

Description

Defrosting Heater and Method of Manufacturing the Same

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Technical Field

The present invention relates to a defrosting heater used in a refrigerating apparatus, such as a refrigerator, for removing frost attached on a cooler of a refrigerating cycle filled with flammable refrigerant, and to a method of manufacturing the defrosting heater.

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Background Art

A conventional defrosting heater for removing frost attached on a cooler of a refrigerating cycle in a refrigerator is disclosed in Japanese Patent Laid-Open Publication No.8-54172.

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Fig. 8 is a cross sectional view of an essential portion of a refrigerator 1 equipped with the conventional defrosting heater 15. The refrigerator 1 includes a freezing compartment 2, a refrigerating compartment 3, a door 4 of the freezing compartment, a door 5 of the refrigerating compartment, a partition 6 separating the freezing compartment 2 from the refrigerating compartment 3, an inlet 7 for introducing air in the freezing compartment 2, an inlet 8 for introducing air in the refrigerating compartment 3, a discharge outlet 9 for discharging cool air, an evaporator 10, a fan 11 for circulating the cool air, and a partition 12 separating the evaporator 10 from the freezing compartment 2. Beneath the evaporator 10, a defrosting heater 15 including a nichrome wire shaped in a coil and a glass tube covering the wire, a roof 16 for shielding evaporating noises generated when water caused by defrosting drops directly on the defrosting heater 15, and a

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bottom plate 17 made of metal. Water is collected in a tub 13 and discharged through an outlet 14.

An operation of the defrosting heater 15 will be explained below. The evaporator 10 is cooled by refrigerant passing in through the evaporator, thus refrigerating the freezing compartment 2 and the refrigerating compartment 3. A fan 11 send air warmed in the freezing compartment 2 and the refrigerating compartment 3 through the inlets 7 and 8 to a cooling chamber (not shown). The air is cooled by having heat exchanged by the evaporator 10 and is send through from the discharge outlet 9 to the freezing compartment 2 by the fan 11. The cooled air is sent from the freezing compartment 2 via a communicating passage (not shown) to the refrigerating compartment 3.

The air to have the heat exchanged by the evaporator 10 is humidified with water contained in external air which has a high temperature and flows in when the door 4 of the freezing compartment 2 and the door 5 of the refrigerating compartment 3 open, and with water in foods stored in the freezing compartment 2 and the refrigerating compartment 3. The water in the humidified air is attached as frost on the evaporator 10 having a temperature lower than that of the humidified air. More amount of the frost prevents the evaporator 10 more from exchanging heat with the air. Further, the attached frost acts as flowing resistance preventing air around the evaporator 10 from flowing, hence preventing the heat from transmitting and reducing a cooling efficiency.

For compensation, the nichrome wire of the defrosting heater 15 is energized before the cooling efficiency is reduced. Upon being energized, the nichrome wire of the defrosting heater 15 emits heat towards the evaporator 10 and neighbor components around the evaporator 10. Portion

of the heat directed to the bottom plate 17 is reflected by the bottom plate 17 and returns back to the evaporator 10 and the neighbor components. The heat returning back to the evaporator and the neighbor components melts the frost attached on the evaporator 10 and the tub 13 about the outlet 14 into water.

Portion of the water drops directly to the tub 13, while the other portion drops the roof 16 to avoid the defrosting heater 15, and the water is discharged through the outlet 14.

In the conventional defrosting heater 15, the glass tube covering the nichrome wire has its surface having a very high temperature as well as the nichrome wire. In addition, since the bottom plate 17 located close to the defrosting heater 15 receives the heat from the defrosting heater 15 and reflects portion of the heat towards the defrosting heater 15, hence further increasing the temperature of the glass tube.

The refrigerant may leak out from piping communicating with the evaporator 10 or from a jointed portion in the refrigerator. If the refrigerant is flammable, the glass tube of the defrosting heater 15 has to be prevented from having a temperature higher than the igniting point of the refrigerant.

Summary of the Invention

According to a first aspect of the present invention, there is provided a defrosting heater for heating and eliminating frost attached on an evaporator in a refrigerating cycle using flammable refrigerant, said defrosting heater comprising: a first glass tube having an opening at an end thereof; a heater wire accommodated in the first glass tube; a cap for closing the opening of the first glass tube, the cap having a first aperture and a second aperture provided therein, the first aperture allowing an inside of the first glass tube communicate with an outside of the first glass tube, the second aperture allowing the inside of the first glass tube to communicate with an outside of the first glass tube, the

second aperture having a cross section thereof having an area for preventing flame from being transmitted therein; a lead wire inserted through the first aperture and connected to an end of the heater wire, the lead wire having a diameter larger than a diameter of the first aperture before the lead wire is inserted through the first aperture; a tube having an opening therein and inserted into the second aperture of the cap; and a valve provided in the tube as to close the opening of the tube, the valve being operable to discharge air from the inside of the first glass tube.

The defrosting heater may prevent the glass tube from having a temperature increased too much.

According to a second aspect of the present invention, there is provided a method of manufacturing a defrosting heater for heating and eliminating frost attached on an evaporator in a refrigerating cycle using flammable refrigerant, said method comprising: providing a glass tube having an opening at an end thereof, a cap having a first aperture and a second aperture therein, a lead wire having a diameter larger than a diameter of the first aperture, and a heater wire; closing the opening of the glass tube with the cap; connecting a sleeve to an end of the lead wire; inserting the sleeve of the lead wire into the first aperture of the cap; and connecting the heater wire to the sleeve.

Brief Description of the Drawings

Fig. 1 is a cross sectional view of an essential portion of a defrosting heater according to an exemplary embodiment of the present invention.

Fig. 2 is a refrigerating system of a refrigerator employing the defrosting heater of the embodiment.

Fig. 3 is an exploded view of the defrosting heater of the embodiment.

Fig. 4 illustrates another defrosting heater of the embodiment.

Fig. 5 illustrates a further defrosting heater of the embodiment.

Fig. 6 is a cross sectional view of an essential portion of the defrosting heater shown in Fig. 5.

Fig. 7 illustrates a still another defrosting heater of the embodiment.

Fig. 8 is a cross sectional view of a refrigerator employing a conventional defrosting heater.

Detail Description of the Preferred Embodiment

Fig. 1 is a cross sectional view of an essential portion of a defrosting heater 20 according to an exemplary embodiment of the present invention. The defrosting heater 20 includes a heater wire 21, a resistive wire shaped in coil. The heater wire 21 has linear connection ends 21a at both ends of the wire. The heater wire 21 is accommodated in a glass tube 23 having an outer diameter of about 10.5mm and having a cylindrical shape having openings at both ends of the tube. The glass tube 24 having the glass tube

23 located therein has an outer diameter of about 20mm and has a cylindrical shape having opening at both ends of the tube. Each ends of the heater wire 21 is connected to a lead wire 26 via an electrically-conductive sleeve 28. The openings of both the glass tubes 23 and 24 are closed with caps 22 made of silicone rubber. The lead wire 26 extends through an aperture 22a in each cap 22 to the heater wire 21. The plug 22 has an aperture 22b provided therein for having a space 24a between the glass tubes 23 and 24 communicate with the outside of the cap 22. The cross section of the aperture 22b has an area substantially not larger than 7.1mm². A valve 25 of rubber closes an opening 27A of a bottomed tube 27 and provided at the aperture 22b of the cap 22. The valve 25 functions as a check valve for opening only in a single direction with a predetermined pressure difference.

The cap 22 has a simple structure in which the aperture 22b is closed with the valve 25, thus being inexpensive.

Fig. 2 illustrates a refrigerating system of the refrigerator employing the defrosting heater 20 of the embodiment. The refrigerating cycle includes a compressor 60, a condenser 61, a decompressor 62, and an evaporator 10 and is filled with flammable refrigerant circulating through the compressor 60, the condenser 61, the decompressor 62, and the evaporator 10. The refrigerating cycle cools a refrigerating compartment in the refrigerator.

An operation of the defrosting heater 20 will be described below. The evaporator 10 is cooled with the refrigerant sent according to an operation of the compressor 60. A fan 11 operating with the compressor 60 makes air in the refrigerator flow through the cooled evaporator 10, and then, air having heat exchanged by the evaporator 10 is discharged into the refrigerator.

The compressor 60 stops after lapse of a predetermined operation time. Just after the stopping, the heater wire 21 is energized through the lead wire 26, and have the defrosting heater 20 emit heat.

A portion of heat radiated from the heater wire 21 is transmitted
5 directly to an outside. The other portion of the heat is transmitted to the glass tubes 23 and 24, raises a temperature at the surface of the tube 24 to a temperature lower than the igniting point of the flammable refrigerant, and is radiated for defrosting the evaporator 10 and neighbor components around the evaporator safely.

10 At this moment, air in the inside 23a of the glass tube 23 and the space 24a between the glass tubes 23 and 24 has a temperature raised and expands in volume. The expanding air urges and deforms the valve 25 and is discharged through the aperture 22b and the valve 25. This prevents the inside 23a and the space 24a from having a pressure increased,
15 hence protecting the glass tubes 23 and 24 from being broken and preventing the cap 22 from removing.

Then, the heater wire 21 stops being energized, and the refrigerating operation starts again to reduce the pressure in the glass tubes 23 and 24 by decreasing the temperature. The defrosting heater 20 has the pressure
20 reduced, and the valve 25 shuts off an external air. Accordingly, even if the flammable refrigerant flows near the defrosting heater 20, the refrigerant can hardly flow into the defrosting heater 20, thus reducing a chance of ignition.

Even in the case that the flammable refrigerant enters into the glass
25 tube and is ignited by the heater wire 21, the valve 25 opens slightly upon receiving a pressure higher than a predetermined level in the glass tube for preventing an excessive pressure, but blocks flame for preventing the flame

from move to the outside.

The aperture 22b of the cap 22 is very thin, having a cross section having a small area not larger than 7.1mm^2 , and thus preventing escape of the flame. That is, the flame is prevented from propagating to the outside through the aperture 22b even if the heater does not include the valve 25.

The valve 25 is mounted through the bottomed tube 27 to the cap 22. The valve 25 may be made of rubber. If the valve 25 is mounted directly to the cap 22 of rubber, the valve 25 is positioned unstably, and an opening pressure at which the valve 25 opens may vary. The valve 25 can be hardly mounted directly to the cap 22. The valve 25 is fixed to the tube 27 made of material harder than the rubber, thus stabilizing the opening pressure. The tube 27 is mounted directly to the cap 22 easily. The opening pressure of the valve 25 is adjustable by changing the size of a portion where the tube 27 is jointed to the valve 25. The opening pressure can be accordingly determined to an optimum level according to conditions, such as the amount of heat generated from the heater 20 and the inner volumes of the glass tubes 23 and 24.

Fig. 3 is an exploded view of the defrosting heater 20. The aperture 22a of the cap 22 has a diameter D1 smaller than a diameter D2 of the lead wire 26. This situation allows the cap 22 to tighten and hold the lead wire 26, hence preventing the external air and the refrigerant from entering through the aperture 22a into the heater 20.

The lead wire 26 is covered with a coating 26A of resilient material, such as silicone rubber, and it may be difficult to insert the wire into the aperture 22a. A leading end of the lead wire 26 is joined with the sleeve 28, and then, the sleeve 28 is inserted in the aperture, thus allowing the lead wire 26 to be inserted into the aperture 22a easily.

Fig. 4 illustrates another defrosting heater 120 of the embodiment. The defrosting heater 20 shown in Fig. 1 includes the glass tube 24 having the outer surface exposed. The glass tube 24 shown in Fig. 4 is covered entirely with a metal tube 50. The metal tube 50 functions as an enclosure
5 for protecting the glass tube 24 from directly receiving water.

Fig. 5 illustrates a further defrosting heater 220 of the embodiment. The defrosting heater 20 shown in Fig. 1 has a double-walled structural having the glass tubes 23 and 24. The heater 220 does not include the glass tube 24 and having the glass tube 23 exposed. The single glass tube
10 23 provides the same effect if the temperature at the surface of the tube remains lower than the igniting point of the flammable refrigerant.

Fig. 6 is a cross sectional view of an essential portion of the defrosting heater 220 shown in Fig. 5. The opening of the glass tube 23 is closed with caps 122 made of silicone rubber. The lead wire 26 extends through an
15 aperture 22a in each cap 122 to the heater wire 21. The cap 122 has an aperture 122b provided therein for having the inside 23a of the glass tube 23 communicate with the outside of the cap 122. The cross section of the aperture 122b has an area substantially not larger than 7.1mm^2 . A valve
20 25 of rubber closes an opening 27A of a bottomed tube 27 and provided at the aperture 122b of the cap 122. The valve 25 functions as a check valve for opening only in a single direction with a predetermined pressure difference.

Fig. 7 illustrates a still another defrosting heater 320 of the embodiment. The defrosting heater 220 shown in Fig. 6 includes the glass
25 tube 23 having the outer surface exposed. The glass tube 23 may be accommodated in a metal tube 50, as shown in Fig. 7. The metal tube 50 functions as an enclosure for protecting the glass tube 24 from directly

receiving water.

Moreover, the metal tube 50 shown in Figs. 4 and 7 may be colored in, e.g., black to increase heat radiated from the metal tube 50, hence increasing defrosting performance of the heaters 120 and 320. The coloring
5 suppresses a rise of the temperature at the surfaces of the heaters 120 and 320, and thus, the metal tube 50 is effective to remain the temperature lower than the igniting point of the flammable refrigerant.

According to the embodiment, the refrigerator is explained as an apparatus employing the defrosting heater 20. The apparatus may employ
10 the defrosting heaters 120, 220, and 320. The apparatus may be an refrigerating apparatus including an evaporator, such as a showcase or an automatic vendor machine, which has a refrigerating cycle including flammable refrigerant.

15 Industrial Applicability

A defrosting heater according to the present invention heats and eliminating frost attached on an evaporator in a refrigerating cycle. The defrosting heater includes a glass tube accommodating a heating wire, and a temperature of the surface of the glass tube does not rise very much.
20 Accordingly, even if the refrigerating cycle includes flammable refrigerant, the glass tube has the temperature lower than the igniting point of the flammable refrigerant, hence requiring no consideration for reducing a rise of the temperature.

Claims

1. A defrosting heater for heating and eliminating frost attached on an evaporator in a refrigerating cycle using flammable refrigerant, said defrosting heater comprising:

a first glass tube having an opening at an end thereof;

a heater wire accommodated in the first glass tube;

a cap for closing the opening of the first glass tube, the cap having a first aperture and a second aperture provided therein, the first aperture allowing an inside of the first glass tube communicate with an outside of the first glass tube, the second aperture allowing the inside of the first glass tube to communicate with an outside of the first glass tube, the second aperture having a cross section thereof having an area for preventing flame from being transmitted therein;

a lead wire inserted through the first aperture and connected to an end of the heater wire, the lead wire having a diameter larger than a diameter of the first aperture before the lead wire is inserted through the first aperture;

a tube having an opening therein and inserted into the second aperture of the cap; and

a valve provided in the tube as to close the opening of the tube, the valve being operable to discharge air from the inside of the first glass tube.

2. The defrosting heater according to claim 1, wherein the valve is operable to deform when a pressure of the inside of the first glass tube is higher than a predetermined pressure.

3. The defrosting heater according to claim 1, wherein the valve comprises a check valve operable to allow air only from the inside of the first glass tube.

4. The defrosting heater according to claim 1, further comprising

a metal tube for accommodating the first glass tube is accommodated.

5. The defrosting heater according to claim 4, wherein the metal tube has a surface thereof colored.

6. The defrosting heater according to claim 1, further comprising

a second glass tube for accommodating the first glass tube and having an openings at an end thereof,

wherein the cap closes the opening of the second glass tube and the opening of the first glass tube, and

wherein the valve is operable discharge air from the inside of the first glass tube and from a space between the first glass tube and the second glass tube.

7. The defrosting heater according to claim 6, wherein the valve is operable to deform when a pressure in the inside of the first glass tube and an inside of the second glass tube is higher than a predetermined pressure.

8. The defrosting heater according to claim 6,
wherein the second aperture allows the inside of the first glass tube and the space between the first glass tube and the second glass tube to communicate with an outside of the second tube.

9. The defrosting heater according to claim 6, wherein the valve comprises a check valve operable to allow air only from the inside of the first glass tube and from an inside of the second glass tube.

10. The defrosting heater according to claim 6, further comprising a metal tube for accommodating the second glass tube.

11. The defrosting heater according to claim 10, wherein the metal tube has a surface thereof colored.

12. A method of manufacturing a defrosting heater for heating and eliminating frost attached on an evaporator in a refrigerating cycle using flammable refrigerant, said method comprising:

providing a glass tube having an opening at an end thereof, a cap having a first aperture and a second aperture therein, a lead wire having a diameter larger than a diameter of the first aperture, and a heater wire;

closing the opening of the glass tube with the cap;

connecting a sleeve to an end of the lead wire;

inserting the sleeve of the lead wire into the first aperture of the cap; and

connecting the heater wire to the sleeve.

13. The defrosting heater according to claim 1, wherein the tube is harder than the cap.