

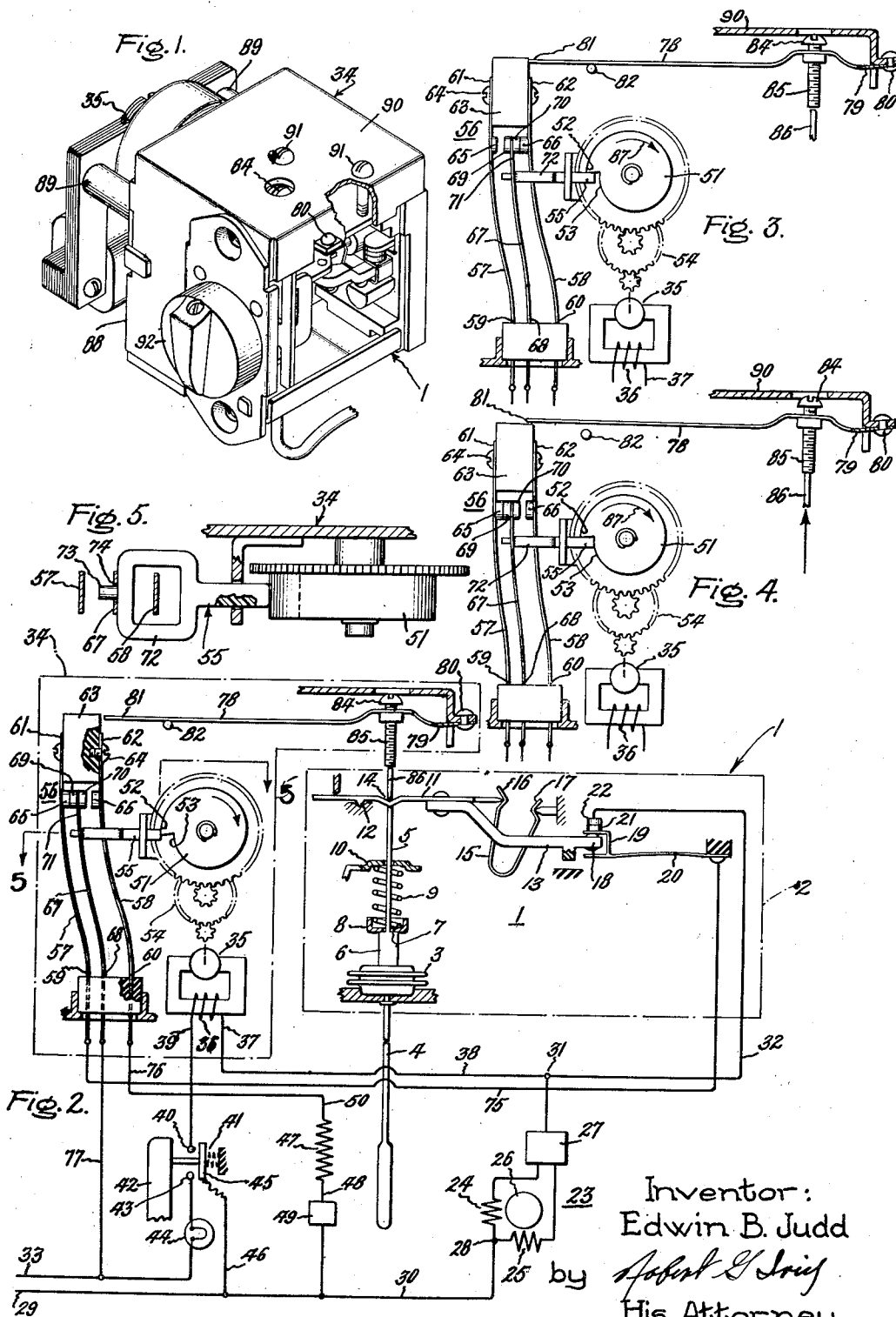
Nov. 20, 1956

E. B. JUDD

2,770,952

REFRIGERATOR CONTROL SYSTEM

Filed June 30, 1953



Inventor:
Edwin B. Judd
by *Robert G. Lief*
His Attorney.

1

2,770,952

REFRIGERATOR CONTROL SYSTEM

Edwin B. Judd, Morrison, Ill., assignor to General Electric Company, a corporation of New York

Application June 30, 1953, Serial No. 365,158

13 Claims. (Cl. 62—4)

This invention relates to control systems for refrigerators and more particularly to control systems providing for automatically defrosting household-type refrigerators.

In the design of certain refrigerating apparatus, most particularly domestic household refrigerators, the evaporator is frequently positioned within the refrigerator and serves not only to cool the interior thereof, but also as a small freezing compartment. It is well known that there is a tendency for frost to form on the exterior surfaces of the evaporator, the accumulation of this frost progressively lowering the efficiency of the unit as the thickness increases since the frost is essentially an insulating blanket surrounding the evaporator. This frost is formed by the admission of moist air into the interior of the refrigerator when the refrigerator door is open.

In the design of household refrigerators, it is necessary to provide a control which will automatically energize the compressor motor when the temperature within the refrigerator rises to a predetermined upper value and subsequently deenergize the motor when the temperature falls to a predetermined lower value. Such control devices to perform this function are well known in the art and are commonly referred to as cold controls. It is further desirable to provide for periodically and automatically removing the frost which is formed on the evaporator. This is preferably accomplished by providing an auxiliary heating element which when energized will rapidly melt the frost formation from the evaporator. This defrosting control must therefore deenergize the compressor motor and energize the heater responsive to some predetermined condition or combination of conditions and subsequently reenergize the motor and deenergize the heater.

A number of different types of automatic defrosting systems for domestic household refrigerators have been provided in the past. In the simplest form, a timing device is provided to periodically deenergize the motor and energize the heater at regular intervals. This system, while simple, does not recognize the fact that frost does not form on the evaporator at uniform rates, but depends rather on many factors including the running time of the refrigerator and the amount of moist air admitted to the interior thereof. In another system, the motor is deenergized and the heater energized after a predetermined number of compressor operating cycles. This is an improvement over the system first described since the formation of frost does to some extent at least depend upon the frequency of the compressor operating cycles. Here again however this system ignores the amount of moist air which is admitted to the interior of the refrigerator. A third system provides for deenergizing the motor and energizing the heater after a predetermined number of openings of the refrigerator door. While this system does recognize that the amount of frost formed on the evaporator is somewhat dependent upon the amount of moist air admitted through the door, the frequency of operation of the compressor motor is ignored.

It is therefore desirable to provide an automatic defrosting control system for a refrigerator wherein defrosting

2

is initiated in response to two factors, i. e., compressor motor running time and the number of door openings. It is further desirable that this automatic defrosting control system be incorporated in a device which can be utilized with a standard cold control device.

An automatic defrosting control system which integrates compressor motor operating time and door openings by initiating the defrosting cycle responsive to a predetermined period of time in which the door is open when the compressor motor is operating is described and claimed in application Serial No. 323,197 filed November 29, 1952, of R. C. Miles, now Patent No. 2,741,097 assigned to the assignee of the present application. In this system, a timing device is operated when the refrigerator door is open and the compressor motor is operating. This device, after a predetermined period of operation, mechanically opens the cold control contacts to initiate the defrosting cycle. Reestablishment of the regular refrigerating cycle is initiated by the cold control itself. In this system however, some substantial modification must be made to the basic cold control and it is therefore desirable to provide an automatic defrost control device incorporating the basic concept of the above entitled application Serial No. 323,197, but which can be readily used with a standard cold control device having only minor modifications. It is further desirable that this automatic defrosting control device provide separate contacts for initiating the defrosting cycle rather than mechanically opening the cold control device contacts.

It is therefore an object of this invention to provide an improved refrigerator control system incorporating an automatic defrosting control device having the desirable features set forth above.

Further objects and advantages of this invention will become readily apparent and the invention will be better understood by reference to the following description and the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with this invention, a cold control device is provided having temperature responsive means including means for sensing the temperature within the refrigerator. This temperature responsive means is arranged to energize the compressor motor responsive to a predetermined upper temperature in the refrigerator and subsequently to deenergize the motor responsive to a predetermined lower temperature in the refrigerator. In order to provide for automatically defrosting the refrigerator, a timing device is provided operable when the refrigerator door is open and the compressor motor is running. For example, this timing device may include a timing motor connected in series with a switch actuated by the refrigerator door, the serially connected timing device and door switch being connected across the compressor motor. Thus, when the cold control contacts are closed energizing the compressor motor and the refrigerator door is open thus closing the contacts of the door switch, the timing motor will operate. Means are provided actuated by the timing means arranged to deenergize the compressor motor after a predetermined period of operation of the timing means and other means are provided actuated by the cold control to again energize the compressor motor when the temperature in the refrigerator has risen to a predetermined upper temperature higher than the normal temperature at which the cold control initiates compressor operation. The refrigerator is preferably provided with a heater to quickly melt the frost from the evaporator and this heater is of course energized when the compressor motor is deenergized by the timing means and subsequently deenergized when the compressor motor is again energized.

In the drawing,

Fig. 1 is a side elevational view, partly in section, illustrating a device incorporating the improved control system of this invention, and more particularly including an automatic defrosting device constructed in accordance with this invention cooperatively connected to a standard cold control device;

Figs. 2, 3 and 4 schematically illustrate the improved system of this invention during various stages of the cooling and defrosting cycle; and

Fig. 5 is a fragmentary cross-sectional view taken along the line 5—5 of Fig. 2.

Referring now to Figs. 2 and 5, there is shown schematically a cold control device generally identified as 1 suitably enclosed in an outer housing schematically outlined by the dashed line 2. The cold control device 1 shown in Figs. 1 and 2 is fully described and claimed in Patent 2,658,121, granted November 3, 1953, on an application Serial No. 239,338 filed July 30, 1951, of R. L. Gray and C. S. Grimshaw, also assigned to the assignee of the present application, and will therefore not be described in detail here.

Cold control device 1 includes an expansible bellows 3 to which tube 4, containing any suitable thermally expansible fluid, is connected. Tube 4 is of course arranged within the refrigerator to sense the temperature therein in accordance with conventional practice. An operating rod 5 is provided having its lower end 6 bearing against the upper surface of bellows 3 and having a shoulder 7 formed therein adjacent its lower end 6 against which spring seat 8 bears. Spring 9 surrounds operating rod 5 with its lower end bearing against spring seat 8 and its upper end bearing against adjustable spring seat 10, through which operating rod 5 passes.

An operating lever 11 is provided having one end pivotally mounted at 12 and having an extension portion 13. Operating lever 11 has a knife edge connection with operating rod 5, as at 14. Operating lever 11 is biased into the position shown in Fig. 2 by a non-overcenter hairpin toggle spring 15 having one end 16 engaging the end of operating lever 11 and its other end 17 engaging a stationary part of the device. End 18 of extension portion 13 of operating lever 11 is arranged to engage free end 19 of resilient contact mounting member 20 on which movable contact 21, which cooperates with stationary contact 22, is mounted. It will be readily seen that with toggle spring 15 biasing operating lever 11 into the position shown in Fig. 2, extension portion 13 biases contacts 21 and 22 to the closed position. When, as will be hereinafter more fully described, operating rod 5 causes operating lever 11 to move to its other position, resilient spring mounting member 20 will open contacts 21 and 22.

The refrigerator is provided with a compressor (not shown) operated by a suitable compressor motor, such as a single phase alternating current motor shown schematically at 23. Motor 23, is preferably an induction motor having a running winding 24, a starting winding 25, and a suitable squirrel cage rotor 26. A suitable starting device shown schematically at 27, such as a conventional starting relay, is provided. The terminal 28 of motor 23 is connected to one side 29 of a suitable source (not shown) of alternating current by line 30 while its other terminal 31 is shown connected to stationary contact 22 by means of line 32. In conventional refrigerators, the movable contact 21 would be connected to the other side 33 of the supply line, however, in the improved device of this invention, another pair of contacts is inserted between movable contact 21 and line 33 in order to provide for automatic defrosting.

To summarize the operation of cold control device 1, tube 4 senses the temperature in the refrigerator and as it rises, the expansible fluid therein tends to expand the expansible bellows 3. Expansion of bellows 3 is opposed by spring 9 acting upon operating rod 5 and

aided by the normal force of toggle spring 15. Thus, the combined forces exerted by bellows 3 and toggle spring 15 are opposed by spring 9. When these forces, with the force exerted by bellows 3 increasing as the temperature in the refrigerator increases, exceed the pressure exerted by spring 9, bellows 3 will expand causing operating rod 5 to move upwardly allowing toggle spring 15 to move operating lever 11 to the position shown in Fig. 2 in which contacts 21 and 22 are closed. As the compressor motor 23 operates and the temperature within the refrigerator decreases, the fluid in tube 4 contracts thus causing bellows 3 to contract. When the combined pressure exerted by bellows 3 and toggle spring 15 falls below that exerted by spring 9, spring 9 will cause operating rod 5 to move downwardly thus moving operating lever 11 downwardly through the knife edge connection 14 to open contacts 21 and 22.

In order to provide for automatically defrosting the refrigerator, an automatic defrosting control device is provided shown schematically in Fig. 2 as being enclosed with a case indicated by dashed lines 34. Defrosted control 34 includes a suitable synchronous timing motor 35 having a field coil 36. It will be readily seen that one end 37 of field coil 36 of timing motor 35 is connected to terminal 31 of compressor motor 23 through line 38 while the other side 39 is connected to one contact 40 of door switch 41. Door switch 41 is adapted to be actuated by door 42 of the refrigerator and to have its contacts open when the door is closed.

Another contact 43 is connected to one side of an interior light 44 which in turn has its other side connected to external supply line 33. The movable contact 45 of door switch 41 is connected to supply line 29 through line 46. The refrigerator is also provided with a suitable heater 47 arranged quickly to melt the frost from the evaporator and having its one end 48 connected to supply line 29 through a suitable overload protector 49, and having its other end 50 connected as to be hereinafter described.

Timing motor 35 is arranged to drive a circular cam 51, having a high point 52 and a low point 53, through a suitable gear train 54. Cam 51 has a follower 55 arranged as now to be described. A contact assembly generally identified as 56 is provided having a pair of spaced apart elongated flexible members 57 and 58 secured at their lower ends 59 and 60 respectively and having their upper ends 61 and 62 secured to a spacing member 63, formed of suitable insulating material, in any suitable manner, as by screws 64. Stationary contacts 65 and 66 are respectively mounted adjacent the upper ends 61 and 62 of flexible members 57 and 58. A third elongated flexible member 67 is provided having its lower end 68 secured and having movable contacts 69 and 70 mounted on its free end 71. Cam follower 55 is provided with an outer yoke portion 72 through which flexible member 58 extends and is provided with an extension portion 73 seated in a suitable slot 74 in the third flexible member 67 adjacent its upper end 71 as best seen in Fig. 5.

It will be readily seen that movable contact 21 of cold control 1 is connected to flexible member 59, and thus to stationary contact 65 mounted thereon, by line 75 and that the end 50 of heater 47 is connected to the other flexible member 60 and to thus stationary contact 66, by line 76. The intermediate flexible member 67, and thus movable contacts 69 and 70, is connected to supply line 33 by line 77.

It will now be seen that the circuit for the compressor motor 23 extends from supply line 29 through line 30, the motor 23, line 32, contacts 21 and 22 of cold control device 1, line 75, contacts 65 and 69 of defrost control contact assembly 56, and thence through line 77 to supply line 33. It will be seen that field coil 36 of timing motor 35 is connected in series with door switch 41 across motor 23 through line 46, switch 41, and line

5

38. Interior lamp 44 is connected across supply lines 29 and 33 through switch 41 and line 46. Heater 47 is connected across supply lines 29 and 33 through line 77, contacts 70 and 66, line 76 and overload device 49.

It will now be readily seen that when cold control contacts 21 and 22 of cold control device 1 are closed and when contacts 65 and 69 of defrost control contact assembly 56 are also closed, motor 23 will be energized. It will also be seen that since timing motor 35 is connected across compressor motor 23 through door switch 41, timing motor 35 will run when compressor motor 23 is operating and door 42 is open, thus closing contacts 40 and 45 of door switch 41. It will further be seen that when contacts 65 and 69 are open, in a manner to be hereinafter described, motor 23 will be deenergized even though contacts 21 and 22 of cold control device 1 are closed.

The final component of this device comprises a leaf spring tripping arm 78 having one end 79 secured as at 80 and having its other end 81 arranged to normally engage spacing member 63 of defrost control contact assembly 56. A stop 82 is provided to limit the downward motion of tripping lever 78 and padded section 83 biases tripping lever 78 into its normal position shown in Fig. 2. An operating screw 84 is seated in a suitable threaded opening adjacent end 79 of tripping lever 78 and with its lower end 85 is arranged to be engaged by upper end 86 of operating rod 5 of cold control device 1 under suitable conditions, as will be hereinafter described.

Referring now to Figs. 3 and 4, in addition to Fig. 2, the operation of the device thus far described will be outlined. Starting with the refrigerator initially warm, expansion of the thermally expansible medium in sensing tube 4 will cause bellows 3 to exert pressure on operating rod 5 and when the combined pressures exerted by bellows 3 and toggle spring 15 overcomes the opposing pressure exerted by spring 9, bellows 3 will expand moving operating rod 5 upwardly allowing toggle spring 15 to move operating lever 11 upwardly to close contacts 21 and 22. Assuming that the contact assembly 56 of the defrost control is in the position shown in Fig. 2 with contacts 65 and 69 closed, compressor motor 23 will operate and each time door 42 is opened, closing contacts 40 and 45 of door switch 41, timing motor 45 will also operate. It will be seen that cooling down of the interior of the refrigerator sufficiently to cause cold control device 1 to open contacts 21 and 22 will open the circuit of the timing device 35 in addition to the circuit of the compressor motor 23 so that subsequent opening of the door 42 will not cause timing motor 35 to operate when contacts 21 and 22 are open. Each time the door 42 is opened closing contacts 40 and 45 of door switch 41 when compressor motor 23 is operating, timing motor 35 operates thus rotating cam 51 through gear train 54. After a predetermined period of operation of timing motor 35, for example 6¼ minutes of timing motor running time, cam 51 will rotate to the position shown in Fig. 3 so that follower 55 falls off high point 52 toward low point 53 under the biasing influence of the flexible members 57, 58 and 67 of contact assembly 56. It will be seen that the entire contact assembly 56 is held deflected toward the left as viewed in Fig. 3 by engagement of spacing member 63 with tripping lever 78 and thus that intermediate flexible member 67 tends to assume a normal vertical position. This tendency of flexible member 67 to assume a vertical position exerts axial pressure on follower 55 causing it to move off high point 52 of cam 51 and also moves movable contact 69 away from stationary contact 65 thus opening the circuit of compressor motor 23 and timing motor 35. It will be seen that the same movement of intermediate flexible member 67 closes contacts 70 and 66 thus energizing heater 47. At this time, therefore, neither compressor motor 23 nor timing motor 35 is operating and heater

6

47 is energized quickly to melt the frost from the evaporator of the refrigerator.

The contacts 21 and 22 of cold control 1 were already closed when the defrosting cycle started since movement of the cam 51 to initiate the defrosting cycle could only occur with timing motor 35 operating, operation of the timing motor as pointed out above occurring only when compressor motor 23 is operating. Thus, under the conditions shown in Fig. 3, cold control device 1 is already anticipating subsequent restarting of the compressor motor as soon as contacts 65 and 69 of defrost control device contact assembly 56 are again closed.

Referring now to Fig. 4, as the interior of the refrigerator warms up, a predetermined upward temperature higher than the temperature which normally closes contacts 21 and 22 is reached and at this temperature, the upward movement of operating rod 5 of cold control device 1 caused by expansion of bellows 3 causes end 86 of operating rod 5 to engage end 85 of operating screw 84. When the upward pressure exerted by end 86 of operating rod 5 on operating screw 84 exceeds the downward pressure on tripping lever 78 exerted by spring 83, tripping lever 78 will be moved upwardly as shown in Fig. 4 away from stop 82 thus moving end 81 out of engagement with spacing member 63 of defrost control contact assembly 56. Since the contact assembly 56 in the positions of Figs. 2 and 3 is held deflected to the left and therefore since the flexible members 58 and 57 tend to move the contact assembly 56 toward the right to assume a normal vertical position, disengagement of end 81 of tripping lever 78 with spacer 63 causes contact assembly 56 to move slightly to the right as viewed in Fig. 4. This movement brings stationary contact 65 into contact with movable contact 69 and further moves follower 55 into engagement with low point 53 of cam 51. This movement, of course, also opens contacts 70 and 66.

It will now be seen that since cold control contacts 21 and 22 were already closed, closing of contacts 65 and 69 will again energize compressor motor 23 to initiate a new cooling cycle. Thus, whenever contacts 21 and 22 are closed and door 42 is opened closing door switch 41, timing motor 35 will run to again begin the defrosting cycle. It will be seen that cam 53 progressively increases in radial width from low point 53 to high point 52. Thus, as cam 51 rotates in the direction shown by the arrow 87, cam 51 progressively urges follower 55 toward the left as viewed in Figs. 2, 3 and 4 thus progressively biasing intermediate flexible member 67 toward the left which in turn acts upon flexible member 57 and the entire contact assembly 56 urging the whole contact assembly to the left since contacts 65 and 69 are closed. As soon as the refrigerator begins to cool off responsive to operation of the compressor motor 23, operating rod 5 moves downwardly under the influence of spring 9 so that its end 86 moves out of engagement with operating screw 84. At the beginning of the defrosting cycle, however, the contact assembly 56 is moved toward the right so that tripping lever 78 cannot be restored to its normal position, as shown in Fig. 2, under the influence of spring 83. As the contact assembly 56 progressively moves toward the left, however, responsive to rotation of cam 51, spacing member 63 will eventually move out from under end 81 of tripping member 78 and spring 83 will restore tripping member 78 to its normal position as shown in Fig. 2, in which all elements are restored to their original positions.

In Fig. 1 a defrost control is shown as being incorporated in case assembly 34 with timing motor 35 secured to its rear side 88 in any suitable manner, as by posts 89. Case 34 of the defrost control has an upward extension portion 90 extending over the upper surface of cold control 1, the cold control 1 being a standard commercial variety of the type shown in the aforesaid application

Serial No. 239,338. In this position, operating screw 84 of the defrost control meets with the end 86 of operating rod 5 of cold control 1 and the two devices are held in assembled relation in any suitable manner, as by screws 91. Operating knob 92 serves to adjust the compression of spring 9 of cold control 1 thus varying the operating range of cold control 1, as more fully described in the aforementioned Patent No. 2,658,121.

It will now be seen that this invention provides an improved refrigerator control system wherein defrosting is automatically accomplished by a simple device integrating compressor motor operating time and the time the refrigerator door is open. Furthermore, this improved automatic defrosting control is adaptable for use with a standard cold control device.

While I have shown and described a particular embodiment of this invention, further modifications and improvements will occur to those skilled in the art. I desire that it be understood therefore that this invention is not limited to the form shown and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a refrigerator having a door, a compressor motor adapted to be connected to an external source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising temperature responsive means including means adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said motor, operating means actuated by said temperature responsive means arranged to close said first pair of contacts thereby energizing said motor at a first predetermined upward temperature and to open said first pair of contacts thereby deenergizing said motor at a second predetermined lower temperature, timing means operable in response to said door being open at the same time said motor is energized, a second pair of contacts adapted to be connected in circuit with said motor, a third pair of contacts adapted to be connected in circuit with said heater, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said motor and to close said third pair of contacts thereby energizing said heater after a predetermined period of operation of said timing means, and tripping means actuated by said operating means arranged to again close said second pair of contacts thereby energizing said motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

2. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, and a compressor motor adapted to be connected to said external source of power; a temperature control device comprising temperature responsive means including means adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said temperature responsive means and movable thereby, means actuated by said operating member arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in circuit with said motor, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said

compressor motor after a predetermined period of operation of said timing means, and tripping means actuated by said operating member and operably associated with said second pair of contacts arranged to again close said second pair of contacts thereby energizing said compressor motor at a third predetermined upper temperature above said first predetermined temperature.

3. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising temperature responsive means including means adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said temperature responsive means and movable thereby, means actuated by said operating member arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in circuit with said compressor motor, a third pair of contacts adapted to be connected in circuit with said heater, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined period of operation of said timing means, and tripping means actuated by said operating member and operably associated with said second and third pair of contacts arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

4. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, and a compressor motor adapted to be connected to said source of power; a temperature control device comprising an expandable bellows, a tube having a thermal expandable medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, operating means actuated by said bellows arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in circuit with said compressor motor, means actuated by said timing means arranged to open said second pairs of contacts thereby deenergizing said compressor motor after a predetermined period of operation of said timing means, tripping means actuated by said operating means arranged to again close said second pair of contacts thereby energizing said compressor mo-

tor at a third predetermined upper temperature above said first predetermined temperature.

5. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a heater arranged to defrost said refrigerator and adapted to be connected to said source of power, and a compressor motor adapted to be connected to said source of power; a temperature control device comprising an expansible bellows, a tube having a thermal expansible medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, operating means actuated by said bellows arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in circuit with said compressor motor, a third pair of contacts adapted to be connected in circuit with said heater, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined period of operation of said timing means, and tripping means actuated by said operating means arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater and a third predetermined upper temperature above said first predetermined temperature.

6. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising an expansible bellows, a tube having a thermal expansible medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said bellows and movable thereby, means actuated by said operating member arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in circuit with said compressor motor, a third pair of contacts adapted to be connected in circuit with said heater, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined period of operation of said timing means, and tripping means actuated by said operating member and operably associated with said second and third pair of contacts arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing

said heater at a third predetermined upper temperature above said first predetermined temperature.

7. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising an expansible bellows, a tube having a thermally expansible medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said bellows and movable thereby, means actuated by said operating member arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a contact assembly including a pair of spaced apart elongated flexible members each secured at one end thereof, each of said pair of elongated members having a stationary contact mounted thereon adjacent its other end, a third elongated flexible member positioned between said pair of elongated members and having one end secured and its other end free, said third elongated member having contacts on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with the said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said second pair of contacts being connected in series with said first pair of contacts, said third pair of contacts being adapted to be connected in circuit with said heater, operating means actuated by said timing means and operably connected to said third elongated member normally biasing the same to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater, said operating means biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means, and tripping means actuated by said operating means and operably associated with said contact assembly arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

8. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising an expansible bellows, a tube having a thermally expansible medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said bellows and movable thereby, means actuated by said operating member arranged to close said first pair of contacts there-

by energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a contact assembly including a pair of spaced apart elongated flexible members each secured at one end thereof, each of said pair of elongated members having a stationary contact mounted thereon adjacent its other end, a third elongated flexible member positioned between said pair of elongated members and having one end secured and its other end free, said third elongated member having contacts mounted on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said second pair of contacts being connected in series with said first pair of contacts, said third pair of contacts being adapted to be connected in circuit with said heater, cam means actuated by said timing means, a second operating member actuated by said cam means and operably connected to said third elongated member normally biasing the same to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater, said second operating member biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means, and tripping means actuated by said operating member and operably associated with said contact assembly arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

9. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising an expansible bellows, a tube having a thermally expansible medium therein connected to said bellows and adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in circuit with said compressor motor, an operating member connected to said bellows and movable thereby, means actuated by said operating member arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a contact assembly having a first normal position and a second position and including a pair of spaced apart elongated flexible members each secured at one end thereof, a spacing member joining said pair of elongated flexible members at their other ends, each of said pair of elongated members having a stationary contact mounted thereon adjacent its said other

end, a third elongated flexible member positioned between said pair of elongated members and having one end secured and its other end free, said third elongated member having contacts mounted on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said second pair of contacts being connected in series with said first pair of contacts, said third pair of contacts being adapted to be connected in circuit with said heater, cam means actuated by said timing motor, a second operating member actuated by said cam means and operably connected to said third elongated member normally biasing the same to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater when said contact assembly is in said second position, said second operating member biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means when said contact assembly is in said second position, a tripping member having a first normal position engaging said spacing member thereby holding said contact assembly in said second position thereof, said first operating member being arranged to engage said tripping member at a third predetermined upper temperature higher than said first temperature thereby moving said tripping member into its second position out of engagement with said spacing member and allowing said contact assembly to return to said normal position, said second pair of contacts being closed thereby again energizing said compressor motor and said third pair of contacts being open to deenergize said heater when said contact assembly is in said normal position, said second operating member progressively moving said contact assembly toward said second position responsive to operation of said timing means until said tripping member comes into engagement therewith.

10. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising a temperature responsive means including means adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in series with said compressor motor, operating means actuated by said temperature responsive means arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means including a timing motor having one side connected to one of said first pair of contacts and having its other side adapted to be connected in series with said door actuated switch and being thereby operable when said door is open at the same time said compressor motor is energized, a second pair of contacts adapted to be connected in series with said compressor motor, a third pair of contacts adapted to be connected in series with said heater, means actuated by said timing means arranged to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined period of operation of said timing means, and tripping means actuated by said operating means ar-

13

ranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

11. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, and a heater arranged to defrost said refrigerator and adapted to be connected to said source of power; a temperature control device comprising a temperature responsive means including means adapted to sense a temperature in said refrigerator, a first pair of contacts adapted to be connected in series with said motor, operating means actuated by said temperature in said refrigerator, a first pair of contacts adapted to be connected in series with said motor, operating means actuated by said temperature responsive means arranged to close said first pair of contacts thereby energizing said compressor motor at a first predetermined upper temperature and to open said first pair of contacts thereby deenergizing said compressor motor at a second predetermined lower temperature, timing means connected in series with said first pair of contacts and adapted to be connected in series with said door actuated switch thereby being operable when said door is open at the same time said compressor motor is energized, a contact assembly including a pair of spaced apart elongated flexible members each secured at one end thereof, each of said pair of elongated members having a stationary contact mounted thereon adjacent its other end, a third elongated flexible member positioned between said pair of elongated members and having one end secured and its other end free, said third elongated member having contacts mounted on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with the said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said third pair of contacts being connected in series with said first pair of contacts and said third pair of contacts being adapted to be connected in circuit with said heater, means actuated by said timing means and operably connected to said third elongated member normally biasing said third elongated member to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater, said last named means biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means, and tripping means actuated by said operating means and operably associated with said contact assembly arranged to again close said second pair of contacts thereby energizing said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

12. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to an external source of power, a compressor motor adapted to be connected to said source of power, a heater arranged to defrost said refrigerator and adapted to be connected to said source of power, and temperature responsive means having a first pair of contacts arranged to energize said compressor motor at a first predetermined upper temperature and to deenergize said compressor motor at a second predetermined lower temperature; a

14

defrosting device comprising timing means including a timing motor adapted to be connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable

5 when said door is open at the same time said compressor motor is energized, a contact assembly including a pair of spaced apart elongated flexible members each secured at one end thereof, each of said pair of elongated members having a stationary contact mounted thereon adjacent its other end, a third elongated flexible member positioned between said pair of elongated members having one end secured and its other end free, said third elongated member having contacts mounted on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said second pair of contacts being adapted to be connected in series with said first pair of contacts, said third pair of contacts being adapted to be connected in circuit with said heater, means actuated by said timing means and operably connected to said third elongated member normally biasing said third elongated member to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater, said last named means biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means, and tripping means adapted to be actuated by said temperature responsive means and operably associated with said contact assembly arranged to again close said second pair of contacts to energize said compressor motor and to open said third pair of contacts thereby deenergizing said heater at a third predetermined upper temperature above said first predetermined temperature.

13. In a refrigerator having a door, a switch actuated by said door and having contacts normally closed when said door is open, said switch being adapted to be connected to a source of power, a compressor motor adapted to be connected to said source of power, a heater arranged to defrost said refrigerator and adapted to be connected to said source of power, and temperature responsive means including a first pair of contacts arranged to energize said compressor motor at a first predetermined upper temperature and to deenergize said compressor motor at a second predetermined lower temperature; a defrosting device comprising timing means including a timing motor adapted to be connected in circuit with said first pair of contacts and adapted to be connected in circuit with said door actuated switch and thereby operable when said door is open at the same time said compressor motor is energized, a contact assembly having a first normal position and a second position including a pair of spaced apart elongated flexible members each secured at one end thereof, a spacing member joining said pair of elongated flexible members at their other ends, each of said pair of elongated members having a stationary contact mounted thereon adjacent its other end, a third elongated flexible member positioned between said pair of elongated members and having one end secured and its other end free, said third elongated member having contacts mounted on its free end, one of said third elongated member contacts cooperating with said stationary contact of one of said pair of elongated members thereby forming a second pair of contacts, the other of said third elongated member contacts cooperating with the said stationary contact of the other of said pair of elongated members thereby forming a third pair of contacts, said second pair of contacts being adapted to be connected in series with said first pair of contacts, said third pair of contacts being adapted to be

15

connected in circuit with said heater, cam means actuated by said timing motor, an operating member actuated by said cam means and operably connected to said third elongated member normally biasing the same to close said second pair of contacts thereby permitting energization of said compressor motor by said first pair of contacts and to open said third pair of contacts thereby deenergizing said heater when said contact assembly is in said second position, said operating member biasing said third elongated member to open said second pair of contacts thereby deenergizing said compressor motor and to close said third pair of contacts thereby energizing said heater after a predetermined operating period of said timing means when said contact assembly is in said second position, a tripping member having a first normal position engaging said spacing member thereby holding said contact assembly in said second position thereof, said tripping member being arranged to be engaged by said temperature responsive means at a third predetermined upper temperature higher than said first temperature thereby moving said tripping means into said second position thereof out of engagement with said spacing member and allowing said contact assembly to return to said normal position, said second

16

pair of contacts being closed thereby again energizing said compressor motor and said third pair of contacts being open to deenergize said heater when said contact assembly is in said normal position, said operating member progressively moving said contact assembly toward said second position responsive to operation of said timing means until said tripping member comes into engagement therewith.

References Cited in the file of this patent

UNITED STATES PATENTS

1,950,115	Kuenali	Mar. 6, 1934
2,064,396	Volpin	Dec. 15, 1936
2,085,868	Pick	July 6, 1937
2,091,884	Rottner	Aug. 31, 1937
2,196,291	Clancy	April 9, 1940
2,459,083	McCloy	Jan. 11, 1949
2,463,027	Frie	Mar. 1, 1949
2,583,661	Morrison	Jan. 29, 1952
2,601,466	Thomas	Jan. 24, 1952
2,612,026	Hanson	Sept. 30, 1952
2,697,332	Duncan	Dec. 21, 1954