

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to a refrigerator configured to remove frost adhered to a cooler using a heater.

Background Art

10 [0002]

As a defrosting apparatus in a refrigerator in the related art, there is a type configured to melt frost adhered to an evaporator (which is the same as "cooler") using a glass tube heater and a pipe heater. For example, there is proposed a configuration such that "A glass tube heater 29 is arranged below an evaporator 13, while a pipe heater 41 is arranged so as to continue substantially in parallel to fins 27 of the evaporator 13 in a state of being in direct contact therewith. The temperatures of the pipe heater 41 and the glass tube heater 29 are controlled to be a preset heater temperature by a controller 43" (For example, see Patent Literature 1). Defrosting without uneven heating is achieved by operating the pipe heater and the glass tube heater depending on places on the basis of whether the amount of frost formation is large or small.

Citation List

Patent Literature

[0003]

[Patent Literature 1] JP-A-2000-121233 (p. 5, Fig. 10)

Summary of Invention

5 Technical Problem

[0004]

10 In the technology in the related art, a plurality of heaters are controlled by determining whether the amount of frost is large or not on the basis of detected values obtained by a plurality of frost amount detection sensors. However, generated heat is not necessarily used for defrosting efficiently if determination is made only on the basis of whether the actual amount of frost is large or small. In contrast, there arises a problem that wasteful
15 power is consumed.

[0005]

20 Before starting defrosting, the peripheral temperature of the evaporator is as low as more or less -24°C . When the glass tube heater and the pipe heater are heated, the temperature of the periphery of the glass tube heater becomes quickly high, but the temperature in the periphery of the pipe heater, that is, in the periphery of the fins does not become high quickly because of the characteristics of these heaters. Therefore, the periphery of the fins
25 cannot be defrosted quickly, and hence the fins are clogged with the frost for the mean time even after energization. A large temperature difference is generated between abruptly

heated air by the glass tube heater and cold air from the evaporator, and causes convection. The air heated by the glass tube heater rides on the convection and hence ascends, but is reflected from a wall of the fins clogged by the frost and is returned downward. The returned warm air passes through a freezing compartment returning air duct, and flowed out to a freezing compartment and other compartments in the refrigerator. Consequently, there arises a problem that the temperatures in the freezing compartment or the other compartments in the refrigerator are risen. There is also a fear of damaging foodstuffs simultaneously due to this temperature rise.

[0006]

In order to solve the problem as described above, it is an object of the present invention to provide a refrigerator in which heat used for defrosting is avoided from flowing into a freezing compartment or the interior of a refrigerator, a defrosting quality is maintained, and power consumption is reduced.

Solution to Problem

[0007]

A refrigerator according to the present invention comprises: a freezing cycle including a compressor configured to compress a refrigerant, a condenser configured to condense the refrigerant, a throttling device configured to expand the condensed refrigerant, and a cooler configured to evaporate the expanded refrigerant,

being arranged in a loop and connected by piping; a pipe heater disposed in abutment with or in the vicinity of the cooler; a radiant heater disposed below the cooler; and control means configured to control energization of the pipe heater and the radiant heater, and the control means energizes the pipe heater and starts energization of the radiant heater after having started partial defrosting, thereby defrosting the cooler.

Advantageous Effects of Invention

[0008]

In the present invention, the control means starts energization of the pipe heater first in order to melt part of the frost clogging spaces between respective adjacent fins of the cooler. Subsequently, the control means starts energization of the radiant heater when the clogging of the fins is determined to be partly resolved. The radiant heater dissipates heat by radiation to melt the frost on the cooler and heat up peripheral air. The heated air passes between the fins where the clogging is resolved, and ascends toward the cooler. Reduction of air flowing backward to the freezing compartment or the interior of the refrigerator due to the clogging of the fins contributes to improvement of cooling efficiency of the freezing compartment or the interior of the refrigerator, and to improvement of quality maintenance of foodstuffs.

The refrigerator of the present invention achieves effects of reducing power consumption while defrosting the cooler and improving the quality maintenance of foodstuffs.

Brief Description of Drawings

5 [0009]

Fig. 1 is a front view of a refrigerator according to Embodiment 1 of the present invention.

Fig. 2 is a cross-sectional view of the refrigerator according to Embodiment 1 of the present invention.

10 Fig. 3 is a side cross-sectional view of a cooler compartment of the refrigerator according to Embodiment 1 of the present invention.

Fig. 4 is a schematic explanatory drawing showing defrosting means of the refrigerator according to Embodiment 1 of the present invention.

15 Fig. 5 is a flow chart of defrosting control using a cooler temperature sensor of the refrigerator according to Embodiment 1 of the present invention.

20 Fig. 6 is a side cross-sectional view of the cooler compartment of the refrigerator according to Embodiment 2 of the present invention.

Description of Embodiment

[0010]

Embodiment 1

25 Fig. 1 is a front view of a refrigerator according to Embodiment 1 of the present invention.

In Fig. 1, a refrigerator 11 includes a refrigerating compartment 12 on the top, an ice making compartment 3 and a switchable compartment 4 arranged side by side under the refrigerating compartment 12, a freezing compartment 5 under the ice making compartment 3 and the switchable compartment 4, and a vegetable compartment 6 under the freezing compartment 5. The presence or absence or the positions of the respective compartments do not limit this embodiment as a matter of course. The refrigerator 11 includes a refrigerating compartment door 7, an ice making compartment door 8, a switchable compartment door 9, a freezing compartment door 10, and a vegetable compartment door 13 which are able to open and close respective openings of the refrigerating compartment 12, the ice making compartment 3, the switchable compartment 4, the freezing compartment 5, and the vegetable compartment 6 freely. When the respective doors are opened, putting in and taking out of foodstuffs or the like therethrough are enabled.

[0011]

Fig. 2 is a side cross-sectional view of the refrigerator according to Embodiment 1 of the present invention.

In Fig. 2, the refrigerator 11 includes a freezing fan 32 and a freezing cycle 20 on the back side thereof. The freezing fan 32 is configured to deliver cold air generated

by the freezing cycle 20 to the respective compartments in the refrigerator 11.

[0012]

5 The freezing cycle 20 includes a compressor 21 configured to compress refrigerant gas, a condenser 22 configured to condense and liquidize the compressed refrigerant, a throttling device 23 configured to decompress the liquidized refrigerant, a cooler 24 configured to evaporate the decompressed refrigerant, being
10 arranged in a loop and connected by piping. The cooler 24, in which a refrigerant evaporates, is cooled by heat absorbing action of the refrigerant evaporated in the interior thereof.

[0013]

15 Subsequently, a cooler compartment in which the cooler 24 is stored will be described.

Fig. 3 is a side cross-sectional view of the cooler compartment of the refrigerator according to Embodiment 1 of the present invention.

20 A pipe heater 41 is disposed in abutment with or in the vicinity of the cooler 24, and a freezing compartment return port 42 which allows air to flow from the freezing compartment 5 to the cooler 24 is provided below the cooler 24 and a wall surface of the freezing compartment 5.
25 Provided at the lower most portion of the cooler compartment are a drain pan 33 for receiving drain water as melted water of frost and a drain hole 34 for discharging

the drain water. A radiant heater 15 is disposed between the drain pan 33 and the cooler 24, and a heater cover 16 is provided between the radiant heater 15 and the cooler 24. The heater cover 16 protects the radiant heater 15 so as to prevent the drain water dripped from the cooler 24 from striking thereon.

[0014]

The pipe heater 41 includes a pipe portion which forms an outline thereof, and a heater provided in the interior of the pipe. The pipe portion is preferably an aluminum tube in terms of cost and workability, and the heater in the interior thereof is preferably a silicon heater coated with silicon in terms of heat resistance. However, the invention is not limited thereto.

[0015]

Fig. 4 is a schematic explanatory drawing showing defrosting means of the refrigerator according to Embodiment 1 of the present invention.

In Fig. 4, control means 45 is connected to a motor 21a of the compressor 21, a throttling device 23, the pipe heater 41 for defrosting, the radiant heater 15, and a cooler temperature sensor 25. The control means 45 is able to control the pipe heater 41 and the radiant heater 15 independently by determining the driving state of the motor 21a or the measured temperature of a cooler temperature sensor 25. Although a single piece of the pipe heater 41 and a single piece of the radiant heater 15 are used in

this embodiment, two or more each of these heaters may be provided. However, in the same manner as the case where one each of these heaters are provided, control means which is able to control a plurality of the heaters provided in abutment with or in the vicinity of the cooler 24 and a plurality of the heaters provided below the cooler 24 independently is required.

[0016]

The control means 45 starts defrosting control under certain conditions such as a case where a predetermined accumulated operating time of the compressor 21 has elapsed. In addition, there is other defrosting start conditions such as a case where the fact that the amount of the frost formation exceeds a predetermined amount is detected using a frost amount sensor. However, this embodiment is not intended to limit the start conditions. When the defrosting is started, the control means 45 firstly energizes the pipe heater 41. The pipe heater 41 directly heats the frost adhered to the cooler 24, and melts the same partly. When it is detected that the frost adhered to the cooler 24 is melted and spaces to allow air to flow to the cooler 24 is formed, the control means 45 starts energization of the radiant heater 15.

Determination of whether the spaces is formed or not includes, for example, determination using the frost amount detection sensor, determination on the basis of elapse of

certain time length, and determination on the basis of the temperature of the cooler.

[0017]

By causing only the pipe heater 41 to generate heat on ahead, the frost adhered to the cooler 24 can be partly slipped off first, so that the clogging of the fins of the cooler 24 due to the frost is partly resolved and the spaces are formed. Then, heat convection generated by energizing the radiant heater 15 circulates through the formed spaces to the cooler 24, so that defrosting with efficiency is achieved. The radiant heater 15 heats the frost by radiation as well and defrosts as a matter of course.

According to this embodiment, by controlling the heat of the radiant heater 15 to flow into the spaces formed on ahead, an effect to reduce heat flowing backward through the freezing compartment return port 42 and entering the freezing compartment 5 is achieved. By extension, the temperature rise of the foodstuffs in the freezing compartment 5 is restrained, and maintenance of food quality is relatively elongated.

[0018]

Fig. 5 is a flowchart of defrosting control using the cooler temperature sensor of the refrigerator according to Embodiment 1 of the present invention.

The control means 45 is connected to the cooler temperature sensor 25 for measuring the temperature of the

cooler 24, and the pipe heater 41 and the radiant heater 15 are controlled by the temperature of the cooler 24. Fig. 5 shows a procedure of controlling the defrosting (all the steps).

5 [0019]

The control means 45 starts the defrosting control under certain conditions in step S1. In Step S2, the energization of the pipe heater 41 is started, and the pipe heater 41 starts to generate heat. With this heat
10 generation, the frost adhered to the cooler 24 is partly melt, and the cooler 24 is heated and hence the temperature in the periphery of the cooler 24 rises. In Step S3, the control means 45 determines whether the measured temperature obtained from the cooler temperature sensor 25
15 is higher than or equal to a predetermined temperature T1. The predetermined temperature T1 is preferably a given value in a range approximately from -13°C to 0°C. When the measured temperature is determined to be lower than the predetermined temperature T1 (N), the control procedure
20 goes back to Step S3 again, and when the measured temperature is determined to be higher than or equal to the predetermined temperature T1 (Y), the control procedure goes to Step S4. In Step S4, energization of the radiant heater 15 is started, and the radiant heater 15 starts to
25 generate heat. With this heat generation, the defrosting of the entire cooler 24 is started, and air in the periphery of the radiant heater 15 is heated up, and the heated air

flow toward the cooler 24 and hence the temperature in the periphery of the cooler 24 rises. In Step S5, the control means 45 determines whether the measured temperature obtained from the cooler temperature sensor 25 is higher than or equal to a predetermined temperature T2. The predetermined temperature T2 is higher than or equal to the predetermined temperature T1 and is approximately 5°C. When the measured temperature is determined to be lower than the predetermined temperature T2 (N), the control procedure goes back to Step S5 again, and when the measured temperature is determined to be higher than or equal to the predetermined temperature T2 (Y), the control procedure goes to Step S6. In Step S6, the energization of the pipe heater 41 is ended. Subsequently, in Step S7, the control means 45 determines whether the measured temperature obtained from the cooler temperature sensor is higher than or equal to a predetermined temperature T3. The predetermined temperature T3 is higher than or equal to the predetermined temperature T2 and is approximately 14°C. Actually, however, the predetermined temperature T3 is preferably set to a given temperature in the cooler 24 which is regarded that the defrosting of the cooler 24 is ended. In Step S7, when the measured temperature is determined to be lower than the predetermined temperature T3 (N), the control procedure goes back to Step S7 again, and when the measured temperature is determined to be higher than or equal to the predetermined temperature T3

(Y), the control procedure goes to Step S8. In Step S8, the energization of the radiant heater 15 is ended, and the defrosting control is ended in Step S9.

[0020]

5 By energizing the pipe heater 41 until the cooler 24 becomes the predetermined temperature T1 in Step S3 in Fig. 5, the frost adhered to the cooler 24 in the periphery of the pipe heater 41 is melted. However, the melting in this case is only the partial melting of the frost on the cooler 10 24 to which the pipe heater 41 is fixed, and the defrosting of the entire cooler 24 is not achieved yet. However, when the defrosting proceeds even partly, the temperature in the interior of the cooler 24 rises. When it reaches a predetermined temperature T1, the radiant heater 15 is 15 energized and the entire cooler 24 is heated from below in a stroke in Step S4. The air heated abruptly by the radiant heater 15 ascends and passes the partly melted space, and flows into the cooler 24. If there is no partial melting, the heated air is reflected by the frost clogged in the 20 fins of the cooler 24, flows backward through the freezing compartment return port 42 into a freezing compartment 5, and lowers the freezing efficiency of the freezing compartment 5.

[0021]

25 In this embodiment, first of all, the frost is partly melted by the pipe heater 41, then the melting state of the frost is determined by the cooler temperature sensor 25,

and then the frost on the entire cooler 24 is melted using the radiant heater 15 after a time lag, so that the cooler 24 can be defrosted with efficiency without allowing heat to flow into the freezing compartment 5.

5 [0022]

The reason for determination of whether the measured temperature in the interior of the cooler 24 becomes higher than or equal to the predetermined temperature T2 or not in Step S5 is to avoid excessive heating of the cooler 24 by
10 the pipe heater 41. When the pipe heater 41 is ended to defrost near the pipe heater 41, subsequently, the pipe heater 41 starts to add excessive heat to the cooler 24. The excessively added heat becomes a load of the freezing control after the defrosting control is ended, and lowers
15 the freezing efficiency, that is, the power consumption efficiency. In order to avoid the lowering of the freezing efficiency, the control means 45 ends the energization of the pipe heater 41 in Step S6.

[0023]

20 Embodiment 2

Fig. 6 is a side cross-sectional view of the cooler compartment of the refrigerator according to Embodiment 2 of the present invention.

In Fig. 6, a heater cover 16A is inclined with respect
25 to the horizontal plane so that heat of the radiant heater 15 reaches the cooler 24 directly. In addition, with the presence of this inclination, a lump of frost and drain

water dropped from the cooler 24 to the heater cover 16A at the time of defrosting slips downward from the heater cover 16A.

[0024]

5 If the heater cover 16A is not inclined and the lump of frost or the drain water accumulates on the heater cover 16A, the heat of the radiant heater 15 is used for melting the frost on the heater cover 16A and rising the temperature of the drain water, so that the defrosting
10 effect of the cooler 24 is lowered.

 In this embodiment, the defrosting efficiency of the cooler 24 can be enhanced by making the heater cover 16A inclined to remove the lump of frost or the drain water from the heater cover 16A.

15 The angle of inclination is preferably at least 7°. However, causing the lump of frost or the drain water to slip off easily is achieved by forming the heater cover 16A with a water repellent material. Therefore, the angle of inclination is not limited to at least 7°.

20 [0025]

 The heater cover 16A is needed to have a size which covers the entire part of the radiant heater 15 when projecting the inclined heater cover 16A and the radiant heater 15 in parallel from above. The heater cover 16A
25 protects the radiant heater 15 so as to prevent the lamp of frost or the drain water dropped from the cooler 24 at the time of defrosting from dropping directly thereon, thereby

restraining a boiling noise generated when the lump of frost or the drain water comes into touch with the radiant heater 15 and evaporates, and avoiding the temperature drop of the radiant heater 15 due to the evaporation.

5 In this embodiment, effects of restraining the noise and preventing the lowering of efficiency are achieved by covering the radiant heater 15 with the heater cover 16A so as to prevent the frost or the drain water dropped from above from striking thereon.

10 Reference Sign List

[0026]

 3 ice making compartment, 4 switchable compartment,
5 freezing compartment, 6 vegetable compartment, 7
refrigerating compartment door, 8 ice making compartment
15 door, 9 switchable compartment door, 10 freezing
compartment door, 11 refrigerator, 12 refrigerating
compartment, 13 vegetable compartment door, 15 radiant
heater, 16 heater cover, 16A heater cover, 20 freezing
cycle, 21 compressor, 22 condenser, 23 throttling device,
20 24 cooler, 25 cooler temperature sensor, 32 freezing fan,
33 drain pan, 34 drain hole, 41 pipe heater, 42 freezing
compartment return port, 45 control means

CLAIMS

1. A refrigerator comprising:

5 a freezing cycle including a compressor configured to compress a refrigerant, a condenser configured to condense the refrigerant, a throttling device configured to expand the condensed refrigerant, and a cooler configured to evaporate the expanded refrigerant, being arranged in a loop and connected by piping;

10 a pipe heater disposed in abutment with or in the vicinity of the cooler;

a radiant heater disposed below the cooler; and
control means configured to control energization of the pipe heater and the radiant heater, wherein

15 the control means energizes the pipe heater and starts energization of the radiant heater after having started partial defrosting, thereby defrosting the cooler.

2. The refrigerator of claim 1, further comprising:

20 a cooler temperature sensor configured to measure the temperature in the cooler; wherein

the control means

energizes the pipe heater and,

25 after a measured temperature of the cooler temperature sensor has reached a predetermined temperature, starts energization of the radiant heater.

3. The refrigerator of claim 1 or 2, further comprising:
a heater cover having an inclined surface between the
radiant heater and the cooler.