

DESCRIPTION

Title of Invention

REFRIGERATOR-FREEZER

Technical Field

5 [0001]

The present disclosure relates to a refrigerator-freezer including a set of double doors.

Background Art

[0002]

10 In recent years, there has been a refrigerator-freezer having a heater unit mounted in a divider configured to close a gap between doors and being configured to reduce dew condensation on the divider by the passage of electricity through a heater in accordance with the ambient room temperature and humidity (see, for example, Patent Literature 1). Patent Literature 1 uses a synthetic resin as a
15 surface part of the divider and thereby reduces the occurrence of dew condensation due to drops in temperature of portions of the surface part that make contact with gaskets provided between the doors and the divider. However, the surface part, which is made of synthetic resin, easily deforms in the height direction, requires a reinforcing plate for reinforcement, and makes the divider have a complex structure.

20 [0003]

Temperatures in a refrigerator-freezer vary depending on the position in a height direction. To address this problem, a regulated heater pattern is disposed in a divider for reduction of electric energy (see, for example, Patent Literature 2). Patent Literature 2 sets the amount of heat generation in an upper region of a heater smaller
25 than the amounts of heat generation in regions of the heater other than the upper region and thereby suppress a rise in temperature in an upper part of the refrigerator-freezer.

Citation List

Patent Literature

30 [0004]

Patent Literature 1: Japanese Patent No. 5961822

Patent Literature 2: Japanese Unexamined Patent Application Publication No.
2015-148366

Summary of Invention

5 Technical Problem

[0005]

10 The divider is provided on one of the doors. The divider is formed to be short relative to an opening of a refrigerator compartment so that the divider can rotate when the door opens. There is a gap formed between an upper part of the divider and a ceiling of the refrigerator compartment and a gap formed between a lower part of the divider and a floor surface of the refrigerator compartment. Further, the upper and lower gaps are closed by fin parts formed in upper and lower portions of the gaskets. Since the upper and lower fin parts are exposed to the refrigerator compartment, they more easily drop in temperature and more easily form dew
15 condensation than a surface of the divider. For the prevention of dew condensation, it is conceivable that a distribution of amounts of heat generation in a height direction might be adjusted by a heater pattern as in the case of Patent Literature 2 for the divider to avoid becoming complex in structure. However, at ends of the divider, structures, such as screws, by which a cover or other components are attached make
20 it difficult to route a heater to upper and lower ends of the divider. As a result, dew condensation easily forms at ends in the height direction of the divider due to drops in temperature of the fin parts. For the prevention of such dew condensation, it is necessary to increase the passage rate of the heater in accordance with the temperatures of the fin parts.

25 [0006]

The present disclosure has been made to solve the above problem and an object thereof is to provide a refrigerator-freezer configured to reduce dew condensation at ends of a divider while suppressing an increase in passage rate.

Solution to Problem

30 [0007]

A refrigerator-freezer according to an embodiment of the present disclosure includes a refrigerator body having an opening and having a storage compartment formed in the opening, two doors arranged side by side at the opening and configured to be opened and closed, and a divider extending along a gap between the two doors and configured to close the gap at the storage compartment. The divider includes a surface part facing the doors and a heater unit having a cord-like heater disposed from one end to the other end of the surface part. The heater includes a heat generating unit configured to generate heat by passage of electricity and a basic insulating layer covering the heat generating unit, and two or more additional insulating layers are provided between the basic insulating layer and the surface part.

Advantageous Effects of Invention

[0008]

The refrigerator-freezer according to the embodiment of the present disclosure allows the heater inside the divider to have an insulating coating structure composed of one basic insulating layer and two or more additional insulating layers, thereby making it possible to increase the degree of freedom of a heater pattern by thinning the heater and route the heater to the ends of the divider. This makes it possible to raise the temperature at the ends of the divider and, while suppressing a rise in passage rate, reduce dew condensation at the ends of the divider.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a front view showing a refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is an upper perspective view showing an open state of a right door in a region R1 of Fig. 1.

[Fig. 3] Fig. 3 is a sectional view showing a section taken along line A-A in Fig. 1.

[Fig. 4] Fig. 4 is an exploded perspective view showing a structure of a divider according to Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 is a sectional view showing a state where a heater unit according

to Embodiment 1 of the present disclosure is to be pasted to a surface part.

[Fig. 6] Fig. 6 is a partially-enlarged view of an R2 region of Fig. 4.

[Fig. 7] Fig. 7 is a longitudinal sectional view showing an upper part of the divider in a section as taken along line C-C in Fig. 1.

5 [Fig. 8] Fig. 8 is a longitudinal sectional view showing a lower part of the divider in a section as taken along line D-D in Fig. 1.

[Fig. 9] Fig. 9 is an explanatory diagram showing examples of the passage rate of the heater unit according to Embodiment 1 of the present disclosure.

10 [Fig. 10] Fig. 10 is an explanatory diagram showing other examples of the passage rate of the heater unit according to Embodiment 1 of the present disclosure.

[Fig. 11] Fig. 11 is a schematic view showing an insulating layer configuration of the heater unit according to Embodiment 1 of the present disclosure.

[Fig. 12] Fig. 12 is a schematic view showing a pattern of the heater unit according to Embodiment 1 of the present disclosure.

15 [Fig. 13] Fig. 13 is a diagram showing a heat generation density distribution of the heater unit according to Embodiment 1 of the present disclosure.

[Fig. 14] Fig. 14 is a diagram showing the temperatures of a surface of the divider and fin parts according to Embodiment 1 of the present disclosure.

20 [Fig. 15] Fig. 15 is a schematic view showing an insulating layer configuration of a heater unit according to Embodiment 2 of the present disclosure.

[Fig. 16] Fig. 16 is a schematic view showing an insulating layer configuration of a heater unit according to Embodiment 3 of the present disclosure.

Description of Embodiments

[0010]

25 In the following, a refrigerator-freezer (refrigerator 100) of the present disclosure is described with reference to the drawings.

[0011]

Embodiment 1

30 Fig. 1 is a front view showing a refrigerator according to Embodiment 1 of the present disclosure. Fig. 2 is an upper perspective view showing an open state of a

right door in a region R1 of Fig. 1. Fig. 3 is a sectional view showing a section taken along line A-A in Fig. 1. A configuration of the refrigerator 100 is schematically described with reference to Figs. 1 to 3. The arrow X represents a width direction of the refrigerator 100. The arrow Y represents a depth direction of the refrigerator 100. The arrow Z represents a height direction of the refrigerator 100.

[0012]

The refrigerator 100 includes a refrigerator body 10 formed in the shape of a box with a front opening and a plurality of doors configured to close an opening 10a of the refrigerator body 10. The refrigerator body 10 includes outer and inner boxes (not illustrated) that forms an outer shell of the refrigerator 100 as a housing, and a space between the outer and inner boxes is filled with a foam insulation material (not illustrated). The foam insulation material fills the gap between the outer and inner boxes, so that the outer and inner boxes are integrated to function as an insulated housing.

[0013]

The inner box has its interior space divided by a plurality of partitions to form storage compartments, such as a refrigerator compartment 1, an ice-making compartment 2, a versatile compartment 3, a freezer compartment 4, and a vegetable compartment 5, arranged in this order from the top of the refrigerator body 10. Each storage compartment is set to a different temperature zone according to use, and each storage compartment is provided with a temperature sensor (not illustrated) composed, for example, of a thermistor. Each storage compartment is provided at the front thereof a door(s) configured to open and close.

[0014]

The refrigerator compartment 1 has its doors formed by a set of double rotating doors including a left door 7 disposed on the left of the front of the refrigerator compartment 1 and a right door 8 disposed on the right of the front of the refrigerator compartment 1. The ice-making compartment 2, the versatile compartment 3, the freezer compartment 4, and the vegetable compartment 5 are each provided with a slide-out door 6.

[0015]

Although not illustrated, connecting hinges configured to connect the refrigerator body 10 to the doors of the refrigerator compartment 1 are provided at both side edges of the outer box in a width direction (direction parallel to the arrow X).

5 The connecting hinge provided at the left side edge of the outer box connects the refrigerator body 10 to the left door 7. The connecting hinge provided at the right side edge of the outer box connects the refrigerator body 10 to the right door 8. The connecting hinges have hinge shafts serving as rotating shafts around which the left door 7 and the right door 8 rotate to open leftward and rightward, respectively, from
10 the middle of the refrigerator body 10. An inter-door gap Gd is provided at a boundary between the left door 7 and the right door 8 so that the left door 7 and the right door 8 do not touch each other on their paths of revolution along which the left door 7 and the right door 8 rotate.

[0016]

15 Further, in a hinge part 7a on the upper part of the left door 7 to which the connecting hinge is attached, an outside air temperature sensor configured to sense outdoor air temperature and an outside air humidity sensor configured to sense outdoor air humidity are provided. Instead of being provided in the hinge part 7a, the outside air temperature sensor and the outside air humidity sensor may be provided
20 in any place where they can detect an ambient environment such as temperature and humidity. In particular, it is desirable that the outside air temperature sensor and the outside air humidity sensor be provided in such a position that detected values are hardly affected by operation of the refrigerator 100. For example, in a case where a condenser pipe, which is not illustrated, is fixed by bonding inside a side surface of
25 the refrigerator body 10, the disposition of the outside air temperature sensor and the outside air humidity sensor in the hinge part 7a makes it possible to reduce the influence of heat from the condenser pipe and accurately detect the ambient environment.

[0017]

30 Further, the refrigerator 100 includes a divider 9 configured to close the inter-

door gap Gd and divide the refrigerator compartment 1 from an exterior space and two gaskets 22 and 23 configured to bring the divider 9 into close contact with each door of the refrigerator compartment 1. The divider 9 is a board-like member that extends in a height direction (direction parallel to the arrow Z) along the inter-door gap Gd and covers the inter-door gap Gd at the refrigerator compartment 1. The divider 9 is provided on an inner plate 7b of the left door 7.

[0018]

Fig. 4 is an exploded perspective view showing a structure of a divider according to Embodiment 1 of the present disclosure. A configuration of the divider 9 is described with reference to Figs. 2 to 4. The divider 9 includes a surface part 30 facing the inner plate 7b of the left door 7, a heater unit 40 disposed in the surface part 30, and a heater cover 50 covering the heater unit 40 disposed in the surface part 30.

[0019]

The surface part 30 is made, for example, of sheet metal and configured to transmit heat from the heater unit 40 to the left door 7, the right door 8, the two gaskets 22 and 23, or other components. The heater unit 40 is composed, for example, of a sheet aluminum foil heater and heats the surface part 30 by the passage of electricity. The heater cover 50 is made, for example, of resin.

[0020]

Fig. 5 is a sectional view showing a state where a heater unit according to Embodiment 1 of the present disclosure is to be pasted to a surface part. Fig. 6 is a partially-enlarged view of an R2 region of Fig. 4. As shown in Figs. 5 and 6, the heater unit 40 includes a cord-like heater 41, a heat shield 42 composed, for example, of aluminum foil, and a double-sided tape 43 configured to paste the heater 41 and the heat shield 42 to the surface part 30.

[0021]

The double-sided tape 43, the heater 41, and the heat shield 42 are arranged in this order from the surface part 30 toward the heater cover 50. The heater 41 includes a heat generating unit configured to generate heat by the passage of

electricity, and is disposed along a serpentine course to form a plurality of folds 41a. The double-sided tape 43 retentively pastes the heater 41, which forms a serpentine pattern (routing), and the heat shield 42 to an inner side of the surface part 30.

[0022]

5 The heat shield 42 covers a heater disposed inside the surface part 30. The heat shield 42 reflects the heat of the heater 41 toward the surface part 30 and reduces the transfer of the heat toward the refrigerator compartment 1. The heat shield 42 is formed in a size larger than the area of a region in which the heater 41 is disposed, so that the pattern of the heater 41 can be fixed. For this reason, the heat
10 shield 42 is usually provided with margins extending from the heater 41 to ends of the heat shield 42 in a width direction (direction parallel to the arrow X) and a height direction (direction parallel to the arrow Z). Note that, for maximum routing of the heater 41 over the surface part 30 of the divider 9 in a height direction (direction parallel to the arrow Z), the heater unit 40 is pasted to the surface part 30 in a state
15 where margins 45 protruding from the pattern at the upper and lower ends of the heat shield 42 are folded back toward the middle.

[0023]

As shown in Figs. 2 to 4, the divider 9 further includes a back cover 60 and a heat insulating material 61 disposed on a side of the heater cover 50 at the
20 refrigerator compartment 1. The heat insulating material 61 is made, for example, of expanded polystyrene and reduces leakage of the heat of the heater unit 40 from the heater cover 50 into the refrigerator compartment 1. The back cover 60 is made, for example, of resin and attached to the heater cover 50 to retain the heat insulating material 61.

25 [0024]

Further, the back cover 60 has an upper end to which an upper hinge 62 and an upper cover 63 are attached by a screw 64 and a lower end to which a spring 65, a lower hinge 66, and a lower cover 67 are attached by a screw 64. The back cover 60 is provided, at both ends thereof, bearing components 60a to which the upper
30 hinge 62 and the lower hinge 66 are attached.

[0025]

The upper hinge 62 and the lower hinge 66 connect the left door 7 to the divider 9 so that the divider 9 rotates in tandem with an opening and closing movement of the left door 7. The upper hinge 62 and the lower hinge 66 have shaft components 62a and 66a, respectively, serving as rotating shafts on which the divider 9 rotates, and the shaft components 62a and 66a are inserted in the bearing components 60a, respectively, of the back cover 60. The spring 65 biases the divider 9 toward the left door 7.

[0026]

The upper cover 63 and the lower cover 67 cover ends of the divider 9 in a height direction (direction parallel to the arrow Z) and, by being attached to the back cover 60, retain the upper hinge 62 and the lower hinge 66, respectively. Further, the upper cover 63 has a cover groove portion 63a formed in an upper part of the upper cover 63.

[0027]

The divider 9 is formed by pasting the heater unit 40 to the inner side of the surface part 30, fitting lugs 31 onto the heater cover 50, placing the heat insulating material 61 on the heater cover 50, and fitting the back cover 60, to which the divider hinges or other components have been attached, onto the heater cover 50.

Moreover, the divider 9 is attached to the left door 7 by fastening the upper hinge 62 and the lower hinge 66 to the inner plate 7b of the left door 7 with attaching screws.

[0028]

The divider 9 is attached to the left door 7 so that the center of the surface part 30 in a width direction (direction parallel to the arrow X) coincides with the center of the inter-door gap Gd formed at the boundary between the left door 7 and the right door 8. A groove portion 16 is formed in the inner plate 7b of the left door 7, and a groove portion 16 is formed in an inner plate 8b of the right door 8. Of the aforementioned two gaskets 22 and 23, the gasket 22 is provided between the surface part 30 and the inner plate 7b of the left door 7 and fitted in the groove portion 16 of the inner plate 7b. Meanwhile, the gasket 23 is provided between the surface

part 30 and the inner plate 8b of the right door 8 and fitted in the groove portion 16 of the inner plate 8b. The gaskets 22 and 23 have magnets 24 buried therein, and when the left door 7 and the right door 8 are closed, the surface part 30 is brought into close contact with the gaskets 22 by the magnets 24.

5 [0029]

The inner plate 7b of the left door 7 and the inner plate 8b of the right door 8 have projecting parts 7c and 8c projecting in a depth direction (direction parallel to the arrow Y) so that the divider 9 is sandwiched between the projecting parts 7c and 8c in a width direction (direction parallel to the arrow X). Packing 25 is provided between the projecting part 7c of the left door 7 and the divider 9. Meanwhile, the gasket 23, which is provided on the right door 8, has a backward extension portion 18 extending between the projecting part 8c of the right door 8 and a right side of the divider 9, and the backward extension portion 18 reduces leakage of heat around the divider 9.

10 [0030]

Further, as shown in Fig. 2, the refrigerator compartment 1 has a ceiling 11 provided with a guide section 15 configured to guide the divider 9 to rotation. The guide section 15 includes a base portion 15b attached to the ceiling 11 and a projection 15a (see Fig. 7) extending downward from the base portion 15b. In a closed state of the left door 7, the projection 15a of the guide section 15 is held in the cover groove portion 63a formed in the upper cover 63. Sliding of an edge of the cover groove portion 63a along the guide section 15 allows the divider 9 to smoothly rotate.

15 [0031]

Next, a movement of the divider 9 is described with reference to Fig. 2. When the left door 7 opens, the divider 9 rotates on the shaft components 62a and 66a, which serve as rotating shafts, with the projection 15a of the guide section 15 in contact with the edge of the cover groove portion 63a formed in the upper cover 63. At this point in time, the biasing force of the spring 65 causes a right part of the divider 9 to turn around backward, so that the divider 9 can be prevented from contacting the right door 8. Meanwhile, when the left door 7 closes, the right part of

the divider 9, which has turned around backward, is guided by the guide section 15 to rotate out rightward from the left door 7. When both the left door 7 and the right door 8 close, the inter-door gap Gd is closed, so that entry of outside air from outside into the refrigerator compartment 1 is reduced.

[0032]

Fig. 7 is a longitudinal sectional view showing an upper part of the divider in a section as taken along line C-C in Fig. 1. Fig. 8 is a longitudinal sectional view showing a lower part of the divider in a section as taken along line D-D in Fig. 1. A configuration between the divider 9 and a wall surface of the refrigerator compartment 1 is described with reference to Figs. 2, 7, and 8. The divider 9 is formed to be shorter than the frontage of the refrigerator compartment 1 in a height direction (direction parallel to the arrow Z). Note that the frontage of the refrigerator compartment 1 refers to the distance between a floor surface 12 of the refrigerator compartment 1 and the ceiling 11. There is a gap Gt formed between an upper end of the divider 9 and the base portion 15b of the guide section 15 provided on the ceiling 11 and a gap Gb formed between a lower end of the divider 9 and the floor surface 12.

[0033]

The gasket 22, which is provided on the left door 7, has an upper fin 22t formed in an upper part of the gasket 22 in a height direction (direction parallel to the arrow Z) and a lower fin 22b formed in a lower part of the gasket 22 in a height direction (direction parallel to the arrow Z), and is formed so that the entire length of the gasket 22 is longer than the length of the divider 9. Similarly, the gasket 23, which is provided on the right door 8, has an upper fin 23t formed in an upper part of the gasket 23 and a lower fin 23b formed in a lower part of the gasket 23, and is formed so that the entire length of the gasket 23 is longer than the length of the divider 9. In Fig. 2, the position of the gasket 23 in a closed state of the right door 8 is indicated by a dot-and-dash line. The upper fins 22t and 23t and the lower fins 22b and 23b are hereinafter referred to as "fin parts" in a case where no distinction is made among them.

[0034]

Each of the upper fins 22t and 23t extends to a position higher than a position of the ceiling 11 of the refrigerator compartment 1 to cover the gap Gt formed on top of the divider 9. In a width direction (direction parallel to the arrow X), the upper fin 22t extends rightward from the left door 7 to cover the inter-door gap Gd, and the upper fin 23t extends leftward from the right door 8 to cover the inter-door gap Gd. That is, in the upper gap Gt, in which the divider 9 is not disposed, the two upper fins 22t and 23t overlap each other to close the inter-door gap Gd.

[0035]

Each of the lower fins 22b and 23b extends to a lower position than a position of the floor surface 12 of the refrigerator compartment 1 to cover the gap Gb formed underneath the divider 9. In a width direction (direction parallel to the arrow X), the lower fin 22b extends rightward from the left door 7 to cover the inter-door gap Gd, and the lower fin 23b extends leftward from the right door 8 to cover the inter-door gap Gd. That is, in the lower gap Gb, in which the divider 9 is not disposed, the two lower fins 22b and 23b overlap each other to close the inter-door gap Gd.

[0036]

Next, a configuration of upper and lower ends of the divider 9 is described in detail with reference to Figs. 6 to 8. The surface part 30 has flanges 32, formed at respective upper and lower ends of the surface part 30, that extend toward the refrigerator compartment 1, and each flange 32 is provided with a screw hole 32a. The heater cover 50 has hollow-shaped screw holders 51 formed at respective upper and lower ends of the heater cover 50. Moreover, the surface part 30 and the heater cover 50 are fastened to each other by the screws 64 being inserted in the screw holes 32a and held in the screw holders 51 at the upper and lower ends of the divider 9.

[0037]

Each screw holder 51 has an opening facing toward the heat insulating material 61 and a semicylindrical wall surface part 51a facing the surface part 30. The screw holders 51 are made of resin and prevent impairment of the heater unit 40

by isolating the heater unit 40 from the screws 64. A gap Gc (e.g. 1.8 mm) that is larger in thickness than the heater unit 40 in a depth direction (direction parallel to the arrow Y) is provided between the surface part 30 and the wall surface part 51a of each screw holder 51, and an end of the heater unit 40 is disposed in the gap Gc.

Note that the gap Gc is the shortest distance between the surface part 30 and the wall surface part 51a. Such a configuration allows the wall surface part 51a to also function as a heater presser that prevents uplift of the heater unit 40 pasted to the surface part 30.

[0038]

Since, as mentioned above, the margins 45 of the heater unit 40 are folded back, the heater 41 has its uppermost turn 41t disposed at an upper end of the heater unit 40 and its lowermost turn 41b disposed at a lower end of the heater unit 40.

Further, the screw holders 51 formed in the heater cover 50 make it possible to paste the heater unit 40 to the surface part 30 from top to bottom by maximally lengthening a pattern top-to-bottom end distance Lp (see Fig. 12) of the heater 41.

[0039]

Since the upper fins 22t and 23t are exposed to the refrigerator compartment 1 through the upper gap Gt and the lower fins 22b and 23b are exposed to the refrigerator compartment 1 through the lower gap Gb, the exposed regions are lower in temperature than overlapping regions that overlap the divider 9. However, since, in the aforementioned divider 9, the heater 41 is disposed from top to bottom of the surface part 30, a drop in temperature can be suppressed by causing the heater 41 to be partly overlapped with the fin parts.

[0040]

Further, as shown in Fig. 1, the refrigerator 100 includes a control unit 90 configured to control overall operation of the refrigerator 100. The control unit 90 is built, for example, in the refrigerator body 10. The control unit 90 controls a compressor, a damper device, or other devices (not illustrated) so that the temperature of each storage compartment sensed by the corresponding temperature sensor is a set temperature set in advance for that storage compartment.

Specifically, the opening and closing of the damper device is controlled on the basis of the difference between the temperature of the refrigerator compartment 1 sensed by the temperature sensor and the set temperature of the refrigerator compartment 1, so that the amount of cold air that is sent to the refrigerator compartment 1 is adjusted. Further, the control unit 90 calculates a passage rate Pr of the heater unit 40 on the basis of the temperature of the refrigerator compartment 1, the outside air temperature, the outside air humidity (outside air relative humidity H_{out}) and gives an instruction to pass electricity. The passage rate Pr needs only be calculated by a known method.

[0041]

Fig. 9 is an explanatory diagram showing examples of the passage rate of the heater unit according to Embodiment 1 of the present disclosure. Fig. 10 is an explanatory diagram showing other examples of the passage rate of the heater unit according to Embodiment 1 of the present disclosure. The passage of electricity through the heater unit 40 is controlled so that the passage rate Pr , at which no dew condensation occurs on the surface part 30 of the divider 9, the gaskets 22 and 23 around the surface part 30, or other components, is attained. Note here that the passage rate Pr refers to the proportion of the duration of passage of electricity through the heater 41. For example, in the case of five seconds of passage of electricity out of ten seconds, the passage rate Pr is expressed as 50%.

[0042]

The passage rate Pr is calculated, for example, by giving the outside air relative humidity H_{out} thus sensed to a plurality of calculation formulas with the outside air temperature set as a parameter. Further, there are variations in reference passage rate, for example, according to structures such as the thickness of the divider 9 and the thermal conductivity of the material of the divider 9, the rated wattage of the heater 41, the set temperature of the refrigerator compartment 1.

[0043]

In Fig. 9, calculation formulas are set for three stages, namely a case where the outside air temperature is not higher than 20 degrees Celsius, a case where the

outside air temperature is higher than 20 degrees Celsius and not higher than 30 degrees Celsius, and a case where the outside air temperature is higher than 30 degrees Celsius and not higher than 40 degrees Celsius, and the passage rate Pr linearly rises as the outside air relative humidity Hout rises. Fig. 9 illustrates passage rates Pr1, Pr2, and Pr3 in the three temperature zones. Meanwhile, in Fig. 10, calculation formulas are set for three stages, namely a case where the outside air temperature is not higher than 20 degrees Celsius, a case where the outside air temperature is higher than 20 degrees Celsius and not higher than 30 degrees Celsius, and a case where the outside air temperature is higher than 30 degrees Celsius and not higher than 40 degrees Celsius, and the passage rate Pr logarithmically rises as the outside air relative humidity Hout rises. Fig. 10 illustrates passage rates Pr4, Pr5, and Pr6 in the three temperature zones.

[0044]

The calculation formulas are stored in advance as a program in the control unit 90. For example, in Fig. 9, each calculation formula is assumed to be "Reference Passage Rate = $C1 \times Hout + C2$ " and determined in such a manner that the coefficients C1 and C2 are set for each temperature zone of outside air temperature. Further, in Fig. 10, each calculation formula is assumed to be "Reference Passage Rate = $C3 \times \ln(Hout) + C4$ " and determined in such a manner that the coefficients C3 and C4 are set for each temperature zone of outside air temperature. Each coefficient may be determined in advance, for example, by experiment. It should be noted that the three stages are not the only temperature zones of outside air temperature for which calculation formulas are set and, for example, calculation formulas may be set in increments of 5 degrees Celsius.

[0045]

Fig. 11 is a schematic view showing an insulating layer configuration of the heater unit according to Embodiment 1 of the present disclosure. An electrical insulating structure of the heater unit 40 is described with reference to Fig. 11. The heater 41 includes a core wire 71 composed, for example, of a conducting wire and resistance wires 72 each composed, for example, of a nichrome wire. Further, the

heater unit 40 used in the refrigerator 100 is required to have a double insulation structure under Electrical Appliances and Materials Safety Act. In particular, since the heater unit 40 is pasted to the back side of a non-live metal part (surface part 30) that a person may touch, the heater unit 40 per se is required to have a double insulation structure.

[0046]

Electrical Appliances and Materials Safety Act stipulates as follows.

(1) Basic insulation: Thickness of covering of not smaller than 0.3 mm, or thickness does not matter provided the withstand voltage is not lower than 1.5 kV/min.

(2) Additional insulation: Thickness of covering of not smaller than 0.4 mm, or thickness does not matter provided that there are two layers and the withstand voltages of the two layers are not lower than 1.5 kV/min.

[0047]

Hitherto, for example, a heater including a basic insulating layer and an additional insulating layer that satisfy the thickness stipulations has been fabricated by spirally winding one resistance wire around a core wire and performing extrusion twice with polyvinyl chloride (PVC). In this case, as shown in Table 1 below, a core wire 0.6 mm in diameter around which a resistance wire 0.08 mm in diameter is wound is covered with a basic insulating layer 0.70 mm in thickness, and the basic insulating layer is covered with an additional insulating layer 1.00 mm in thickness. The finished outer diameter D_h is approximately 3 mm, and the minimum bend radius R is approximately 5 mm.

[0048]

[Table 1]

		Present Example	Related art
Core wire 71 diameter (mm)		0.14	0.60
Resistance wire 72 diameter (mm)	Nichrome wire	0.05	0.08
Basic insulating layer 73	Material	ETFE	PVC
	Thickness (mm)	0.08	0.70
Additional insulating layer 74	Material	ETFE	PVC
	Thickness (mm)	0.15	1.00
Additional insulating layer 75	Material	ETFE	N/A
	Thickness (mm)	0.15	N/A
Finished outer diameter Dh (mm)		0.9	3.0
Minimum bend radius R (mm)		2	5
Heater length (mm)		3333	1380
Heater resistance value (Ω)		901	901
Heater rating (100 V-W)		11.1	11.1
Pattern top-to-bottom end distance Lp (mm)		781	754

[0049]

In general, in a case where the bend radius R is smaller than the finished outer diameter Dh, the pattern of the heater 41 may not be maintained in being pasted to the surface part 30. For this reason, the minimum bend radius R is usually set to be larger than the finished outer diameter Dh.

[0050]

In the heater 41 of Embodiment 1, the insulating layers are made of fluorinated material (ethylene-tetrafluoroethylene (ETFE)). This makes it possible to achieve small thicknesses of covering while satisfying the withstand voltage stipulations under Electrical Appliances and Materials Safety Act. Specifically, the heater 41 is fabricated by winding three resistance wires 72 0.05 mm in diameter around a core wire 71 0.14 mm in diameter, covering the core wire 71 with a basic insulating layer 73 0.08 mm in thickness, and covering the basic insulating layer 73 with two additional insulating layers 74 and 75. Each of the additional insulating layers 74 and 75 has a thickness of 0.15 mm, and the heater 41 has a finished outer diameter Dh of 0.9 mm. By thus thinning the finished outer diameter Dh of the heater 41, the minimum bend radius R of the cord-like heater 41 can be made as small as 2 mm. This makes it possible to increase the degree of freedom of a pattern that the heater

41 forms.

[0051]

In the heater 41, the arrangement of three resistance wires 72 is such that the three resistance wires 72 are spirally wound around the core wire 71. The three resistance wires 72 are used here because the heater 41 is lengthened for a higher degree of freedom in pattern with about the same heater rating as the related-art heater rating. The number of resistance wires 72 may be changed according to the required heater rating and pattern.

[0052]

Fig. 12 is a schematic view showing a pattern of the heater unit according to Embodiment 1 of the present disclosure. The heater rating here is 100 V and 11.1 W. As mentioned above, the cord-like heater 41 is fixed by being sandwiched between the heat shield 42 and the double-sided tape 43 and pasted to the surface part 30. The heater 41 is formed so that the pattern top-to-bottom end distance L_p (e.g. 781 mm), which is the distance between the uppermost turn 41t and the lowermost turn 41b of the pattern, is longer than the pattern top-to-bottom end distance (e.g. 754 mm) of the related-art heater. This is intended to bring the heater as close as possible to the upper gap G_t and the lower gap G_b of the divider 9. By forming the pattern so that the pattern is partly overlapped with the fin parts, excessive drops in temperature of the regions of the fin parts exposed to the refrigerator compartment 1 are prevented, so that dew condensation is reduced.

[0053]

In a case where the pattern of the related-art heater is routed to the ends of the divider 9 in a height direction (direction parallel to the arrow Z), the heater 41 cannot be provided at the ends, since the screw 64 by which the upper cover 63 is fastened and the screw 64 by which the lower cover 67 is fastened project inward. Meanwhile, in the divider 9 of Embodiment 1, the heater 41 is thinned by forming the screw holders 51 in the heater cover 50 and folding back the margins 45 of the heater unit 40 toward the middle. This makes it possible to dispose parts of the pattern in the gaps G_c between the surface part 30 and each screw holder 51.

[0054]

[Table 2]

Distance (mm)	Present Example	Related art
Distance Lt between uppermost turn 41t and upper end face of divider 9	6.2	15.5
Distance Lb between lowermost turn 41b and lower end face of divider 9	4.2	9.2

[0055]

In Table 2, the distances between the pattern of the heater 41 and end faces of the divider 9 are compared with those of the related-art example regarding the heater pattern of Fig. 12. As shown in Figs. 7 and 8 and Table 2, the distance Lt between the uppermost turn 41t of the pattern and the upper end face of the divider 9 is 6.2 mm in the heater unit 40 and 15.5 in the related-art example. Further, the distance Lb between the lowermost turn 41b of the pattern and the lower end face of the divider 9 is 4.2 mm in the heater unit 40 and 9.2 mm in the related-art example.

[0056]

Thus, in the heater unit 40, each of the distances Lt and Lb can be reduced to not longer than 7 mm, and the overlapping regions of the upper fins 22t and 23t and the lower fins 22b and 23b overlapping the pattern can be widened. Accordingly, in a case where a comparison is made at about the same passage rate, the fin parts can be made higher in temperature than they have hitherto been, so that dew condensation can be reduced.

[0057]

In particular, as shown in Fig. 12, in a case where the pattern is formed so that the number of folds 41a is larger at the upper and lower ends of the divider 9 than in a middle part of the divider 9, a high heat generation density Hd (wattage) is attained at the upper and lower ends, which easily drop in temperature. This makes it possible to, while suppressing the drops in temperature of the fin parts, reduce dew condensation with a minimum passage rate by reducing the difference in temperature of the divider 9 in a height direction (direction parallel to the arrow Z).

[0058]

Fig. 13 is a diagram showing a heat generation density distribution of the heater unit according to Embodiment 1 of the present disclosure. The horizontal axis represents a height position Z_p in the divider 9, and the vertical axis represents the heat generation density H_d [W] of the heater unit 40. The solid line indicates a heat generation density distribution of the heater unit 40, and the dotted line indicates a heat generation density distribution of the related-art heater unit. On the horizontal axis, a graduation 1 represents the upper end of the divider 9, and a graduation 31 represents the lower end of the divider 9. In Fig. 13, the height position Z_p of the divider 9 is divided into twenty-nine height positions Z_p between the upper and lower ends of the divider 9, and a heat generation density in each height position Z_p is calculated. The heat generation density distribution of the heater unit 40 and the heat generation density distribution of the related-art example are calculated using the same rated wattage.

[0059]

A comparison shows that heat generation densities H_d in height positions Z_p (e.g. graduations 1 to 3 and 29 to 31) overlapped with the fin parts are higher in the heater unit 40 than in the related-art example. This is because the heater 41 is smaller in minimum bend radius R than it has hitherto been and more of the pattern can be placed in the regions overlapped with the fin parts. Further, the heat generation density H_d is smaller in a middle position (e.g. a graduation 16) on the divider 9 than it has hitherto been because the heat generation density H_d is concentrated at the upper and lower ends with the rating being the same. By thus making the heat generation density H_d higher at the upper and lower ends of the divider 9 than in the middle part, a high degree of dew condensation immunity can be attained with minimum heater input, that is, passage rate.

[0060]

In the present example, the pattern is adjusted so that the heat generation density H_d of the regions overlapped with the fin parts is approximately 0.6 to 0.7 W. This is intended to improve the after-mentioned temperature distribution in consideration of the surface temperature of the divider 9 and the temperatures of the

fin parts when the refrigerator compartment 1 is at 3 degrees Celsius and the gaps at the upper and lower ends of the divider are approximately 5 mm. Although the heat generation density H_d of the regions overlapped with the fin parts may be changed according to the size of the upper gap G_t and the size of the lower gap G_b , it is desirable that the heat generation density H_d be not lower than 0.5 W at each of the upper and lower ends, that is, not lower than 4.5% of the heater rating.

[0061]

Fig. 14 is a diagram showing the temperatures of a surface of the divider and fin parts according to Embodiment 1 of the present disclosure. The horizontal axis represents parts Z_h in an up-down direction, the left being the part near the ceiling of the refrigerator compartment, the right being the part near the floor surface of the refrigerator compartment 1. The vertical axis represents the temperatures T_h of the divider 9, the upper fins 22t and 23t, or the lower fins 22b and 23b. In environmental conditions where the outside air temperature is 30 degrees Celsius and the outside air relative humidity H_{out} is 75%, these temperatures are results measured at a heater rating of 100 [V] and 11.1 [W].

[0062]

Temperature data 83 of the related-art example as indicated by a dotted line is a result yielded in a case where the passage rate Pr is 53%. In a height direction (direction parallel to the arrow Z), the temperature T_p of the middle part of the divider 9 is 35 degrees Celsius, and the temperatures T_p of the upper fins 22t and 23t and the lower fins 22b and 23b (fin parts) are approximately 27 degrees Celsius. Although the dew-point temperature is not lower than 25.8 degrees Celsius in each part, the temperature distribution is poor, as the difference in temperature between the fin parts and the middle part is large. So far, the setting of a passage rate in accordance with the fin parts has resulted in an excessive rise in temperature of the middle part and waste of heater input.

[0063]

Temperature data 84 indicated by a dot-and-dash line is a result yielded in a case where the passage rate Pr is 53% in the heater unit 40. The heater unit 40 is

higher in temperature of the fin parts and lower in temperature of the middle part of the divider 9 than the related-art example, and exhibits a good temperature distribution, as the difference in temperature of the divider 9 as a whole is small.

Since even the temperature of the fin part that is lowest in temperature of the divider

9 and the fin parts is well above the dew-point temperature T_d , the passage rate Pr

can be lowered until the temperature of the fin part becomes about the same as it is

in the related-art example. Temperature data 85 indicated by a solid line is a result

yielded in a case where the passage rate Pr is adjusted so that the fin parts are about

the same in temperature as they are in the related-art example. In this case, the

passage rate Pr changes from 53% to 34%, so that a 19% reduction is attained.

Since the rating is 11.1 W, the heater input is reduced by approximately 20% (2 W).

[0064]

As noted above, in the refrigerator 100 of Embodiment 1, the heater 41

includes a heat generating unit (resistance wires 72) and a basic insulating layer 73

covering the heat generating unit, and two or more additional insulating layers 74 and

75 are provided between the basic insulating layer 73 and the surface part 30.

Moreover, the heater 41 is disposed from one end to the other end of the surface part

30. This allows the heater 41 inside the divider 9 to have an insulating coating

structure composed of three layers, namely one basic insulating layer and two

additional insulating layers, thereby making it possible to increase the degree of

freedom of a pattern by reducing the minimum bend radius R by thinning the heater

41 and route the heater 41 to the ends of the divider 9. This makes it possible to

raise the temperature at the ends of the divider 9 and, while suppressing a rise in

passage rate Pr by reducing the difference in temperature of the divider 9 in a height

direction (direction parallel to the arrow Z), reduce dew condensation at the ends of

the divider 9.

[0065]

Further, the heater cover 50 is provided with at ends thereof heater pressers

(wall surface parts 51a) extending inward to sandwich ends of the heater 41 while

forming preset gaps G_c between the ends of the heater cover 50 and the surface part

30. This makes it possible to inhibit uplift of the heater unit 40, prevent impairment of the heater 41 by isolating the heater 41 from the screws 64 or other components, and suppress drops in temperature at the ends of the divider 9 by disposing the heater 41 from one end to the other end of the divider 9.

5 [0066]

Further, the heater unit 40 includes a heat shield 42, and the heat shield 42 is provided with margins 45 protruding from the pattern of the heater 41 at the ends of the divider 9 and folded back toward the middle. This makes it possible to provide the pattern of the heater 41 to the full length of the surface part 30 and further reduce dew condensation by increasing the amounts of heat generation at the ends.

10 [0067]

Further, the refrigerator 100 further includes gaskets 22 and 23 including fin parts, and the heater 41 extends to overlapped regions of the surface part 30 overlapped with the fin parts. This makes it possible to dispose the heater 41 so that the heater 41 is partly overlapped with the fin parts, which especially easily decrease in temperature by being exposed to the refrigerator compartment 1, and reduce dew condensation by raising the temperatures of the fin parts.

15 [0068]

Embodiment 2

20 Fig. 15 is a schematic view showing an insulating layer configuration of a heater unit according to Embodiment 2 of the present disclosure. Embodiment 2 differs from Embodiment 1 in terms of an insulating structure of a heater unit 140. On the premise that the insulation withstand voltage is kept, the insulation specification is changed while the degree of freedom of a heater pattern is secured. This is unlike in the case of Embodiment 1. Embodiment 2 is the same as Embodiment 1 unless otherwise specified, and the same functions and components are described with reference to the same reference signs.

25 [0069]

A heater 141 includes a core wire 171, three resistance wires 172 wound around the core wire 171, a basic insulating layer 173 covering the core wire 171 and

the three resistance wires 172, and an additional insulating layer 174 covering the basic insulating layer 173. In Embodiment 2, a second additional insulating layer is formed by an insulating sheet 175. The insulating sheet 175 may be constituted, for example, by a polyethylene sheet 25 μm in thickness having an insulation withstand voltage of not lower than 1.5 kV/min (in actuality, approximately 5 kV/min). A double-sided tape 143, the insulating sheet 175, and a double-sided tape 143 are stacked in this order from the surface part 30 between the surface part 30 and the cord-like heater 141. In this case, the insulating sheet 175 may be pasted in advance to the inner side of the surface part 30 in view of balance between the workability with which to fabricate the heater unit 140 and the industrial workability with which to assemble the divider 9 with the heater unit 140. It is also possible to, instead of using two double-sided tapes 143, paste a heat shield 142 and the insulating sheet 175 to each other by gluing.

[0070]

In the divider 9, there is provided a triple insulation structure from the surface part 30, which a person may touch, and the side of the heater 141 at the refrigerator compartment 1 is surely insulated by being covered with the heat insulating material 61 and the back cover 60. That is, beside the refrigerator compartment 1, there is provided a triple insulation structure from the back cover 60, which a person may touch.

[0071]

In Embodiment 2, the insulating sheet 175 is used as the second additional insulating layer. This makes it only necessary to perform extrusion molding twice in fabricating the heater 141, making it possible to reduce manufacturing steps.

Further, as compared with the case of Embodiment 1, the heater 141 makes it possible to omit one additional insulting layer with which the heater 141 is covered, thus making it possible to thin the finished outer diameter D_h (for example, to 0.6 mm). In this case, too, the minimum bend radius R of the heater 141 can be reduced to approximately 2 mm. This makes it possible to increase the degree of freedom of the pattern of the heater 141 and dispose the heater 141 from top to

bottom of the divider 9.

[0072]

Alternatively, two insulating sheets 175 may be provided as additional insulating layers between the surface part 30 and the heater 141 so that the basic insulating layer 173 is the only one insulating coating of the heater 141. Such a configuration makes it possible to further thin the finished outer diameter D_h of the heater 141 because of fewer coatings and further reduce manufacturing steps because the heater 141 needs only to be subjected to extrusion molding once. In this case, too, a stack of two insulating sheets 175 may be pasted in advance to the surface part 30.

[0073]

As mentioned above, in Embodiment 2, one of the two or more additional insulating layers is formed in the heater 141 to cover the basic insulating layer 173, and another one of the two or more additional insulating layers is the insulating sheet 175 disposed between the heater 141 and the surface part 30. As in the case of Embodiment 1, this reduces dew condensation at the ends of the divider 9 by disposing the pattern at the ends of the divider 9 with a higher degree of freedom and makes wiring easy by further thinning the heater 141 by providing one additional insulating layer outside the heater 141.

[0074]

Embodiment 3

Fig. 16 is a schematic view showing an insulating layer configuration of a heater unit according to Embodiment 3 of the present disclosure. Embodiment 3 differs from Embodiment 1 in terms of an insulating structure of a heater unit 240. Embodiment 3 is the same as Embodiment 1 unless otherwise specified, and the same functions and components are described with reference to the same reference signs.

[0075]

A heater 241 includes a core wire 271, three resistance wires 272 wound around the core wire 271, an additional insulating layer 274 covering the core wire

271 and the three resistance wires 272, and an additional insulating layer 275 covering the additional insulating layer 274. Note here that each resistance wire 272 wound around the core wire 271 is covered with a basic insulating layer 273. Since the resistance wires 272 are thin, it is difficult to form the basic insulating layers 273 by extrusion molding. In this case, each resistance wire 272 may be covered with the basic insulating layer 273 by dip brazing. As in the case of Embodiment 1, the additional insulating layers 274 and 275 are molded by extrusion. Such a configuration makes it possible to reduce the minimum bend radius R of the heater 241 to approximately 2 mm by reducing the finished outer diameter Dh to approximately 0.6 mm and secure about the same degree of freedom of a pattern as that of Embodiment 1. This makes it possible to reduce dew condensation at the upper and lower ends of the divider 9 while reducing the passage rate.

[0076]

Alternatively, it may be possible to provide each resistance wire with two insulating coatings (namely a basic insulating layer and a first additional insulating layer) and cover the two insulating coatings with one additional insulating layer.

[0077]

As noted above, in Embodiment 3, the basic insulating layers 273 are provided to cover the resistance wires 272, and the two or more additional insulating layers 274 and 275 are formed in the heater 241 to cover the basic insulating layers 273. As in the case of Embodiment 1, this makes it possible to reduce dew condensation at the ends of the divider 9 by disposing the pattern at the ends of the divider 9 with a higher degree of freedom and surely insulate the heat generating unit, which generates heat by the passage of electricity, by directly covering the heat generating unit with the basic insulating layers 273.

[0078]

It should be noted that embodiments of the present disclosure are not limited to the embodiments described above but may be subject to various changes. For example, although the refrigerator compartment 1, the ice-making compartment 2, the versatile compartment 3, the freezer compartment 4, and the vegetable compartment

5 are arranged in this order from the top of the body in the refrigerator, the arrangement or other structures do not matter provided the refrigerator compartment has a set of double doors. Further, the heater unit 40 may be provided with three or more additional insulating layers.

5 Reference Signs List

[0079]

1 refrigerator compartment 2 ice-making compartment 3 versatile
compartment 4 freezer compartment 5 vegetable compartment 6 door 7
left door 7a hinge part 7b inner plate 7c projecting part 8 right door 8b
10 inner plate 8c projecting part 9 divider 10 refrigerator body 10a opening
11 ceiling 12 floor surface 15 guide section 15a projection 15b base
portion 16 groove portion 18 backward extension portion 22, 23 gasket
22b, 23b lower fin 22t, 23t upper fin 24 magnet 25 packing 30 surface
part 31 lug 32 flange 32a screw hole 40 heater unit 41 heater 41a
15 fold 41b lowermost turn 41t uppermost turn 42 heat shield 43 double-
sided tape 45 margin 50 heater cover 51 screw holder 51a wall surface
part 51a 60 back cover 60a bearing component 61 heat insulating material
62 upper hinge 62a shaft component 63 upper cover 63a cover groove
portion 64 screw 65 spring 66 lower hinge 66a shaft component 67
20 lower cover 71 core wire 72 resistance wire 73 basic insulating layer 74
additional insulating layer 75 additional insulating layer 83, 84, 85 temperature
data 90 control unit 100 refrigerator 140 heater unit 141 heater 142
heat shield 143 double-sided tape 171 core wire 172 resistance wire 173
basic insulating layer 174 additional insulating layer 175 insulating sheet 240
25 heater unit 241 heater 271 core wire 272 resistance wire 273 basic
insulating layer 274 additional insulating layer 275 additional insulating layer
Dh finished outer diameter Gb gap Gc gap Gd inter-door gap Gt gap
Hd heat generation density Hout outside air relative humidity Lb distance Lp
pattern top-to-bottom end distance Lt distance Pr passage rate Td dew-

point temperature T_h temperature T_p temperature Z_h part Z_p height
position

CLAIMS

[Claim 1]

A refrigerator-freezer comprising:

a refrigerator body having an opening and a storage compartment formed in
5 the opening;

two doors arranged side by side at the opening and configured to be opened
and closed; and

a divider extending along a gap between the two doors and configured to close
the gap at the storage compartment, wherein

10 the divider includes

a surface part facing the doors, and

a heater unit having a cord-like heater disposed from one end to an other
end of the surface part,

the heater includes

15 a heat generating unit configured to generate heat by passage of
electricity, and

a basic insulating layer covering the heat generating unit, wherein
two or more additional insulating layers are provided between the basic
insulating layer and the surface part.

20 [Claim 2]

The refrigerator-freezer of claim 1, further comprising a heater cover covering
the heater unit disposed in the surface part, wherein

the heater cover has heater pressers extending inward to sandwich ends of the
heater while forming preset gaps between ends of the heater cover and the surface
25 part, the heater pressers being formed at the ends of the heater cover.

[Claim 3]

The refrigerator-freezer of claim 1 or 2, wherein

the heater unit includes a heat shield covering the heater disposed in the
surface part, and

30 the heat shield is provided with margins protruding from a heater pattern of the

heater at ends of the divider and folded back toward a middle.

[Claim 4]

The refrigerator-freezer of any one of claims 1 to 3, wherein
the heater of the heater unit has a heater pattern formed so that heat
5 generation densities at ends of the divider are higher than a heat generation density
in a middle part of the divider.

[Claim 5]

The refrigerator-freezer of any one of claims 1 to 4, wherein
the heater is disposed between both ends of the divider to form a plurality of
10 folds, and
the heater has a heater pattern formed so that numbers of the folds at ends of
the divider are larger than a number of the folds in a middle part of the divider.

[Claim 6]

The refrigerator-freezer of any one of claims 1 to 5, further comprising gaskets
15 configured to bring the doors and the surface part into close contact with each other
when the doors are closed, wherein

the gaskets include fin parts covering gaps between edges of a frontage of the
storage compartment and ends of the divider, and

the heater extends to overlapped regions of the surface part overlapped with
20 the fin parts.

[Claim 7]

The refrigerator-freezer of claim 6, wherein
the heater has a heater pattern formed so that heat generation densities in the
overlapped regions are not lower than 4.5% of a heater rating.

[Claim 8]

The refrigerator-freezer of any one of claims 1 to 7, wherein
the two or more additional insulating layers are formed in the heater.

[Claim 9]

The refrigerator-freezer of any one of claims 1 to 7, wherein
30 one of the two or more additional insulating layers is formed in the heater to

cover the basic insulating layer, and

another one of the two or more additional insulating layers is an insulating sheet disposed between the heater and the surface part.

[Claim 10]

- 5 The refrigerator-freezer of claim 8, wherein
- the heater includes a core wire,
- the heat generating unit is a resistance wire,
- the basic insulating layer covers the core wire around which the resistance wire
- is wound, and
- 10 the two or more additional insulating layers are formed in the heater to cover
- the basic insulating layer.