

March 3, 1970

ZENJI KUSUDA ET AL

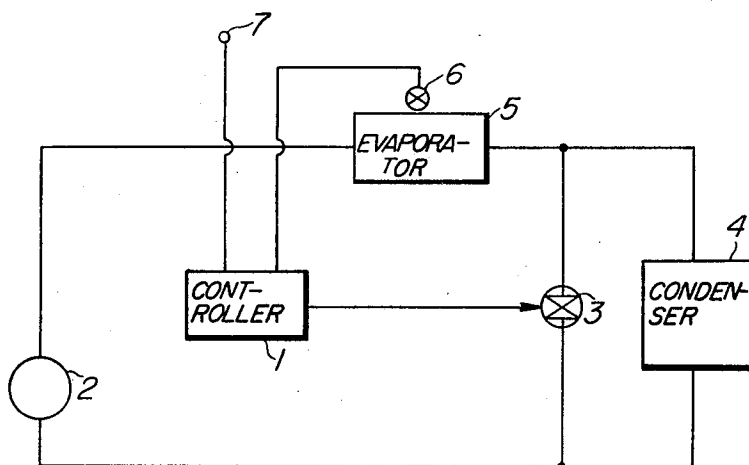
3,498,073

DEFROSTING CONTROLLER FOR ELECTRIC REFRIGERATOR

Filed Aug. 27, 1968

2 Sheets-Sheet 1

FIG. 1



INVENTORS

ZENJI KUSUDA,

TAKEJI KOBAYASHI,

BY

Storons, Davis, Miller & O'Brien

ATTORNEYS

March 3, 1970

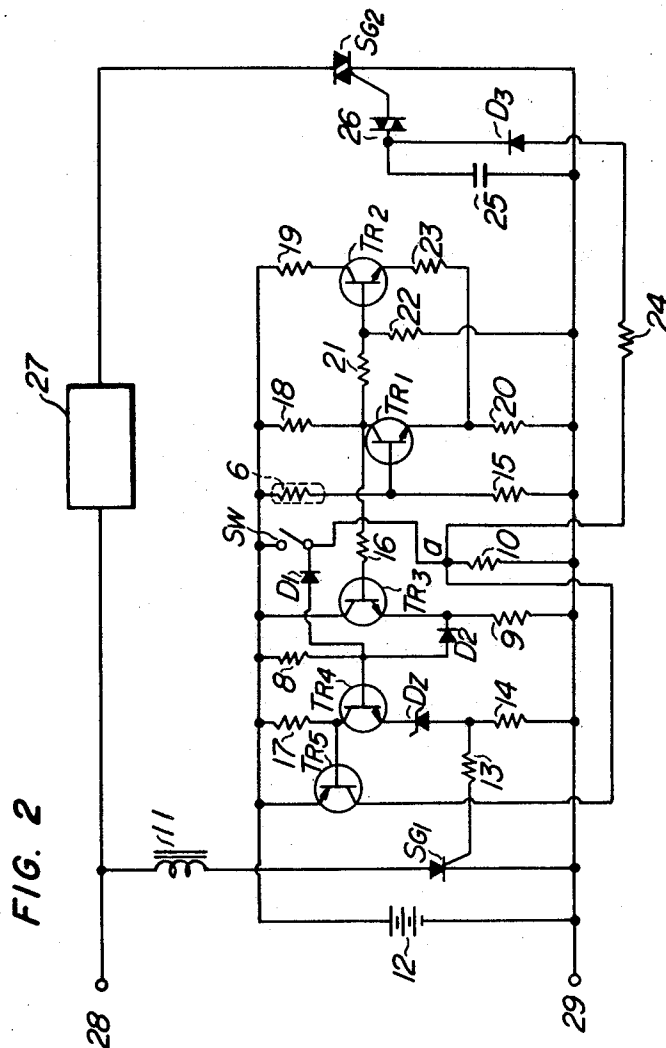
ZENJI KUSUDA ET AL

3,498,073

DEFROSTING CONTROLLER FOR ELECTRIC REFRIGERATOR

Filed Aug. 27, 1968

2 Sheets-Sheet 2



INVENTORS:
ZENJI KUSUDA,
TAKEJI KOBAYASHI

Stevens, Davis, Miller & Hooper

BY

ATTORNEYS

1

3,498,073

DEFROSTING CONTROLLER FOR ELECTRIC REFRIGERATOR

Zenji Kusuda, Ibaragi-shi, and Takeji Kobayashi, Kyoto, Japan, assignors to Matsushita Electronics Corporation, Osaka, Japan, a corporation of Japan

Filed Aug. 27, 1968, Ser. No. 755,528

Claims priority, application Japan, Aug. 31, 1967, 42/56,277

Int. Cl. F25d 21/02, 21/08; F25b 49/00

U.S. Cl. 62—155

2 Claims

ABSTRACT OF THE DISCLOSURE

A defrosting controller for electric refrigerators which is selectively operable so as not to start the defrosting operation even at the arrival of a defrosting signal when there is no frost in the freezer and which can automatically stop the operation of the defrosting heater as soon as the temperature within the freezer reaches a predetermined value, thereby ensuring positive defrosting and avoiding an unnecessary temperature rise within the freezer.

This invention relates to a defrosting controller for electric refrigerators which detects a variation in the temperature within the freezer during the defrosting operation and automatically brings the defrosting operation to an end.

In known electric refrigerators, it is common practice to perform the defrosting operation for a predetermined period of time under control of a timer for the removal of frost deposits within the freezer. However, the conventional electric refrigerator in which the duration of defrosting operation is thus predetermined according to the setting of the timer and the defrosting operation is continued for the predetermined time independently of the amount of frost accumulated within the freezer has 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 been completely removed resulting in a rise of the temperature within the freezer and the refrigerator to a point which is undesirably high, while when quite a large amount of frost is accumulated within the freezer, the defrosting operation is stopped before all the frost can completely be removed.

It is therefore a first object of the present invention to provide a defrosting controller which can automatically stop the operation of the defrosting heater as soon as frost accumulated within the freezer is completely removed.

A second object of the present invention is to provide a defrosting controller which is selectively operable in such a manner that the defrosting operation will not be started even at the arrival of a signal instructing the start of the defrosting operation when there is no frost within the freezer.

In accordance with the present invention, there is provided 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 a Schmitt circuit including a first transistor having its base connected with a thermistor which is thermally coupled to the interior of the freezer and acts as a base bias dividing resistor for said first transistor, and a second transistor urged to its conducting state when said first transistor is in its cutoff state and to its cutoff state when said first transistor is in its conducting state, a third transistor urged to its conducting state and to its cutoff state when said first transistor is driven to its cutoff state and to its con-

2

ducting state, respectively, depending on the state of said Schmitt circuit, a first diode urged to its conducting state and to its cutoff state in response to opening and closure, respectively, of a timer switch which is actuated for a short time, a second diode urged to its conducting state and to its cutoff state in response to cutoff and conduction, respectively, of said third transistor, a fourth transistor associated with base bias supply means including a series connection of said first diode and a resistor, a series connection of said second diode and a resistor disposed in parallel with said first series connection, and a resistor, said fourth transistor having its emitter connected with a Zener diode, and a fifth transistor urged to its conducting state and to its cutoff state in response to conduction and cutoff, respectively, of said fourth transistor and operative to maintain said first transistor in its cutoff state during the defrosting operation, wherein said Zener diode conducts only when both said first and second diodes are in their cutoff state thereby urging said fourth transistor to conduct and allowing said thyristor to conduct.

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

FIG. 1 is a block diagram of an embodiment of the defrosting controller according to the present invention; and

FIG. 2 is an electrical connection diagram of the defrosting controller shown in FIG. 1.

Referring first to FIG. 1, the refrigerating operation in an electric refrigerator equipped with the defrosting controller 1 according to the present invention is normally performed by a system comprising a compressor motor 2, a condenser 4 and an evaporator 5. A defrosting signal is applied to the defrosting controller 1 through a terminal 7 which is connected to means such as a timer or a push button switch. In response to the application of the defrosting signal, the defrosting controller 1 is operative to open a hot gas supply valve 3, which therefore supplies hot gas to the section where the evaporator 5 is disposed so as to remove frost accumulating on the evaporator 5. According to the present invention, a thermistor 6 thermally coupled to the section including the evaporator 5 therein constitutes an element of the defrosting controller 1, and a variation in the resistance of the thermistor 6 is detected to start or stop the defrosting operation. The defrosting control is such that the defrosting operation is immediately stopped as soon as frost accumulated on the evaporator 5 is completely removed, and the hot gas supply valve 3 is not opened even when a defrosting signal is applied to the defrosting controller 1 insofar as no frost accumulates on the evaporator 5.

A preferred form of the defrosting controller according to the present invention based on the defrosting system described above is shown in FIG. 2. Briefly, the defrosting operation by the defrosting controller is such that a thyristor SG₁ is triggered to conduct thereby to energize a heater only when a diode D₁ and a diode D₂ are both in their cutoff state. The operating state of these diodes D₁ and D₂ is controlled depending on the temperature within the evaporator.

Referring now to FIG. 2, the operation of the defrosting controller according to the present invention will be described in detail.

Suppose now that frost accumulates on the evaporator and the temperature of the evaporator is quite low. Then, the thermistor 6 thermally coupled to the evaporator has naturally a higher resistance than when no frost exists on the evaporator. The circuit conditions of the defrosting controller are so determined that, when the thermistor 6 takes such a high resistance, a transistor TR₁ is kept in

its cutoff state by such a base bias voltage which is obtained by dividing the voltage of a D.C. power supply 12 by a resistor 15 and the thermistor 6. The transistor TR₁ constitutes a Schmitt circuit well known in the art in combination with a transistor TR₂. Thus, the transistor TR₂ is in its conducting state when the transistor TR₁ is in its cutoff state. Furthermore, in the above state, a transistor TR₃ is in its conducting state, and the diode D₂ is back-biased to be kept in its cutoff state.

On the other hand, the diode D₁ is forward-biased to conduct, and a voltage obtained by dividing the voltage of the power supply 12 by a resistor 8 and a resistor 10 is applied to the base of a transistor TR₄. A Zener diode D_z is connected in series with the emitter of the transistor TR₄ and is so selected as to conduct at a voltage which is higher than the voltage applied to the base of the transistor TR₄. Accordingly, the transistor TR₄ is in its cutoff state, and hence a transistor TR₅ and the thyristor SG₁ are both in their cutoff state. As a result, no current flows across a coil 11 associated with the defrosting or hot gas supply valve and no defrosting operation is performed. In other words, in the above state of the circuit elements, no defrosting operation is started even when frost accumulates on the evaporator. Because of the fact that the transistor TR₅ is in its cutoff state, no current flows through a charging circuit for a capacitor 25 including the transistor TR₅, a point *a*, a resistor 24 and a diode D₃, and therefore a bilateral switching device 26 having a negative resistance is not in its conducting state. Since the bilateral switching device 26 is thus kept in its cutoff state, a thyristor SG₂ is in its cutoff state and means 27 for circulating the hot gas is not in operation.

Suppose that a defrosting timer is operated under the above state of the circuit shown in FIG. 2. Then, a switch SW is closed for a moment and the diode D₁ is urged to its cutoff state. This results in a cutoff of both the diode D₁ and the diode D₂ since the diode D₂ has been in its cutoff state. Consequently, a voltage substantially equal to the voltage of the power supply 12 is applied to the Zener diode D_z, allowing the Zener diode D_z to conduct and urging the transistor TR₄ to conduct. A trigger pulse is therefore applied to the gate of the thyristor SG₁ so that the thyristor SG₁ conducts to supply current through the coil 11 associated with the defrosting valve thereby to open the defrosting valve. Since the transistor TR₅ is also urged to its conducting state at the same time, current flows through the capacitor charging circuit including the transistor TR₅, point *a*, resistor 24 and diode D₃ to charge the capacitor 25. The voltage charged in the capacitor 25 urges the bilateral switching device 26 to conduct, which urges the thyristor SG₂ to conduct. As a result, the hot gas circulation means 27 is actuated to circulate the hot gas through the evaporator to remove the frost accumulated on the evaporator. Although the switch SW is closed only momentarily and is opened again, the diode D₁ is kept in its cutoff state because it is still back-biased by the transistor TR₅ which is conducting. Thus, the transistor TR₄ is kept in its conducting state and the defrosting operation is thereby continuously performed to remove all the frost accumulated on the evaporator.

At the completion of the defrosting operation, the temperature of the portion where the thermistor 6 is disposed starts to rise up to a certain value, hence the resistance of the thermistor 6 decreases to a certain value until the transistor TR₁ conducts. This results in a cutoff of the transistor TR₃ and conduction of the diode D₂. Because the condition that both the diodes D₁ and D₂ are in their cutoff state is no more satisfied due to the conduction of the diode D₂, the transistor TR₄ is urged to its cutoff state to place the thyristor SG₁ in its cutoff state. The transistor TR₅, the bilateral switching device 26 and the thyristor SG₂ are likewise urged to their cutoff state and the defrosting operation is ended.

Suppose a case in which the defrosting timer is operated to close the switch SW when the transistor TR₁ is in its

conducting state. Since, in such a case, the diode D₂ is also conducting, the voltage which is obtained by dividing the voltage of the power supply 12 by the resistor 8 and the resistor 9 is applied to the base of the transistor TR₄. However, it will be apparent from the previous description that such a voltage can not drive the transistor TR₄ because the Zener diode D_z is set to conduct at a voltage higher than the above voltage, and no defrosting operation will be performed. In this connection, it is to be understood that the voltage at which the Zener diode D_z conducts is selected at such a value which is higher than the voltage applied to the base of the transistor TR₄ when both the diodes D₁ and D₂ are conducting, that is, the voltage obtained by dividing the power supply voltage by the resistance of the resistor 8 and the composite resistance of the resistors 9 and 10.

In FIG. 2, the reference numeral 13 designates a gate current control resistor for the thyristor SG₁; 14, a gate bias supply resistor; 16, a base resistor for the transistor TR₃; 17, 18 and 19, collector resistors for the respective transistors TR₄, TR₁ and TR₂; 20, an emitter resistor for the transistor TR₁; 21 and 22, voltage dividing resistors for base bias supply to the transistor TR₂; 23, an emitter resistor for the transistor TR₂; and 28 and 29, terminals connected to an A.C. power supply.

It will be understood 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 started solely when a defrosting signal is applied to the controller under a limited condition in which the controller detects the accumulation of frost on the evaporator, and the defrosting operation is ended as soon as the frost is completely removed. Thus, the defrosting operation is always correctly performed irrespective of the relative amount of frost accumulated on the evaporator. The above manner of defrosting operation completely eliminates the prior problem of an unnecessary and objectionable rise in the temperature within the refrigerator or imperfect removal of frost which has been inevitable with the conventional method of defrosting.

Although the above description has referred to the case in which hot gas is used for the removal of frost, it will be understood that the coil 11 for actuating the defrosting valve may be replaced by a heater, in which case the resistor 24, the diode D₃, the capacitor 25, the bilateral switching device 26, the thyristor SG₂ and the hot gas circulation means 27 constituting the hot gas circulation circuit are utterly unnecessary.

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 a Schmitt circuit including a first transistor having its base connected with a thermistor which is thermally coupled to the interior of the freezer and acts as a base bias dividing resistor for said first transistor, and a second transistor urged to its conducting state when said first transistor is in its cutoff state and to its cutoff state when said first transistor is in its conducting state, a third transistor urged to its conducting state and to its cutoff state when said first transistor is driven to its cutoff state and to its conducting state, respectively, depending on the state of said Schmitt circuit, a first diode urged to its conducting state and to its cutoff state in response to opening and closure, respectively, of a timer switch which is actuated for a short time, a second diode urged to its conducting state and to its cutoff state in response to cutoff and conduction, respectively, of said third transistor, a fourth transistor associated with base bias supply means including a series connection of said first diode and a resistor, a series connection of said second diode and a resistor disposed in parallel with said first series connection, and a resistor, said fourth transistor having its

5

emitter connected with a Zener diode, and a fifth transistor urged to its conducting state and to its cutoff state in response to conduction and cutoff, respectively, of said fourth transistor and operative to maintain said first diode in its cutoff state during the defrosting operation, wherein said Zener diode conducts only when both said first and second diodes are in their cutoff state thereby urging said fourth transistor to conduct and allowing said thyristor to conduct.

2. A defrosting controller for an electric refrigerator according to claim 1, in which the operation of said first diode is controlled by the opening and closure of the timer switch and the operation of said second diode is

6

controlled by said Schmitt circuit whose operating state is variable depending on the temperature within the freezer.

References Cited

UNITED STATES PATENTS

2,847,833	8/1958	Merrick	-----	62—155
3,126,712	3/1964	Gebert	-----	62—155

MEYER PERLIN, Primary Examiner

U.S. Cl. X.R.

62—156, 196, 209