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DEFROSTING CONTROLLER FOR ELECTRIC REFRIGERATOR

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FIG. 1

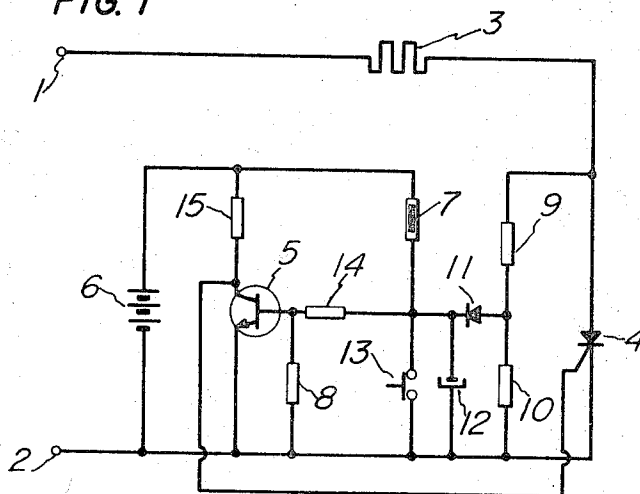
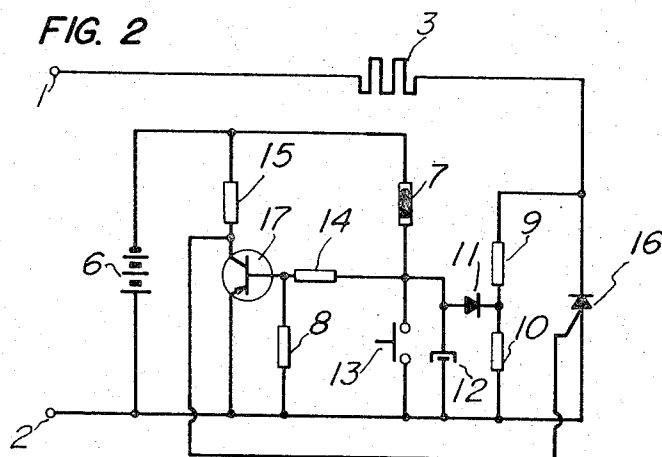


FIG. 2



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DEFROSTING CONTROLLER FOR ELECTRIC REFRIGERATOR

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5 Claims

ABSTRACT OF THE DISCLOSURE

A defrosting controller for electric refrigerators which is operated under control of a temperature detector detecting the temperature within the freezer during the defrosting operation so that the defrosting operation is continued until the temperature within the freezer reaches a predetermined setting and is automatically stopped as soon as the predetermined setting is reached. Thus, the frost accumulating within the freezing compartment can completely be removed and an unnecessary temperature rise within the freezing and provisional compartments can be prevented.

This invention relates to a defrosting controller for electric refrigerators which controls electronically the defrosting operation of electric refrigerators and detects a variation in the temperature within the freezer during the defrosting step, thereby automatically bringing the defrosting operation to an end.

It is commonly known that the cooling efficiency of an electric refrigerator is reduced when frost accumulates within the freezer, or more specifically, when frost deposits on the surface of the evaporator in the electric refrigerator. Measures previously taken for the removal of frost are such that a defrosting valve is opened for a predetermined period of time for circulating hot gas through the evaporator or a heater is placed in operation to generate heat for a predetermined period of time. However, the prior defrosting methods in which the duration of the defrosting operation is thus predetermined and the defrosting operation is continued for a predetermined period of time independently of the amount of frost accumulated within the freezer have had certain inherent inconveniences. More precisely, even when frost in a small amount is accumulated within the freezer, the defrosting operation is still continued after the frost has completely been removed resulting in a rise of the temperature in the provisional compartment to a point which is undesirably high, while when quite a large amount of frost is accumulated within the freezer, the defrosting operation is ended before all the frost within the freezer can completely be removed.

It is therefore an object of the present invention to overcome the inconveniences encountered with these and other known defrosting systems and to provide a novel defrosting controller which acts to automatically stop the heating operation of the defrosting heater as soon as frost accumulated within the freezer is completely removed.

Another object of the present invention is to provide a defrosting controller which brings the defrosting operation to an end by closing a hot gas circulating valve.

The above and other objects, features and advantages of the present invention will be apparent from the following detailed description of a few preferred embodiments thereof taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an electrical circuit diagram of an embodi-

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ment of the defrosting controller according to the present invention; and

FIG. 2 is an electrical circuit diagram of another embodiment of the present invention.

In accordance with the present invention, a thyristor, such as a silicon controlled rectifier is connected in series with a heating means disposed in a main circuit as shown in FIG. 1, and the silicon controlled rectifier is urged to its conductive state or cutoff state for closing or opening the main circuit thereby placing the heating means in operation when so required.

Referring to FIG. 1, a heating means 3 such as a heater is connected with A.C. power source terminals 1 and 2. The means 3 may be a relay for driving a hot gas valve. The defrosting controller comprises a silicon controlled rectifier 4, a transistor 5 which is turned ON and OFF when the silicon controlled rectifier 4 is OFF and ON, respectively, a D.C. bias supplying means 6 for the transistor 5, a thermistor 7 thermally coupled to the interior of the freezer for detecting a variation in the temperature within the freezer, a base bias dividing resistor 8, voltage dividing resistors 9 and 10 for dividing the A.C. voltage when the silicon controlled rectifier 4 is in its cutoff state, a diode 11 for rectifying the voltage divided by the resistors 9 and 10, a charge-up capacitor 12, a switch 13 which is normally opened and is urged close momentarily in starting the defrosting operation, a base resistor 14 for the transistor 5, and a collector resistor 15 for the transistor 5.

In the circuit described above, the silicon controlled rectifier 4 is in its cutoff state and the switch 13 is in its open position in the normal state, that is, in the state in which no defrosting is required. Thus, the circuit including the heater 3 therein is in its open state and no heat is generated by the heater 3. In the above state, the A.C. power source voltage appears across the silicon controlled rectifier 4, and the capacitor 12 is charged by the resistors 9, 10 and the diode 11. The voltage appearing across the capacitor 12 is dependent upon the voltage dividing ratio of the resistors 9 and 10. The emitter-base junction of the transistor 5 is forward biased by the above voltage so that the transistor 5 is kept in its conductive state. Accordingly, no gate trigger current flows to the gate of the silicon controlled rectifier 4 which is connected with the collector of the transistor 5, and the silicon controlled rectifier 4 is still kept in its cutoff state.

The switch 13 may be closed to give the defrosting starting instruction to the defrosting control circuit which is kept in the state described above, thereby placing the defrosting control circuit in defrosting operation. The purpose can easily be accomplished by associating a means such as a timer with the switch 13 so that the switch 13 can periodically be closed by the action of the timer.

Suppose now that the switch 13 is momentarily closed by the action of the timer. Then, the electric charge accumulated in the capacitor 12 is discharged through the closed switch 13 to cut off the transistor 5. As a result, a gate trigger current flows to the gate of the silicon controlled rectifier 4 to urge the same into its conductive state. This results in the closure of the main circuit comprising the A.C. power source terminal 1, heater 3, silicon controlled rectifier 4, and A.C. power source terminal 2. The heater 3 is thus energized to start removal of frost accumulated within the freezer.

Since the silicon controlled rectifier 4 is urged to its conductive state in a moment and the forward voltage drop across the conducting silicon controlled rectifier 4 is quite small or in the order of several volts, voltage of such a magnitude as will urge the transistor 5 to its conductive state does not appear across the capacitor 12 when the switch 13 is forced open again. Thus, the transistor 5 is

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continuously kept in its cutoff state and the defrosting control circuit is held in the operating state which is entirely the same as when the switch 13 is kept continuously closed. Therefore, the heater 3 continues to generate heat and the defrosting operation for the removal of frost within the freezer is continued.

As the frost accumulated within the freezer is removed, the temperature within the freezer rises gradually and the resistance of the thermistor 7 thermally coupled to the interior of the freezer decreases gradually. As a result, the base-emitter junction of the transistor 5 is deeply forward biased by the voltage obtained by dividing the voltage of the D.C. bias supplying means 6 by the thermistor 7 and the resistor 8. At a point at which the temperature within the freezer reaches the defrosting ceasing temperature, the transistor 5 makes a transition from its cutoff state to its active region, resulting in a decrease of the gate trigger current supplied to the silicon controlled rectifier 4.

Therefore, the conduction angle of the silicon controlled rectifier 4 is now less than 180° and there appears a phase in which no conduction takes place. The capacitor 12 is charged during the non-conduction phase of the silicon controlled rectifier 4, and a voltage appears across the capacitor 12. This voltage is also applied to the base of the transistor 5 so that the transistor 5 approaches its conductive state more and more. In the meantime, the so-called positive feedback occurs in the silicon controlled rectifier 4, in which the gate trigger current is further reduced and the conduction angle of the silicon controlled rectifier 4 becomes smaller. As a result, the transistor 5 is rapidly urged to its conductive state and the silicon controlled rectifier 4 is rapidly urged to the cutoff state to open the main circuit again and to stop the defrosting operation, that is, the heating operation by the heater 3.

After the transistor 5 is urged to the conductive state and the silicon controlled rectifier 4 is urged to the cutoff state, the temperature within the freezer is reduced and the transistor 5 is deeply biased by the voltage charged in the capacitor 12 in spite of any increase in the resistance of the thermistor 7 and is not urged to its cutoff state until the switch 13 is closed again. Thus, the circuit is kept in the state of cooling operation.

While the above description has referred to a defrosting control circuit employing a thyristor in the form of a P-gate silicon controlled rectifier, it will be understood that a defrosting control circuit similar to the one above may be obtained by employing an N-gate silicon controlled rectifier.

FIG. 2 shows a defrosting control circuit employing such an N-gate silicon controlled rectifier. The N-gate silicon controlled rectifier is indicated by the reference numeral 16. As is apparent from FIG. 2, a transistor 17 has a polarity opposite to that of the transistor 5 shown in FIG. 1. More precisely, the transistor 17 is of the pnp type and is connected with a D.C. bias supplying means 6, a diode 11 and a capacitor 12 in a relation entirely opposite to the relation shown in FIG. 1. In FIG. 2, like reference numerals are used to denote like parts appearing in FIG. 1. The operation of the transistor 17 and the silicon controlled rectifier 16 in the circuit of FIG. 2 is the same as the operation of the circuit of FIG. 1, that is, in the cooling operation, the transistor 17 is kept in its conductive state and the silicon controlled rectifier 16 is kept in its cutoff state.

Therefore, the silicon controlled rectifier 16 is not triggered to become conductive in such a state of the circuit. Then, when a switch 13 is the circuit is closed momentarily, the electric charge accumulated in the capacitor 12 is discharged through the switch 13 to cut off the transistor 17. As a result, the silicon controlled rectifier 16 is urged to conduct so that the defrosting operation by a heater 3 is started. Thereafter, an operation entirely the

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same as that of FIG. 1 is effected to remove frost accumulated within the freezer and the defrosting operation is automatically stopped as soon as the frost has completely been removed.

A bidirectional triode thyristor may be used in combination with the silicon controlled rectifier in the circuit shown in FIGS. 1 and 2. While the arrangement in FIGS. 1 and 2 is such that the voltage appearing across the thyristor is divided by the voltage dividing resistors and this divided voltage is applied to the base of the transistor through the charging means consisting of the diode and the capacitor, it will be understood that an alternative arrangement may be made in such a way that a voltage appearing across the charging means is first divided by the voltage dividing resistors and this divided voltage is then applied to the base of the transistor.

It will be appreciated from the foregoing description that the defrosting controller according to the present invention is adapted to perform the defrosting operation solely under a predetermined condition. More precisely, the defrosting operation is ended as soon as frost accumulated within the freezer is completely removed. Thus, the defrosting operation is always correctly performed irrespective of the relative amount of frost accumulated within the freezer. The above manner of defrosting operation completely eliminates the prior problem of an unnecessary and objectionable rise in the temperature of the provisional compartment or imperfect removal of frost which has been inevitable with the conventional method of defrosting.

What is claimed is:

1. A defrosting controller for an electric refrigerator having a defrosting heater, a thyristor for controlling the operation of said defrosting heater, and control means for triggering said thyristor, said control means comprising voltage conversion means by which an A.C. voltage appearing across the anode and cathode of said thyristor during its cutoff state is converted into a D.C. voltage, a transistor to the base of which the D.C. voltage obtained by said voltage conversion means is applied, said transistor being urged to its conductive state and to its cutoff state when said thyristor is in its cutoff state and conductive state, respectively, and D.C. bias supplying means for supplying a D.C. bias voltage to said transistor, wherein a temperature detector such as a thermistor thermally coupled to the freezer is connected with the base of said transistor as a base bias dividing resistor, a switch adapted to be closed in starting the defrosting operation is connected between the base and the emitter of said transistor, and the collector of said transistor is electrically connected with the gate of said thyristor.

2. A defrosting controller according to claim 1, in which said voltage conversion means is a diode.

3. A defrosting controller according to claim 1, in which said transistor is of the pnp type.

4. A defrosting controller according to claim 1, in which said transistor is of the npn type.

5. A defrosting controller according to claim 1, in which said switch is of the momentary-contact type.

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