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(54) **REFRIGERATOR**

(57) Abstract: The present embodiment of a refrigerator is provided with an insulated box body, an airflow duct, a hous - ing concavity, and tubing. The insulated box body is provided with an outer box, an inner box, and an insulating material, and the inner box has a storage chamber. The outer box has a left-side plate, a right-side plate, a top plate, a bottom plate, and a back plate. The inner box is disposed within the outer box, and has a left-side plate corresponding to the left-side plate of the outer box, a right-side plate corresponding to the right-side plate of the outer box, a top plate corresponding to the top plate of the outer box, a bottom plate corresponding to the bottom plate of the outer box, and a back plate corresponding to the back plate of the outer box. The insulating material is disposed between the inner box and the outer box, and configures an insulating wall for each section. The air-flow duct is provided to the rear of the storage chamber of the insulated box body, and therewithin is disposed an airflow fan and a cooler configuring a refrigeration cycle that provides cold air to the storage chamber. The housing concavity is formed at the inner box and protrudes inwards. The tubing is disposed in the housing concavity.

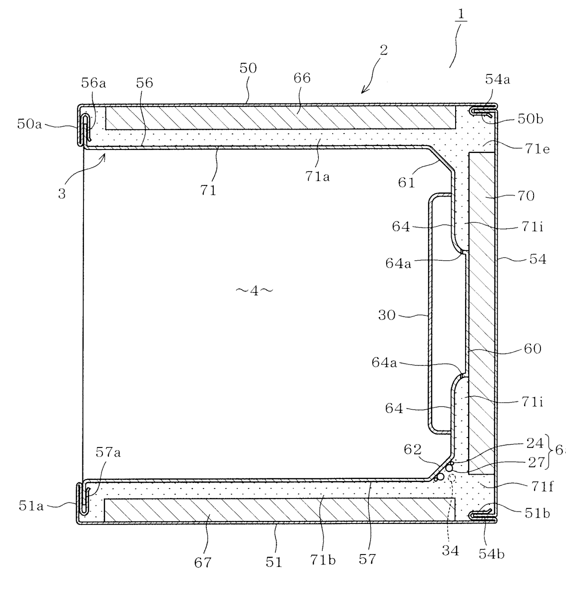

FIG.1

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Description

Technical Field

[0001] Embodiments described herein relate to a refrigerator.

Background Art

[0002] A heat insulation box used in household refrigerators is generally formed by filling a space defined between a steel outer box and a synthetic resin inner box with a foam insulation comprised of urethane foam while the foam insulation is being foamed. The outer box has a left side plate, a right side plate, a ceiling plate, a bottom plate and a rear plate. The inner box has a left side plate, a right side plate, a ceiling plate, a bottom plate and a rear plate corresponding to the left side plate, the right side plate, the ceiling plate, the bottom plate and the rear plate respectively. The foregoing heat insulation box has a storage compartment with a front opening, inside the inner box. The storage compartment is surrounded by heat insulating walls. An air duct is provided in an inner interior of the storage compartment. A condenser and a blast fan are disposed in the air duct to supply cold air into the storage compartment.

[0003] A refrigerating cycle includes a capillary tube and a suction pipe both serving as piping connected to a refrigerant inlet side and a refrigerant outlet side of the condenser respectively. Heat exchange is carried out in the capillary tube and the suction pipe so that vaporization of refrigerant is enhanced by heat of the capillary tube. This can improve an operating efficiency and reduce electricity consumption. In the refrigerators, the capillary tube and the suction pipe are drawn out of the inner box through the rear plate of the inner box. The capillary tube and the suction pipe are integrated into a pipe assembly by soldering them so as to be heat-exchangeable. The pipe assembly is disposed along the rear plate, for example, into a U-shape in order that a sufficient length allowing heat exchange may be ensured. Further, a drain hose serving as piping to discharge defrosting water in the condenser is also drawn out of the inner box through the rear plate of the inner box and disposed along the rear plate so as to be directed to a defrosting water evaporation pan provided in a lower part of the heat insulation box.

[0004] On the other hand, a space defined between the rear plates of the outer and inner boxes is filled with the foam insulation, whereby a rear heat insulating wall is constructed. Rendering the rear heat insulating wall thinner has been tried for reduction in an amount of use of foam insulation. However, when the piping is provided outside the rear plate of the inner box as described above, the foam insulation is required to have a thickness such that the piping is completely buried therein. Accordingly, rendering the rear heat insulating wall thinner has definite limits.

Prior Art Document

Patent Document

[0005] Patent Document 1: Japanese Patent Application Publication No. JP-A-2007-78264

Summary of the Invention

Problem to be overcome by the Invention

[0006] An object is to provide a refrigerator in which the heat insulation constructing the rear heat insulating wall can be rendered thinner without adverse effects of piping.

Means for Overcoming the Problem

[0007] A refrigerator includes a heat insulation box including an outer box having a left side plate, a right side plate, a ceiling plate, a bottom plate and a rear plate, an inner box having a left side plate corresponding to the left side plate of the outer box, a right side plate corresponding to the right side plate of the outer box, a ceiling plate corresponding to the ceiling plate of the outer box, a bottom plate corresponding to the bottom plate of the outer box and a rear plate corresponding to the rear plate of the outer box and a heat insulator disposed between the inner box and the outer box to constitute heat insulating walls, the heat insulation box defining a storage compartment therein, an air duct provided in an inner interior of the storage compartment of the heat insulation box and having an interior in which are disposed a cooler constituting a refrigerating cycle supplying cold air into the storage compartment, and a blast fan, an accommodation recess formed in the inner box and protruding inward of the inner box, and piping disposed in the accommodation recess.

Brief Description of the Drawings

[0008]

FIG. 1 is an enlarged sectional view of a refrigerator taken along line F1-F1 in FIG. 2, showing a first embodiment;
FIG. 2 is a schematic longitudinal cross section of a whole refrigerator;
FIG. 3 is a diagram showing a refrigerating cycle;
FIG. 4 is an exploded perspective view of an outer box;
FIG. 5 is a perspective view of an inner box as viewed from the rear;
FIG. 6 is a view similar to FIG. 1, showing a second embodiment;
FIG. 7 shows a step of applying a bonding agent to a vacuum insulation panel;
FIG. 8 is a view similar to FIG. 5, showing a third

embodiment;

FIG. 9 is a view similar to FIG. 1, showing a fourth embodiment;

FIG. 10 is a view similar to FIG. 5;

FIG. 11 is a view similar to FIG. 2, showing a fifth embodiment;

FIG. 12 is a view similar to FIG. 5;

FIG. 13 is a view similar to FIG. 5, showing a sixth embodiment; and

FIG. 14 shows an arrangement of pipe assembly in a seventh embodiment.

Best Mode for Carrying Out the Invention

[0009] Several embodiments will be described with reference to the accompanying drawings. Identical or similar parts will be labeled by the same reference symbols throughout the embodiments.

First Embodiment

[0010] A first embodiment will be described with reference to FIGS. 1 to 5. A heat insulation box 1 includes an outer box 2 made of a steel plate, an inner box 3 made of a synthetic resin and a heat insulation material filling a space defined between the outer and inner boxes 2 and 3, as will be described in detail later. A plurality of storage compartments is defined in an interior of the heat insulation box 1. More specifically, as shown in FIG. 2, a refrigerating compartment 4 and a vegetable compartment 5 are provided in the heat insulation box 1 in turn from above. An ice-making compartment 6 and a small freezing compartment (not shown) are juxtaposed below the vegetable compartment 5, and a freezing compartment 7 is provided below the ice-making compartment 6 and the small freezing compartment. An automatic ice making device 8 is provided in the ice-making compartment 6.

[0011] The refrigerating compartment 4 and the vegetable compartment 5 are storage compartments of a refrigeration temperature zone (a positive temperature zone of 1°C to 4°C). The refrigerating compartment 4 and the vegetable compartment 5 are vertically partitioned by a partition wall 9 made of a synthetic resin. A heat insulation door 4a is hingedly mounted on a front opening of the refrigerating compartment 4. A pullout heat insulation door 5a is located at a front opening of the vegetable compartment 5. A lower case 10 constituting a storage container is mounted on the back of the heat insulation door 5a. An upper case 11 smaller than the upper case 10 is provided in an upper interior of the lower case 10. A chilling compartment 12 is provided in a lowermost interior of the refrigerating compartment 4 or on the partition wall 9. A chilling case 13 is withdrawably mounted in the chilling compartment 12.

[0012] The ice-making compartment 6, the small freezing compartment and the freezing compartment 7 are storage compartments of a freezing temperature zone (a negative temperature zone of -10°C to -20°C).

[0013] The vegetable compartment 4, and the ice-making compartment 6 and the small freezing compartment 7 are vertically partitioned by a heat insulation partition wall 14. A pullout heat insulation door 6a is located at a front opening of the ice-making compartment 6. An ice storage container 15 is mounted on the back of the door 6a. Another pullout heat insulation door on which a storage container is mounted is located at a front opening of the small freezing compartment although not shown. Further another pullout heat insulation door 7a on which a lower storage container 7b and an upper storage container 7c are mounted is located at a front opening of the freezing compartment 7.

[0014] A refrigerating cycle 16 (see FIG. 3) for cooling atmospheres of the respective storage compartments is incorporated in the heat insulation box 1. The refrigerating cycle 16 includes a refrigerating cooler 17 for cooling the atmospheres of storage compartments (the refrigerating compartment 4 and the vegetable compartment 5) of the refrigeration temperature zone and a freezing cooler 18 for cooling the atmospheres of storage compartments (the ice-making compartment 6, the small freezing compartment and the freezing compartment 7) of the freezing temperature zone. Both coolers 17 and 18 will be described in detail later. An equipment compartment 19 is provided at the rear lower end of the heat insulation box 1 as shown in FIG. 2. In the equipment compartment 19 are disposed a compressor 20 and a condenser 21 (see FIG. 3) both constituting the refrigerating cycle 16, a cooling fan (not shown) for cooling the compressor 20 and the condenser 21, a defrosting water evaporation pan 35 which will be described later, and the like.

[0015] In inner interiors of the storage compartments (the refrigerating compartment 4 and the vegetable compartment 5) of the refrigeration temperature zone of the heat insulation box 1 are provided the refrigerating cooler 17, a cold air supply duct 30 for supplying cold air generated by the cooler 17 into the refrigerating compartment 4 and the vegetable compartment 5, a refrigeration side blast fan 31 for circulating the cold air and the like in the following manner. More specifically, a refrigeration side cooler compartment 32 which doubles as an air duct is located in the rear of the lowermost chilling compartment 12 of the refrigerating compartment 4. The cooler compartment 32 has a suction opening 37 which is formed in a front lower part thereof so as to face an interior of the vegetable compartment 5 from above. The refrigerating cooler 17 is located in the cooler compartment 32.

[0016] A refrigerating side water receiver 33 is provided in a rear lower part of the cooler compartment 32 to receive defrosting water from the refrigerating cooler 17. The water receiver 33 communicates with the defrosting water evaporation pan 35 in the equipment compartment 19 through a refrigerating side drain hose 34 serving as drain piping disposed in a manner as described later. As a result, defrosting water received by the water receiver 33 is guided through the drain hose 34 to the defrosting water evaporation pan 35. The defrosting water is to be evaporated on the defrosting water evaporation pan 35.

[0017] The refrigerating side blast fan 31 and an air duct 36 are provided in the rear of the chilling compartment 12. The air duct 36 has a lower end communicating with a rear upper part of the cooler compartment 32 and an upper end communicating with a lower end of the cold air supply duct 30. The cold air supply duct 30 extends upward along a rear heat insulating wall of the refrigerating compartment 4 with a constant width. The cold air supply duct 30 is provided with a plurality of cold air inlets 30a open in the interior of the refrigerating compartment 4. The partition wall 9 constituting a bottom plate of the refrigerating compartment 4 has rear right and left corners formed with respective communicating holes although the communicating holes are not shown. One of the communicating holes communicates between the refrigerating compartment 4 and the vegetable compartment 5 located below the refrigerating compartment 4. The other communicating hole communicates between the refrigerating compartment 4 and the front of the cooler compartment 32.

[0018] Upon drive of the refrigeration side blast fan 31, air in the vegetable compartment 5 is suctioned through the suction opening 37 into the cooler compartment 32. The suctioned air is blown to the air duct 36 side. The air blown to the air duct 36 side is further blown into the refrigerating compartment 4 through the cold air supply duct 30 and the cold air inlets 30a in the refrigerating compartment 4. Part of the air blown into the refrigerating compartment 4 is also supplied through the communicating holes into the vegetable compartment 5, being finally suctioned through the cooler compartment 32 into the air duct 36 by the blast fan 31. The air is thus circulated when the blast fan 31 is driven. During the process, air passing through the interior of the cooler compartment 32 is cooled by the refrigerating cooler 17 into cold air. The cold air is supplied into the refrigerating compartment 4 and the vegetable compartment 5 with the result that the atmospheres in the refrigerating compartment 4 and the vegetable compartment 5 are cooled to a temperature in the refrigeration temperature zone.

[0019] A freezing side cooler compartment 38 which doubles as an air duct is provided in inner interiors of the storage compartments (the ice-making compartment 6, the small freezing compartment and the freezing compartment 7) in the freezing temperature zone of the heat insulation box 1. A freezing cooler 18, a defrosting heater (not shown) and the like are provided in a lower interior of the cooler compartment 38. A freezing side blast fan 39 is provided in an upper interior of the cooler compartment 38. A front of the cooler compartment 38 has a cold air outlet 38a formed in a middle part thereof and a return opening 38b formed in a lower part thereof.

[0020] A freezing side water receiver 40 is provided below the freezing cooler 18. The water receiver 40 receives defrosting water resulting from defrosting. The water receiver 40 communicates with the defrosting water evaporation pan 35 provided in the equipment compartment 19 through a freezing side drain hose 41 extending through the bottom heat insulating wall of the heat insulation box 1. As a result, the defrosting water received by the water receiver 40 is guided through the drain hose 41 to the defrosting water evaporation pan 35. The defrosting water is evaporated on the defrosting water evaporation pan 35.

[0021] Upon drive of the freezing side blast fan 39 in the foregoing construction, cold air generated by the freezing cooler 18 is supplied from the cold air outlet 38a into the ice-making compartment 6, the small freezing compartment and the freezing compartment 7 and thereafter returned from the return opening 38b into the cooler compartment 38. The cold air is thus circulated by driving the freezing side blast fan 39, whereby the atmospheres in the ice-making compartment 6, the small freezing compartment and the freezing compartment 7 are cooled.

[0022] The configuration of the refrigerating cycle will now be described in detail. As shown in FIG. 3, the refrigerating cycle 16 includes the compressor 20, the condenser 21, a drier 22, a three-way valve 23 and capillary tubes 24 and 25 connected one to another sequentially in a flowing direction of refrigerant into an annular form. The compressor 20 has a high-pressure discharge outlet to which the condenser 21 and the drier 22 are in turn connected via connecting pipes 26. The drier 22 has a discharge side to which the three-way valve 23 is connected. The three-way valve 23 has one inlet to which the drier 22 is connected and tow outlets. The freezing side capillary tube 24 serving as connecting piping and the refrigerating cooler 17 are in turn connected to one of the outlets of the three-way valve 23. The cooler 17 is connected to the compressor 20 via the refrigerating side suction pipe 27 serving as connecting piping.

[0023] The freezing side capillary tube 25 serving as connecting piping and the freezing cooler 18 are in turn connected to the other outlet of the three-way valve 23. The cooler 18 is connected to the compressor 20 via the freezing side suction pipe 28 serving as connecting piping. A check valve 29 is provided between the cooler 18 and the compressor 20 to prevent reverse flow of refrigerant from the refrigerating cooler 17 to the freezing cooler 18 side.

[0024] A concrete construction of the heat insulation box 1 will be described with reference to FIGS. 1 and 3 to 5. The outer box 2 made of steel plate has a left side plate 50, a right side plate 51, a ceiling plate 52, a bottom plate 53 and a rear plate 54 and further has a front opening. The left side plate 50, the right side plate 51 and the ceiling plate 52 are formed by folding ends of respective elongate steel plates substantially into a U-shape. The bottom plate 53 is formed with a stepped portion 53a for defining the equipment compartment 19. The left side plate 50 has a front end formed with an inwardly protruding flange 50a and a rear end formed with a frontwardly oriented flange 50b, as shown in FIG. 1. The right side plate 51 has a front end formed with an inwardly protruding flange 51a and a rear end formed with a frontwardly oriented flange 51b. The rear plate 54 has a right end formed with a flange 54b inserted into the flange 51b of the right plate 51 and a left end formed with a flange 54a inserted into the flange 50b of the left side plate 50. The rear plate 54 has filler holes 55 formed in middle portions of right and left sides thereof respectively, as shown in FIG. 4.

[0025] The inner box 3 made of the synthetic resin is integrally formed by a vacuum forming machine (not shown). The inner box 3 has a left side plate 56 corresponding to the left side plate 50 of the outer box 2, a right side plate 57 corresponding to the right side plate 51 of the outer box 2, a ceiling plate 58 corresponding to the ceiling plate 52 of the outer box 2, a bottom plate 59 corresponding to the bottom plate 53 of the outer box 2 and a rear plate 60 corresponding to the rear plate 54 of the outer box 2. The inner box 3 has a front opening. The bottom plate 59 has a stepped portion 59a formed to define the equipment compartment 19 and corresponding to the stepped portion 53a of the bottom plate 53 of the outer box 2. The left side plate 56 has a front end formed with a flange 56a which is inserted into the flange 50a of the left side plate 50 of the outer box 2. The right side plate 57 has a front end formed with a flange 57a which is inserted into the flange 51a of the right side plate 51 of the outer box 2. Corners are formed between the rear plate 60 and the left side plate 56, the right side plate 57 and the ceiling plate 58 serving as other plates continuous to the rear plate 60, respectively, as shown in FIGS. 1, 2 and 4. The corners are formed with respective chamfered portions 61, 62 and 63 serving as accommodation recesses recessed inward of the inner box 3 relative to the corners. The rear plate 60 of the inner box 3 has right and left sides each of which is formed with a plurality of recesses 64. The recesses 64 are recessed inward of the inner box 3 and have proximal ends which are located at the chamfered portion 61 to be continuous between the left side plates 50 and 56 or which are located at the chamfered portion 62 to be continuous between the right side plates 51 and 57. The recesses 64 have distal ends formed with vent holes 64a respectively as shown in FIG. 1.

[0026] The refrigeration side capillary tube 24 and the refrigeration side suction pipe 27 of the refrigerating cycle are guided from the rear plate 60 side to the chamfered portion 62 side in the inner box 3 thereby to be led out of the chamfered portion 62. The refrigeration side capillary tube 24 and the refrigeration side suction pipe 27 are soldered to each other, for example to be integrated so as to be heat-exchangeable into a pipe assembly 65, as shown in FIGS. 1 and 2. The pipe assembly 65 extends upward along an outer surface of the chamfered portion 62 of the inner box 3 and is oriented along an outer surface of the chamfered portion 63 toward the left side plate 56, as shown in FIG. 5. The pipe assembly 65 is then turned around at the left side plate 56 side to be oriented toward the right side plate 57. The pipe assembly 65 is further disposed to extend downward along the outer surface of the chamfered portion 62.

[0027] The refrigeration side capillary tube 24 and the refrigeration side suction pipe 27 are thus integrated so as to be heat-exchangeable for the purpose of enhancing vaporization of refrigerant in the refrigeration side suction pipe 27 thereby to improve an operating efficiency of the refrigerating cycle 16 with the result of reduction in electric power consumption. Since the freezing side capillary tube 25 and the freezing side suction pipe 28 are disposed in the same manner as described above, the disposition is eliminated in the drawings. Further, as shown in FIG. 5, the refrigeration side drain hose 34 extends from the rear plate 60 side to the chamfered portion 62 side in the inner box 3 thereby to be led out of the chamfered portion 62. The drain hose 34 is further disposed to extend downward along the outer surface of the chamfered portion 62.

[0028] Reverse sides of vacuum insulation panels 66 and 67 serving as heat insulators are bonded to inner surfaces of the left and right side plates 50 and 51 of the outer box by a double-faced adhesive tape or a bonding agent such as hot melt adhesive, respectively, as shown in FIGS. 1, 2 and 4. Surfaces of vacuum insulation panels 68 and 69 are bonded to outer surfaces of the ceiling plate 58 and the bottom plate 59 of the inner box 3 by the double-faced adhesive tape or a bonding agent such as hot melt adhesive, respectively. A reverse side of a vacuum insulation panel 70 serving as a heat insulator is bonded to an inner surface of the rear plate 54 of the outer box 2 by the double-faced adhesive tape or a bonding agent such as hot melt adhesive. The inner box 3 is then placed in the outer box 2, so that the flange 56a of the left side plate 56 of the inner box 3 is engaged with the flange 50a of the left side plate 50 of the outer box 2 and the flange 57a of the right side plate 57 of the inner box 3 is engaged with the flange 51a of the right side plate 51 of the outer box 2, as shown in FIG. 1. The bottom plate 53 is then attached to the right and left side plates 51 and 50 of the outer box 2. Further, the rear plate 54 is attached to the left side plate 50, the right side plate 51, the ceiling plate 52 and the bottom plate 53 of the outer box 2, so that the surface of the vacuum insulation panel 70 is pressed against the outer surface of the rear plate 60 of the inner box 3.

[0029] Subsequently, the front openings of the outer and inner boxes 2 and 3 are cast down as shown in FIG. 4. An undiluted solution of foam insulator comprised of urethane foam is injected from the filler holes 55 of the rear plate 54 of the outer box 2 while a foaming jig (not shown) is inserted into the inner box 3. The undiluted solution of foam insulator injected from the filler holes 55 into a space between the outer and inner boxes 2 and 3 is received by the flanges 50a and 51a and the flanges 56a and 57a of the front openings of the outer and inner boxes 2 and 3 respectively. Subsequently, while foaming, the undiluted solution is expanded to move upward between the left side plates 50 and 56, the right side plates

51 and 57 and the ceiling plates 52 and 58 of the outer and inner boxes 2 and 3, thereby filling the space. Consequently, a foam insulation 71 serving as a heat insulator is constituted.

[0030] The heat insulation box 1 uses the vacuum insulation panels 66, 67, 68, 69 and 70 and the foam insulation 71 as the heat insulator jointly, as shown in FIG. 1. In the heat insulation box 1, the left side plates 50 and 56, the vacuum insulation panel 66 and the foam insulation 71a constitute a left side heat insulating wall. The right side plates 51 and 57, the vacuum insulation panel 67 and the foam insulation 71b constitute a right side heat insulating wall. Further, the ceiling plates 52 and 58, the vacuum insulation panel 68 and the foam insulation 71c constitute a ceiling heat insulating wall as shown in FIG. 2. The bottom plates 53 and 59, the vacuum insulation panel 69 and the foam insulation 71d constitute a bottom heat insulating wall. The rear plates 54 and 60 and the vacuum insulation panel 70 constitute a rear heat insulating wall as shown in FIGS. 1 and 2. In this case, the vacuum insulation panels 66 to 70 have respective thicknesses that are set to be substantially equal to one another. Further, the foam insulations 71a, 71b, 71c and 71d have respective thicknesses that are set to be substantially equal to one another. However, the thicknesses of the foam insulations 71a, 71b, 71c and 71d are set to be equal to or smaller than the thicknesses of the vacuum insulation panels 66 to 70, for example, are set to be substantially equal to the thicknesses of the vacuum insulation panels 66 to 70.

[0031] Further, as shown in FIG. 1, a foam insulation 71e fills a space defined in the heat insulation box 2 by a corner made between the left side plate 50 and the rear plate 54 of the outer box 2, a rear surface of the vacuum insulation panel 66, a left side surface of the vacuum insulation panel 70 and the chamfered portion 61 of the inner box 3. The foam insulation 71e has a larger thickness than the foam insulations 71b, 71c and 71d. A foam insulation 71f fills a space defined in the heat insulation box 1 by a corner made between the right side plate 51 and the rear plate 54, the rear surface of the vacuum insulation panel 67, the right side surface of the vacuum insulation panel 70 and the chamfered portion 62 of the inner box 3. The foam insulation 71f has a larger thickness than the foam insulations 71b, 71c and 71d. Further, as shown in FIG. 2, a foam insulation 71g fills a space defined in the heat insulation box 1 by a corner made between the ceiling plate 52 and the rear plate 54 of the outer box 2, a rear surface of the vacuum insulation panel 68, an upper surface of the vacuum insulation panel 70 and the chamfered portion 63 of the inner box 3. The foam insulation material 71g has a larger thickness than the foam insulation materials 71a, 71b, 71c and 71d. A foam insulation 71h fills a space defined in the heat insulation box 1 by a corner made between the bottom plate 53 and the rear plate 54, an underside of the vacuum insulation panel 70 and the stepped portions 53a and 59a. The foam insulation 71h has a larger thickness than the foam insulations 71a, 71b, 71c and 71d.

[0032] Further, as shown in FIG. 1, a foam insulation 71i fills a space defined between the vacuum insulation panel 70 having a rear surface bonded to an inner surface of the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3 pressed against the vacuum insulation panel 70 in the heat insulation box 1. The foam insulation 71i is formed by a foam insulation moving upward between the left side plates 50 and 56 or between the right side plates 51 and 57 to flow into the recesses 64. The surface of the vacuum insulation panel 70 is bonded to an outer, that is, rear surface of the rear plate 60 of the inner box 3 by the foam insulation 71i.

[0033] A side heat insulating wall of the heat insulation box 1 is constituted by the left side heat insulating wall, the right side heat insulating wall, the ceiling heat insulating wall and the bottom heat insulating wall. The left side heat insulating wall includes the left side plates 50 and 56, the vacuum insulation panel 66 and the foam insulation 71a. The right side heat insulating wall includes the right side plates 51 and 57, the vacuum insulation panels 67 and the foam insulation 71b. The ceiling heat insulating wall includes the ceiling plates 52 and 58, the vacuum insulation panel 68 and the foam insulation 71c. The bottom heat insulating wall includes the bottom plates 53 and 59, the vacuum insulation panel 69 and the foam insulation 71d. The rear heat insulating wall includes the rear plates 54 and 60 and the vacuum insulation panel 70. The side heat insulating walls which are heat insulating walls other than the rear heat insulating wall are constituted by the left side heat insulating wall, the right side heat insulating wall, the ceiling heat insulating wall and the bottom heat insulating wall.

[0034] In the left side heat insulating wall, the foam insulation 71a is located between the inner box 3 and the surface of the vacuum insulation panel 66 corresponding to the inner box 3. In the right side heat insulating wall, the foam insulation 71b is located between the inner box 3 and the surface of the vacuum insulation panel 67 corresponding to the inner box 3. In the ceiling heat insulating wall, the foam insulation 71c is located between the outer box 2 and the back side of the vacuum insulation panel 68 corresponding to the outer box 2. In the bottom heat insulating wall, the foam insulation 71d is located between the outer box 2 and the back side of the vacuum insulation panel 69 corresponding to the outer box 2. In the rear heat insulating wall, however, the inner box 3 abuts against the surface of the vacuum insulation panel 70 corresponding to the inner box 3. In the rear heat insulating wall, only the bonding foam insulation 71i is located partially between the inner box 3 and the vacuum insulation panel 70. Accordingly, the rear heat insulating wall has an area of part in which the vacuum insulation panel 70 is not in contact with the foam insulation (a total of an area of surface of the vacuum insulation panel 70 corresponding to the inner box 3 and an area of back side of the vacuum insulation panel 70 corresponding to the outer box 2, in this case). This are of the rear heat insulating wall is larger than those of parts in which the vacuum insulation panels are not in contact with the foam insulations in the other side heat insulating walls (the left side heat insulating wall, the right heat insulating wall, the ceiling heat insulating wall and the bottom heat insulating wall respectively). In other words, the usage of foam insulation in the rear heat insulating wall is exceedingly smaller than usages of foam insulations in the other side heat insulating walls (the left side heat insulating wall, the right side heat insulating wall, the ceiling heat insulating wall and the bottom heat insulating wall).

[0035] Further, the heat insulation box 1 has the chamfered portion 62 formed on the corner 62 made between the right side plate 57 and the rear plate 60 of the inner box 3 and the chamfered portion 63 formed on the corner made between the ceiling plate 58 and the rear plate 60. The chamfered portions 62 and 63 protrude inward of the inner box 3 with the result that a space is defined lateral to the chamfered portions 62 and 63. The space serves as an accommodation recess. The space is also filled with the foam insulations 71f and 71g, so that the thicknesses of the foam insulations 71f and 71g are increased. The pipe assembly 65 is buried in the foam insulations 71f and 71g whose thicknesses are increased, as shown in FIGS. 1 and 2. The refrigerating side drain hose 34 is also buried in the foam insulation 71f as shown in FIG. 1.

[0036] According to the foregoing embodiment, the chamfered portions 61, 62 and 63 are formed at the corners made between the rear plate 60 of the inner box 3 and the left side plate 56, the right side plate 57 and the ceiling plate 58 all continuous to the rear plate 60. The chamfered portions 61 to 63 serve as the storage recess protruding inward of the inner box 3 relative to the corners. The foam insulations 71f and 71g fill the space lateral to at least one of the chamfered portions, that is, the chamfered portions 62 and 63 in this case. This increases the thicknesses of the foam insulations. The pipe assembly 65 serving as the connecting piping is buried in the foam insulations 71f and 71g whose thicknesses are increased. The refrigerating drain hose 34 serving as drain piping is buried in the foam insulation 71f. As a result, the pipe assembly 65 and the refrigerating drain hose 34 need not be disposed between the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3. Accordingly, the vacuum insulation panel 70 having a smaller thickness can be easily disposed between the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3. More specifically, the rear plate 60 of the inner box 3 includes a part coming close to the vacuum insulation panel 70 or in this case, no pipe assembly 65 and no refrigerating side drain hose 34 are located lateral to the rear plate 60.

[0037] The vacuum insulation panel 70 is disposed between the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3 so that the foam insulation does not flow almost into a space between the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3 and a space between the vacuum insulation panel 70 and the rear plate 60 of the inner box 3 when the undiluted solution of foam insulation is injected into the space between the outer and inner boxes 2 and 3 to be foamed. This does not require a foam pressure of the undiluted solution of foam insulation to be increased to a value not less than an expansion ratio, with the result that the usage of foam insulation can be reduced.

[0038] Further, the rear plate 60 of the inner box 3 is formed with a plurality of inwardly protruding recesses 64. The undiluted solution of foam insulation is caused to flow into the recesses 64 so that the foam insulation fills the recesses 64. As a result, the vacuum insulation panel 70 can be bonded to the rear plate 60 of the inner box 3 while the foam insulation 71i is used as a bonding agent. This does not require the heat insulation panel 70 to be bonded to the rear plate 60 of the inner box 3 before the filling of the foam insulation, simplifying the assembly work. In this case, since the distal ends of the recesses 64 are formed with the respective vent holes 64a, a sufficient amount of foam insulation 71i can be caused to flow into the recesses 64 even when the widths of the recesses 64 (the widths of grooves along which the foam insulation flows) are small.

Second Embodiment

[0039] FIGS. 6 and 7 illustrate a second embodiment. The differences between the first and second embodiments will be described. The rear plate 60 of the inner box 3 is formed with no recesses 64 in the second embodiment, as shown in FIG. 6. More specifically, the vacuum insulation panel 70 is bonded to the rear plate 60 of the inner box 3 before the filling of the foam insulation.

[0040] Describing more concretely, the vacuum insulation panel 70 is bonded to an inner surface of the rear plate 54 of the outer box 2 by the double-faced adhesive tape or the bonding agent such as hot melt adhesive. The rear plate 54 is disposed so that the surface side of the vacuum insulation panel 70 faces upward. The hot melt adhesive serving as the adhesive agent is applied to the surface of the vacuum insulation panel 70 (the upper surface as shown in FIG. 7) by a roll coater 72.

[0041] The roll coater 72 includes a coating roll 73 applying the hot melt adhesive in contact with the surface of the vacuum insulation panel 70, a backup roll 74 coming in contact to an outer surface (the underside in FIG. 7) of the rear plate 54 and pickup roll 75 supplying the hot melt adhesive to the coating roll 73. The coating roll 73, the backup roll 74 and the pickup roll 75 are rotatably supported by supports (not shown) respectively. When the rear plate 54 is moved in the right direction as viewed in FIG. 7, the hot melt adhesive is applied to the surface of the vacuum insulation panel 6. In this case, the rear plate 54 has flanges 54a and 54b both having a height Lb (projection) smaller than a height La (an addition of the thickness of the vacuum insulation panel 70 and the thickness of the rear plate 54). More specifically, the height Lb of the flanges 54a and 54b are set in the relation of Lb<La. As a result, the flanges 54a and 54b are prevented from being brought into contact with the coating roll 73 thereby to damage the coating roll 73.

[0042] The rear plate 54 having the vacuum insulation panel 70 with the surface to which the hot melt adhesive is applied is attached to the outer box 2 by inserting the flange 54b into the flange 50b of the left side plate 50. In this case, the surface of the vacuum insulation panel 70 is pressed against the backside (the outer surface) of the rear plate 60 of the inner box 3 to be bonded to the backside of the rear plate 60 by the hot melt adhesive.

[0043] Subsequently, the undiluted solution of foam insulation is injected between the outer box 2 and the inner box 3 to be foamed. However, the flange 56a of the front opening is merely inserted into the flange 50a and the flange 57a of the inner box 3 is merely inserted into the flange 51a until the undiluted solution of foam insulation is injected, so that the inner box 3 is unstable relative to the outer box 2. Accordingly, there is a possibility of deformation of the inner box 3 having a low mechanical strength. According to the embodiment, however, the rear plate 54 of the outer box 2 and the rear plate 60 of the inner box 3 are integrated by the vacuum insulation panel 70 bonded to both rear plates. This increases the strength of the inner box 3 with the result that deformation of the inner box 3 can be avoided until the foam insulation fills the space. Further, the deformation of the inner box 3 can be avoided even when a substantial time elapses until the foam insulation fills the space, for example.

[0044] The inner box 3 is in an unstable installation condition relative to the outer box 2 until the foam insulation fills the space, as described above. Accordingly, there is a possibility that the vacuum insulation panel 70 may not be bonded to a normal position (a specified position) on the rear plate 60 of the inner box 3 when the rear plate 54 is mounted to the outer box 2 and the vacuum insulation panel 70 is bonded to the rear plate 60 of the inner box 3. If the inner box 3 is displaced from the normal position, there is a possibility that the vacuum insulation panel 70 would be bonded to a position displaced from the normal position on the rear plate 60 of the inner box 3. When the foaming jig (a jig for injecting the undiluted solution of foam insulation to the space between the outer box 2 and the inner box 3 to foam the undiluted solution) is inserted into inner box 3 in this condition, the inner box 3 is forcedly moved to the normal position. This causes a stress to act on the outer box 2 and the inner box 3 via the vacuum insulation panel 70, resulting in deformation (corrugations, distortion or the like) of the inner box 3 with the low mechanical strength.

[0045] According to the embodiment, however, the chamfered portions 61, 62 and 63 are formed on the corners made between the rear plate 60 of the inner box 3 and the left side plate 56, the right side plate 57 and the ceiling plate 58 continuous to the rear plate 60 respectively. Accordingly, the stress resulting from displacement in the position of the bonded vacuum insulation panel 70 can be absorbed by the chamfered portions 61, 62 and 63 with the result that the inner box 3 can be prevented from occurrence of deformation. It is desirable that the chamfered portions 61, 62 and 63 should be formed into a linear shape. However, the chamfered portions 61, 62 and 63 may be formed into a slightly arc shape.

Third Embodiment

[0046] FIG. 8 illustrates a third embodiment. The differences between the first and third embodiments will be described. The third embodiment will be described also with reference to FIG. 2 for the sake of easiness in the description.

[0047] In the third embodiment, the rear plate 60 of the inner box 3 is formed with no recesses 64. The rear plate 60 is formed with an accommodation recess 76 protruding inward of the inner box 3, instead. The accommodation recess 76 is located on the back of the refrigeration side cooler compartment 32 functioning as an air duct. The accommodation recess 76 extends horizontally from a vertical middle of the rear plate 60 to the chamfered portion 62. The rear plate 60 of the inner box 3 is also formed with an accommodation recess 77 protruding inward of the inner box 3. The accommodation recess 77 is located near the refrigeration side cooler compartment 32 or on the back of a lower part of the refrigeration side cooler compartment 32. The accommodation recess 77 also extends horizontally from the vertical middle of the rear plate 60 to the chamfered portion 62.

[0048] The pipe assembly 65 is drawn from the middle of the rear plate 60 of the inner box 3 into the accommodation recess 76. The pipe assembly 65 is then guided along the accommodation recess 65 to the outer surface of the chamfered portion 62. The pipe assembly 65 is further guided upward along the outer surface of the chamfered portion 62 and toward the left side plate 56 along the outer surface of the chamfered portion 63 and still further downward along the outer surface of the chamfered portion 61. In other words, the pipe assembly 65 is arranged into a portal shape along the periphery of the rear plate 60. Further, the refrigeration side drain hose 34 is led from the middle of the rear plate 66 into the accommodation recess 77. The refrigeration side drain hose 34 then guided downward along the outer surface of the chamfered portion 62.

[0049] The vacuum insulation panel 70 is bonded to the rear plate 60 of the inner box 3. In this case, the accommodation recess 76 accommodates the pipe assembly 65 serving as the piping. The accommodation recess 77 accommodates the refrigeration side drain hose 34 serving as the piping. Accordingly, the vacuum insulation panel 70 is prevented from being driven onto the pipe assembly 65 and the refrigeration side drain hose 34 thereby to float. The undiluted solution of foam insulation is injected between the outer box 2 and the outer box 3 to be foamed, after the adhesive bonding of the vacuum insulation panel 70. In the filling of the foam insulation, the foam insulation flows from the chamfered portion 62 into the accommodation recesses 76 and 77. Accordingly, the pipe assembly 65 and the refrigeration side drain hose 34 are buried in the foam insulation.

[0050] According to the embodiment, the inwardly protruding accommodation recesses 76 and 77 are formed in the rear plate 60 of the inner box 3. The pipe assembly 65 and the refrigeration side drain hose 34 are led to be accommodated in the accommodation recesses 76 and 77. Accordingly, even when the pipe assembly 65 and the refrigeration side drain hose 34 are forced to be led out of the inner box 3 from the middle of the rear plate 60 of the inner box 3 in structural or technical circumstances, the vacuum insulation panel 70 can be prevented from deformation in which the vacuum insulation panel 70 is driven onto the pipe assembly 65 and the drain hose 34 thereby to float, and the like. Accordingly, the insulation performance of the foam insulation panel 70 can be prevented from adverse effects. Moreover, the pipe assembly 65 is formed into the portal shape and disposed in all the chamfered portions 61, 62 and 63. This can ensure a sufficient length (distance) of the pipe assembly 65.

Fourth Embodiment

[0051] FIGS. 9 and 10 illustrate a fourth embodiment. The differences between the first and fourth embodiments will be described in the following. The fourth embodiment will be described also with reference to FIG. 2 for the sake of easiness in the description. No recesses 64 are formed in the rear plate 60 of the inner box 3 in the fourth embodiment.

[0052] A freezing side cooler compartment 38 which doubles as an air duct is provided in an inner interior of the freezing compartment 7, as shown in FIG. 2. The freezing cooler 18 and the freezing side blast fan 39 are provided in the freezing side cooler compartment 38. The freezing side cooler compartment 38 includes right and left end sides which are unnecessary spaces (dead spaces) where food cannot be stored. In the embodiment, the rear plate 60 of the inner box 3 is formed with an accommodation recess 78 protruding inward of the inner box 3 in order that one of the right and left end side dead spaces or the right end side dead space in this case may be used.

[0053] The freezing side capillary tube 25 and the freezing side suction pipe 28 both connected to the freezing cooler 18 are led from the inner box 3 into the accommodation recess 78. The freezing side capillary tube 25 and the freezing side suction pipe 28 are soldered to each other to be integrated so as to be heat-exchangeable, thereby constituting a pipe assembly 79 serving as connecting piping. The pipe assembly 79 is disposed so that a distal end thereof is oriented downward after having been folded twice in the accommodation recess 78 into a U-shape, as shown in FIG. 10.

[0054] The vacuum insulation panel 70 is bonded to the rear plate 60 of the inner box 3 and thereafter, the undiluted solution of foam insulation is injected between the outer box 2 and the inner box 3 to be foamed. As a result, the accommodation recess 78 is also filled with the foam insulation 71f, and the pipe assembly 79 is buried in the foam insulation 71f, as shown in FIG. 9.

[0055] According to the embodiment, the accommodation recess 78 is formed so as to protrude into one of the dead spaces defined at right and left end sides of the freezing side cooler compartment 38 on the freezing compartment 7 respectively. The pipe assembly 79 is accommodated in the accommodation recess 78. Thus, the pipe assembly 79 can be disposed by skillfully using the dead space in the freezing compartment 7.

[0056] The accommodation recess may be formed to protrude into the other of the dead spaces defined at right and left end sides of the freezing side cooler compartment 38 on the freezing compartment 7 respectively and the pipe assembly 65 (see FIG. 1) may be accommodated in the accommodation recess.

Fifth Embodiment

[0057] FIGS. 11 and 12 illustrate a fifth embodiment. The differences between the first and fifth embodiments will be described in the following. No recesses 64 are formed in the rear plate 60 of the inner box 3 in the fifth embodiment.

[0058] More specifically, the bottom plate 53 of the outer box 2 is formed with no stepped portion 53a, and the bottom plate 59 of the inner box 3 is formed with no stepped portions, as shown in FIG. 11. The ceiling plate 59 of the inner box 3 is formed with a stepped portion 52 for defining the equipment compartment 19 and the ceiling plate 58 of the inner box 3 is formed with a stepped portion 58a for defining the equipment compartment 19, instead. The stepped portion 58a serves as the accommodation recess corresponding to the stepped portion 52a of the ceiling plate 52 and protrudes inward of the inner box 3. The pipe assembly 65 is disposed to move upward along the outer surface of the chamfered portion 62 of the inner box 3 as shown in FIG. 12. The pipe assembly 65 is further disposed on a horizontal portion of the stepped portion 58a so as to be guided toward the left side plate 56. Further, the pipe assembly 65 is caused to U-turn to be guided toward the right side plate 57 and then to U-turn again to be guided to the left side plate 56. The pipe assembly 65 is disposed so that an end thereof is oriented upward near the left side plate 56. More specifically, the pipe assembly 65 is arranged while being turned around twice on the horizontal portion of the stepped portion 58a.

[0059] The vacuum insulation panel 70 is bonded to the rear plate 60 of the inner box 3 and thereafter, the undiluted solution of foam insulation is injected between the outer box 2 and the inner box 3 to be foamed. As a result, the foam insulation 71g fills a space between the stepped portion 52a of the ceiling plate 52 and the stepped portion 58a of the ceiling plate 58, so that the pipe assembly 65 is buried in the foam insulation 71g, as shown in FIG. 11.

[0060] In the equipment compartment 19 are provided the compressor 20, the condenser 21 (see FIG. 3), a cooling fan (not shown) for cooling the compressor 20 and the condenser 21, and the like. The cold air supply duct 30 includes an extension duct 30b extending along the stepped portion 58a. The extension duct 30b has an upper end provided with a cold air supply opening 30a.

[0061] The refrigerator of the embodiment is of the type including the compressor 20 and the like provided in an upper part of the heat insulation box 1. In this type of refrigerator, in order that the equipment compartment 19 may be formed to house the compressor 20 and the like, the ceiling plate 52 of the outer box 2 is formed with the stepped portion 52a and the ceiling plate 58 of the inner box 3 is formed with the stepped portion 58a. The pipe assembly 65 is accommodated in a space that is necessarily formed between the stepped portions 52a and 58a.

Sixth Embodiment

[0062] FIG. 13 illustrates a sixth embodiment. The differences between the fifth and sixth embodiments will be described in the following. In the fifth embodiment, the pipe assembly 65 is arranged while being turned around twice on the horizontal portion of the stepped portion 58a. In the sixth embodiment, the pipe assembly 65 is arranged while being turned around once on the horizontal portion of the stepped portion 58a. The pipe assembly 65 further proceeds to a vertical portion of the stepped portion 58a to be arranged while being turned around twice. The pipe assembly 65 is then arranged so that the end thereof is oriented upward.

[0063] According to the embodiment, the refrigeration side capillary tube 24 and the refrigeration side suction pipe 27 (see FIG. 3) are integrated so as to be heat-exchangeable. The length (distance) of the pipe assembly 65 can be rendered larger in the fifth embodiment. This can perform sufficient heat exchange between the refrigeration side capillary tube 24 and the refrigeration side suction pipe 27, thereby achieving further electrical power saving.

Seventh Embodiment

[0064] FIG. 14 illustrates a seventh embodiment. The differences between the fifth and seventh embodiments will be described in the following. In the fifth embodiment, the pipe assembly 65 is arranged while being turned around twice into a U-shape on the horizontal portion of the stepped portion 58a formed on the ceiling plate 58 (see FIG. 12). In the seventh embodiment, the pipe assembly 65 is arranged on the horizontal portion of the stepped portion 58a in a spiral. The pipe assembly 65 has an end which is drawn from the central part of the spiral to be oriented upward. The pipe assembly 65 may be configured so that a plurality of spiral portions is arranged on the horizontal portion of the stepped portion 58a. Alternatively, the pipe assembly 65 may be provided on a vertical portion of the stepped portion 58a.

Other Embodiments

[0065] In each one of the first to third embodiments, the pipe assembly is the piping formed by integrating the freezing side capillary tube 25 and the freezing side suction pipe 28 so that the freezing side capillary tube 25 and the freezing side suction pipe 28 are heat-exchangeable. The pipe assembly may be accommodated at the outer surface side of the stepped portion 59a which is an accommodation recess formed in the bottom plate 59 of the inner box 3.

[0066] In the first embodiment, the accommodation recess is formed in the rear plate 60 of the inner box 3. The accommodation recess is located between the upper end of the air duct 36 and the ceiling plate 58 and protrudes inward of the inner box 3. The pipe assembly 65 may be disposed in the accommodation recess.

[0067] In the fifth embodiment, the accommodation recess is formed in the rear plate 60 of the inner box 3. The accommodation recess is located between the lower end of the freezing side cooler compartment 38 serving as the air duct and the bottom plate 59 and protrudes inward of the inner box 3. A pipe assembly 79 (see FIG. 9) may be disposed in the accommodation recess.

[0068] At least one of the first to third embodiments may be combined with the fourth embodiment in reduction to practice. Further, a plurality of the above-described embodiments may be suitably combined in reduction to practice.

[0069] The insulated wall constituting each part of the heat insulation box 1 may not comprise the foam insulation and the vacuum insulation panel but may comprise the foam insulation.

[0070] As described above, the refrigerator includes a heat insulation box, an air duct, an accommodation recess and piping. The heat insulation box includes an outer box, an inner box and a heat insulating material and has a storage compartment therein. The outer box has a left side plate, a right side plate, a ceiling plate, a bottom plate and a rear plate. The inner box is disposed in the outer box and has a left side plate corresponding to the left side plate of the outer box, a right side plate corresponding to the right side plate of the outer box, a ceiling plate corresponding to the ceiling plate of the outer box, a bottom plate corresponding to the bottom plate of the outer box and a rear plate corresponding to the rear plate of the outer box. The heat insulating material is disposed between the inner box and the outer box and constitutes a heat insulating wall of each part. The air duct is provided in an inner interior of the storage compartment of the heat insulation box. A cooler unit constituting the refrigerating cycle supplying cold air to the storage compartment and a blast fan are disposed in the air duct. The accommodation recess formed in the inner box and protrudes inward of the inner box. The piping is arranged in the accommodation recess. The rear plate of the inner box includes a part coming close to the heat insulator. No piping is provided in the part. As a result, the heat insulator constituting the rear heat insulating wall can be thinned without adverse effect of the piping.

[0071] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the invention. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

Claims

1. A refrigerator comprising:

a heat insulation box including:

an outer box having a left side plate, a right side plate, a ceiling plate, a bottom plate and a rear plate;
an inner box having a left side plate corresponding to the left side plate of the outer box, a right side plate corresponding to the right side plate of the outer box, a ceiling plate corresponding to the ceiling plate of the outer box, a bottom plate corresponding to the bottom plate of the outer box and a rear plate corresponding to the rear plate of the outer box; and
a heat insulator disposed between the inner box and the outer box to constitute heat insulating walls, the heat insulation box defining a storage compartment therein;

an air duct provided in an inner interior of the storage compartment of the heat insulation box and having an interior in which are disposed a cooler constituting a refrigerating cycle supplying cold air into the storage compartment, and a blast fan;
an accommodation recess formed in the inner box and protruding inward of the inner box; and piping disposed in the accommodation recess.

2. The refrigerator according to claim 1, wherein:

the bottom plate or the ceiling plate of the inner box is formed with a stepped portion serving as the accommodation recess;
the stepped portion defines an equipment compartment in which a compressor constituting the refrigerating cycle is disposed; and
the piping includes a capillary tube and a suction pipe both connected to the cooler, the capillary tube and the suction pipe being disposed in the stepped portion so as to be heat-exchangeable.

3. The refrigerator according to claim 1, wherein:

the accommodation recess is formed in one or both of right and left sides of the air duct or in a part of the rear plate of the inner box located between an upper end of the air duct and the ceiling plate of the inner box or a part of the rear plate of the inner box located between a lower end of the air duct and the bottom plate of the inner box; and
the capillary tube and the suction pipe both connected to the cooler and serving as the piping are disposed in the accommodation recess so as to be heat-exchangeable.

4. The refrigerator according to claim 1, wherein:

corners are made between the rear plate of the inner box and the left side plate, the right side plate and the ceiling plate of the inner box respectively, and the corners are formed with respective chamfered portions serving as the accommodation recess; and
the piping includes a capillary tube and a suction pipe both connected to the cooler, the capillary tube and the suction pipe being disposed in at least one of the chamfered portions so as to be heat-exchangeable.

5. The refrigerator according to claim 1, wherein:

corners are made between the rear plate of the inner box and the left side plate, the right side plate and the ceiling plate of the inner box respectively, and the corners are formed with respective chamfered portions serving as the accommodation recess; and
the piping includes a drain hose for drainage of defrosting water produced by the cooler, the drain hose being disposed in at least one of the chamfered portions.

6. The refrigerator according to any one of claims 1 to 5, wherein the accommodation recess is formed in a part of the rear plate of the inner box, the part being located on or near a rear of the air duct, and the piping is disposed in the accommodation recess.

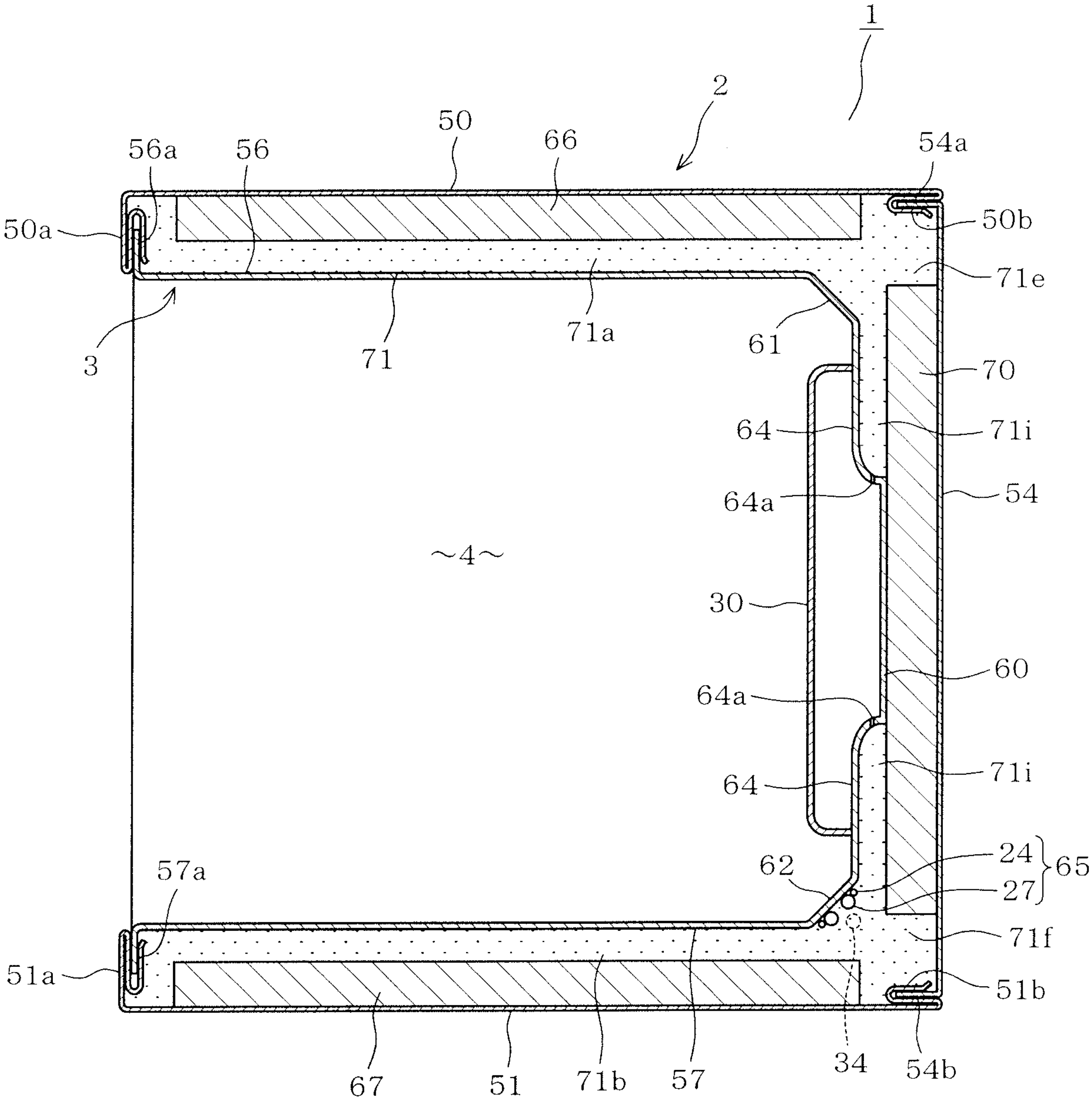
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FIG. 1

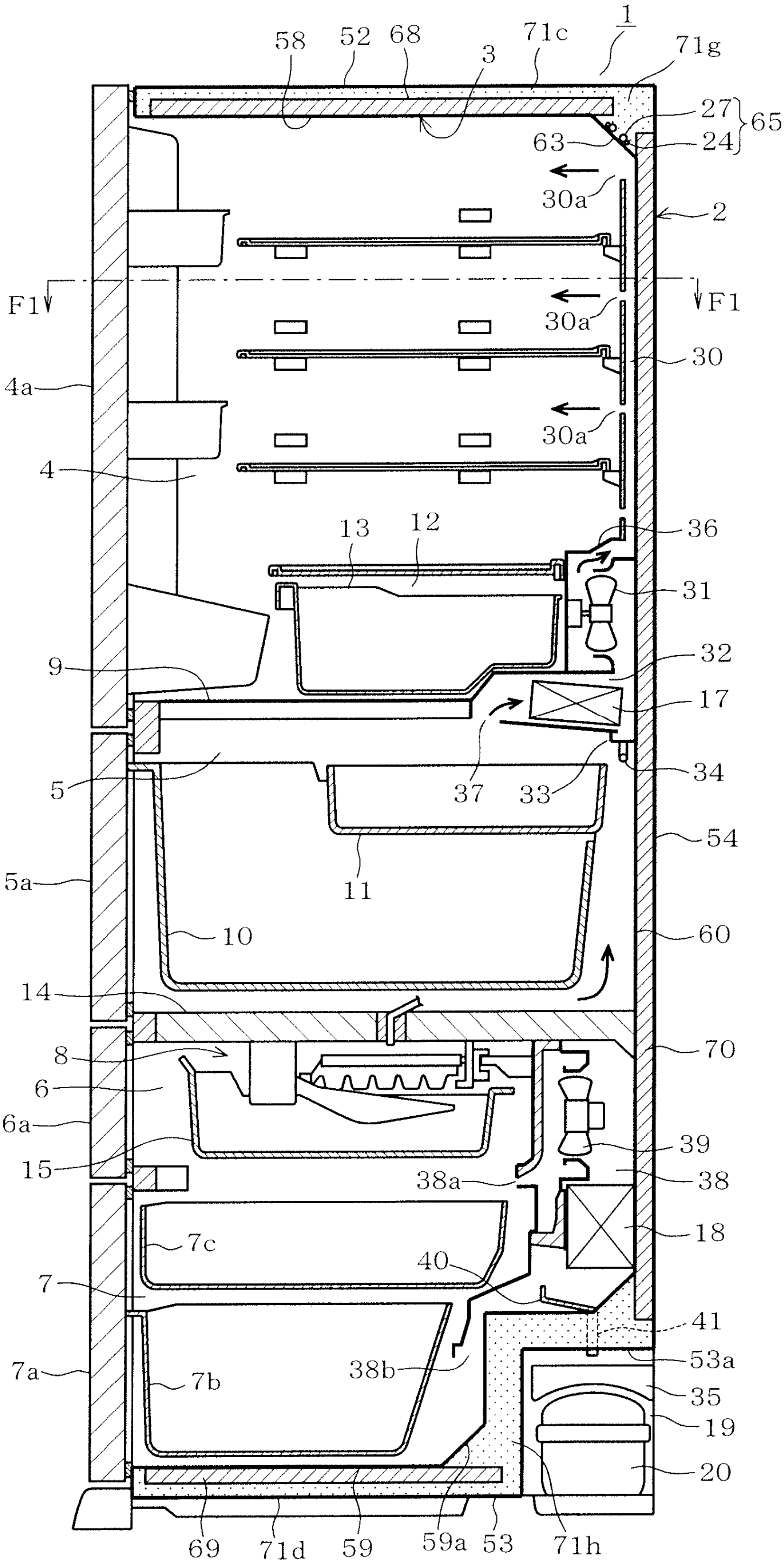
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FIG.2

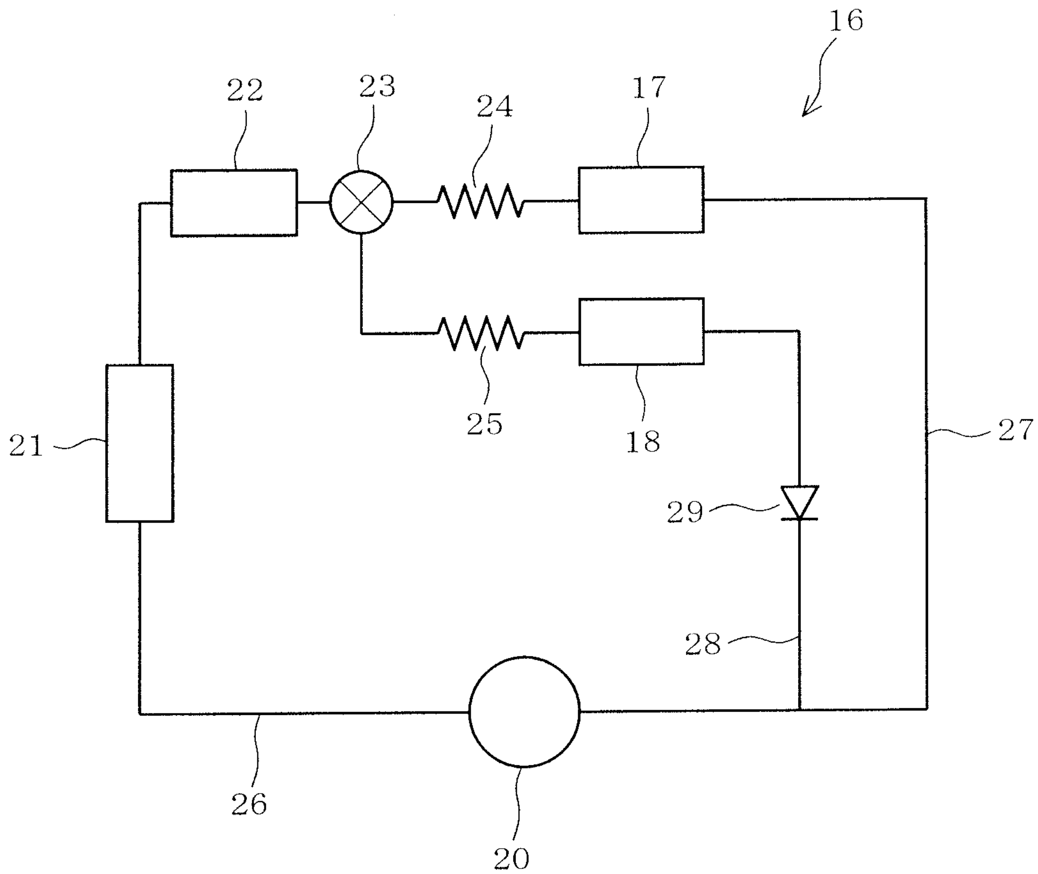

FIG.3

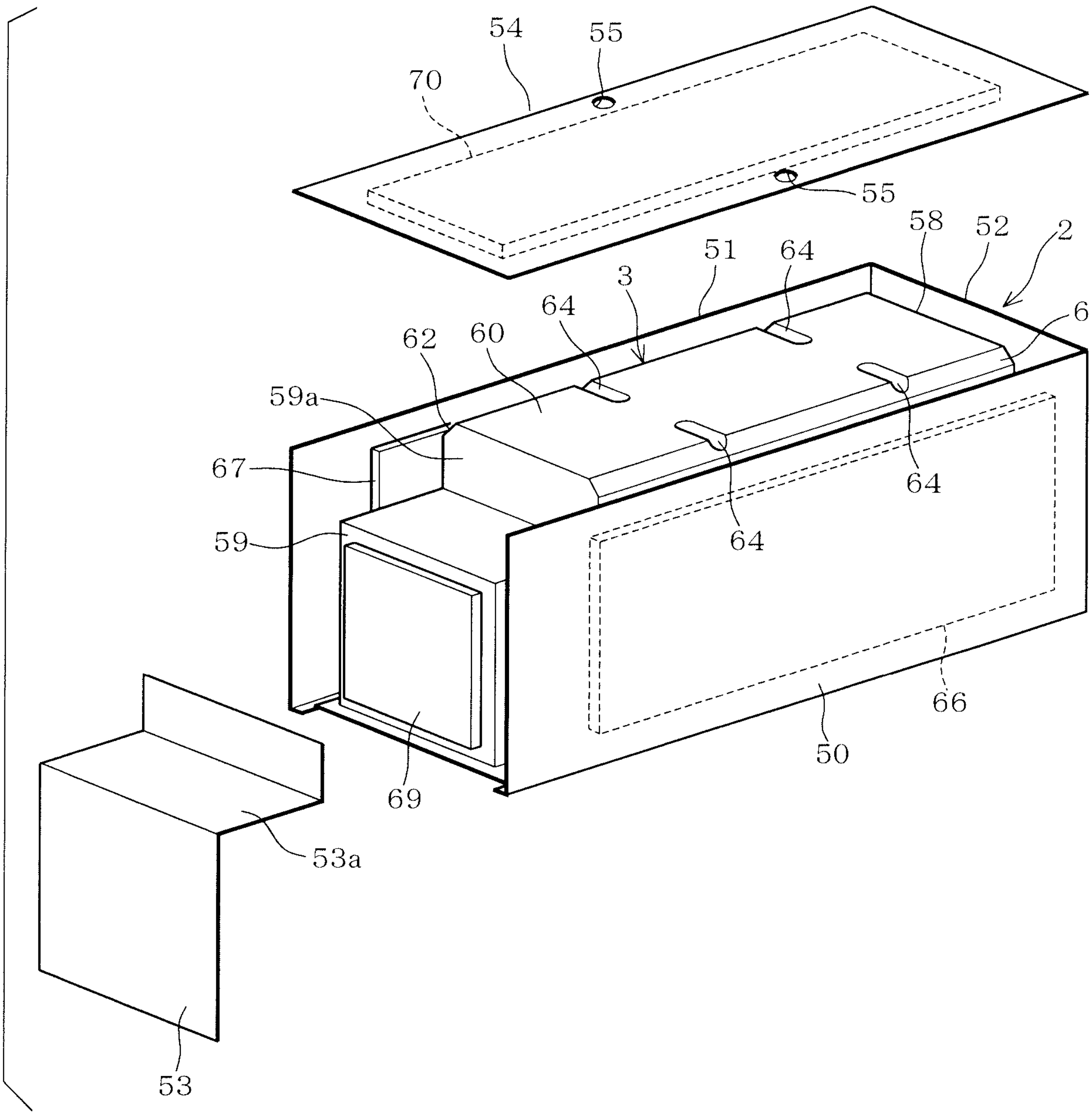

FIG.4

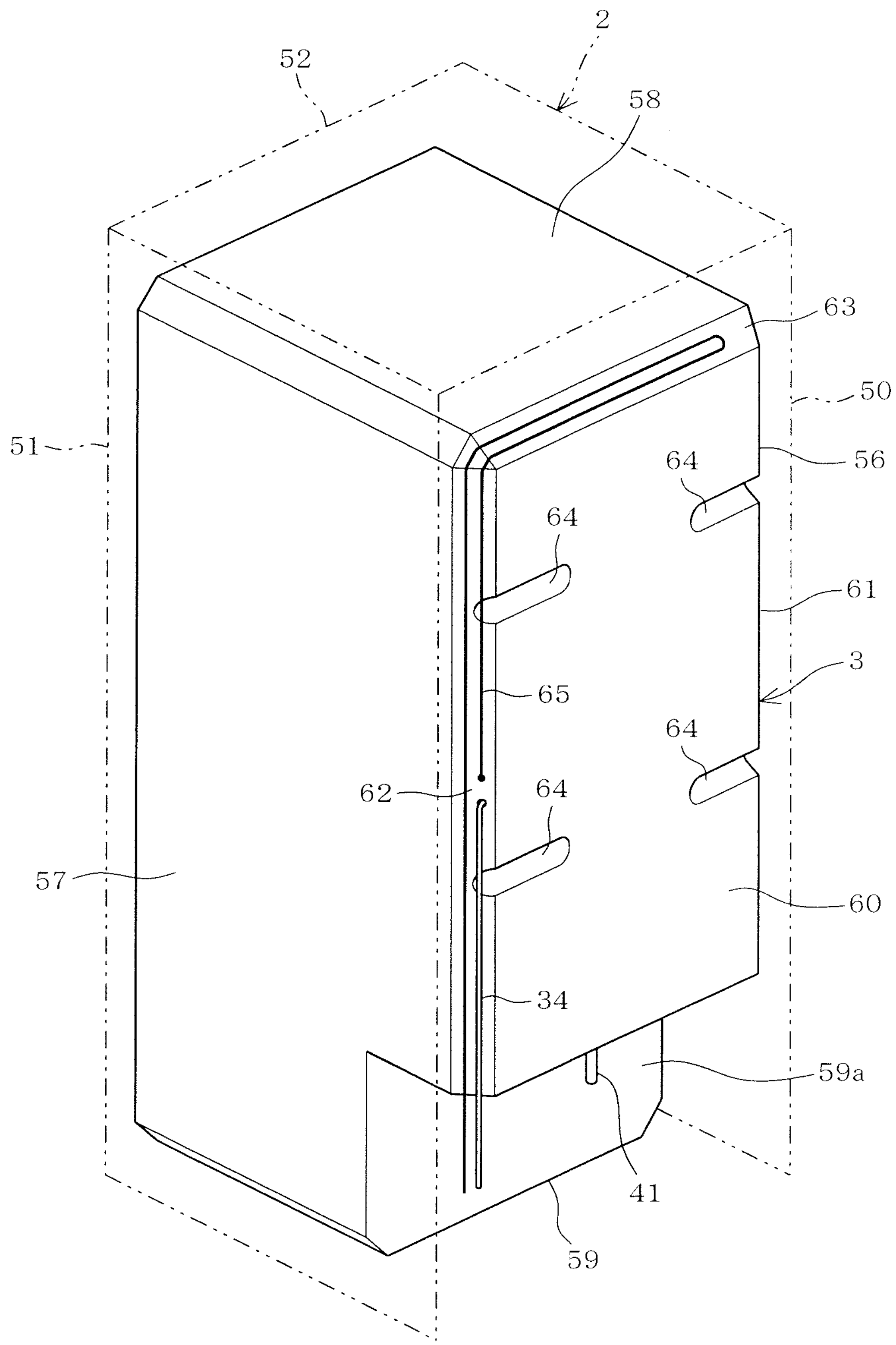

FIG.5

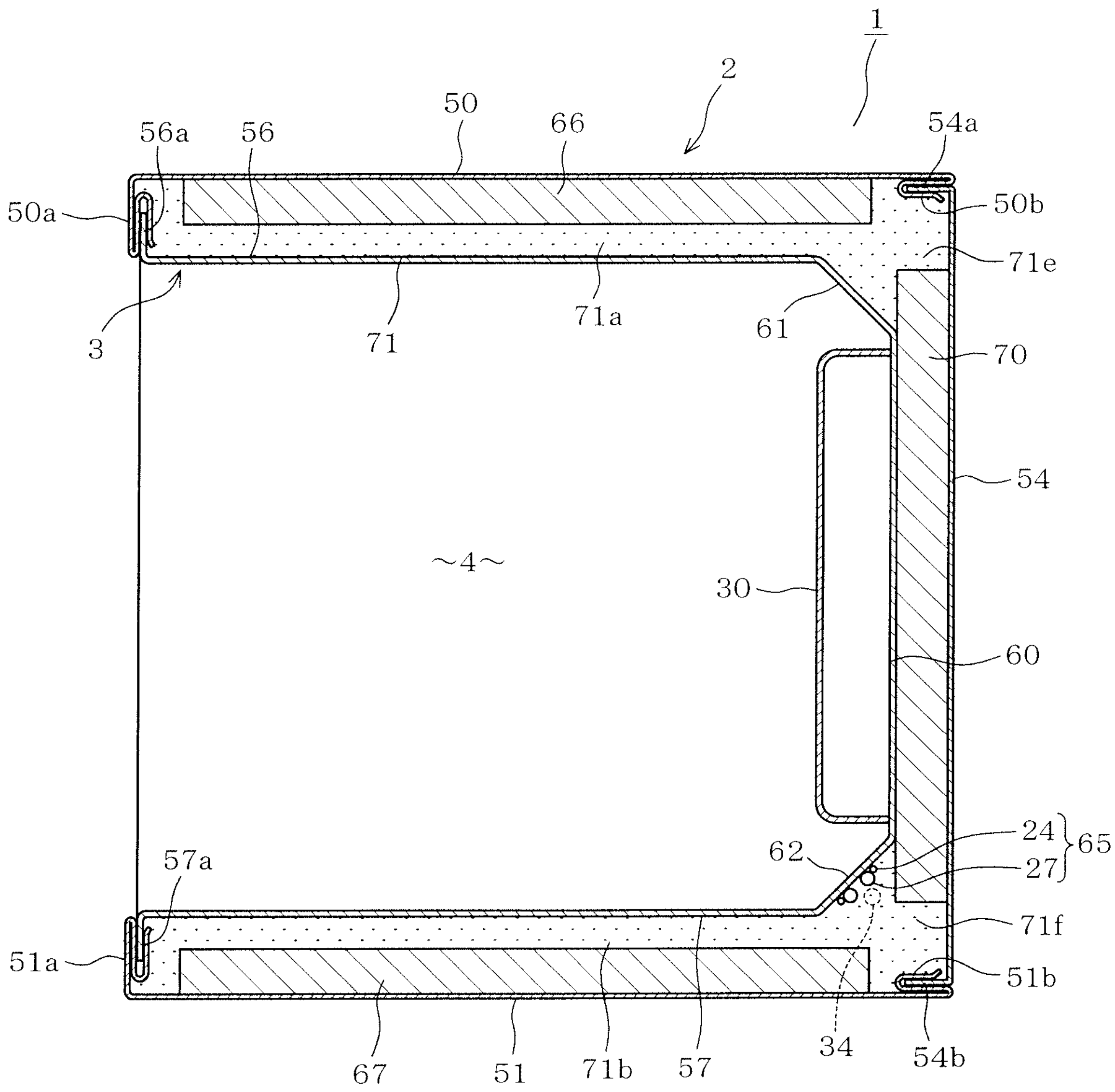
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FIG.6

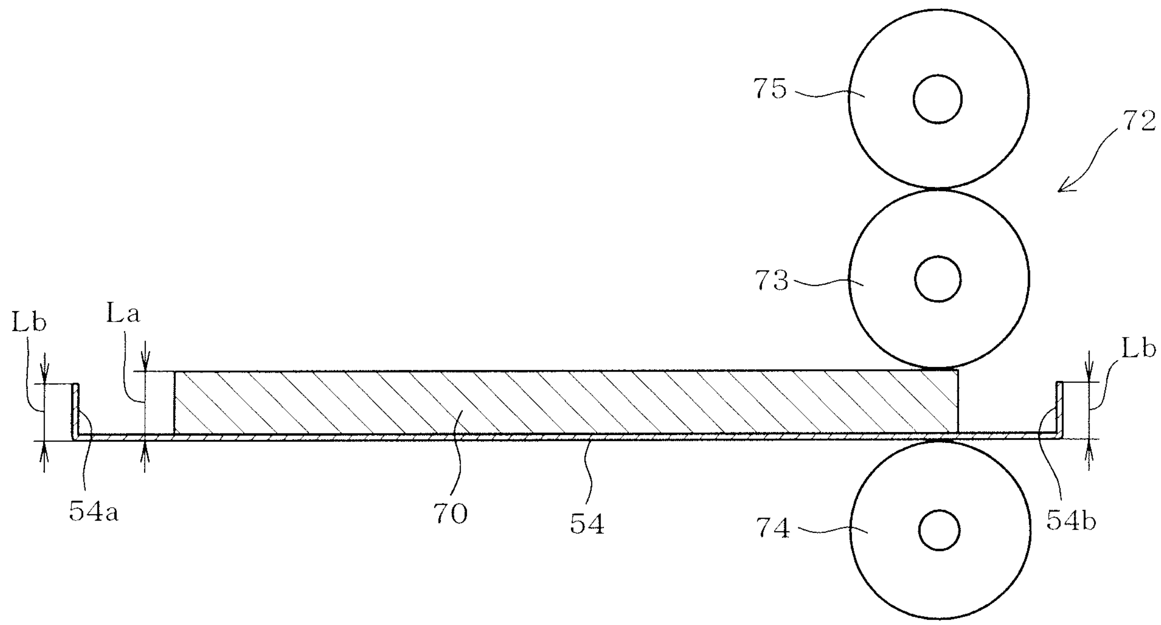

FIG.7

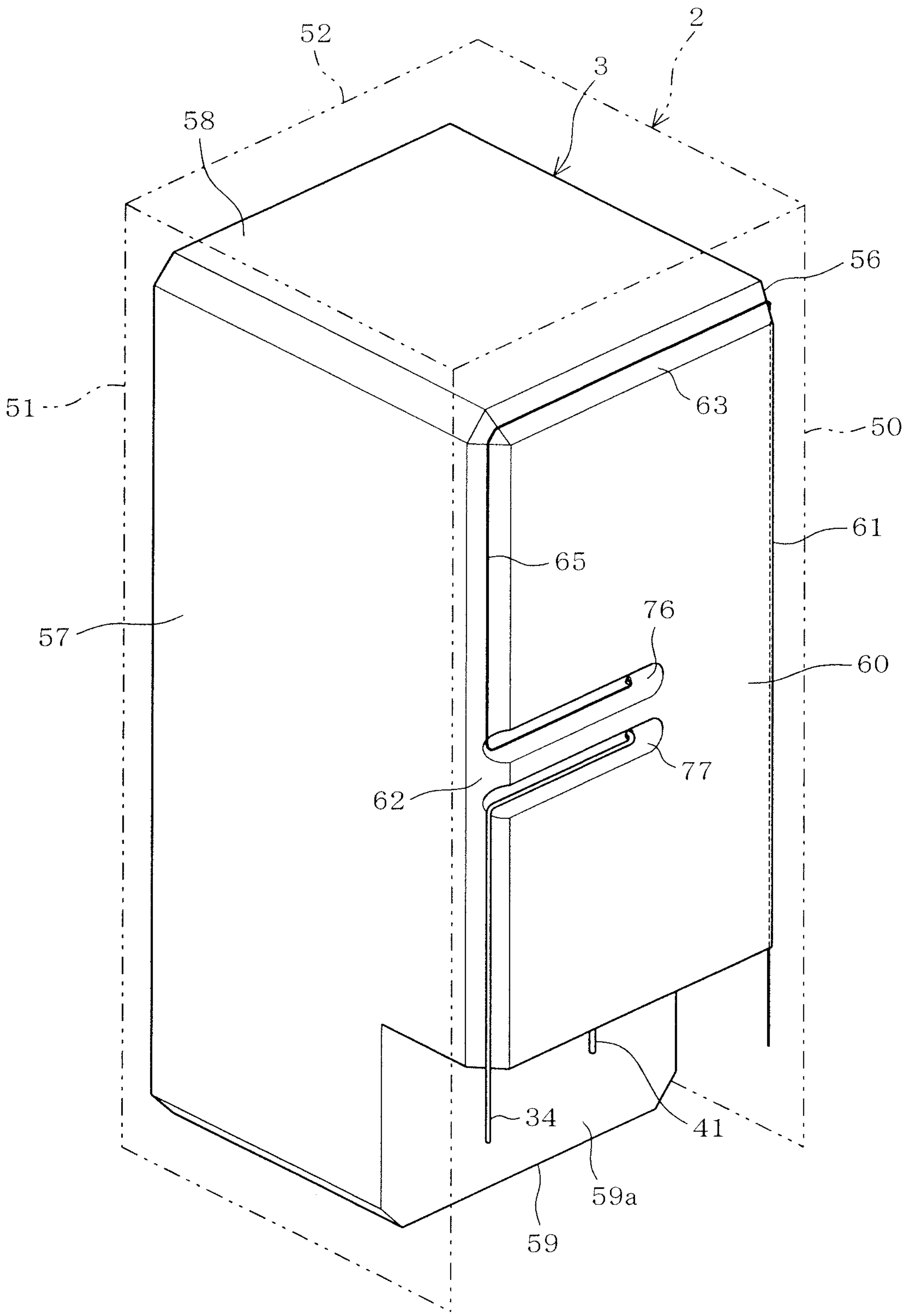

FIG.8

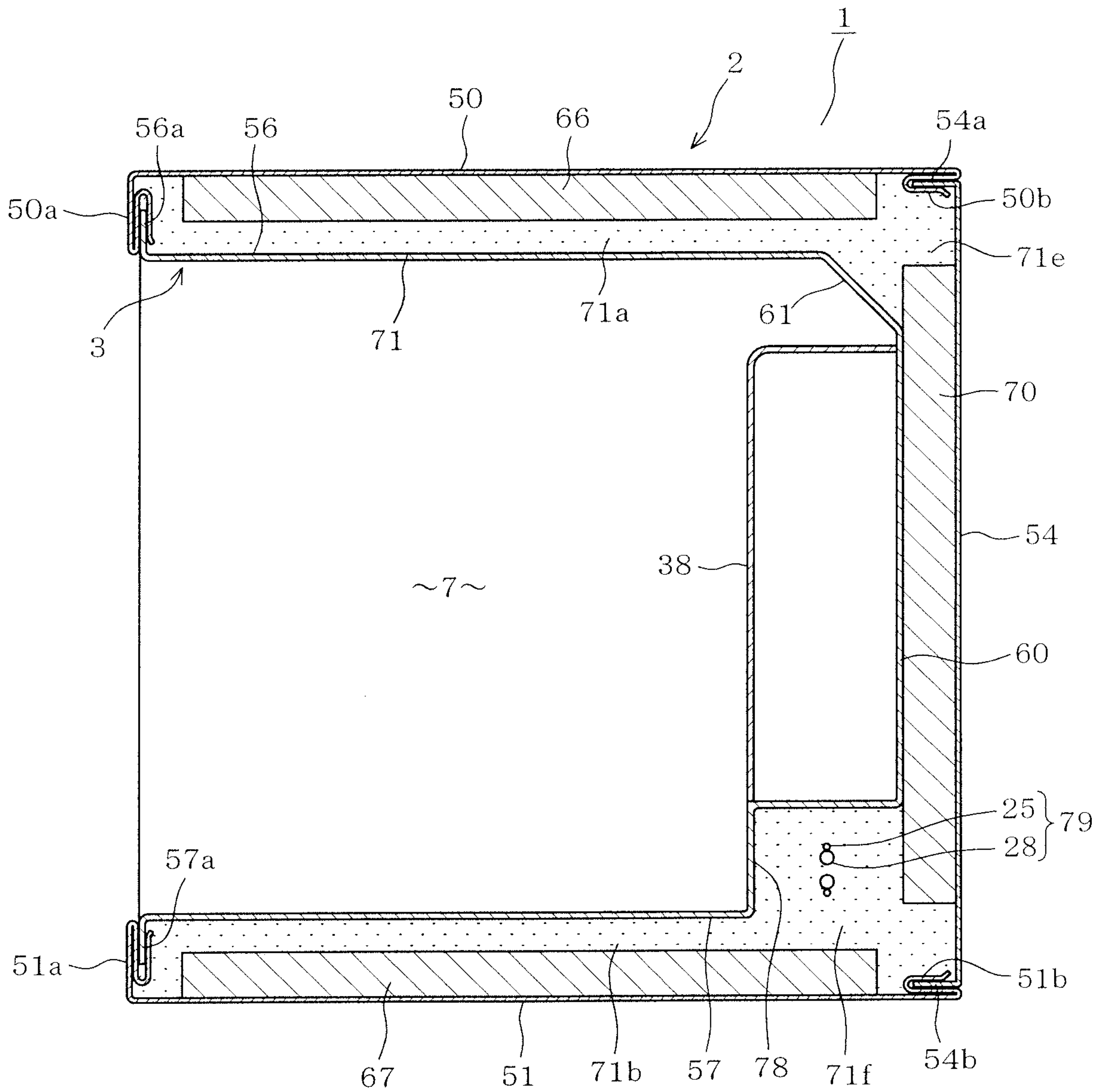
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FIG. 9

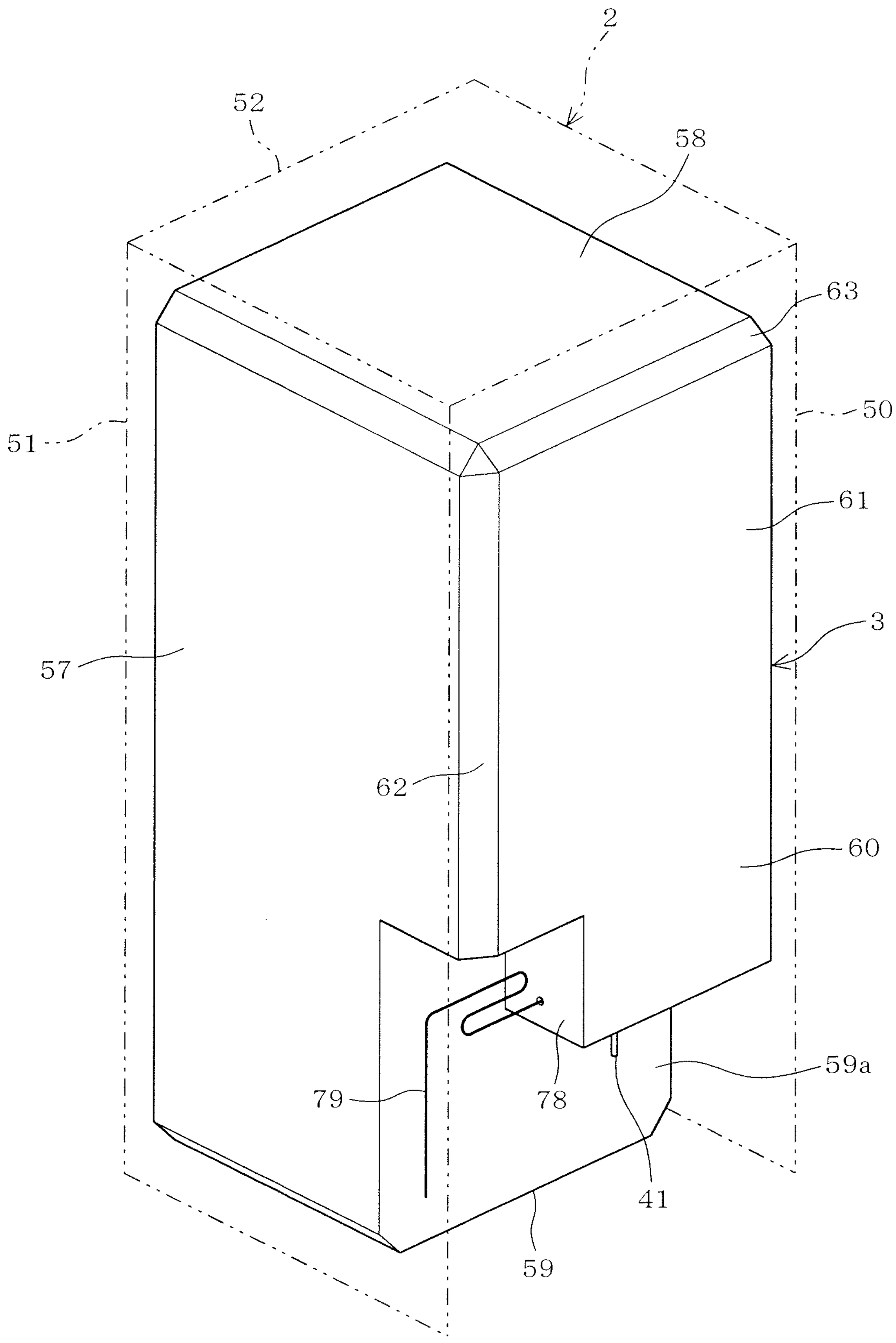

FIG.10

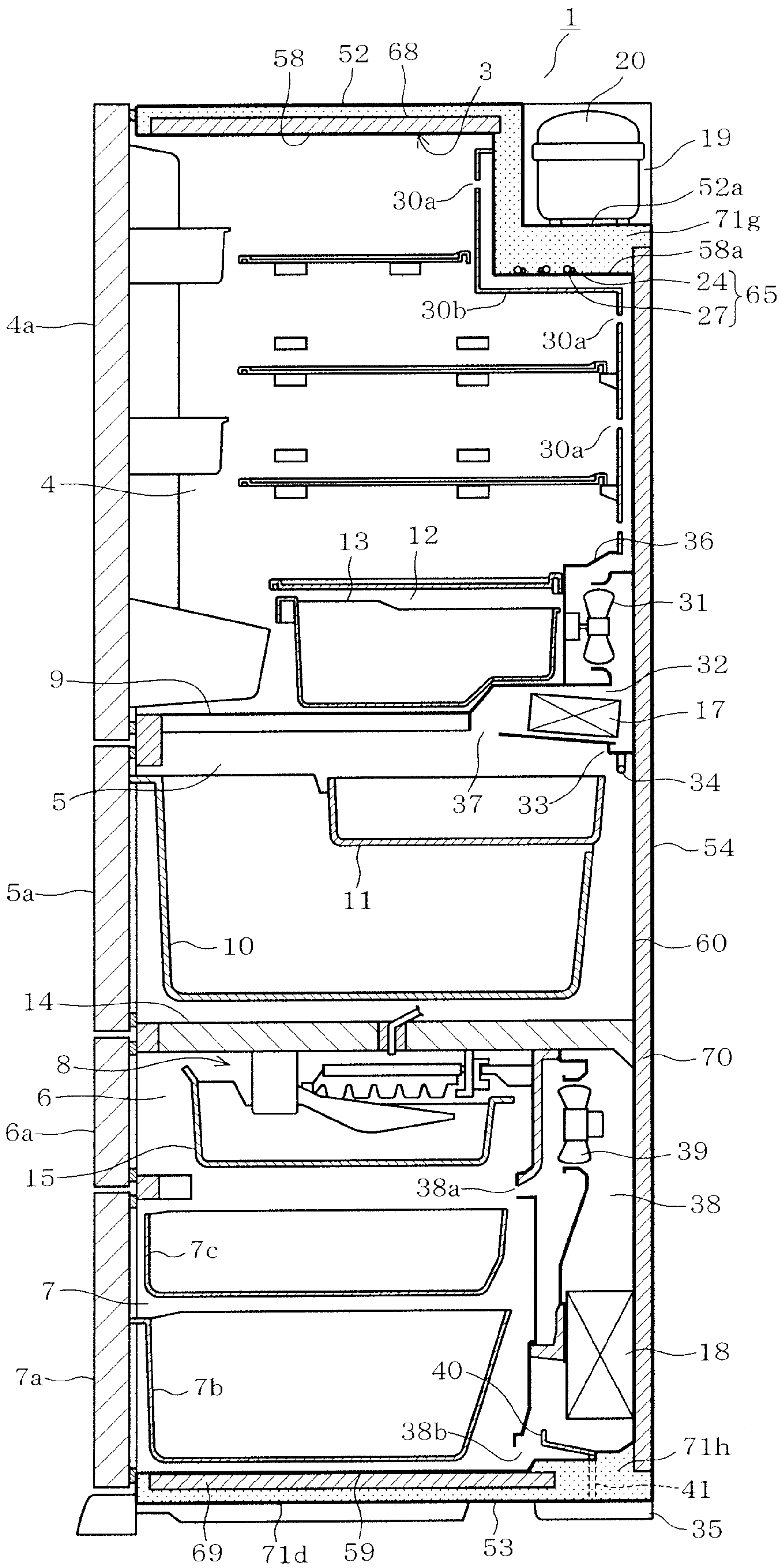
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FIG.11

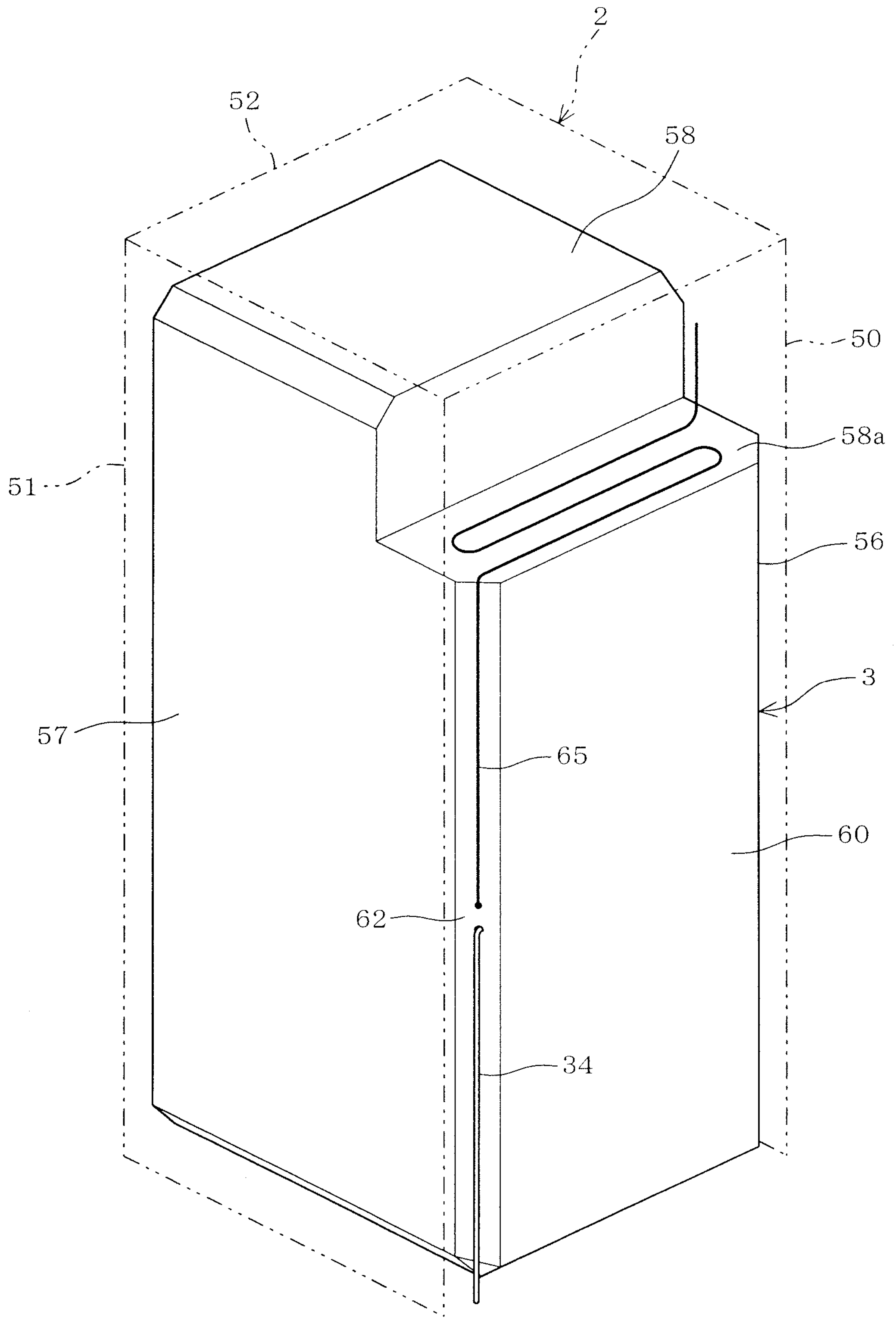

FIG.12

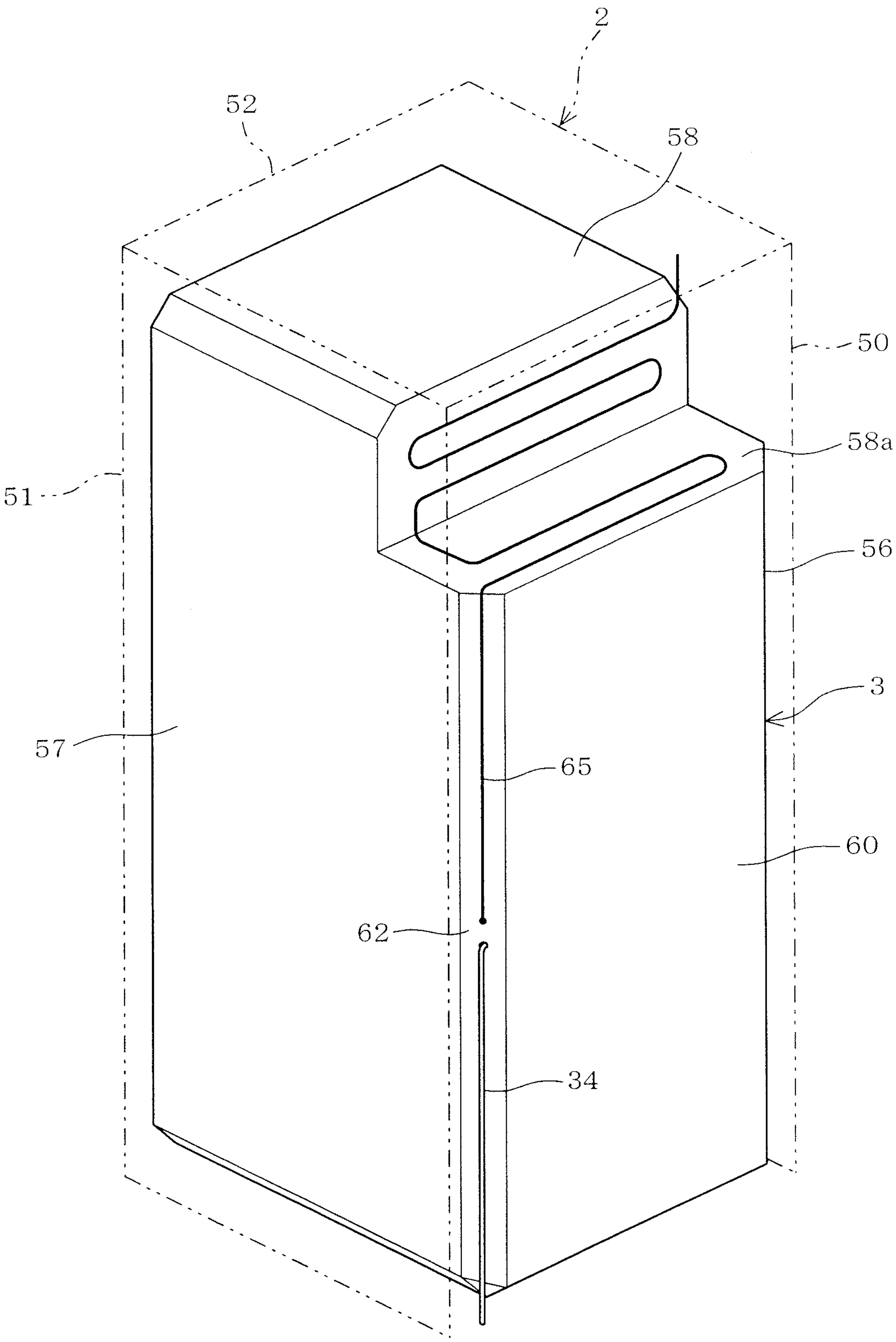

FIG.13

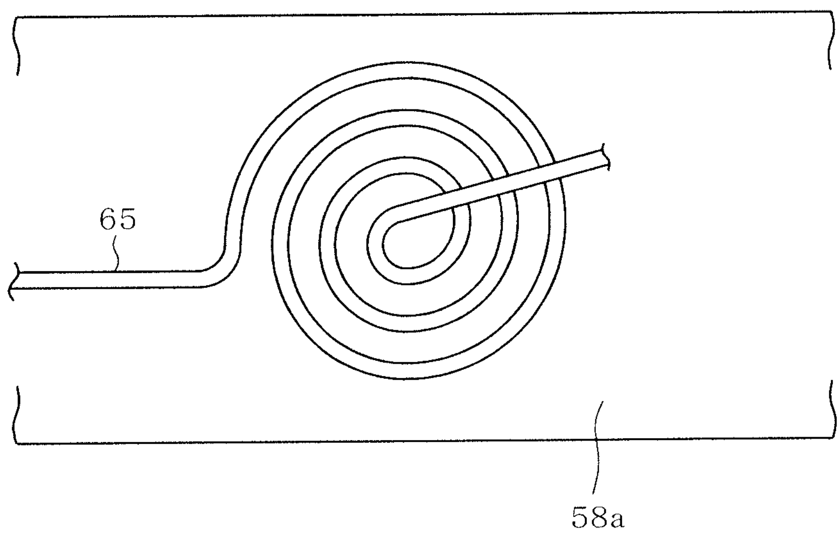

FIG.14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/051157

A. CLASSIFICATION OF SUBJECT MATTER
F25D23/00(2006.01)i, *F25D19/00*(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)
F25D23/00, F25D19/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-78264 A (Sanyo Electric Co., Ltd.), 29 March 2007 (29.03.2007), paragraphs [0020] to [0022]; fig. 1 to 3 (Family: none)	1-6
Y	JP 7-190599 A (Sharp Corp.), 28 July 1995 (28.07.1995), paragraphs [0012] to [0016]; fig. 1, 2, 4, 6 (Family: none)	1-6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 April, 2013 (16.04.13)	07 May, 2013 (07.05.13)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/051157

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 43016/1993(Laid-open No. 12879/1995) (Matsushita Refrigeration Co.), 03 March 1995 (03.03.1995), paragraphs [0003] to [0009]; fig. 1, 3, 4 (Family: none)	2,6
Y	JP 51-138947 A (Sanyo Electric Co., Ltd.), 30 November 1976 (30.11.1976), page 2, upper left column, lines 8 to 20; fig. 1 to 3 (Family: none)	2-4,6
Y	JP 2002-267323 A (Hoshizaki Electric Co., Ltd.), 18 September 2002 (18.09.2002), paragraph [0003]; fig. 5 (Family: none)	4-6
Y	JP 2005-221211 A (Toshiba Corp.), 18 August 2005 (18.08.2005), paragraphs [0017] to [0018]; fig. 3, 4 (Family: none)	4-6

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- JP 2007078264 A **[0005]**