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DEFROSTER CONTROL FOR REFRIGERATING SYSTEMS

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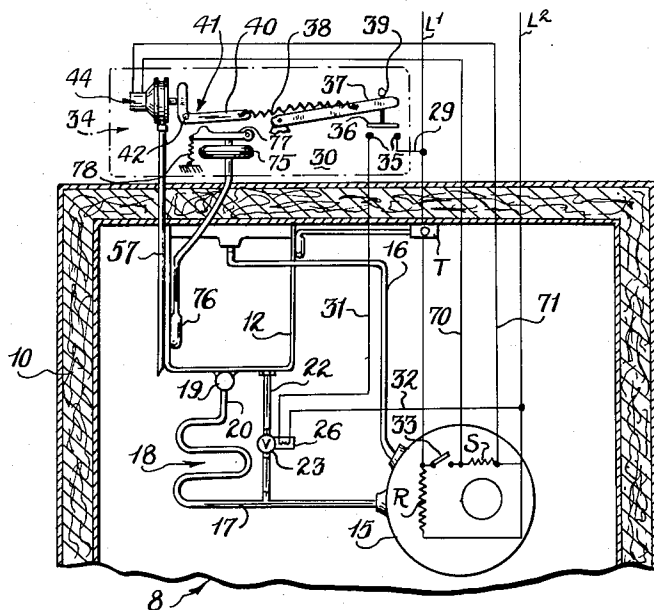


Fig. 1

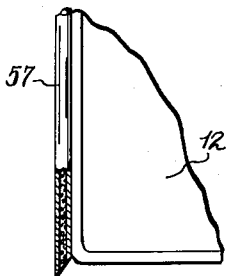


Fig. 2

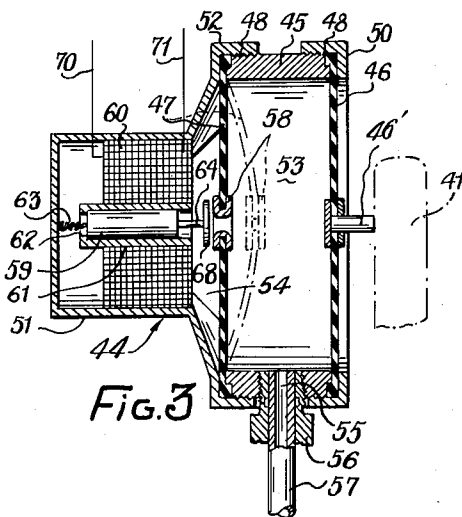


Fig. 3

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DEFROSTER CONTROL FOR REFRIGERATING SYSTEMS

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6 Claims. (Cl. 62—4)

The present invention relates to a control mechanism for controlling refrigerating systems, and more particularly to a control mechanism for causing automatic defrosting of the cooling units or evaporators of refrigerating systems.

It is well known that frost collects on the exposed surfaces of evaporators or cooling units of refrigerating systems operating at sub-freezing temperatures and reduces the heat exchange efficiency thereof and otherwise interferes with their use. It has been found desirable to provide means to remove automatically the collection of frost from the cooling units by periodically establishing so-called "defrosting" cycles of operation in refrigerating systems by which the temperatures of the cooling units are temporarily elevated above the melting point of frost so that the frost is melted and removed by drainage.

The principal object of the present invention is the provision of means to periodically initiate a defrosting cycle in the cooling unit of a refrigerating system comprising an air pump adapted to be actuated periodically and having a conduit connected thereto through which air is normally relatively freely moved by the pump, the conduit being subjected to freezing temperatures and of such diameter that moisture from the air therein is condensed and frozen to block the tube and prevent the free passage of air therethrough which then renders the pump effective to operate a device to initiate a defrosting cycle.

Another object of the invention is to provide means of the character referred to comprising an air pump including a chamber having two movable walls, one of which is moved periodically to change the volume of the chamber and the other of which is moved by change in air pressure in the chamber to actuate a device to initiate a defrost cycle, the chamber having an air conduit connected thereto through which air normally freely passes and which is subjected to freezing temperatures and is of such diameter that moisture condenses and freezes to block the free passage of air therethrough whereby a subsequent operation of the pump is effective to move the second mentioned wall and initiate a defrost cycle.

Other objects and advantages of the invention will be apparent from the following description of a preferred form of the invention, reference being made to the accompanying drawing wherein

Fig. 1 is a schematic showing of a part of a mechanical refrigerator having a control mechanism therefor embodying the invention;

Fig. 2 is a fragmentary view of a portion of the evaporator of the refrigerating system showing a part of the control mechanism associated therewith, and

Fig. 3 is a sectional view of an air pump of the control mechanism.

Although the invention may be advantageously employed in various types of mechanical refrigerating systems, for the purposes of illustration it is here shown in a compressor-condenser-expander system for a so-called household refrigerator 8. The refrigerator comprises a conventional cabinet 10 having a door, not shown and

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an evaporator or cooling unit 12 is attached in the top portion of the cabinet 10 in a conventional manner. The refrigerating system of the refrigerator comprises an hermetically sealed electric motor driven compressor unit 15 which is operative to withdraw vaporized refrigerant from the evaporator through a tube 16, compress the refrigerant and direct it through a tube 17 to a condenser 18. The cooled and condensed refrigerant is lead from the condenser to a suitable expansion valve 19 through a tube 20 and thence into the evaporator 12 where it vaporizes and cools the walls of the evaporator, as is well understood in the art.

In the refrigerating system shown, the cooling unit 12 is defrosted by applying heat thereto by hot compressed refrigerant gas which is by-passed around the condenser 18 and expansion valve 19, and is introduced into the evaporator through a conduit 22 connected to pipe 17. The flow of hot refrigerant through conduit 22 is controlled by a solenoid operated valve 23 connected in conduit 22. The valve 23 is normally closed and is adapted to be opened by the energization of a solenoid 26, the circuit for which includes a suitable power line L1 of two power supply lines L1, L2, wire 29, control switch mechanism 30, wire 31, solenoid 26 and wire 32 to line L2. The particular method disclosed to heat the evaporator 12 for defrosting purposes is well known in the art, but other methods, such as applying heat by electrical heating units or merely interrupting normal operation of the compressor, could be employed with the present invention if desired.

The electric motor for the compressor 15 includes the usual running winding R and starting winding S, the circuit for the latter being controlled by a conventional starting switch 33, and the windings are connected with the power lines L1, L2 in the usual manner. The operation of the motor is controlled by a thermostatically operated switch mechanism T connected in line L1 and which is responsive to the temperatures of the evaporator 12 to cause operation of the compressor to produce refrigeration cycles as required to maintain the mean temperature of the evaporator 12 at that desired, which is normally below freezing temperatures, i. e., below 32° F. The details of the thermostat T are not shown since such thermostats are commercially available and the operations thereof are well known in the art.

The switch mechanism 30 for controlling the solenoid 26 is preferably enclosed within a suitable housing or casing indicated by broken lines 34 and it may be disposed in any suitable location. In the present instance it is located outside the cabinet 10 and at the top thereof. The switch mechanism 30 comprises two fixed, spaced contacts 35 which are adapted to be bridged by a contact 36 carried on the free end of a pivoted switch arm 37. The contact 36 is insulated from the arm 37 and the arm is adapted to be snapped in opposite directions by an over center tension spring 38 to close the contact or contacts 35 to complete the circuit for solenoid 26, and to open the contacts by moving to a stop 39. One end of the spring 38 is attached to the arm 37 and the opposite end is attached to an arm 40 of a bell crank lever 41 arranged to swing the spring from one side to the other of the center line of arm as the bell crank is oscillated about its pivot. Any other suitable switching mechanism could be employed and that just described is merely one example.

The bell crank lever 41 is pivoted at 42 and is adapted to be moved clockwise about its pivot by a combination air pump and pressure responsive mechanism 44 to cause switch arm 37 to close switch contact 36 on contacts 35. The mechanism 44 comprises a rigid cylinder 45 having flexible end walls 46, 47. In the form shown, the walls 46, 47 are circular rubber disks or membranes having rims or flanges 48 formed thereabout which lie in under-

cut peripheral grooves about each end of the cylinder 45 and the edges of the walls are held in air tight engagement with the end edges of the cylinder by a flanged ring 50 threaded onto one end thereof and a frame 51 having a flanged ring portion 52 threaded on the opposite end of the cylinder. The walls 46, 47 are normally retained by their resiliency in the positions shown in full lines in Fig. 3. An opening 54 is formed in the frame 51 to provide an air passage to the wall 47. The cylinder 45 and walls 46, 47 form an air chamber 53 and the cylinder has an opening 55 in one side thereof to provide an air outlet from the chamber. A nipple 56 is threaded in the opening 55 and a metal tube 57 is attached in the nipple. The rubber wall 46 has a post 46' attached thereto as shown, which is adapted to engage an arm of the bell crank lever 41 when the wall is bulged outwardly and move the lever clockwise to close switch 31. The rubber wall 47 has a central opening and an annular valve seat member 58 is secured therein and provides a valve seat on the outer side of the wall. The wall 47 is adapted to be moved inwardly by the armature 59 of an electromagnetic device comprising a solenoid 60 having a sleeve like core 61 in which the armature 59 slides. The armature 59 is normally urged against an inturned flange 62 at one end of the sleeve 61 by a tension spring 63 as shown. A stem 64 is attached to one end of the armature and is in alignment with the opening of the valve seat member 58 and carries a valve plate 68 thereon which is adapted to engage and close the valve seat at 58 when the armature is moved to the right from the position shown in Fig. 3, which occurs when the solenoid is energized.

Movement of the armature 59 to the right as described closes the port in the valve seat 58 and moves the wall 47 to the position indicated by the broken lines in Fig. 3. This action forces air from the chamber 53 outwardly through the opening 55 and through the tube 57, provided the tube is not blocked, and the wall 46 will be unaffected and will remain in the position shown. On the other hand, should the tube 57 be blocked under circumstances described hereinafter, air cannot be forced from the chamber and consequently wall 46, being resilient and responsive to the increased pressure in chamber 53 will be forced outwardly and will actuate the bell crank lever 41 to cause closing of the switch 30 to initiate a defrosting cycle in the evaporator 12. When the solenoid 60 is deenergized, the armature 59 is quickly moved to the left by the spring 63 and valve plate 68 is withdrawn from the valve seat member 58, thereby opening the port therein and permitting the wall 47 to spring back to its normal position, during which movement air is drawn into the chamber 53 through the valve seat 58. The solenoid 60 is automatically momentarily energized intermittently, as described presently, so that a relatively small volume of atmospheric air will be intermittently pumped through the tube 57, the purpose of which is explained hereinafter.

The solenoid 60 is connected in parallel circuit with the starting winding S by wires 70, 71 and is therefore momentarily energized each time the refrigerator compressor is operated. Alternatively, the wall 47 could be flexed inwardly to pump air by any suitable means, such as by movement of the refrigerator door, clock mechanism, etc.

The bell crank lever 41 is adapted to be moved counterclockwise by a thermally responsive mechanism to cause switch arm 37 to open contacts 35, 36. The thermally responsive mechanism comprises an expansible wafer 75 having a tube and bulb 76 connected therewith, and the bulb, tube and wafer are filled with a suitable thermally responsive fluid, such as methyl chloride, which expands upon an increase in temperature. The bulb 76 is attached in close heat exchange relation with the evaporator 12 so that the wafer 75 will tend to expand on increase in temperature of the evaporator. A lever 77 is urged against the wafer 75 by a spring 78 the tension of

which is such that when the evaporator reaches a predetermined temperature above the melting point of ice, such as 38° F., for example, the wafer 75 moves the lever 77 against the arm 40 of the bell crank lever 41, when the bell crank lever is in the position to close the switch 30, raising the arm and moving it to the switch opening position to break the circuit for solenoid 26 so that valve 23 is closed to terminate heating of the evaporator.

The construction of the switch mechanism 30 is such that the switch remains open until arm 40 of the bell crank lever 41 is urged counter-clockwise by the wafer 75 as just described.

The tube 57 which is connected with the air outlet 55 of the chamber 53 extends through the top wall of the cabinet 10 and downwardly alongside the evaporator 12, the lower end thereof terminating adjacent to the bottom of the evaporator. The temperature of the portion of the tube 57 adjacent to the evaporator is substantially the same as that of the evaporator and when the wall 47 is flexed by the armature 59, as described, air is forced from the chamber 53 and exhausted through the tube. Since the temperature of the portion of the tube 57 adjacent to the evaporator will be below freezing, moisture in the air forced through the tube will condense and freeze on the walls of the tube. The inside diameter of the tube 57 is preferably one fourth to three eighths of an inch in diameter and, depending upon the prevailing relative humidity of the air and the frequency of operation of the compressor unit 15, the condensation and freezing of the moisture from the air in the tube will sooner or later substantially block the tube, thereby causing the wall 46 to be flexed when the armature 59 is operated to close the defrost control switch 30, as described. When the evaporator 12 is warmed to melt the ice therefrom, the ice in the tube 57 also melts and drains therefrom, and to expedite the drainage, the tube is pointed by cutting the end on a bias, as clearly shown in Fig. 2.

It will be readily understood that generally the rate of frost collection on the evaporator will be substantially in accordance with the prevailing humidity of the atmosphere and the frequency at which the door of the refrigerator cabinet is opened. Since the frequency of operation of the compressor unit 15 will be affected by the frequency at which the cabinet door is opened, the volume of atmospheric air passed through the tube 57 will be substantially proportional to the amount of exposure of the evaporator to the atmospheric air and the rate of collection of frost in the tube 57 will be proportional to the rate of frost collection on the evaporator. Thus, the control method and apparatus described causes defrost cycles to occur at intervals having correspondence to the rate at which frost forms on the evaporator.

It will be noted that a relatively small quantity of air is pumped into the refrigerator and it has no appreciable effect on the efficiency of the refrigerator.

Although but one form of the invention has been shown and described, it will be apparent that modifications could be made without departing from the spirit of the invention as defined in the claims which follow.

Having thus described my invention, I claim:

1. In a refrigerating system including a cooling unit normally maintained below freezing, an air pump comprising means forming an air chamber having two movable walls, means forming an air passage communicating with said air chamber and forming the sole passage for air movable in one direction by movement of one of said walls in one direction, said passage having a portion adapted to be substantially blocked by frost collected therein, means to reciprocate said one wall to change the volume of said chamber and to cause movement of the other of said walls when said air passage for said chamber is substantially blocked, means responsive to movement of the other of said walls to initiate a defrosting cycle in the cooling unit, and means to chill a part of said air passage means to a temperature below freez-

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ing to cause condensation and freezing of water therein to block said air passage.

2. In a refrigerating system including a cooling unit normally maintained at freezing temperatures, an air pump comprising means forming an air chamber having two movable walls, means forming an air exhaust passage from said chamber and having a portion adapted to be substantially closed by frost collected therein, means to reciprocate one of said walls to change the volume of said chamber and to cause movement of the other of said walls when said air exhaust passage is substantially blocked, said means forming said air passage having said portion in close heat exchange relation with said cooling unit to cause condensation and freezing of water in said air passage to block said air passage, and means responsive to movement of the other of said walls to initiate a defrosting cycle in the cooling unit.

3. In a refrigerating system having a cabinet, a cooling unit in said cabinet normally maintained at freezing temperatures and means to effect a defrost cycle in said cooling unit, an air pump having an air intake exteriorly of said cabinet, means forming an air exhaust passage for air moved by operation of said pump and including a portion adapted to be substantially closed by the collection of frost therein, means connected with said pump and operative in response to operation of said pump when said conduit means is substantially blocked to the passage of air to actuate the first-mentioned means and initiate a defrost cycle in said cooling unit, means to cool said portion of said passage forming means to a temperature below 32° F. to cause moisture from air in said passage to condense and freeze therein to block said air passage, and means to actuate said pump.

4. The combination of a refrigerating mechanism having a cabinet and a cooling unit in said cabinet, means forming a conduit for directing air from the exterior of said cabinet into heat exchange relation with said cooling unit, said conduit arranged to be substantially blocked by the condensation and freezing of moisture from air passed therethrough and affected by subfreezing temperatures of said cooling unit, and means responsive to the presence of said frozen moisture to initiate a defrosting cycle in said cooling unit.

5. The combination of a refrigerating mechanism having a cabinet and a cooling unit in said cabinet, means

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forming a conduit for directing air from the exterior of said cabinet into heat exchange relation with said cooling unit, said conduit arranged to be substantially blocked by the condensation and freezing of moisture from air passed therethrough and affected by subfreezing temperatures of said cooling unit, means to pump air through said conduit, and means responsive to an increase in pressure of air in said conduit to initiate a defrosting cycle in said cooling unit.

6. In a refrigerating system having a cooling unit normally maintained at freezing temperatures and means to effect a defrosting cycle in said cooling unit, an air pump comprising an air chamber having two movable walls, means to reciprocate one wall to intermittently change the volume of said chamber, check valve means to admit air to said chamber when said one wall is moved in one direction, a tube connected with said chamber and adapted to have air moved therethrough by movement of said one wall in the other direction, said tube having a portion in heat exchange relation with a part only of said cooling unit and adapted to be closed to the passage of air therethrough by the collection of frost in said portion thereof, means connected with the other of said walls and adapted to be actuated by air pressure resulting from movement of the last mentioned wall to actuate the first mentioned means and initiate a defrost cycle in said cooling unit, the second mentioned wall being unaffected by movement of said one wall while air moves relatively freely through said tube, and means to move said one wall.

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