Fig. 1

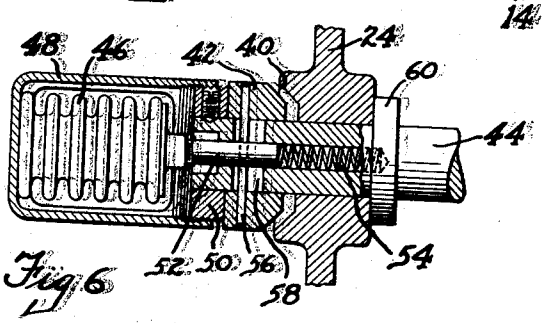


Fig. 6

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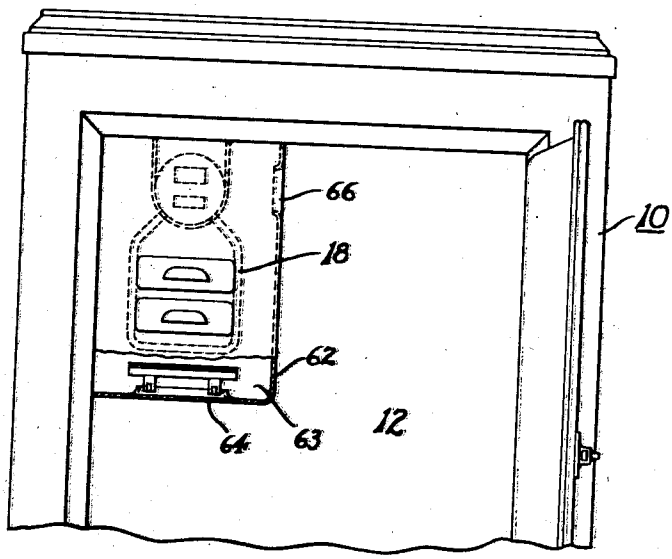


Fig. 2

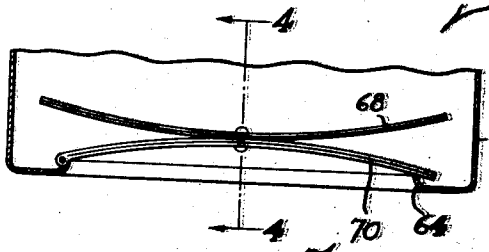


Fig. 3

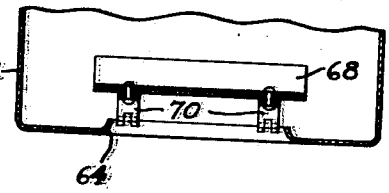


Fig. 4

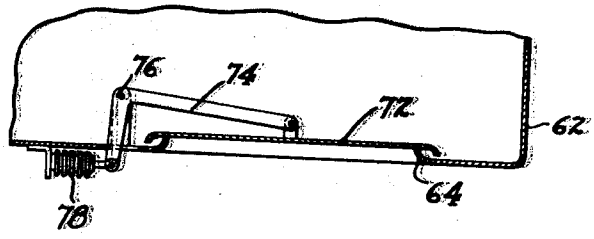


Fig. 5

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REFRIGERATING APPARATUS

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Application December 29, 1934, Serial No. 759,757

6 Claims. (Cl. 62—116)

This invention relates to refrigerating apparatus and more particularly to a novel system and control therefor for automatically varying the refrigeration output of the apparatus.

Heretofore in the construction of refrigerators, particularly those comprising a cabinet having a food storage compartment and which are intended principally for household use, in meeting the problem of refrigeration output of the machine to provide substantially constant food preserving temperatures in the cabinet, it has been customary to provide an automatic switch for stopping and starting the refrigerant liquefying unit as by controlling the motor which drives the compressor and to thus operate the apparatus intermittently. With such a method of control, the system while it is operating produces refrigeration at a substantially constant rate and the variation in average amount of refrigerant produced over a given period results from variations in the lengths of the period during which the machine operates or is idle. A refrigerating apparatus of this character has certain disadvantages, among them being high first cost and frequent service difficulties, together with certain difficulties arising from the continued stopping and starting of the refrigerant liquefying unit, particularly with liquefying units of the compression type.

It is an object, therefore, of the present invention to provide a refrigerating apparatus which is readily adapted to extremely low cost production and in which the difficulties inherent in an intermittently operated refrigerator are avoided.

It is a further object of the invention to provide a refrigerating apparatus in which automatic control of the output of the apparatus is attained while the refrigerant liquefying unit is constantly running.

It is also an object of the invention to provide a refrigerating apparatus in which the liquefying unit runs continuously throughout a substantial range of room temperatures normally encountered and in which substantially constant temperatures are maintained in the food preserving or other compartment to be cooled solely by varying the rate of circulation of air in the compartment to be cooled.

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:

Referring now to the drawings, Fig. 1 illustrates a vertical cross section of a refrigerator cabinet embodying one form of the present invention;

Fig. 2 is a front view of a refrigerator cabinet embodying a second form of the invention;

Fig. 3 is a fragmentary view partially in section of a thermostatic damper forming part of the refrigerator illustrated in Fig. 2;

Fig. 4 is a fragmentary cross sectional view on line 4—4 of Fig. 3;

Fig. 5 is a view corresponding to Fig. 3 illustrating a modified form of damper for use in a refrigerator of the type illustrated in Fig. 2; and

Fig. 6 is a fragmentary sectional view of a thermostatically controlled clutch adapted to be used with a further embodiment of the invention.

In the form of the invention illustrated in Fig. 1, there is provided a refrigerator cabinet generally designated as 10 having a food compartment 12 in which substantially constant temperatures are to be maintained throughout a wide range of room temperatures. For example, in an ordinary household refrigerator, it is desirable to maintain a temperature within the compartment 12 between substantially 42° and 50° F., while room temperatures may run as high as 110° F. and are generally not below 60° F. Associated with the cabinet 10 is a refrigerant liquefying unit comprising a compressor 14, and a condenser 16 both of which may take any of numerous suitable forms in order to maintain a constant supply of liquefied refrigerant for use in the system. Within the compartment 12, there is mounted a refrigerant evaporator 18 for cooling the air within the compartment 12, and which may also be provided with means for freezing water as is well known in the art. Suitable means for controlling the flow of liquid refrigerant from the liquefying unit to the evaporator are provided and may comprise a fixed restrictor or other refrigerant control device 20. The elements so far described are connected in series by suitable refrigerant conduits in the well known manner to provide a closed refrigerant circuit.

The cabinet 12 is also provided with a motor driven air impelling means for providing a forced draft circulation of the air in compartment 12. This may comprise a small electric motor 22 having an air impelling fan 24 secured to its drive shaft. On the interior wall of the compartment 12, there is provided a vertical air conduit 26 having an inlet 28, and an outlet 30 for drawing air from the lower part of the cabinet and lifting it to the upper part adjacent the evaporator 18. Suitable means are provided for controlling the

operation of the impeller 24 which may comprise a thermostatic switch 32 of well known construction which is connected in circuit in a manner to cause operation of the motor 22 intermittently in accordance with temperature conditions within the compartment 12. The refrigerating system without the fan has sufficient capacity to satisfy ordinary demands when the system is operating alone and continuously and the capacity of the fan is so correlated to the capacity of the refrigerating system that the fan and system operating together can satisfy the heavier demands for refrigeration. The heat exchange surface between the evaporator and the circulating air in the cabinet is so proportioned in relation to the normal temperature of the evaporator and to the volume of the compartment 12 that naturally induced circulation of the air in compartment 12 is sufficient to maintain proper temperature within the compartment 12. In the form of the invention illustrated, the motor 22 is also utilized to circulate air over the condenser 16. To this end, there is also driven by the motor 22 a second air impelling fan 34 situated outside the cabinet and an air circulating duct 36 for directing the passage of air from the impeller 34 over the condenser 16. It will be understood, of course, that it is within the purview of the invention to provide cooling of the condenser 16 by natural draft, in which case, the impeller 34 and the duct 36 may be omitted, and the condenser 16 made sufficiently larger to radiate the required quantity of heat by natural convection. There is also illustrated a switch 38 in the circuit of the motor-compressor unit 14 for controlling its operation under certain conditions. This may take the form of a manually operated switch for the purpose of shutting down the refrigerator unit when room temperatures are so low that refrigeration is not needed. Alternatively, a thermostatic switch may be employed for this purpose, and may be responsive either to room temperature or to the temperature within the cabinet 12. If a thermostatic switch is employed, it may be adjusted to stop the unit when any desired low temperature is reached, below which continuous operation of the unit is not desirable.

In operation of the apparatus described, assuming the switch 38 to be closed and the temperature within the compartment 12 to be above the maximum desirable temperature, the motor-compressor unit 14 will be caused to operate as well as the motor 22, and its impellers 24 and 34. The compressor 14 withdraws expanded refrigerant from the evaporator 18, compressing it and delivering it to the condenser 16 where the latent heat of vaporization is given off to the air circulating over the condenser and the refrigerant liquefies. The liquid refrigerant is fed from the condenser 16 to the refrigerant control device 20 where its pressure is reduced before entering the evaporator 18 to vaporize and withdraw heat from the air in compartment 12. The air impeller 24 produces a forced circulation of air in the compartment 12, drawing warm air through the inlet 28 and delivering it from the outlet 30 to be cooled by the evaporator and to pass downwardly over the food or other material in the compartment 12. As soon as the desired low temperature has been reached in the compartment 12, switch 32 will open, stopping operation of the motor 22. Under these conditions, the natural circulation of air in the compartment 12 is insufficient to maintain the desired temperature therein, and as heat gradually enters the compartment 12, its temperature will rise gradually until the point is reached where the switch 32 again closes, resuming the forced draft circulation. It will be noted that regardless of whether the motor 22 is operated or not, the refrigerant liquefying unit is maintained in continuous operation and that the temperature of the air in compartment 12 is maintained substantially constant notwithstanding the continuous operation of the refrigerant liquefying unit. By this construction, it is possible to provide a refrigerating apparatus wherein the refrigerant liquefying unit runs continuously throughout substantially the entire range of room temperatures normally encountered. Obviously, if a thermostatic switch is provided for controlling the motor-compressor 14, its cut-out point may be selected so as to provide intermittent operation of the liquefying unit below any desired room temperature less than maximum.

In Fig. 6, there is illustrated a modified construction which may be substituted for the air circulation control mechanism shown in Fig. 1. By this modification, the switch 32 is omitted and the motor 22 is connected in circuit to operate continuously, or whenever the motor-compressor unit 14 operates. Control of the air circulation within the compartment 12 is provided by clutching and declutching the impeller 24 to the shaft of the motor 22 in accordance with temperature conditions within the compartment 12. One mechanism for accomplishing such a control may comprise a conical recess 40 formed on one side of the hub of the impeller 24 and a conical clutch ring 42 carried by the shaft 44 of the motor 22, in a manner to move axially thereon without rotating relative thereto. A bellows 46 containing a volatile liquid has one end carried by a yoke member 48 adjustably secured to a collar 50 mounted on the end of the shaft 44, while its other end carries a plunger member 52 which pushes against a spring 54 located in a bore of the shaft 44. A pin 56 is secured to the plunger 52 and to the clutch ring 42 and passes through slots 58 formed in the shaft 44. A collar 60 is provided adjacent the other side of the hub of the impeller 24 to act as a stop against which the hub may be pressed by the clutch ring 42.

In operation, whenever the temperature within the compartment 12 is sufficiently high so that forced circulation is necessary, the volatile fluid within the bellows 46 causes the bellows to expand, pushing the clutch ring 42 into engagement with the clutch face 40 and causing operative connection to be made between shaft 44 of the motor 22 and the impeller 24. When the temperature within the compartment 12 lowers, the bellows 46 contracts, withdrawing the clutch ring 42 from the clutch face 40 and permitting the shaft 44 to turn without driving the impeller 44. Adjustment of the temperature responsive mechanism is provided by the threaded engagement between the yoke member 48 and the collar 50 by which the fixed end of the bellows 46 may be moved toward and away from the shaft 44. The operation of this modification is substantially equivalent to that of the form illustrated in Fig. 1, except that the motor 22 runs continuously whenever the motor-compressor unit 14 runs. By this construction, where a forced draft is provided for the condenser 16 by means of the impeller 34, the forced draft on the condenser is not interrupted at times when the forced draft in the compartment 12 is interrupted.

In the form of the invention illustrated in Fig.

2, the refrigerant liquefying and evaporating portions of the system may be substantially the same as those illustrated in Fig. 1, except that the evaporator is proportioned with sufficient surface to maintain proper temperatures within the compartment 12 under a natural circulation of air in that compartment. In order to control the temperature within compartment 12, means are provided for varying the rate of circulation of air over the evaporator which may comprise a baffle 62 forming a compartment 63 surrounding the evaporator 18 and having an outlet opening 64 at the bottom and an inlet opening 66 adjacent the top. The opening 64 is provided with a closure member 68 comprising a bimetallic sheet which is supported by a pair of bimetallic arms 70 in such a manner that as the arms 70 and the sheet 68 warp under changes of temperature, the amount of opening at the inlet 64 is varied. In this manner, when the air leaving the outlet 64 is too warm, its passage over the bimetal members 68 and 70 causes additional warpage and consequently a greater opening at the outlet 64. This increases the rate of circulation in the cabinet, resulting in faster cooling of the air and a consequent reduction of temperature in the compartment 12. Conversely, when the air leaving outlet 64 is too cold, the bimetal members 68 and 70 tend to straighten out and reduce the amount of opening at the outlet 64, thus decreasing the rate of circulation of air in the compartment 12.

In Fig. 5, there is illustrated an alternative form of thermostatic damper for controlling the inlet 64 which comprises a closure member 72 carried by a bell crank 74 pivoted at 76. A thermostatic bellows 78 is positioned beneath the baffle 62 so as to be influenced by the air within the compartment 12 and is connected to operate the bell crank 74. As the air in compartment 12 warms or cools, the bellows 78 expands or contracts, respectively, moving the closure member 72 to vary the rate of circulation of air over the evaporator 18 in much the same manner as described in connection with the mechanism illustrated in Fig. 2.

Thus, the present invention provides a refrigerating apparatus having means for maintaining the temperature of the compartment to be cooled within a predetermined range, while the refrigerating system for the compartment is maintained in continuous operation.

While the form of embodiment of the present 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. In combination, an evaporator unit, a refrigerant liquefying unit supplying refrigerant to said evaporator unit, an enclosure to be cooled by said evaporator unit, the capacity of said units being so correlated to the ordinary refrigeration requirements for said enclosure as to satisfy ordinary refrigeration requirements when operating continuously, and means for increasing the flow of air over said evaporator unit, the capacity of said means being so correlated to the capacity of said units whereby the simultaneous operation of said means and said units produces sufficient capacity to satisfy heavier demands for refrigeration.

2. A refrigerating apparatus comprising in combination, a refrigerator cabinet, a refrigerant liquefying unit and a refrigerant evaporator so correlated as to have sufficient capacity to satisfy ordinary refrigeration demands when operating continuously, and a fan for circulating air over said evaporator having a capacity so correlated to the capacity of the refrigerating apparatus that the fan and refrigerating apparatus operating together have sufficient capacity to satisfy heavier demands for refrigeration.

3. A refrigerating apparatus comprising in combination, a refrigerator cabinet, a refrigerant liquefying unit and a refrigerant evaporator so correlated as to have sufficient capacity to satisfy ordinary refrigeration demands when operating continuously, a fan for circulating air over said evaporator having a capacity so correlated to the capacity of the refrigerating apparatus that the fan and refrigerating apparatus operating together have sufficient capacity to satisfy heavier demands for refrigeration, and thermostatic means for controlling the operation of said fan.

4. In combination, a refrigerator cabinet, a refrigerant liquefying unit and a refrigerant evaporator unit so correlated as to have sufficient capacity to satisfy ordinary refrigeration demands when operating continuously, and a fan for circulating air over one of said units having a capacity so correlated to the capacity of the refrigerating apparatus that the fan and refrigerating apparatus operating together have sufficient capacity to satisfy heavier demands for refrigeration.

5. In combination with a food storage compartment in a refrigerator, a refrigerating system including an evaporator for cooling said compartment, means for varying the flow of air over said evaporator, said storage compartment, system and air flow varying means being so correlated whereby said system may be operated continuously and the temperature within said compartment may be controlled by varying the flow of air over said evaporator by means of said air flow varying means.

6. In combination with a food storage compartment in a refrigerator, a refrigerating system including an evaporator for cooling said compartment, means for varying the flow of air over said evaporator, said storage compartment, system and air flow varying means being so correlated whereby said system may be operated continuously and the temperature within said compartment may be controlled by varying the flow of air over said evaporator by means of said air flow varying means, said air flow varying means comprising a thermostatically operated damper.

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