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(54) **DEFROSTING DEVICE AND REFRIGERATOR COMPRISING SAME**

(57) Disclosed are a defrosting device (2) and a refrigerator comprising same. The defrosting device (2) comprises: a defrosting heater (10) which is provided with a heating element within a single-layer glass tube (12); a roof section (22) which is arranged above the glass tube (12) and extends in the longitudinal direction of the

glass tube (12), with the roof section (22) being made of a metal sheet and having an upwards protruding shape; a tray (30) which is arranged below the glass tube (12) and provided with an opening (32) in the bottom (30A) thereof; and a drain pipe (40) which extends downwards from the opening (32).

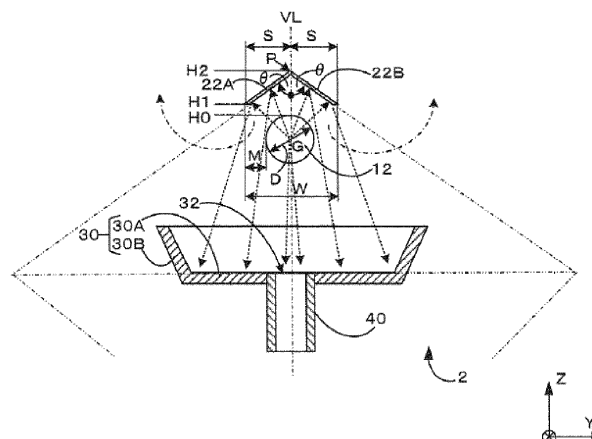


FIG.5

Description

TECHNICAL FIELD

[0001] The present invention relates to a defrosting device for defrosting an evaporator of a refrigerator and a refrigerator including the same.

BACKGROUND

[0002] In order to defrost an evaporator, a defrosting device is widely used, and the defrosting device includes a glass tube heater below the evaporator. In such a refrigerator, a temperature of an outer surface of the glass tube heater is required to be sufficiently lower than a flammable temperature of a solvent flowing in the evaporator. However, when input power of the glass tube heater is reduced to lower the temperature of the outer surface of the glass tube heater, an insufficient defrosting performance may be obtained. In particular, even when frost in the evaporator above the glass tube heater is melted by heat transferred by natural convection due to the glass tube heater, water falling from the evaporator after the melting process may be refrozen in a tray disposed below the glass tube heater.

[0003] In order to solve the problem, there is proposed a defrosting device with a defrosting heater in which a heating element is provided in a double-layer glass tube (for example, see patent document 1). In the defrosting device described in patent document 1, by using the double-layer glass tube, sufficient heat may be applied to melt the frost refrozen in the tray even when the outer surface of the glass tube heater has a low temperature.

[0004] Patent document 1: Publication No.JP2004198097.

[Problem to be solved by invention]

[0005] However, the glass tube heater including the double-layer glass tube has a high manufacturing cost, and the defrosting device including the glass tube heater or the refrigerator including the defrosting device has an increased manufacturing cost.

SUMMARY

[0006] An object of the present invention is to solve the above problems and to provide a defrosting device which may be manufactured at a low cost and has a sufficient defrosting function, and a refrigerator including the same.

[Means for solving problem]

[0007] A defrosting device according to the present invention includes: a defrosting heater having a heating element in a single-layer glass tube with a circular cross section perpendicular to a length direction; a roof portion disposed above the glass tube and extending in the

length direction of the glass tube, the roof portion being made of a metal sheet and having an upwards protruding shape; a tray disposed below the glass tube, extending in the length direction of the glass tube, and having an opening formed in a bottom thereof; and a drainage pipe extending downwards from the opening, wherein in a cross section perpendicular to the length direction of the glass tube, a top of the roof portion is located on a vertical line passing through a general center of the glass tube, and the roof portion is symmetrical with respect to the vertical line within at least a predetermined range on both sides of the vertical line, and in a cross section along the length direction of the glass tube including the vertical line, end regions on both sides of the roof portion in the length direction are inclined downwards to downwards reflect radiant heat from a lower side, and the opening is located directly below the glass tube.

[0008] According to the present invention, the single-layer glass tube is used to reduce the manufacturing cost of the device. Even when input power of the defrosting heater is suppressed to reduce a temperature of an outer surface of the glass tube, the radiant heat from the defrosting heater may be reflected towards the tray side by the roof portion, so as to melt frost in the tray. In particular, in the cross section perpendicular to the length direction of the glass tube, the upwards protruding shape of the roof portion is symmetrical with respect to the vertical line within at least the predetermined range on both sides of the vertical line passing through the general center of the glass tube, and further, in the cross section along the length direction of the glass tube including the above-mentioned vertical line, the upwards protruding shape of the roof portion is formed obliquely in the end regions on both sides, so as to downwards reflect the radiant heat from the lower side. That is, four corners of the roof portion are formed into a shape for improving reflection. Thus, the radiant heat with a small offset or deflection may be incident into a main part of the tray except a part directly below the glass tube.

[0009] Furthermore, the opening of the tray is located directly below the glass tube, and therefore, the radiant heat from the defrosting device is directly incident to the opening and a periphery thereof. Thus, the frost refrozen in the tray may be melted and reliably discharged through the opening and the drainage pipe.

[0010] As mentioned above, a defrosting device which is manufactured at a low cost and has a sufficient defrosting performance may be provided.

[0011] In addition, the present invention provides a defrosting device in which a lower end portion of the roof portion is disposed at a same position as or above an upper end of the glass tube in a height direction, and in the height direction, the top of the roof portion is disposed at a position higher than a position of the upper end of the glass tube by a length which is 1.5 times an outer diameter of the glass tube or less.

[0012] According to the present invention, since the lower end portion of the roof portion is disposed at the

same position as or above the upper end of the glass tube, frost adhering to an evaporator above the defrosting device may be reliably melted by the heat transferred by natural convection. Furthermore, since in the height direction, the top of the roof portion is disposed at the position higher than the position of the upper end of the glass tube by the length which is 1.5 times the outer diameter of the glass tube or less, the glass tube may be disposed near the evaporator, thus improving an effect of melting the frost adhering to the evaporator. Meanwhile, since the top of the roof portion is not too far away from the tray, the radiant heat from the defrosting heater may be strongly reflected towards the tray side by the roof portion, so as to improve the effect of melting the frost in the tray.

[0013] With the arrangement of the roof portion as mentioned above, the frost on the evaporator and the tray may be effectively melted to achieve a high defrosting performance.

[0014] In addition, the present invention provides a defrosting device in which a width at a lower end of the roof portion is 2 to 3 times the outer diameter of the glass tube in the cross section perpendicular to the length direction of the glass tube.

[0015] The width at the lower end of the roof portion is set to be 2 to 3 times the outer diameter of the glass tube, thus well balancing and effectively melting the frost of the evaporator and the tray.

[0016] Furthermore, the present invention provides a defrosting device further including a defrosting component made of a bent metal rod, the defrosting component having: a hook portion formed at one end portion of the metal rod and inserted into a hole portion provided at the roof portion in a free rotation state; a heat receiving portion connected with the hook portion and extending obliquely downwards while connected with the roof portion; a bypassing portion connected with the heat receiving portion and bent to bypass the glass tube; and a heat dissipation portion connected with the bypassing portion and extending downwards into the tray and the drainage pipe.

[0017] According to the present invention, in the defrosting component mounted to the roof portion by the hook portion in the free rotation state, the heat receiving portion comes into contact with the roof portion by gravity, and may receive the heat from the defrosting heater through a metal roof. Furthermore, the heat dissipation portion may be disposed inside the tray and the drainage pipe by gravity in a case where the bypassing portion does not interfere in the glass tube. The heat received by the roof portion is conducted through the bypassing portion to the heat dissipation portion extending downwards, and the heat may be supplied from the heat dissipation portion to the frost or water in the tray or the drainage pipe.

[0018] As mentioned above, by using the defrosting component, manufacture may be realized at a low manufacturing cost, and the heat from the defrosting heater

may be effectively supplied to the frost or water in the tray or the drainage pipe.

[0019] In addition, a refrigerator according to the present invention is characterized by including the above-mentioned defrosting device.

[0020] The refrigerator according to the present invention may also achieve any of the above-mentioned effects.

10 [Effects of invention]

[0021] As mentioned above, in the present invention, a defrosting device which may be manufactured at a low cost and has a sufficient defrosting performance and a refrigerator including the same may be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 schematically shows a side sectional view of a refrigerator having a defrosting device according to an embodiment of the present invention.

FIG. 2 is a schematic perspective diagram schematically showing a defrosting device according to a first embodiment of the present invention.

FIG. 3 is a view showing a cross section perpendicular to a length direction of a glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing the defrosting device according to the first embodiment of the present invention.

FIG. 4 is a view showing a cross section along the length direction of the glass tube, the view including a vertical line passing through a general center of a circular shape of the glass tube, and is a side sectional view schematically showing the defrosting device according to the first embodiment of the present invention.

FIG. 5 is a view showing the cross section perpendicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view for illustrating an arrangement of a roof portion according to an embodiment of the present invention.

FIG. 6 is a view showing the cross section perpendicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device according to a second embodiment of the present invention.

FIG. 7 is a view showing the cross section perpendicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device according to a third embodiment of the present invention.

FIG. 8 is a view showing the cross section perpen-

dicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device according to a fourth embodiment of the present invention.

FIG. 9 is a perspective view for illustrating a defrosting component according to an embodiment of the present invention.

REFERENCE NUMERALS

[0023] 2-defrosting device, 10-defrosting heater, 12-glass tube, 14-cover, 20-heater cover, 22-roof portion, 22A-first region, 22B-second region, 22C-third region, 22D-fourth region, 24-bracket, 26-hole portion, 30-tray, 30A-bottom, 30B-side wall, 32-opening, 40-drainage pipe, 50-defrosting component, 52-hook portion, 54-heat receiving portion, 56-bypassing portion, 58-heat dissipation portion, 100-refrigerator, 102A-freezing chamber, 102B-refrigerating chamber, 104A, 104B-inflow passage, 106-partition, 106A-blow-out port, 110-evaporator, 120-compressor, 130-fan, 140-damper, 150-drainage pipe, 160-evaporating pan, G-general center, VL-vertical line, and S-specified range.

DETAILED DESCRIPTION

[0024] Embodiments for implementing the present invention will be described below with reference to accompanying drawings. A defrosting device described below is used for embodying the technical idea of the present invention, and the present invention is not limited to the following unless otherwise specified.

[0025] In the drawings, members having the same function may be denoted by the same reference numerals. For convenience of explanation or understanding of key points, there are cases where the description is divided into embodiments for convenience, but parts of structures shown in different embodiments may be replaced or combined. In the embodiment described below, descriptions about matters common to the above are omitted, and only different points will be described. In particular, the same effects caused by the same structure will not be mentioned in turn in each embodiment. In order to clarify the description, the sizes, positional relationships, or the like, of members shown in each drawing may be shown in an expanded manner. In the following description and drawings, an X-axis, a Y-axis, and a Z-axis are shown assuming that a refrigerator is disposed on a floor. The Z-axis is used to indicate a vertical direction, and the X-axis is used to indicate a length direction of a glass tube 12 included in a defrosting heater 10 described below.

(Refrigerator including defrosting device according to present invention)

[0026] FIG. 1 is a side sectional view schematically

showing an example of a refrigerator 100 including a defrosting device 2 according to an embodiment of the present invention. The refrigerator 100 shown in FIG. 1 includes a freezing chamber 102A and a refrigerating chamber 102B. Inflow passages 104A, 104B spaced apart by a partition 106 are provided on rear sides of the freezing chamber 102A and the refrigerating chamber 102B. An evaporator 110 is disposed in the inflow passage 104A on the freezing chamber 102A side, and a fan 130 is disposed above the evaporator 110. The defrosting device 2 according to each embodiment described below is disposed below the evaporator 110.

[0027] A compressor 120 in communication with the evaporator 110 is disposed in a machinery chamber outside the rear side of the freezing chamber 102A. The following cycle is repeated: a refrigerant (gas) compressed by the compressor 120 is liquefied by a condenser, the liquefied refrigerant absorbs heat of the gas in a tank in the evaporator 110 and is vaporized, and the vaporized refrigerant is compressed again by the compressor 120. A damper 140 is disposed between the inflow passage 104A on the freezing chamber 102A side and the inflow passage 104B on the refrigerating chamber 102B side. In FIG. 1, the damper 140 is shown in a closed state.

[0028] As shown by the dotted arrow in FIG. 1, when the compressor 120 and the fan 130 are actuated in the state where the damper is closed, the gas in the freezing chamber 102A flows, and the cold gas passing through the evaporator 110 flows into the freezing chamber 102A from a blow-out port 106A provided in the partition 106. The inflow gas circulates in the freezing chamber 102A and returns to a lower side of the evaporator 110 in the inflow passage 104A again. An interior of the freezing chamber 102A is cooled by the circulation of the gas cooled by the evaporator 110. In a state where the damper 140 is opened, cool air also circulates on the refrigerating chamber 102B side.

[0029] Moisture contained in the cooled air is condensed into frost and adheres to a surface of a heat exchange tube of the evaporator 110. A cooling performance is degraded when a large amount of frost adheres to the heat exchange tube, and therefore, the evaporator 110 is required to be defrosted periodically. Therefore, the defrosting device 2 is disposed below the evaporator 110. The defrosting device 2 includes a defrosting heater 10, and when the compressor 120 and the fan 130 do not work, the defrosting heater 10 is turned on, thus heating and defrosting the heat exchange tube. Water falling after the frost on the evaporator 110 is melted is discharged from a drainage pipe 40 of the defrosting device 2, flows in a drainage pipe 150 of the refrigerator 100, and is discharged to a steam tray 160 disposed in the machinery chamber.

(Defrosting device according to first embodiment)

[0030] FIG. 2 is a schematic perspective diagram sche-

matically showing a defrosting device 2 according to a first embodiment of the present invention. FIG. 3 is a view showing a cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing the defrosting device 2 according to the first embodiment of the present invention. FIG. 4 is a view showing a cross section along the length direction of the glass tube including a vertical line passing through a general center of a circular shape of the glass tube, and is a side sectional view schematically showing the defrosting device according to the first embodiment of the present invention. In FIG. 4, a description of a tray is omitted. Next, the defrosting device 2 according to the first embodiment of the present invention will be described with reference to FIGS. 2 to 4.

[0031] The defrosting device 2 according to the present embodiment includes a defrosting heater 10 having a heating element in a single-layer quartz glass tube 12. Furthermore, the defrosting device 2 includes a heater cover 20, and the heater cover 20 includes a roof portion 22 which is disposed above the glass tube 12, extends in the length direction of the glass tube 12, is made of a metal sheet and protrudes upwards. Furthermore, the defrosting device 2 includes a tray 30 disposed below the glass tube 12 and extending along the length direction of the glass tube 12, and a drainage pipe 40 extending downwards from an opening 32 provided in a bottom of the tray 30. FIG. 3 schematically shows the drainage pipe 40 shown in FIG. 2.

[0032] Further, the defrosting device 2 according to the present embodiment includes a defrosting component 50 formed by bending a metal rod. The defrosting component 50 includes: a hook portion 52 formed at one end portion of the metal rod and inserted into a hole portion 26 provided in the metal sheet forming the roof portion 22 in a free rotation state, a heat receiving portion 54 connected with the hook portion 52 and extending obliquely downwards while connected with the metal sheet forming the roof portion 22, a bypassing portion 56 connected with the heat receiving portion 54 and bent to bypass the glass tube 12, and a heat dissipation portion 58 connected with the bypassing portion 56 and extending downwards into the tray 30 and the drainage pipe 40.

<Defrosting heater>

[0033] The glass tube 12 included in the defrosting heater 10 in the present embodiment has an elongated cylindrical shape. The heating element made of a metal wire, such as a nichrome wire, is disposed inside the glass tube 12. A coil-shaped heater made of a metal wire wound into a coil shape is disposed in a central heating region of the glass tube 12, and the metal wire extends outwards from both ends thereof. Both end portions of the glass tube 12 are covered with covers 14 made of a material having an excellent heat resistance and excellent electrical insulation, such as silicone rubber, or the

like. Portions of the metal wire extending from both sides of the coil-shaped heater extend outside the glass tube 12 through the covers 14, and are electrically connected with external cables.

[0034] In order to comply with IEC regulations, input power is controlled, such that an outer surface of the heated glass tube 12 has a temperature of 360°C or lower. The evaporator 100 may be sufficiently defrosted practically even when such control is performed on the input power, which will be described in detail below.

<Heater cover>

[0035] The heater cover 20 includes the roof portion 22 extending in the length direction of the glass tube 12, made of the metal sheet and protruding upwards, and brackets 24 provided on both sides of the roof portion 22 in the length direction. The covers 14 at both ends of the glass tube 12 are inserted into substantially C-shaped openings provided in the brackets 24, and the heater cover 20 is connected to the defrosting heater 10.

[0036] In the present embodiment, an aluminum sheet having a high reflectance and a high thermal conductivity is used as the metal sheet forming the roof portion 22. However, the present invention is not limited thereto, and other arbitrary metal sheets, such as a copper sheet, may be used. The upwards protruding shape may also be formed by bending an aluminum sheet, or by joining 2 aluminum sheets.

[0037] In the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the metal sheet of the roof portion 22 is formed in the upwards protruding shape, and the upwards protruding shape is symmetrical with respect to the vertical line VL within at least a predetermined range S on both sides of the vertical line VL passing through the general center G of the circular shape of the glass tube 12. Here, the predetermined range S on both sides of the vertical line VL refers to a range with a left side and a right side at a distance S from the vertical line VL in the Y-axis direction perpendicular to the vertical line VL in 2 regions divided by the vertical line VL in the Z-axis direction. The upwards protruding shape of the roof portion 22 has 2 flat plates: a first region 22A and a second region 22B. As described below, planes or smoothly curved surfaces may be used as reflection surfaces of the first region 22A and the second region 22B.

[0038] Further, as shown in FIG. 4, in the cross section along the length direction of the glass tube 12, the roof portion 22 has a third region 22C and a fourth region 22D inclined downwards in end regions on both sides in the length direction, so as to downwards reflect radiant heat from a lower side. That is, as shown in FIG. 2, the roof portion 22 has a structure like a hipped roof formed by 4 sheet-like members: the first to fourth regions 22A to 22D, and all side surfaces have shapes for improving reflection. Planes or smoothly curved surfaces may also be used as reflection surfaces of the third region 22C and

the fourth region 22D.

[0039] With the above structure, the radiant heat from the defrosting heater 10 may be reflected downwards and incident on a main part of the tray 30 below the defrosting heater, thus melting frost refrozen in the tray 30.

<Tray and drainage pipe>

[0040] The tray 30 extends along the length direction of the glass tube 12, has the bottom 30A and a side wall 30B surrounding the bottom 30A, and opens upwards. The opening 32 is provided in a substantially central position in a length direction of the bottom 30A of the tray 30. The bottom 30A of the tray 30 is inclined to minimize a height of the opening 32. Thus, the water falling from the evaporator 110 above the defrosting device flows in the bottom 30A of the tray 30 into the opening 32. The drainage pipe 40 is mounted to the opening 32 provided in the bottom 30A of the tray 30, and extends downwards from the opening 32.

[0041] In the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the opening 32 of the tray 30 is located directly below the glass tube 12. With such an arrangement, the opening 32 and a region around the opening may directly receive the radiant heat from the defrosting heater 10, so as to melt the frost refrozen in the tray 30.

[0042] The tray 30 is preferably made of a metal material with a high thermal conductivity, such as aluminum. In consideration of ease of mounting the defrosting device 2 to the refrigerator 100, or the like, the drainage pipe 40 is preferably made of a resin material with an elasticity, or the like.

(Arrangement of roof portion)

[0043] FIG. 5 is a view showing the cross section perpendicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view for illustrating an arrangement of a roof portion 22 according to an embodiment of the present invention. In FIG. 5 and FIGS. 6 to 8 described below, the dotted arrow indicates the radiant heat emitted from the defrosting heater 10, and the dash-and-dot arrow indicates an upward flow of ambient gas heated by the defrosting heater 10 due to natural convection. Although FIG. 5 illustrates the defrosting device according to the first embodiment shown in FIG. 3, functions of the roof portion 22 are basically same in defrosting devices according to the second to fourth embodiments described with reference to FIGS. 6 to 8.

[0044] In the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL within the predetermined range S on both sides of the vertical line VL passing through the general center G of the circular shape of the glass tube 12. In the first em-

bodiment, the predetermined range S is uniform in an entire region of the roof portion 22, and the whole region is symmetrical with respect to the vertical line VL. However, the present invention is not limited thereto, and other cases will be described in detail below.

[0045] The predetermined range S is preferably determined in accordance with a width of the tray 30 perpendicular to the length direction as viewed from the X-axis direction. In a case where both end portions of the tray 30 in the width direction are located at a same distance from the vertical line VL, preferably, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL up to a range where reflected light reaches both end portions of the tray 30. In a case where both end portions of the tray 30 in the width direction are located at different distances from the vertical line VL, preferably, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL up to a range where the reflected light reaches at least the end portion close to the vertical line VL side. Thus, the radiant heat with a small offset or deviation may be incident into the main part of the tray 30, so as to efficiently melting the frost in the tray 30.

[0046] In the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the first region 22A and the second region 22B are shown as two side surfaces connected at a top P located on the vertical line VL. Moreover, an angle θ formed by the first region 22A and the vertical line VL substantially coincides with an angle θ formed by the second region 22B and the vertical line VL. Further, in an example shown in FIG. 5, the first region 22A and the second region 22B also have uniform lengths.

[0047] This case may also be considered as follows: in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the first region 22A and the second region 22B form 2 equal sides of an isosceles triangle with a vertex P located on the vertical line VL as a vertex.

[0048] As shown by the double-dot dash line in FIG. 5, the first region 22A and the second region 22B extend obliquely downwards to intersect with a horizontal line of a bottom surface of the tray 30, thus forming an upper half of a parallelogram. Moreover, a center of the opening 32 of the tray 30 substantially coincides with the position of the vertical line VL. That is, the opening 32 of the tray 30 is located at a center of a parallelogram having the roof portion 22 of the upwards protruding shape and extended lines thereof as two sides.

[0049] With such an arrangement, the radiant heat emitted upwards from the defrosting heater 10 may be reflected downwards by the roof portion 22, and the radiant heat with the small offset or deflection may be incident on the main part of the tray 30 except a part directly below the glass tube 12. A region where the reflected light from the roof portion 22 does not reach exists directly below the glass tube 12, but the radiant heat emitted downwards from the defrosting heater 10 is directly inci-

dent on such a region, thus efficiently melting the frost refrozen in the main part of the tray 30. The melting water flows into the drainage pipe 40 through a switch 32, flows in the drainage pipe 150 of the refrigerator 100, and is discharged to an evaporation pan 160 disposed in the machinery chamber.

[0050] In the example shown in FIG. 5, a position H1 of a lower end portion of the roof portion 22 is disposed above a position H0 of an upper end of the glass tube 12 in a height direction (the Z-axis direction). However, the present invention is not limited thereto, and the position H1 of the lower end portion of the roof portion 22 may be same as the position H0 of the upper end of the glass tube 12. That is, the position H1 of the lower end portion of the roof portion 22 is the same as or above the position H0 of the upper end of the glass tube 12 in the height direction (the Z-axis direction).

[0051] With such a setting, the gas around the glass tube 12 heated by the defrosting heater 10 may efficiently flow upwards by natural convection. Thus, the heat may be provided for the evaporator 110 by natural convection heat transfer, thereby reliably melting the frost adhering to the evaporator 110.

[0052] Furthermore, in the height direction (the Z-axis direction), the top P of the roof portion 22 is disposed at a position H2 higher than the position H0 of the upper end of the glass tube 12 by a length which is 1.5 times an outer diameter of the glass tube 12 or less. With such a setting, the defrosting heater 10 may be relatively close to the evaporator 110, thus improving the effect of melting the frost adhering to the evaporator 110. Meanwhile, since the top P of the roof portion 22 is not too far away from the tray 30, the radiant heat from the defrosting heater 10 may be strongly reflected towards the tray 30 by the roof portion 22, so as to improve the effect of melting the frost in the tray 30. With the arrangement of the roof portion 22 as mentioned above, the frost on the evaporator 110 and the tray 30 may be effectively melted to achieve a high defrosting performance.

[0053] Furthermore, in the present embodiment, a width W at a lower end of the roof portion 22 is 2 to 3 times the outer diameter D of the glass tube in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction. Furthermore, when an end portion of the lower end of the roof portion 22 in the width direction has a distance M from the shape of the glass tube 12, $0.5D \leq M \leq D$.

[0054] When the width W at the lower end of the roof portion 22 is not much greater than the outer diameter of the glass tube 12, the heat generated by the defrosting heater 10 is unable to be sufficiently reflected downwards. On the other hand, when the width W at the lower end of the roof portion 22 is considerably greater than the outer diameter of the glass tube 12, the heat is difficult to be supplied to the evaporator 110 side above the defrosting device by natural convection. Therefore, the width W at the lower end of the roof portion 22 is set to be 2 to 3 times the outer diameter of the glass tube 12,

thereby well balancing and effectively melting the frost of the evaporator 110 and the tray 30. A same relationship is also shown in a cross section perpendicular to the length direction of the glass tube 12 as viewed from a direction opposite to the X-axis direction.

(Defrosting device according to second embodiment)

[0055] FIG. 6 is a view showing the cross section perpendicular to the length direction of the glass tube as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device according to a second embodiment of the present invention. In the defrosting device 2 according to the second embodiment, the roof portion 22 also has an upwards protruding shape formed by connecting a first region 22A and a second region 22B which have flat plate shapes. However, in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the second region 22B has a same length as the second region in the first embodiment, but the first region 22A is longer than the first region in the first embodiment.

[0056] As shown in FIG. 6, in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL within the predetermined range S on both sides of the vertical line passing through the general center G of the circular shape of the glass tube 12, but not symmetrical with respect to the vertical line VL in the whole region. In one first region 22A of the roof portion 22, a width is extended by an amount T.

[0057] In the above-mentioned first embodiment, in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the end portions in the width direction of the tray 30 on the lower side have substantially the same distance from the vertical line VL in the Y-axis direction perpendicular to the vertical line VL, but the two end portions of the tray 30 in the width direction have different distances from the vertical line VL in the second embodiment. The upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL in a range where the reflected light is incident on the end portion of the tray 30 in the width direction close to the vertical line VL side (the right end portion in the drawing). Then, by adjusting a length of the roof portion 22, the reflected light is also incident on the other end portion (the left end portion in the drawing). A same relationship with the left and right reversed is shown in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the direction opposite to the X-axis direction.

(Defrosting device according to third embodiment)

[0058] FIG. 7 is a view showing the cross section perpendicular to the length direction of the glass tube 12 as

viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device 2 according to a third embodiment of the present invention.

[0059] In the defrosting devices according to the first and second embodiments described above, the roof portion 22 is formed by the first region 22A and the second region 22B which have flat plate shapes, but in the third embodiment, the roof portion 22 is formed by a smooth curved surface.

[0060] In this case, by appropriately determining curvature of the curved surface of the roof portion 22, as shown in FIG. 7, the radiant heat emitted upwards from the defrosting heater 10 may be reflected downwards by the roof portion 22, so as to be incident on the main part of the tray 30 except the region shielded by the glass tube 12. In the third embodiment, similarly to the first embodiment, the whole region of the roof portion 22 is symmetrical with respect to the vertical line VL passing through the general center G of the circular shape of the glass tube 12. A same relationship is also shown in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the direction opposite to the X-axis direction.

(Defrosting device according to fourth embodiment)

[0061] FIG. 8 is a sectional view perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction in FIG. 2, and is a side sectional view schematically showing a defrosting device 2 according to a fourth embodiment of the present invention.

[0062] In the fourth embodiment, the roof portion 22 is also formed by a smooth curved surface. In the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL within the predetermined range S on both sides of the vertical line passing through the general center G of the circular shape of the glass tube 12, but the roof portion 22 is not symmetrical with respect to the vertical line VL in the whole region. In one first region 22A of the roof portion 22, the width is extended by an amount T.

[0063] In the fourth embodiment, in the cross section perpendicular to the length direction of the glass tube 12 as viewed from the X-axis direction of FIG. 2, the two end portions of the tray 30 in the width direction have different distances from the vertical line VL. The upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL in the range where the reflected light is incident on the end portion of the tray 30 in the width direction close to the vertical line VL side (the right end portion in the drawing). Then, by adjusting the length of the roof portion 22, the reflected light is also incident on the other end portion (the left end portion in the drawing). A same relationship with the left and right reversed is shown in the cross section perpendicular to

the length direction of the glass tube 12 as viewed from the direction opposite to the X-axis direction.

[0064] As mentioned above, the defrosting device 2 according to any one of the first to fourth embodiments of the present invention described above includes: the defrosting heater 10 having the heating element in the single-layer glass tube 12 with the circular cross section perpendicular to the length direction; the roof portion 22 disposed above the glass tube 12, extending in the length direction of the glass tube 12, made of the metal sheet and having the upwards protruding shape; the tray 30 disposed below the glass tube 12, extending in the length direction of the glass tube 12, and having the opening 32 formed in the bottom thereof; and the drainage pipe 40 extending downwards from the opening 32, wherein in the cross section perpendicular to the length direction of the glass tube 12, the top P of the roof portion 22 is located on the vertical line VL passing through the general center G of the glass tube 12, and the roof portion 22 is symmetrical with respect to the vertical line VL within at least the predetermined range on both sides of the vertical line VL, and in the cross section along the length direction of the glass tube 12 including the vertical line VL, the end regions on both sides of the roof portion 22 in the length direction are inclined downwards to downwards reflect the radiant heat from the lower side, and the opening 32 is located directly below the glass tube 12.

[0065] The single-layer glass tube 12 is used to reduce a manufacturing cost of the device. Even when input power of the defrosting heater 10 is suppressed to reduce a temperature of an outer surface of the glass tube 12, the radiant heat from the defrosting heater 10 may be reflected towards the tray 30 side by the roof portion 22, so as to melt the frost in the tray 30. In particular, the upwards protruding shape of the roof portion 22 is symmetrical with respect to the vertical line VL in at least the predetermined range S on both sides of the vertical line VL passing through the general center G of the glass tube 12, and in the length direction (the X-axis direction shown in FIG. 2) of the glass tube 12, the end regions (see 22C and 22D in FIG. 4) on both sides are inclined to downwards reflect the radiant heat from the lower side, and the opening 32 of the tray 30 is located directly below the glass tube 12, thus using the reflected heat from the roof portion 22 and the radiant heat directly received from the defrosting heater 10, and making the radiant heat with the small offset or deflection incident into the main part of the tray 30. Therefore, the frost adhering to the evaporator 110 may be melted and discharged through the opening 32 of the tray 30 and the drainage pipe 40. As mentioned above, a defrosting device 2 which may be manufactured at a low cost and has a sufficient defrosting performance may be provided.

[0066] In addition, in the defrosting devices 2 according to the first to fourth embodiments, since the position H1 of the lower end portion of the roof portion 22 is the same as or above the position H0 of the upper end of the glass tube 22 in the height direction (the Z-axis direction), the

frost adhering to the evaporator 110 may be effectively melted by the heat transferred by natural convection. Further, in the height direction (the Z-axis direction), the top P of the roof portion 22 is disposed at the position H2 higher than the position H0 of the upper end of the glass tube 12 by the length which is 1.5 times the outer diameter of the glass tube 12 or less, thus improving the effect of melting the frost adhering to the evaporator 110 and the frost in the tray 30. With the arrangement of the above roof portion 22, the frost on the evaporator 110 and the tray 30 may be effectively melted to provide the high defrosting performance.

[0067] In addition, in the defrosting devices 2 according to the first to fourth embodiments, the width W at the lower end of the roof portion 22 is 2 to 3 times the outer diameter D of the glass tube 12, thus well balancing and effectively melting the frost of the evaporator 110 and the tray 30.

(Defrosting component)

[0068] FIG. 9 is a perspective view for illustrating a defrosting component according to an embodiment of the present invention. FIG. 9 schematically shows the shape of the roof portion 22. Any of the defrosting devices 2 according to above-mentioned embodiments includes the defrosting component 50 formed by bending the metal rod. As shown in FIG. 3 or 9, the defrosting component 50 has the hook portion 52 formed at one end portion of the metal rod and inserted into the hole portion 26 provided in the metal sheet forming the roof portion 22 in the free rotation state. Further, the defrosting component 50 has the heat receiving portion 54 connected with the hook portion 52 and extending obliquely downwards while connected with the metal sheet forming the roof portion 22. The defrosting component 50 mounted, at one end portion thereof, to the roof portion 22 by the hook portion 52 in the free rotation state is suspended by gravity, and the heat receiving portion 54 extends obliquely downwards while coming into contact with the metal sheet forming the roof portion 22.

[0069] Further, the defrosting component 50 has the bypassing portion 56 connected with the heat receiving portion 54 and bent to bypass the glass tube 12. Since the heat receiving portion 54 and the metal sheet forming the roof portion 22 come into contact by gravity to have fixed positions, the bypassing portion 56 may be reliably separated from the glass tube 12. Further, the defrosting component 50 has the heat dissipation portion 58 connected with the bypassing portion 56 and extending downwards into the tray 30 and the drainage pipe 40. The defrosting component 50 terminates at an end portion of the heat dissipation portion 58.

[0070] In the defrosting component 50 mounted to the roof portion 22 by the hook portion 52 in the free rotation state, the heat receiving portion 54 comes into contact with the roof portion 22 by gravity, and therefore receives the heat from the defrosting heater 10 through the contact

part of the metal roof portion 22. Furthermore, the heat received by the heat receiving portion 54 is conducted through the bypassing portion 56 to the heat dissipation portion 58 extending downwards. Thus, the heat is supplied from the heat dissipation portion 58 to the frost or water in the tray 30 or the drainage pipe 40. Therefore, the frost in the tray 30 or the drainage pipe 40 may be melted and discharged through the drainage pipe 40.

[0071] As mentioned above, by using the defrosting component 50 in addition to the roof portion 22, the heat from the defrosting heater 10 may be effectively supplied to the frost or water in the tray 30 or the drainage pipe 40 at a low manufacturing cost.

[0072] Further, as shown by arrows A, B in FIG. 9, the defrosting component 50 may be rotated to be disposed along a surface of the roof portion 22. Therefore, when the defrosting device 2 is mounted in the refrigerator 100, or when components are dismounted or replaced, the defrosting component 50 is placed along the surface of the roof portion 22 and fixed using adhesive tape, or the like, thus preventing the defrosting component 50 from interfering with other members, so as to improve a working efficiency.

(Refrigerator)

[0073] The refrigerator 100 shown in FIG. 1 including the defrosting device 2 according to the above-mentioned embodiment may also achieve any of the above-mentioned effects.

[0074] While the embodiments of the present invention have been described, the disclosure may vary in details of the structure, and combinations of elements, changes of sequences, or the like, of the embodiments may be realized without departing from the scope and idea claimed by the present invention.

Claims

1. A defrosting device (2), comprising:

a defrosting heater (10) having a heating element in a single-layer glass tube (12) with a circular cross section perpendicular to a length direction;

a roof portion (22) disposed above the glass tube (12) and extending in the length direction of the glass tube (12), the roof portion (22) being made of a metal sheet and having an upwards protruding shape;

a tray (30) disposed below the glass tube (12), extending in the length direction of the glass tube (12), and having an opening (32) formed in a bottom (30A) thereof; and

a drainage pipe (40) extending downwards from the opening (32),

wherein in a cross section perpendicular to the

- length direction of the glass tube (12),
a top of the roof portion (22) is located on a vertical line (VL) passing through a general center (G) of the glass tube (12), and the roof portion (22) is symmetrical with respect to the vertical line (VL) within at least a predetermined range (2) on both sides of the vertical line (VL), and in a cross section along the length direction of the glass tube (12) comprising the vertical line (VL), end regions on both sides of the roof portion (22) in the length direction are inclined downwards to downwards reflect radiant heat from a lower side, and the opening (32) is located directly below the glass tube (12).
2. The defrosting device (2) according to claim 1, wherein a lower end portion of the roof portion (22) is disposed at a same position as or above an upper end of the glass tube (12) in a height direction, and in the height direction, the top of the roof portion (22) is disposed at a position higher than a position of the upper end of the glass tube (12) by a length which is 1.5 times an outer diameter of the glass tube (12) or less.
3. The defrosting device (2) according to claim 1, wherein a width at a lower end of the roof portion (22) is 2 to 3 times the outer diameter of the glass tube (12) in the cross section perpendicular to the length direction of the glass tube (12).
4. The defrosting device (2) according to claim 1, further comprising a defrosting component (50) made of a bent metal rod, the defrosting component (50) having:
- a hook portion (52) formed at one end portion of the metal rod and inserted into a hole portion (26) provided at the roof portion (22) in a free rotation state;
- a heat receiving portion (54) connected with the hook portion (52) and extending obliquely downwards while connected with the roof portion (22);
- a bypassing portion (56) connected with the heat receiving portion (54) and bent to bypass the glass tube (12); and
- a heat dissipation portion (58) connected with the bypassing portion (56) and extending downwards into the tray (30) and the drainage pipe (40).
5. The defrosting device (2) according to claim 1, wherein the roof portion (22) is formed by a first region (22A) and a second region (22B) having flat plate shapes; or the roof portion (22) is formed by a first region (22A) and a second region (22B) having curved surface shapes.
6. The defrosting device (2) according to claim 5, wherein the first region (22A) and the second region (22B) are symmetrically arranged with respect to the vertical line (VL).
7. The defrosting device (2) according to claim 5, wherein an angle θ formed by the first region (22A) and the vertical line (VL) coincides with an angle θ formed by the second region (22B) and the vertical line (VL), and the first region (22A) is longer than the second region (22B).
8. The defrosting device (2) according to claim 1, wherein the roof portion (22) has a third region (22C) and a fourth region (22D) inclined downwards in end regions on both sides in the length direction thereof.
9. The defrosting device (2) according to claim 8, wherein planes or curved surfaces serve as reflection surfaces of the third region (22C) and the fourth region (22D).
10. A refrigerator comprising the defrosting device (2) according to claim 1.

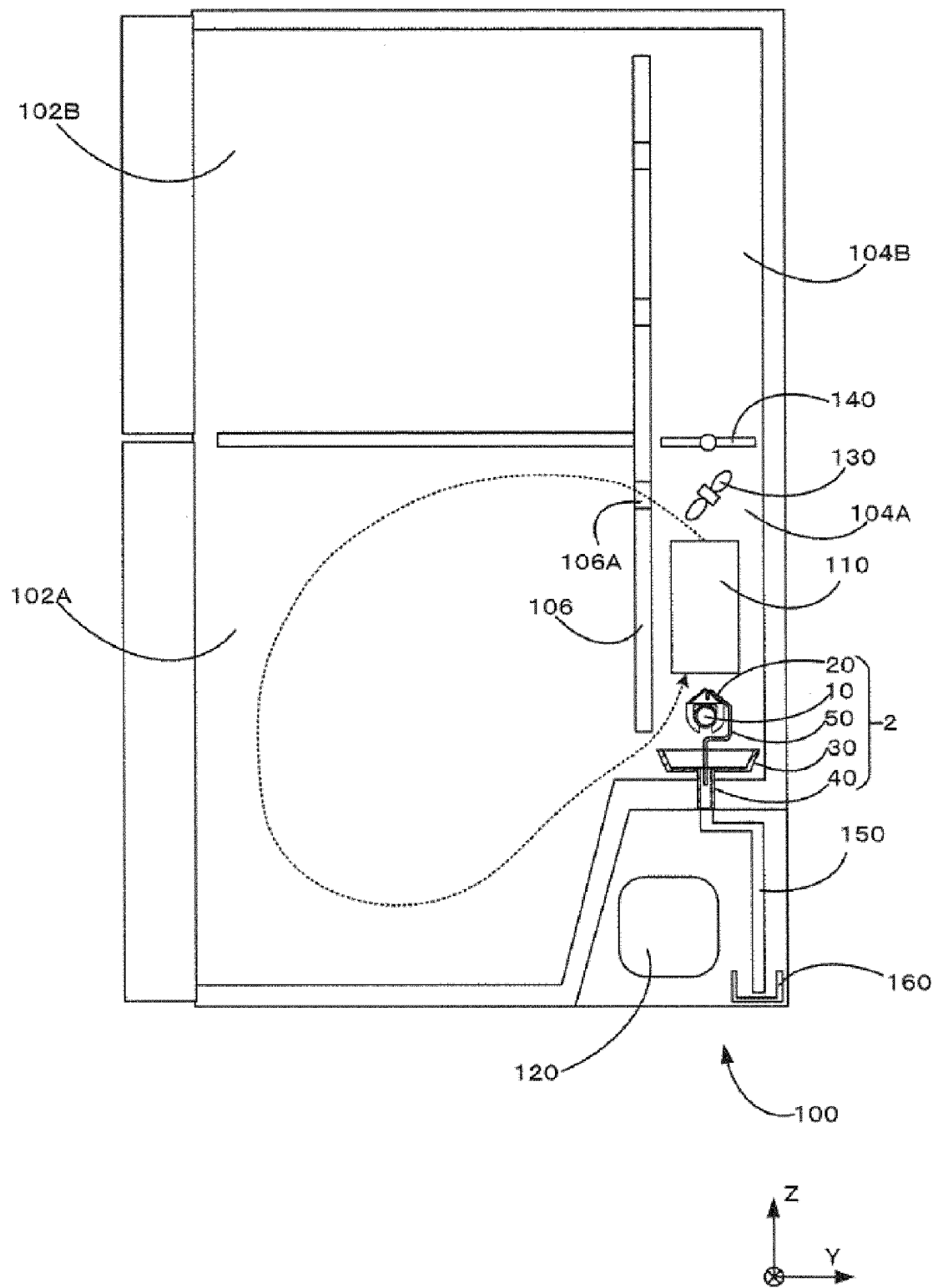


FIG.1

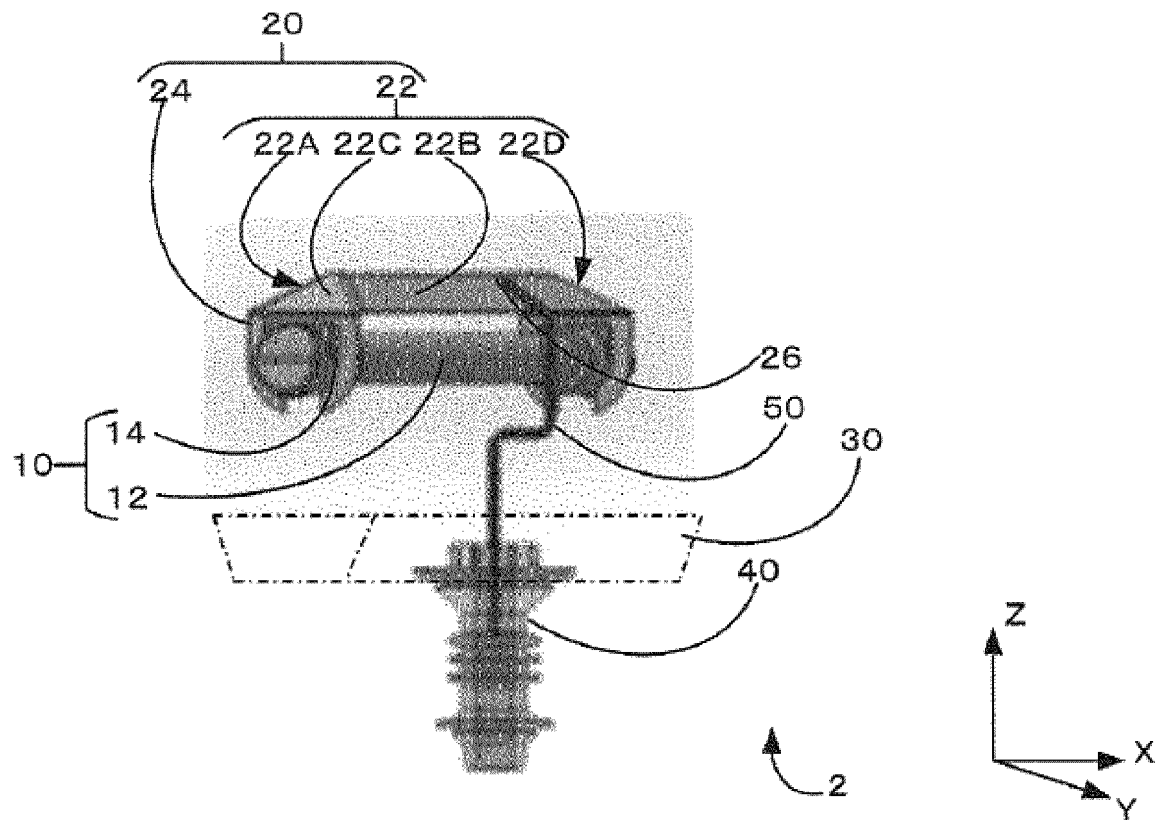


FIG.2

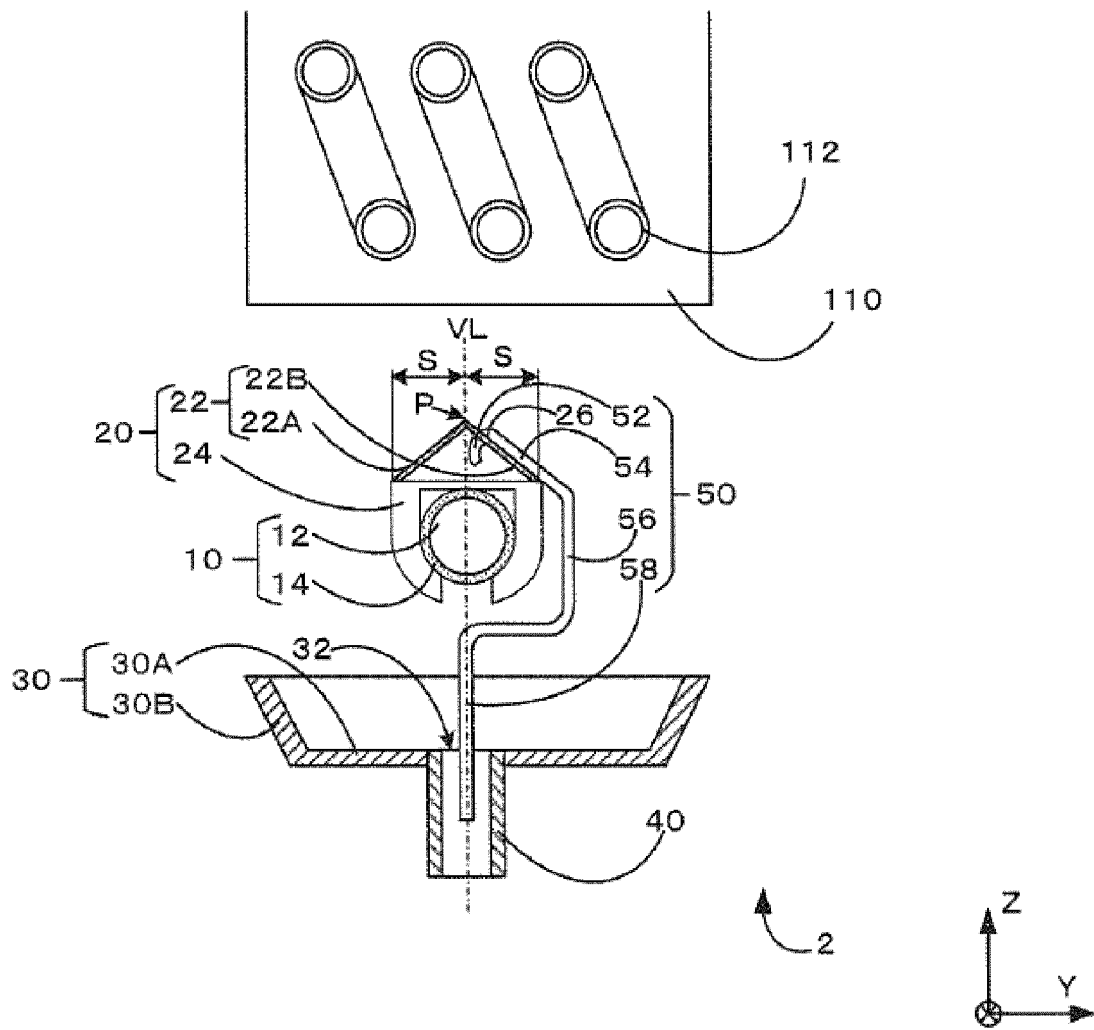


FIG.3

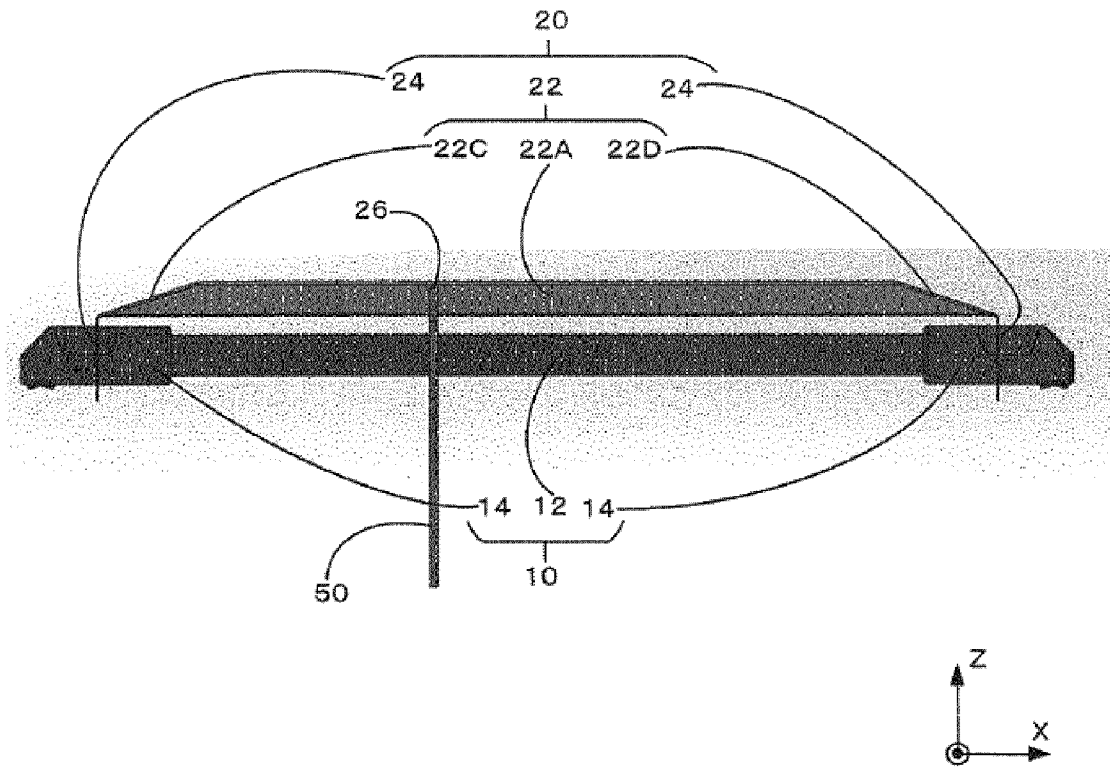


FIG. 4

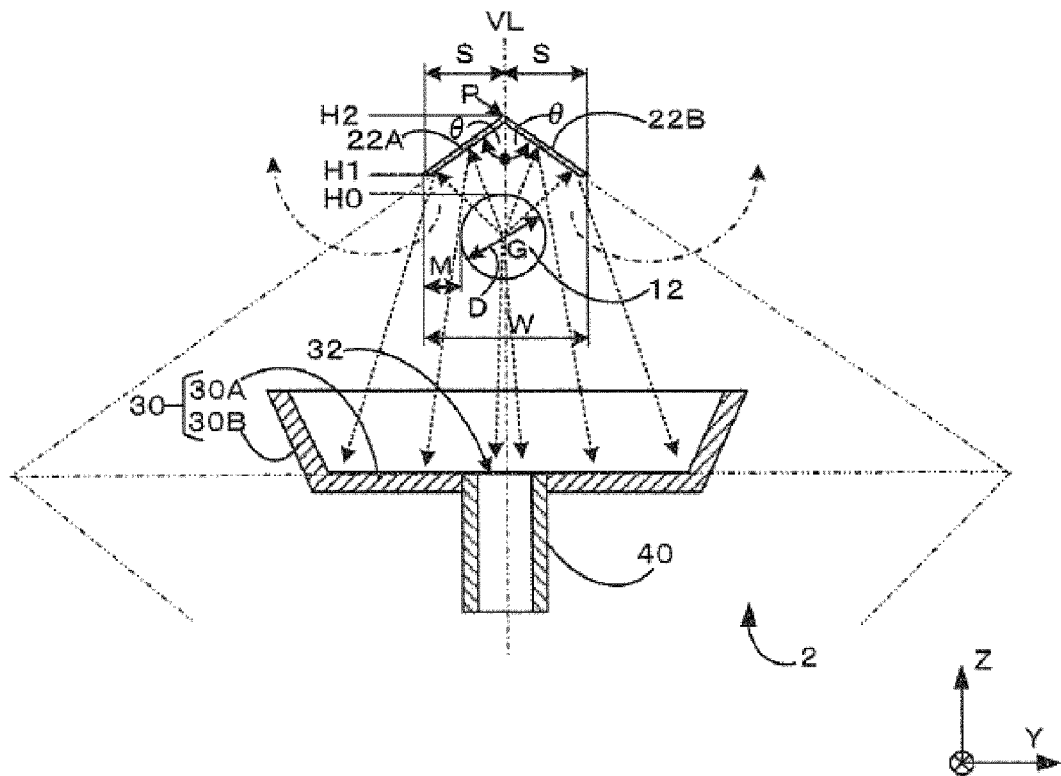


FIG. 5

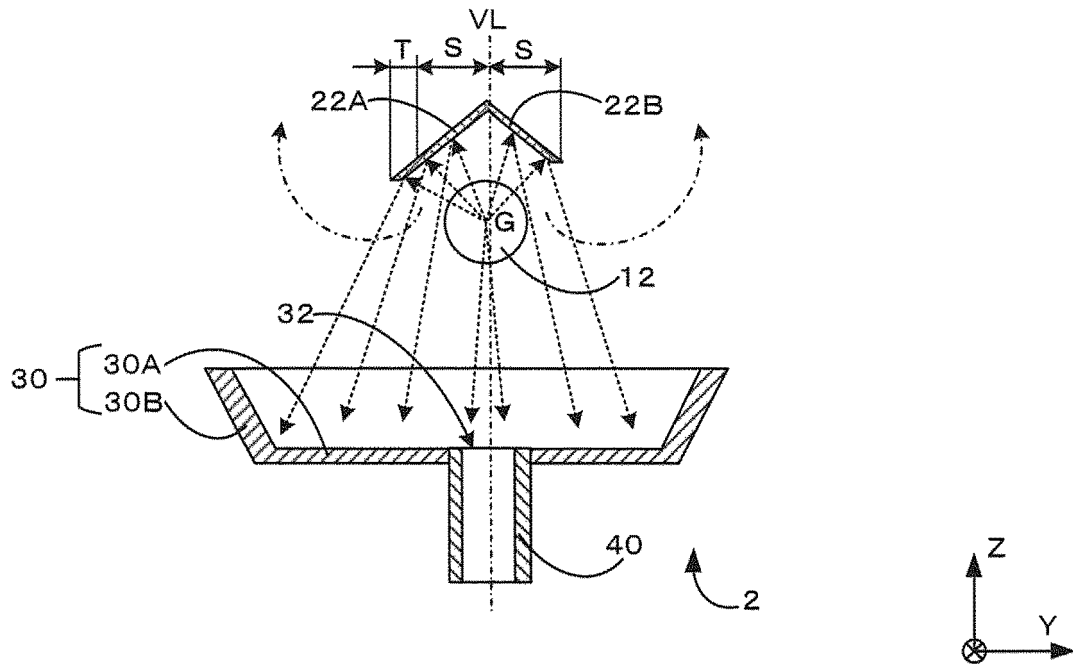


FIG. 6

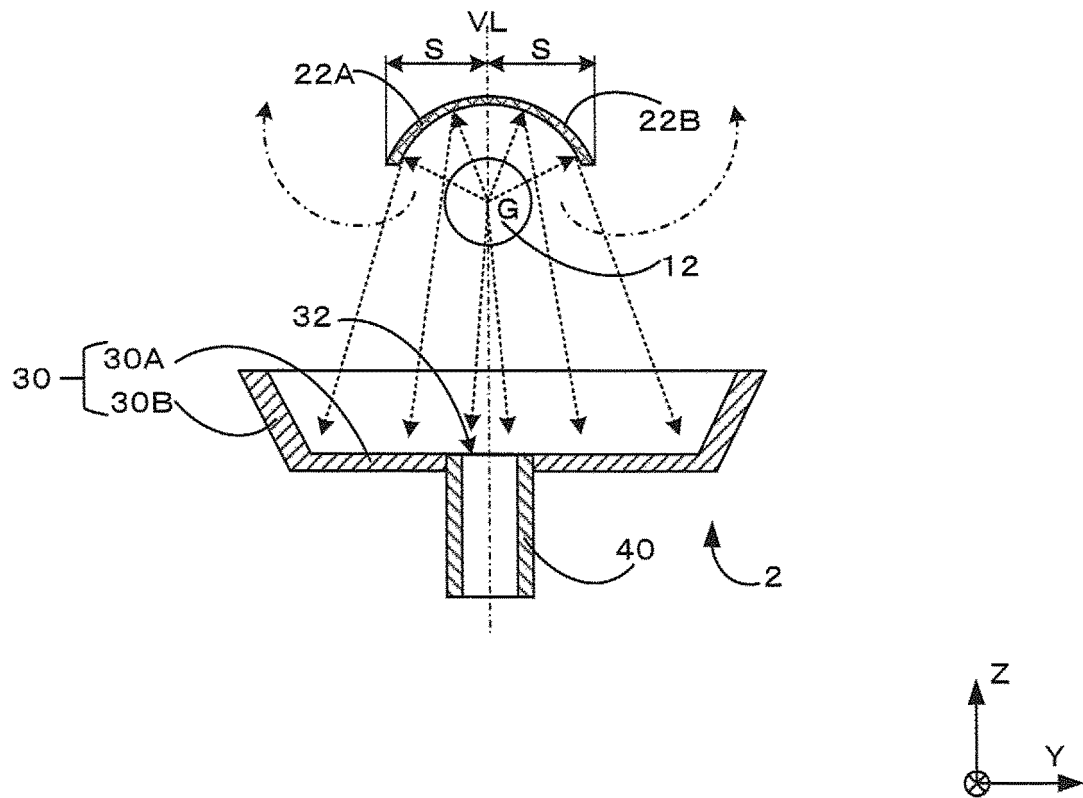


FIG. 7

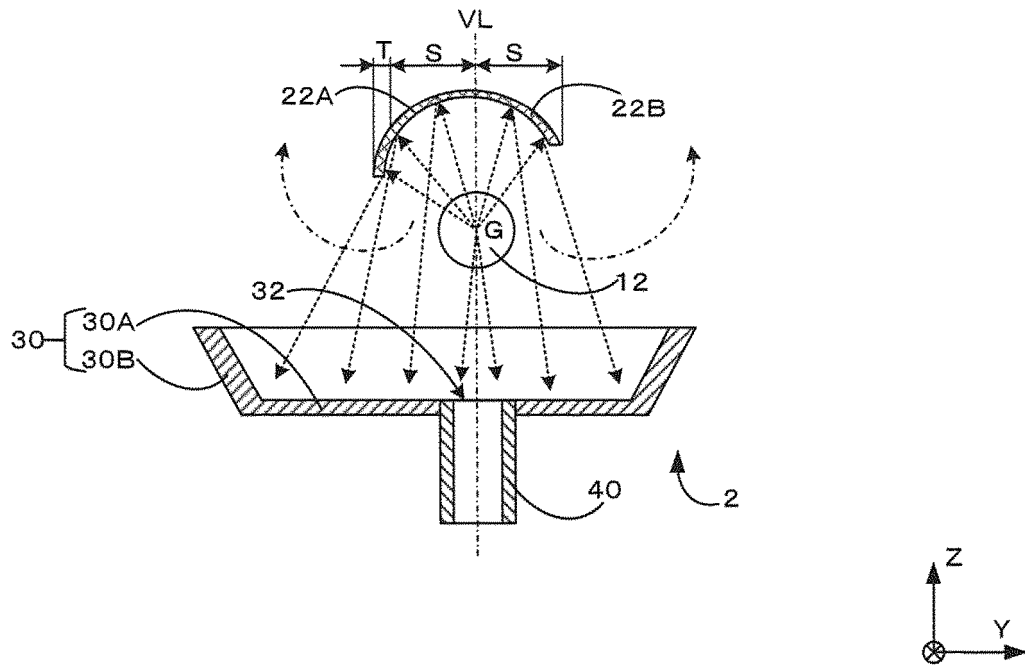


FIG. 8

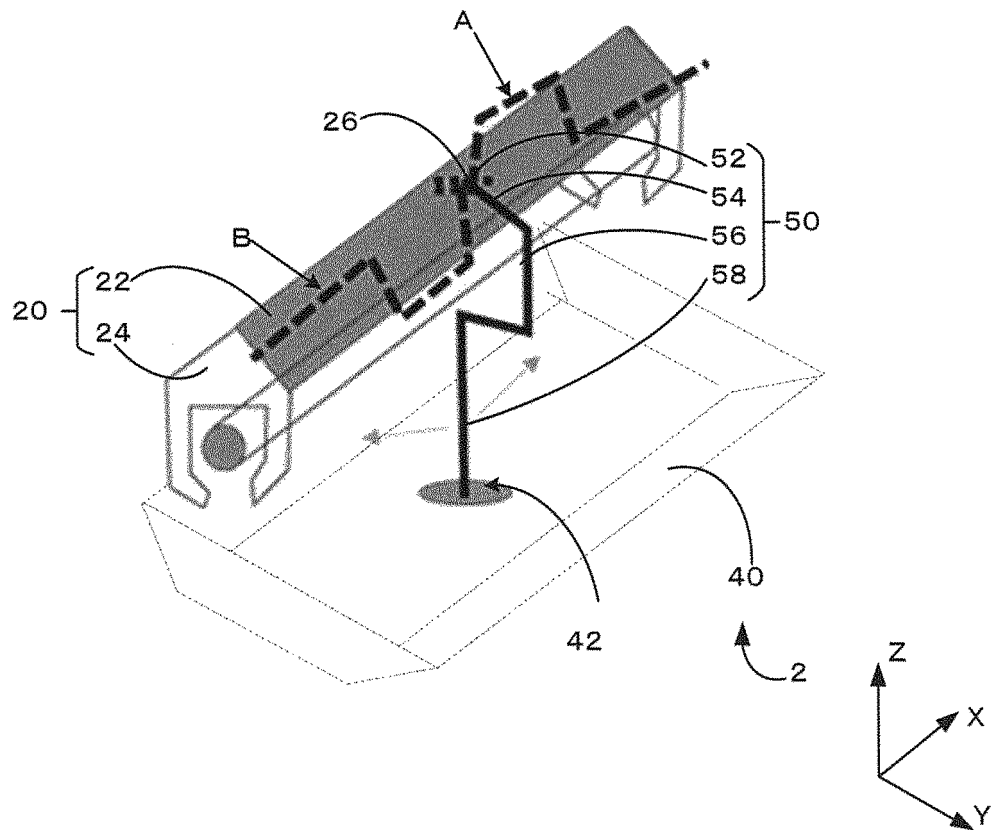


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/127645

A. CLASSIFICATION OF SUBJECT MATTER F25D 21/08(2006.01)i; F25D 21/14(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC																								
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F25D21 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																								
 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNABS; CNTXT; DWPI; SIPOABS; USTXT; EPTXT: 海尔, AQUA, 冰箱, 除霜, 化霜, 加热, 发热, 电热, 屋顶, 顶棚, 盖, 罩, 托盘, 水盘, 水管, 辐射, 反射, 导热, 传热, 热传导, refrigerator, defrost+, heat+, roof+, cover?, water, tray, pond, container, reflect+, radiat+, conduct+, transfer+																								
C. DOCUMENTS CONSIDERED TO BE RELEVANT																								
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>PX</td> <td>CN 210220362 U (PANASONIC R&D CENTER SUZHOU CO., LTD.) 31 March 2020 (2020-03-31) description, paragraphs 0027-0037, figures 1-6</td> <td>1-10</td> </tr> <tr> <td>X</td> <td>JP 2000314581 A (SANYO ELECTRIC CO., LTD.) 14 November 2000 (2000-11-14) description, paragraphs 0009-0023, figures 1-4</td> <td>1-10</td> </tr> <tr> <td>X</td> <td>JP H11132637 A (SANYO ELECTRIC CO., LTD.) 21 May 1999 (1999-05-21) description, paragraphs 0007-0022, figures 1-5</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>JP H08313146 A (SANYO ELECTRIC CO., LTD.) 29 November 1996 (1996-11-29) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>JP 2004183998 A (TOSHIBA K. K.) 02 July 2004 (2004-07-02) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 103453718 A (MATSUSHITA ELECTRIC INDUSTRY CO., LTD.) 18 December 2013 (2013-12-18) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 1580676 A (HITACHI APPLIANCES CO., LTD.) 16 February 2005 (2005-02-16) entire document</td> <td>1-10</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	PX	CN 210220362 U (PANASONIC R&D CENTER SUZHOU CO., LTD.) 31 March 2020 (2020-03-31) description, paragraphs 0027-0037, figures 1-6	1-10	X	JP 2000314581 A (SANYO ELECTRIC CO., LTD.) 14 November 2000 (2000-11-14) description, paragraphs 0009-0023, figures 1-4	1-10	X	JP H11132637 A (SANYO ELECTRIC CO., LTD.) 21 May 1999 (1999-05-21) description, paragraphs 0007-0022, figures 1-5	1-10	A	JP H08313146 A (SANYO ELECTRIC CO., LTD.) 29 November 1996 (1996-11-29) entire document	1-10	A	JP 2004183998 A (TOSHIBA K. K.) 02 July 2004 (2004-07-02) entire document	1-10	A	CN 103453718 A (MATSUSHITA ELECTRIC INDUSTRY CO., LTD.) 18 December 2013 (2013-12-18) entire document	1-10	A	CN 1580676 A (HITACHI APPLIANCES CO., LTD.) 16 February 2005 (2005-02-16) entire document	1-10
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Date of the actual completion of the international search 21 January 2021	Date of mailing of the international search report 18 February 2021																							
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451	Authorized officer Telephone No.																							

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International application No.

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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