

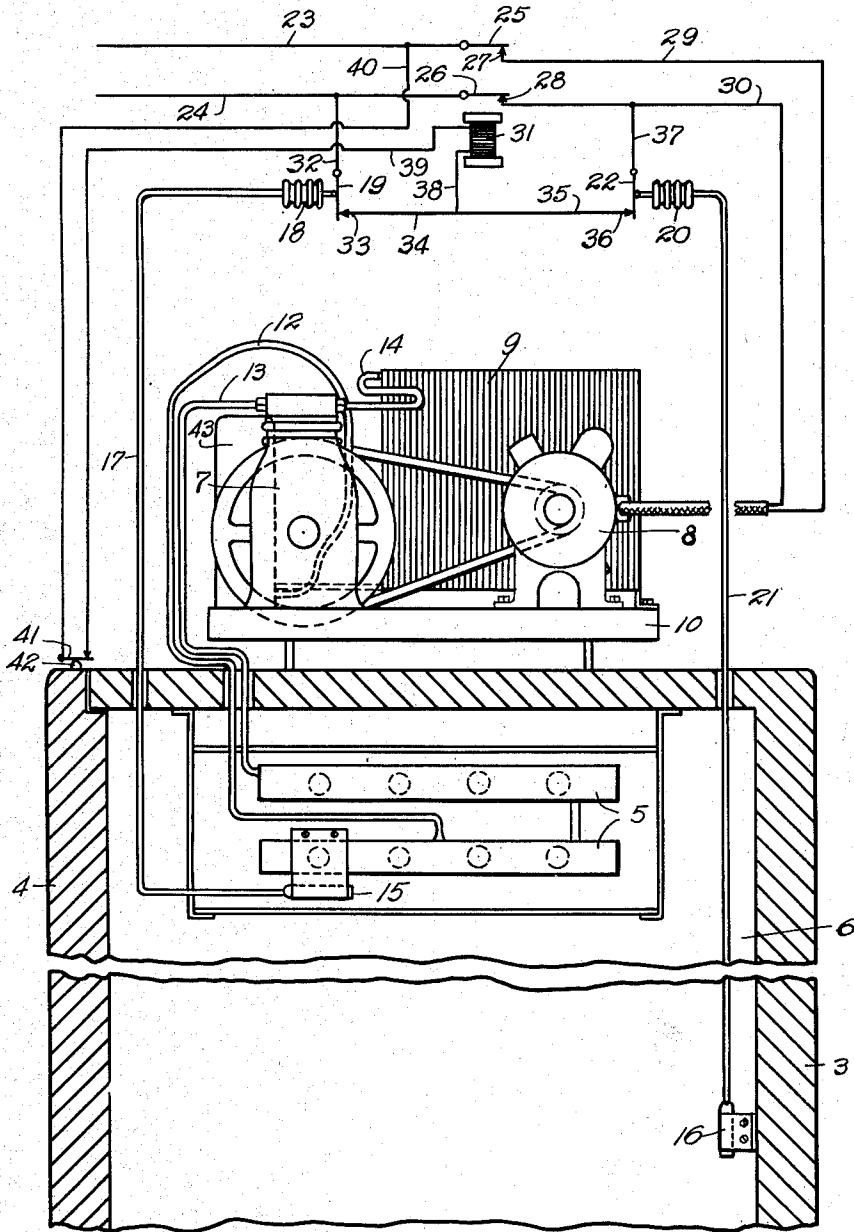
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MOTOR CONTROL FOR REFRIGERATION SYSTEMS

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MOTOR CONTROL FOR REFRIGERATION
SYSTEMS

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The present invention relates to an improvement in control apparatus for a mechanical refrigerator.

An object of the invention is to provide a mechanical refrigerator with control means so designed as to regularly and completely defrost the evaporator thereof automatically in advance of each running cycle, so that coolers in which such refrigerators are installed may be maintained in a most efficient operating condition without frequent servicing or supervision. The automatic defrosting feature is particularly advantageous in dispenser-type coolers for beverages and other commodities, located in buildings or at a multiplicity of locations in a community, for example.

Another object is to improve the electric contactor arrangement in a refrigerator control circuit, by relieving all small or delicate impairable circuit-closing contacts of the full current load of the motor, thereby avoiding the need for frequent contactor servicing and adjusting, and prolonging greatly the time period through which the refrigerator will operate without requiring attention of any kind.

Another object is to provide means in a control apparatus for refrigerators, to terminate the running cycle of the refrigerator and initiate the defrosting period for the evaporator, whenever the cooling compartment is opened to admit warm air and thereby excessively ice the evaporator.

The foregoing and other objects are attained by the means described herein and illustrated in the accompanying drawing, in which the figure is a cross-sectional view taken vertically through a cabinet or cooling compartment, the mechanical refrigerating apparatus being shown in elevation and the electric circuit of the control means being shown diagrammatically.

As is well known to those conversant with the refrigeration art, the icing or frosting of the evaporator in any refrigerating system, seriously impairs the operating efficiency and imposes a burden on the mechanism such that premature repairs and replacements are often necessary. Moreover, the cooling function of the evaporator is diminished by the presence of the frosted condensate thereon, and as the result, the commodity being cooled often fails to retain its sales appeal. This is particularly the case where beverages and other hot-weather commodities are offered for sale in a cold condition, as for example, by means of dispensing coolers some of which are coin controlled and placed in a wide variety of locations. Such coolers are expected to re-

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main in efficient dispensing condition for long periods of time, and without any care on the part of the service crew.

Prior to this invention, various proposals were advanced for periodically defrosting the evaporators of coolers, but up to the present time no satisfactory means for the purpose has merited general acceptance as a completely automatic and serviceable device. Rather than incorporate an unreliable defrosting means in the coolers, some operators have given preference to a plan of regular and periodic servicing by a crew of mechanics. In this manner, the product on sale was kept reasonably attractive to consumers, but at considerable expense to the seller. One of the primary objects of the present invention is to constantly maintain the product in a salable condition, while at the same time eliminating the expense and inconvenience of regularly servicing the cooling equipment in order to sell the product in such condition as to retain the confidence of purchasers.

The foregoing situation is cited by way of example only, and it must be understood that the same general problem exists in other forms of coolers, whether or not they are of the dispensing type. Accordingly, it should be appreciated that the invention is not limited to application in situations of the character above referred to, as it will manifestly appear applicable in a wide variety of circumstances under which frosting of the evaporator constitutes a disadvantage or an obstacle to the attainment of a desired result.

Referring to the accompanying drawing, 3 indicates a cabinet or cooler for produce or merchandise, for example, beverages in bottles or other containers. The cabinet may be provided with an access door 4, hinged or otherwise applied to the cabinet for movement to opened and closed positions. The cooler may be quite ordinary in character, or it may be of the type which dispenses merchandise upon deposit of a coin or check, or otherwise. The door 4 may provide either a loading or a dispensing station, or both, although in the automatic dispensing type of cooler, the product usually is delivered from a separate smaller opening of the cooler, and the door such as 4 is used principally for access in loading or replenishing the supply of merchandise to be dispensed. These considerations are immaterial to the present invention, as it is applicable to many different types of coolers regardless of the manner in which they are used or the nature of the commodity stored therein. As will be understood, the cabinet of the cooler

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will preferably be insulated in accordance with common practice in the art. For the purposes of this disclosure, the walls of the cabinet may be of suitable insulating material, this applying to the door also.

Within the cabinet, at any proper location, is placed one or more evaporators of standard design and construction, these being indicated at 5. At any suitable location exteriorly of the cooling compartment 6, a motor driven compressor unit 7 is placed, operating in the usual manner to cool the evaporator means. The motor of the unit is shown at 8, and the condenser at 9. The motor, condenser and receiver 43 may be mounted upon a base 10, which in the present instance is supported atop the cabinet. The usual tubes 12, 13 and 14 provide for circulation of the refrigerant through the compressor, condenser, receiver and evaporator, as in any conventional system.

The control means for the refrigerating unit includes a cut-in thermostat and a cut-out thermostat, the bulbs of which are indicated at 15 and 16, respectively. Bulb 15 is applied directly to the evaporator so as to be responsive to temperature changes of the evaporator itself. The remote bulb 16 of the cut-out thermostat is located within the cooler compartment so as to respond to variations of mean temperature occurring therein amongst the articles of merchandise. A tube 17 leads from bulb 15 to a location exteriorly of the cooler, where it connects to a pressure responsive device, for example a Sylphon 18, which acts to open and close an electric switch the movable contact of which is indicated at 19. In like manner, a Sylphon or other pressure responsive device 20 is actuated by pressure transferred from bulb 16, through a tube 21, to open and close a second switch the movable contact of which is indicated at 22. Both switches are shown in the closed circuit position, which results when the evaporator and the cooling compartment are warm, or above a desired working temperature.

The switch contact 19 of the cut-in thermostat is set to close an electric circuit to the unit motor when the thermostatic bulb 15 of the evaporator rises in temperature to a point slightly above the freezing point of water, or about 33° or 34° F. This switch opens, however, at a bulb temperature several degrees below freezing, for example at about 25° F., more or less, depending upon various factors of use, capacity, etc., of the cooler. In any event, this thermostatic switch may be considered a wide differential temperature responsive switch. On the other hand, the cut-out switch whose movable contact is indicated at 22, may be considered a close differential temperature responsive switch, as its contacts open and close with slight changes in bulb temperature. The differential here may be one or two degrees, preferably. Other characteristics of the thermostatic switches will be mentioned as the description proceeds.

Electric energy for the motor 8 is supplied from the service leads 23—24, which are connected to the movable contacts 25 and 26 of a relay controlled main switch whose stationary contacts are indicated at 27 and 28. From the stationary contacts, current is supplied to the motor by the conductors 29 and 30. The main switch is shown in closed-circuit position, and is held in that position by the electromagnetic force of relay coil 31, as long as the coil is energized. Upon de-energization of the coil, the main switch

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contacts return to open-circuit position to stop the unit motor 8.

Electric connections to the various elements of the control circuit are as follows. From service wire 24, a conductor 32 makes connection to the movable contact 19 of the thermostatic cut-in switch. The stationary contact 33 of said switch is electrically connected by means of conductors 34 and 35, to the stationary contact 36 of cut-out switch 22. The latter switch has its movable contact connected to motor lead 30 by means of a conductor 37. To the conductor 34—35 is tapped a lead 38 of relay coil 31, the other lead 39 thereof being connected to service wire 23 by way of conductor 40 and a normally closed door-operated switch 41. In some installations, the switch 41 may be omitted, in which case the relay coil lead is to be connected directly to service wire 23. When switch 41 is used, it may be controlled by a lug 42 on the door 4, or otherwise, the object being to ensure breaking the relay coil circuit as long as the door is open, but to maintain said circuit closed, at the switch at least, as long as the cooler door is closed.

With the foregoing arrangement of electrical control elements understood, the operation of the device is as follows.

Assuming a warm evaporator and cabinet compartment, the contacts of both switches 19 and 22 are closed by expansive action of the Sylphons caused by pressure of fluid within the bulbs and tubes of the cut-in and cut-out thermostats. Accordingly, an electric circuit is completed through the relay coil by way of conductors 24, 32, 19, 33, 34, 38, 31, 39, 41, 40, and 23, to energize the relay coil and close the main switch 25—26 of the unit motor 8. It may here be noted that the main switch carries substantially the entire current load of the motor, relieving the thermostatic switch contacts of injurious arcing and loading, and thereby greatly prolonging the life and enhancing the serviceability of those elements.

The unit continues to operate under the above conditions. In due time, the evaporator temperature drops sufficiently to actuate Sylphon 18 for opening the cut-in thermostat contacts 19—33; but this does not necessarily break the relay coil circuit to open the main switch 25—26, because with cut-out thermostat switch 22—36 remaining closed, the coil is kept energized by reason of the circuit kept closed through conductors 23, 40, 41, 39, 31, 38, 35, 36, 22, 37, 26, and 24. Finally, the temperature within the cooler compartment lowers to an extent necessary to satisfy the demand of the cut-out thermostat 16—20, with the result that switch 22—36 is thereby open-circuited to de-energize the relay coil and release the main switch contacts to open-circuit position, thus stopping the unit motor 8.

Proper temperature conditions within the cabinet being thusly established, the refrigerator unit remains idle, and the evaporator has accumulated a coating of frost. When the temperature of the evaporator rises and passes the freezing point of water, defrosting of the evaporator takes place, and the water released thereby drops into a pan beneath the evaporator or is conveyed to a receptacle outside the cabinet. In the meantime, the cut-out switch, by reason of its close-differential setting, has closed due to rise of temperature within the cabinet. The temperature of the evaporator in due time approaches the cut-in point, (slightly above freezing), at which the cut-in thermostat is set to close the

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switch contacts 19—33. Upon reaching the cut-in temperature, said contacts 19—33 of the cut-in thermostat close and complete the control circuit 23, 40, 41, 39, 31, 38, 34, 33, 19, 32 and 24, thereby energizing the relay coil 31 and closing the motor circuit contacts 25—26. The running cycle of the unit then proceeds as previously explained, until the demand of cut-out thermostat 16—20 is satisfied.

From the foregoing, it will be apparent that a defrosting period precedes each running period of the refrigerating unit, so that the evaporator means of the unit may be defrosted regularly and completely to maintain the system in a most efficient operating condition.

With reference to the door switch 41, it will be appreciated that opening of the door to open-circuit this switch, simply terminates the running cycle, and when the door is subsequently closed, the refrigeration unit goes into operation in accordance with the previous explanation, preceded by a defrosting period. In fact, opening of switch 41 at any time will initiate a defrosting period of the evaporator, unless such period has already begun. As previously explained, however, the system will operate in a satisfactory manner without door switch 41 included in the control circuit, but inclusion of the switch provides the added advantage of preventing initiation of the running cycle while the cabinet is being loaded with merchandise.

The following characteristics concerning the control elements are to be noted. The cut-in thermostat should be set to close its contacts 19—33 at an evaporator temperature slightly above the freezing point of water, in order to ensure defrosting before initiation of the running period of the unit. This thermostat should have a comparatively wide temperature range, preferably eight to twelve degrees below the cut-in point. However, in setting this thermostat, its contacts should open at a temperature above the minimum evaporator temperature, to ensure that the running period of the unit will be under the control of the cut-out thermostat 16—20, and will be terminated thereby, under normal operating conditions with the door 4 closed and the switch 41 completing the circuit through relay coil 31. Whenever the door is open, of course, the open-circuit condition of switch 41 precludes operation of the unit irrespective of conditions existing within the cooling compartment. However, in structures which do not include a door switch, as previously suggested herein, the cyclic operation of the unit is determined solely by the thermostatic switches.

As previously explained, the cut-out thermostat has its switch contacts set to open and close at a close temperature differential of one or two degrees, by preference, so as to maintain a uniform cooling compartment temperature. This cut-out thermostat can be set to any cabinet temperature that may be desired, and for that purpose it may be of the adjustable type, if desired, or may even be of the common room type if frequent changes in desired temperature are necessary. However, the differential setting of the cut-out thermostat must be close enough to ensure closing of its electrical contacts before the refrigeration unit is started by closing of the cut-in thermostat contacts 19—33.

The foregoing completes the description of the control means and its mode of operation. Since the disclosure does not elaborate upon the character of the cabinet employed, and since it

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is shown very conventionally in the drawing, the intention is that the cabinet can be of practically any design appropriate for its intended usage. Some suggested designs of cabinets have been mentioned herein by way of example, but application of the invention is not to be restricted thereto. Moreover, the refrigeration unit is conventional as shown, and this likewise may be of one type or another. The holding relay is one of many types available for use in the system, and it must be obvious that one form or another of thermostatic switches may be substituted for those conventionally illustrated herein. Therefore, it will be appreciated that various modifications and changes in structural details may be resorted to, within the scope of the appended claims, without departing from the spirit of the invention.

The invention does not interfere with the use of circulating fans in the cabinet, as sometimes employed to distribute the cold air therethrough, nor does it interfere with the installation of other control devices that might possibly be appropriate. The various electrical elements of the present control device may readily be incorporated in a small casing or box that may be mounted upon the unit base 18, or elsewhere, as may be desired.

What is claimed is:

1. A cooler comprising a cabinet having an access opening and a door for closing same, an electric motor driven refrigerator unit including an evaporator within the compartment for transferring heat therefrom, means controlled by temperature changes within the compartment for initiating a running period of the refrigerator unit, followed by a defrosting period for the evaporator, in succession, and means operative upon opening and subsequently closing the cabinet door, to preclude resumption of the running period until defrosting of the evaporator is complete.

2. Refrigeration control means for a cooling compartment having an access opening closed by a door, and comprising in combination, a refrigerating unit including an electric motor for driving same, an electro-magnetic switch for control of the motor, an evaporator within the compartment and operatively associated with said unit, an electric cut-out switch, and temperature responsive means within the compartment to keep the cut-out switch closed until the compartment reaches a desired chilling temperature at which said cut-out switch opens, an electric cut-in switch, and temperature responsive means within the compartment to close the cut-in switch when the evaporator temperature rises slightly above the freezing point of water, and to open said cut-in switch when the evaporator temperature falls below the freezing point of water and in advance of opening of the cut-out switch, an electric switch for the compartment door and kept closed thereby as long as the door is closed upon the access opening, and an electric circuit including the motor, the switches, and a source of electricity, arranged to initiate a complete defrosting period of the evaporator with each opening movement of the door and the door switch, and with each opening of the cut-out switch irrespective of a closed condition of the door switch.

3. Refrigeration control means for a cooling compartment, comprising in combination, a refrigerating unit including an electric motor for driving same, a motor switch, an evaporator

within the compartment and operatively associated with said unit, an electric cut-out switch, and temperature responsive means within the compartment to keep the cut-out switch closed until the compartment reaches a desired chilling temperature at which said cut-out switch opens, an electric cut-in switch, and temperature responsive means within the compartment to close the cut-in switch when the evaporator temperature rises slightly above the freezing point of water, and to open said cut-in switch when the evaporator temperature falls below the freezing point of water and in advance of opening of the cut-out switch, an electric circuit including the motor, the switches, and a source of electricity, arranged to initiate a complete defrosting period of the evaporator with each opening of the cut-out switch.

4. Control apparatus for an electric motor driven refrigerator compressor supplying refrigerant to an evaporator in a refrigerator compartment, said apparatus comprising a starter switch having a solenoid to effect opening and closing of the switch to thereby connect and disconnect the motor from a source of power, said solenoid having one terminal disposed for connection to the power source side of said switch and the other terminal to a branched circuit each branch of which has therein a control switch, the control switch in one branch being connected to the power side of said starter switch and the control switch in the other branch being connected to the motor side of said starter switch, temperature actuated means responsive to the temperature of the evaporator and being disposed to close the control switch in the branch on the power side of said starter switch when the temperature of the evaporator rises above the freezing temperature of water and to keep said switch closed until the temperature of the evaporator has reached a predetermined value below the freezing point of water, and temperature actuated means responsive to the temperature in the refrigerator compartment and being disposed to close the control switch on the motor side of said starter switch when the temperature in the compartment is above a predetermined value and to open the same when the temperature is below said predetermined value whereupon the starter

switch is opened and the compartment temperature actuated control switch rendered inoperative to energize said solenoid until the control switch actuated by the means responsive to the temperature of the evaporator has been closed.

5. Refrigerating control apparatus for a cooling compartment, comprising in combination, a motor driven refrigerating unit having an evaporator within the cabinet, a motor switch for said unit, an electric cut-out switch, temperature responsive means in the compartment adapted to keep the cut-out switch closed as long as the compartment is warmer than a predetermined temperature, said cut-out switch opening when said compartment is cooled below the predetermined temperature, an electric cut-in switch, temperature responsive means in the compartment adapted to close the cut-in switch when the temperature of the evaporator rises above the freezing point of water and to open the cut-in switch when the temperature of the evaporator falls below the freezing point of water, and an electric circuit adapted to close said motor switch and cause operation of said refrigeration unit when said cut-in and cut-out switches are closed and to open said motor switch when said cut-in and cut-out switches are open, said circuit being adapted to hold said motor switch closed after said motor switch has been closed until said cut-out switch has been opened, said motor switch, when opened, remaining open until the cut-in switch is closed, whereby the evaporator is defrosted following each opening of the motor switch.

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