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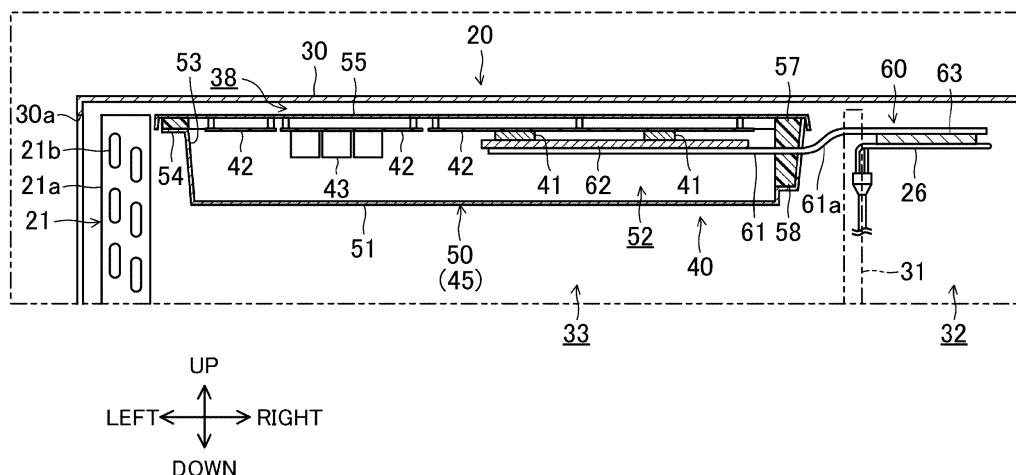
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(54) **REFRIGERATION CYCLE DEVICE**

(57) A partitioning member (31) partitions an inside of a body casing (30) into a machine chamber (32) and a fan chamber (33). A compressor (24) and a refrigerant pipe (26) through which a flammable refrigerant flows are disposed in the machine chamber (32). An outdoor fan

(22) and an electric component (40) are disposed in the fan chamber (33). The electric component (40) includes a substrate (42) on which a heat-generating component (41) is mounted, and a sealing member (45) for sealing the substrate (42).

FIG.5



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigeration cycle apparatus.

BACKGROUND ART

[0002] Patent Document 1 discloses an outdoor unit of an air conditioner configured to cool a high-heat-generating component mounted on a control board of an electric component unit disposed in a fan chamber, by blowing outside air sucked through an outside air suction port to the electric component unit.

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Publication No. 2017-083148

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0004] In the invention of Patent Document 1, for example, when a highly combustible, flammable refrigerant, such as propane, is used, the high-heat-generating component may become an ignition source.

[0005] Specifically, when the flammable refrigerant leaks from the refrigerant pipe, and the leaked flammable refrigerant is mixed with outside air and sucked into a fan chamber, the high-heat-generating component is cooled by the outside air including the flammable refrigerant. Thus, the high-heat-generating component may serve as an ignition source and ignite the flammable refrigerant.

[0006] An object of the present disclosure is to reduce the risk of ignition from an electric component as an ignition source even when a flammable refrigerant leaks from a refrigerant pipe.

SOLUTION TO THE PROBLEM

[0007] A first aspect of the present disclosure is directed to a refrigeration cycle apparatus including: a body casing (30); a partitioning member (31) partitioning an inside of the body casing (30) into a machine chamber (32) and a fan chamber (33); a compressor (24) disposed in the machine chamber (32); and a fan (22) disposed in the fan chamber (33), wherein a refrigerant pipe (26) which is connected to the compressor (24) and through which a flammable refrigerant flows is disposed in the machine chamber (32), an electric component (40) is disposed in the fan chamber (33), and the electric component (40) includes a substrate (42) on which a heat-generating component (41) is mounted, and a sealing mem-

ber (45) for sealing the substrate (42).

[0008] According to the first aspect, the substrate (42) of the electric component (40) is sealed and isolated from the machine chamber (32) to reduce the risk of ignition from the electric component (40) as an ignition source even when the flammable refrigerant leaks from the refrigerant pipe (26).

[0009] A second aspect of the present disclosure is directed to the refrigeration cycle apparatus of the first aspect. In the second aspect, the sealing member (45) is a substrate casing (50) having a housing space (52) for housing the substrate (42).

[0010] According to the second aspect, the substrate (42) is housed in the substrate casing (50), so that the substrate (42) can be in the sealed state.

[0011] A third aspect of the present disclosure is directed to the refrigeration cycle apparatus of the second aspect. In the third aspect, a heat exchanger (21) having a heat transfer tube (21b) is disposed in the fan chamber (33), the heat transfer tube (21b) including multiple sections in an up-down direction, the substrate casing (50) includes: a first member (51) having an opening (53) communicating with the housing space (52); and a second member (55) in contact with the first member (51) to close the opening (53) and seal the housing space (52) from an outside of the substrate casing (50), and a contact portion between the first member (51) and the second member (55) is located above an uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b).

[0012] According to the third aspect, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing into the housing space (52) through the contact portion between the first member (51) and the second member (55).

[0013] A fourth aspect of the present disclosure is directed to the refrigeration cycle apparatus of the third aspect. In the fourth aspect, the first member (51) is provided with a flange (54) extending outward along a peripheral portion of the opening (53), the second member (55) is attached to the flange (54), and the flange (54) is placed on a fin (21a) of the heat exchanger (21).

[0014] According to the fourth aspect, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing into the housing space (52) through the superposed surface of the flange (54). Further, placing the flange (54) on the fins (21a) facilitates the alignment of the height of the substrate casing (50).

[0015] A fifth aspect of the present disclosure is the refrigeration cycle apparatus of the first aspect. In the fifth aspect, the sealing member (45) is a coating material (70) covering an entire surface of the substrate (42).

[0016] According to the fifth aspect, the coating material (70) covers the entire surface of the substrate (42) to keep the substrate (42) sealed.

[0017] A sixth aspect of the present disclosure is di-

rected to the refrigeration cycle apparatus of any one of the first to fifth aspects. In the sixth aspect, a heat exchanger (21) having a heat transfer tube (21b) is disposed in the fan chamber (33), the heat transfer tube (21b) including multiple sections in an up-down direction, and the substrate (42) is disposed above an uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b).

[0018] According to the sixth aspect, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing toward the substrate (42).

[0019] A seventh aspect of the present disclosure is directed to the refrigeration cycle apparatus of any one of the first to sixth aspects. In the seventh aspect, the refrigeration cycle apparatus further includes: a cooling unit (60) including a working fluid channel (61) through which a working fluid flows, an evaporator (62) configured to evaporate the working fluid, and a condenser (63) configured to condense the working fluid, wherein in the working fluid channel (61), the working fluid is circulated between the evaporator (62) and the condenser (63), the evaporator (62) causes heat exchange between the heat-generating component (41) and the working fluid, and the condenser (63) causes heat exchange between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid.

[0020] According to the seventh aspect, heat exchange occurs between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid at a position away from the heat-generating component (41), thereby making it possible to cool the heat-generating component (41) while reducing the risk of ignition of the flammable refrigerant.

[0021] An eighth aspect of the present disclosure is directed to the refrigeration cycle apparatus of any one of the first to seventh aspects. In the eighth aspect, the refrigeration cycle apparatus further includes: a fan support base (34) supporting the fan (22), wherein the fan support base (34) is provided with an electric component support base (37) supporting the electric component (40).

[0022] According to the eighth aspect, the support post of the support base is shared since the fan support base (34) is provided with the electric component support base (37), and the space can thus be saved.

[0023] A ninth aspect of the present disclosure is directed to the refrigeration cycle apparatus of any one of the first to eighth aspects. In the ninth aspect, the sealing member (45) is a substrate casing (50) having a housing space (52) for housing the substrate (42), and a heat dissipation space (38) for dissipating heat generated in the heat-generating component (41) is provided between a top panel of the body casing (30) and an upper surface of the substrate casing (50).

[0024] According to the ninth aspect, heat generated in the heat-generating component (41) is dissipated into the heat dissipation space (38), thereby making it possi-

ble to reduce heat retention around the electric component (40).

[0025] A tenth aspect of the present disclosure is directed to the refrigeration cycle apparatus of any one of the first to ninth aspects. In the tenth aspect, the electric component (40) is disposed away from the partitioning member (31).

[0026] According to the tenth aspect, the electric component (40) can be located at a position further away from the refrigerant pipe (26).

[0027] An eleventh aspect of the present disclosure is directed to the refrigeration cycle apparatus of any one of the first to tenth aspects. In the eleventh aspect, the flammable refrigerant is R290.

[0028] According to the eleventh aspect, it is possible to reduce the risk of ignition from the electric component (40) as an ignition source even when R290 is used as the flammable refrigerant.

[0029] A twelfth aspect of the present disclosure is directed to the refrigeration cycle apparatus of the second aspect. In the twelfth aspect, the substrate casing (50) includes: a first member (51) having an opening (53) communicating with the housing space (52); and a second member (55) in contact with the first member (51) to close the opening (53) and seal the housing space (52) from an outside of the substrate casing (50), the substrate (42) is located in the first member (51) on a surface opposite to the opening (53), and the substrate casing (50) is disposed in the fan chamber (33) such that the second member (55) is located below the first member (51).

[0030] According to the twelfth aspect, even if the refrigerant flows into the housing space (52) from a gap between the first member (51) and the second member (55), the refrigerant is less likely to come into contact with the substrate (42) located at a position away from the opening (53), and the risk of ignition from the electric component (40) of the substrate (42) as an ignition source can be reduced.

[0031] A thirteenth aspect of the present disclosure is directed to the refrigeration cycle apparatus of the twelfth aspect. In the thirteenth aspect, the refrigeration cycle apparatus further includes: an electric wire (47) drawn out of the substrate (42), wherein a wiring hole (66) for drawing the electric wire (47) out of the substrate casing (50) is formed in a sidewall of the first member (51) at a position below the substrate (42).

[0032] According to the thirteenth aspect, the wiring holes (66) are formed in the sidewall of the first member (51) at a position below the substrate (42), and thus, the refrigerant which has flowed into the substrate casing (50) is easily discharged to the outside of the substrate casing (50). This can reduce refrigerant retention in the housing space (52).

[0033] A fourteenth aspect of the present disclosure is directed to the refrigeration cycle apparatus of the thirteenth aspect. In the fourteenth aspect, the electric wire (47) includes a plurality of electric wires (47), the wiring hole (66) includes a plurality of wiring holes (66), and the

plurality of electric wires (47) are bundled into a plurality of groups, and the plurality of groups of the electric wires (47) are drawn out through the respective wiring holes (66).

[0034] According to the fourteenth aspect, since the plurality of electric wires (47) are divided into a plurality of groups and bundled as described above, the plurality of electric wires (47) can be drawn out of the substrate casing (50) while maintaining sealability of the housing space (52), and it is possible to facilitate a connection operation for connecting the electric wires (47) to devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

FIG. 1 is a refrigerant circuit diagram of a refrigeration cycle apparatus according to this embodiment.

FIG. 2 is a plan sectional view of a configuration of an outdoor unit.

FIG. 3 is a front sectional view of the configuration of the outdoor unit.

FIG. 4 is a perspective view of configurations of a substrate casing and a cooling unit.

FIG. 5 is a front sectional view of the configurations of the substrate casing and the cooling unit.

FIG. 6 is a front sectional view of an exploded configuration of the substrate casing.

FIG. 7 is a front sectional view of a configuration of an outdoor unit according to a first variation.

FIG. 8 is a front sectional view of a configuration of an outdoor unit according to a second variation.

FIG. 9 is a front sectional view of a configuration of an outdoor unit according to a third variation.

FIG. 10 is a view of a state where a plurality of electric wires are grouped, as viewed from an opening side.

FIG. 11 is a refrigerant circuit diagram of a refrigeration cycle apparatus according to another embodiment.

DESCRIPTION OF EMBODIMENTS

[0036] As illustrated in FIG. 1, a refrigeration cycle apparatus (1) is an air-conditioning device. The refrigeration cycle apparatus (1) includes a refrigerant circuit (5). The refrigerant circuit (5) is filled with a flammable, natural refrigerant. The refrigerant circuit (5) performs a refrigeration cycle by circulating the refrigerant.

[0037] In this embodiment, propane (R290), which is a highly flammable natural refrigerant, is used as the refrigerant. The natural refrigerant is a refrigerant having an ozone depletion potential of zero, a low global warming potential, and a low environmental load. Propane ignites at 500°C or less.

[0038] The flammable refrigerant with which the refrigerant circuit (5) is filled may be other than propane. The flammable refrigerant with which the refrigerant circuit

(5) is filled may be, for example, ammonia (R717), which is a natural refrigerant. Alternatively, the flammable refrigerant with which the refrigerant circuit (5) is filled may be methane (R50), ethane (R170), butane (R600), or isobutane (R600a), which is a highly flammable natural refrigerant.

[0039] The refrigeration cycle apparatus (1) includes an indoor unit (10) and an outdoor unit (20). The indoor unit (10) is placed inside. The outdoor unit (20) is placed outside. The indoor unit (10) and the outdoor unit (20) are connected to each other by a gas pipe (6) and a liquid pipe (7). A gas shut-off valve (8) is connected to the gas pipe (6). A liquid shut-off valve (9) is connected to the liquid pipe (7).

<Indoor Unit>

[0040] The indoor unit (10) includes an indoor heat exchanger (11) and an indoor fan (12). The indoor heat exchanger (11) is, for example, a cross-fin type fin-and-tube heat exchanger. In the indoor heat exchanger (11), heat exchange occurs between the refrigerant flowing through the heat transfer tube and air blown by the indoor fan (12).

<Outdoor Unit>

[0041] The outdoor unit (20) includes an outdoor heat exchanger (21), an outdoor fan (22) as a fan, an outdoor expansion valve (23), a compressor (24), a four-way switching valve (25), an electric component (40), and a cooling unit (60). The outdoor heat exchanger (21), the outdoor expansion valve (23), the compressor (24), and the four-way switching valve (25) are connected by a refrigerant pipe (26). A flammable refrigerant flows through the refrigerant pipe (26).

[0042] The outdoor heat exchanger (21) is, for example, a cross-fin type fin-and-tube heat exchanger. The outdoor heat exchanger (21) includes a plurality of fins (21a) and a heat transfer tube (21b). The plurality of fins (21a) are arranged at intervals in the direction orthogonal to the air flow direction. The heat transfer tube (21b) extends so as to pass through the fins (21a) in the thickness direction and is folded back at both ends of the outdoor heat exchanger (21) to form multiple sections in the up-down direction.

[0043] In the outdoor heat exchanger (21), heat exchange occurs between the refrigerant flowing through the heat transfer tube (21b) and air blown by the outdoor fan (22). The outdoor expansion valve (23) is, for example, an electronic expansion valve.

[0044] The compressor (24) is, for example, a rotary compressor such as a scroll compressor. The four-way switching valve (25) has a first port (P1), a second port (P2), a third port (P3), and a fourth port (P4).

[0045] During the cooling operation, the four-way switching valve (25) is in a state (indicated by the solid lines in FIG. 1) where the first port (P1) and the second

port (P2) are in communication with each other, and the third port (P3) and the fourth port (P4) are in communication with each other. During the heating operation, the four-way switching valve (25) is in a state (indicated by the broken lines in FIG. 1) where the first port (P1) and the third port (P3) are in communication with each other and the second port (P2) and the fourth port (P4) are in communication with each other.

[0046] As illustrated in FIGS. 2 and 3, the outdoor unit (20) includes a body casing (30). In the drawings, the up and down, front and rear, and left and right directions are indicated by arrows. Unless otherwise specified, directions such as up and down will be described in accordance with the directions indicated by these arrows.

[0047] The body casing (30) is formed in a box shape. A partitioning member (31) extending in a front-to-rear direction is disposed to stand in the body casing (30). The partitioning member (31) partitions the body casing (30) into a machine chamber (32) and a fan chamber (33).

[0048] The machine chamber (32) is a space in the body casing (30) on the right side of the partitioning member (31). The compressor (24), the four-way switching valve (25), and the refrigerant pipe (26) are arranged in the machine chamber (32).

[0049] The fan chamber (33) is a space in the body casing (30) on the left side of the partitioning member (31). The outdoor fan (22), the outdoor heat exchanger (21), and the electric component (40) are arranged in the fan chamber (33).

[0050] The fan chamber (33) is provided with the fan support base (34). The fan support base (34) includes a pair of supports (35), a motor bracket (36), and an electric component support base (37). The supports (35) in a pair are disposed in the fan chamber (33) so as to stand at a distance from each other in a right-to-left direction. The motor bracket (36) is attached across the pair of supports (35). A fan motor (22a) of the outdoor fan (22) is attached to the motor bracket (36).

[0051] The electric component support base (37) protrudes forward from the pair of supports (35) at a position above the outdoor fan (22). The electric component (40) is placed on, and supported by, the electric component support base (37). The electric component (40) is located at a position away from the partitioning member (31). The supports (35) are shared since the fan support base (34) is provided with the electric component support base (37), and the space can thus be saved.

[0052] A suction port (30a) communicating with the fan chamber (33) is formed in each of the rear and left sidewalls of the body casing (30). When the outdoor fan (22) is driven, outside air is sucked into the fan chamber (33) through the suction ports (30a). An outlet port (30b) communicating with the fan chamber (33) is formed in the front sidewall of the body casing (30). When the outdoor fan (22) is driven, the air in the fan chamber (33) is blown out through the outlet port (30b).

[0053] The electric component (40) constitutes a power converter for supplying power to the motor of the com-

pressor (24). As illustrated in FIGS. 4 to 6, the electric component (40) includes a heat-generating component (41), a substrate (42), and a sealing member (45). The sealing member (45) seals the substrate (42). The sealing member (45) is configured as a substrate casing (50) having a housing space (52) inside.

[0054] The heat-generating component (41) is mounted on the substrate (42). The heat-generating component (41) is a switching element (e.g., IGBT or MOSFET) of an inverter circuit (not shown). The heat-generating component (41) is a component which generates a great amount of heat during the operation of the compressor (24). Thus, in order to operate the refrigeration cycle apparatus (1) normally, the heat-generating component (41) needs to be cooled so as not to exceed an operable temperature (e.g., 90°C). As will be described in detail later, the heat-generating component (41) is cooled by the cooling unit (60). In addition to the heat-generating component (41), an electric component (43) such as a capacitor is mounted on the substrate (42). The substrate (42) is housed in the housing space (52) of the substrate casing (50).

[0055] The substrate casing (50) includes a first member (51) and a second member (55). The first member (51) has an opening (53) communicating with the housing space (52). Specifically, the first member (51) is formed in a box shape with an upper opening, and the opening (53) is the upper opening of the first member (51). A portion of the right sidewall of the first member (51) is cut out. A heat pipe (61) to be described later of the cooling unit (60) is drawn out of the substrate casing (50) through the cutout of the first member (51).

[0056] The first member (51) includes a flange (54). The flange (54) extends outward along the peripheral portion of the opening (53). The first member (51) includes a first sealing member (57) and a second sealing member (58).

[0057] The first sealing member (57) is an integrally-formed portion of a portion extending along the upper surface of the flange (54) and a portion closing the cut-out portion in the right sidewall of the first member (51). The first sealing member (57) is disposed above the heat pipe (61).

[0058] The second sealing member (58) is disposed to close the cut-out portion in the right sidewall of the first member (51). The second sealing member (58) is disposed below the heat pipe (61). The heat pipe (61) is sandwiched between the first sealing member (57) and the second sealing member (58). The electric wires (47) (see FIG. 4) drawn out of the substrate (42) are also sandwiched between the first sealing member (57) and the second sealing member (58).

[0059] The second member (55) is formed in a box shape with a lower opening, and is disposed to cover the flange (54) of the first member (51) from above. The second member (55) is attached to the first member (51) to close the opening (53). The substrate (42) is attached to the bottom surface side of the second member (55).

[0060] The first member (51) and the second member (55) are attached to each other with screws fastening four corners of the flange (54), for example (see FIG. 4). The first sealing member (57) is sandwiched between the flange (54) of the first member (51) and the second member (55) to seal them.

[0061] Thus, the substrate (42) is disposed in the housing space (52) of the substrate casing (50) in a sealed state. Here, the state where the substrate (42) is sealed is a state satisfying a water resistance rating of IPX4 or more, more preferably IPX6 or more.

[0062] As illustrated in FIG. 5, the substrate (42) is located above the uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b). Thus, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing toward the substrate (42) because propane as the flammable refrigerant is heavier than air.

[0063] In this embodiment, a contact portion between the first member (51) and the second member (55) is located above the uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b). In other words, a superposed surface between the flange (54) of the first member (51) and the second member (55) (more strictly, the superposed surface between the flange (54) and the first sealing member (57)) is located above the uppermost section of the heat transfer tube (21b).

[0064] Thus, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing into the housing space (52) through the superposed surface of the flange (54). The substrate (42) does not need to be located above the uppermost section of the heat transfer tube (21b) if the contact portion between the first member (51) and the second member (55) is located above the uppermost section of the heat transfer tube (21b).

[0065] A heat dissipation space (38) for dissipating heat generated in the heat-generating component (41) is provided between a top panel of the body casing (30) and an upper surface of the substrate casing (50). Thus, heat generated in the heat-generating component (41) is dissipated into the heat dissipation space (38), thereby making it possible to reduce heat retention around the electric component (40).

<Cooling Unit>

[0066] As illustrated in FIG. 5, the cooling unit (60) includes a plurality of heat pipes (61) as working fluid channels, a heat sink (62) as an evaporator, and a refrigerant jacket (63) as a condenser.

[0067] A working fluid is sealed in each of the heat pipes (61). For example, water whose boiling point is lowered by lowering the pressure is used as the working fluid. The working fluid can be, for example, lithium, naphthalene, methanol, and ammonia, but is not limited there-

to.

[0068] The heat pipes (61) pass through the partitioning member (31) and extend in the fan chamber (33) and the machine chamber (32). In each of the heat pipes (61), the working fluid circulates between a heat sink (62) and the refrigerant jacket (63). An inclined portion (61a) is provided in an intermediate portion of the flow path of the heat pipe (61). The inclined portion (61a) extends obliquely upward from the heat sink (62) toward the refrigerant jacket (63).

[0069] The heat sink (62) is made of a metal material such as aluminum, for example. The heat sink (62) is disposed in the fan chamber (33). Specifically, the heat sink (62) is disposed in tight contact with the heat-generating component (41) inside the substrate casing (50).

[0070] The heat pipe (61) is disposed in tight contact with the heat sink (62). Thus, heat exchange occurs between the heat-generating component (41) and the working fluid through the heat sink (62), and the working fluid evaporates. The evaporated working fluid flows toward the refrigerant jacket (63) in the heat pipe (61).

[0071] The refrigerant jacket (63) is made of a metal material such as aluminum, for example. The refrigerant jacket (63) is disposed in the machine chamber (32). The plurality of heat pipes (61) are disposed in tight contact with the upper portion of the refrigerant jacket (63). The refrigerant pipe (26) is disposed in tight contact with the bottom portion of the refrigerant jacket (63). For example, the liquid pipe (7) is used as the refrigerant pipe (26).

[0072] Thus, heat exchange occurs between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid through the refrigerant jacket (63), and the working fluid condenses. The condensed working fluid flows through the heat pipe (61) toward the heat sink (62).

[0073] Thus, in the cooling unit (60), heat exchange occurs between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid at a position away from the heat-generating component (41). This makes it possible to cool the heat-generating component (41) while reducing the risk of ignition of the flammable refrigerant.

-Advantages of Embodiments-

[0074] According to the features of this embodiment, the substrate (42) of the electric component (40) is sealed and isolated from the machine chamber (32) to reduce the risk of ignition from the electric component (40) as an ignition source even when the flammable refrigerant leaks from the refrigerant pipe (26).

[0075] According to the features of this embodiment, the substrate (42) is housed in the substrate casing (50), so that the substrate (42) can be in the sealed state.

[0076] According to the features of this embodiment, a contact portion between the first member (51) and the second member (55) is located above the uppermost section of the heat transfer tube (21b) among the multiple

sections of the heat transfer tube (21b). Thus, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing into the housing space (52) through the contact portion between the first member (51) and the second member (55).

[0077] According to the features of this embodiment, the substrate (42) is located above the uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b). Thus, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing toward the substrate (42).

[0078] According to the features of this embodiment, in the working fluid channel (61), the working fluid is circulated between the evaporator (62) and the condenser (63), the evaporator (62) causes heat exchange between the heat-generating component (41) and the working fluid, and the condenser (63) causes heat exchange between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid. Thus, heat exchange occurs between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid at a position away from the heat-generating component (41), thereby making it possible to cool the heat-generating component (41) while reducing the risk of ignition of the flammable refrigerant.

[0079] According to the features of this embodiment, the support post of the support base is shared since the fan support base (34) is provided with the electric component support base (37), and the space can thus be saved.

[0080] According to the features of this embodiment, the heat dissipation space (38) is provided between the top panel of the body casing (30) and the upper surface of the substrate casing (50). Thus, heat generated in the heat-generating component (41) is dissipated into the heat dissipation space (38), thereby making it possible to reduce heat retention around the electric component (40).

[0081] According to the features of this embodiment, the electric component (40) is disposed away from the partitioning member (31). Thus, the electric component (40) can be located at a position further away from the refrigerant pipe (26).

[0082] According to the features of this embodiment, in the eleventh aspect, it is possible to reduce the risk of ignition from the electric component (40) as an ignition source even when R290 is used as the flammable refrigerant.

«First Variation»

[0083] In the following description, the same reference characters denote the same components as those of the foregoing embodiment, and the description is focused only on the difference.

[0084] As illustrated in FIG. 7, the substrate casing (50)

includes a first member (51) and a second member (55). The first member (51) includes a flange (54). The flange (54) extends outward along the peripheral portion of the opening (53). The second member (55) is attached to the flange (54) of the first member (51) to close the opening (53). The substrate (42) is housed in the housing space (52) of the substrate casing (50).

[0085] The flange (54) of the substrate casing (50) is placed on the fins (21a) of the outdoor heat exchanger (21). Therefore, a superposed surface between the flange (54) of the first member (51) and the second member (55) (more strictly, the superposed surface between the flange (54) and the first sealing member (57)) is located above the uppermost section of the heat transfer tube (21b) of the outdoor heat exchanger (21).

[0086] Thus, even if the flammable refrigerant leaks from the heat transfer tube (21b), it is possible to keep the leaked refrigerant from flowing into the housing space (52) through the superposed surface of the flange (54). Further, placing the flange (54) on the fins (21a) facilitates the alignment of the height of the substrate casing (50).

«Second Variation»

[0087] As illustrated in FIG. 8, the electric component (40) includes a heat-generating component (41), a substrate (42), and a sealing member (45). The sealing member (45) seals the substrate (42). The sealing member (45) is a coating material (70) covering the entire surface of the substrate (42). The coating material (70) is made of, for example, a resin material. In the example illustrated in FIG. 8, a portion of the heat pipe (61) and the heat sink (62) are covered with the coating material (70) in the same manner.

[0088] In this way, the coating material (70) covers the entire surface of the substrate (42) to keep the substrate (42) sealed. Accordingly, the risk of ignition from the electric component (40) as an ignition source can be reduced even if the flammable refrigerant leaks from the refrigerant pipe (26).

[0089] Since the coating material (70) covers the heat-generating component (41), the substrate (42), the electric component (43), a portion of the heat pipe (61), and the heat sink (62), thermal conduction of not only the heat-generating component (41) in tight contact with the heat sink (62) but also of the electric component (43) is accelerated via the coating material (70). A cooling effect can thus be obtained.

[0090] In the example illustrated in FIG. 8, the entire surface of the substrate (42) including the heat-generating component (41), a portion of the heat pipe (61), and the heat sink (62) are covered with the coating material (70), but the configuration is not limited thereto. Specifically, in order to reduce the risk of ignition from the electric component (40) as an ignition source, the entire surface of the substrate (42) including at least the heat-generating component (41) may be covered with the coating material (70).

«Third Variation»

[0091] As illustrated in FIG. 9, the substrate casing (50) includes a first member (51) and a second member (55). The first member (51) has an opening (53) communicating with the housing space (52). Specifically, the first member (51) is formed in a box shape with a lower opening, and the opening (53) is the lower opening of the first member (51).

[0092] A portion of the right sidewall of the first member (51) is cut out. The heat pipe (61) of the cooling unit (60) and the electric wires (47) of the substrate (42) are drawn out of the substrate casing (50) through the cutout of the first member (51).

[0093] The first member (51) includes a flange (54). The flange (54) extends outward along the peripheral portion of the opening (53). The first member (51) is provided with a sealing member (65). The sealing member (65) is disposed to close the cut-out portion in the right sidewall of the first member (51). As will be described later, the sealing member (65) has a hole for the heat pipe (61) and a wiring hole (66) for the electric wire (47).

[0094] The second member (55) is formed in a box shape with an upper opening, and is disposed to cover the flange (54) of the first member (51) from below. The second member (55) comes into contact with the first member (51) to close the opening (53), thereby sealing the housing space (52) and the outside of the substrate casing (50).

[0095] The substrate (42) is located in the first member (51) on a surface opposite to the opening (53). In other words, the substrate (42) is located on the bottom surface side (the upper side in FIG. 9) of the box-shaped first member (51). The substrate casing (50) is disposed in the fan chamber (33) such that the second member (55) is located below the first member (51).

[0096] Thus, even if the refrigerant flows into the housing space (52) from a gap between the first member (51) and the second member (55), the refrigerant is less likely to come into contact with the substrate (42) located at a position away from the opening (53), and the risk of ignition from the electric component (40) of the substrate (42) as an ignition source can be reduced.

[0097] The sealing member (65) forming part of the sidewall of the first member (51) has a hole for inserting the heat pipe (61) and wiring holes (66) for inserting the electric wires (47). A plurality of electric wires (47) are provided. A plurality of wiring holes (66) are formed. Protective tubes (48) are disposed in the respective wiring holes (66). The protective tubes (48) protect the electric wires (47). The electric wires (47) are drawn out of the substrate casing (50) through the protective tubes (48). The wiring holes (66) are formed in the sealing member (65) at a position below the substrate (42).

[0098] As described above, the wiring holes (66) are formed in the sealing member (65) forming the sidewall of the first member (51) at a position below the substrate (42), and thus, the refrigerant which has flowed into the

substrate casing (50) is easily discharged to the outside of the substrate casing (50). This can reduce refrigerant retention in the housing space (52).

[0099] As illustrated in FIG. 10, the plurality of electric wires (47) are bundled into a plurality of groups, and the plurality of groups of the electric wires (47) are drawn out through the respective wiring holes (66). Specifically, the plurality of electric wires (47) are divided into Group A, Group B, Group C, and Group D.

[0100] The high-voltage electric wires (47) of the inverter circuit are bundled with a bundling band (68) as Group A. In the example illustrated in FIG. 10, the electric wire (47) connected to the first terminal (81) for the compressor (24) and the electric wire (47) connected to the second terminal (82) for the outdoor fan (22) belong to Group A.

[0101] The low-voltage electric wires (47) of the control circuit are bundled with a bundling band (68) as Group B. In the example illustrated in FIG. 10, the electric wire (47) connected to the third terminal (83) for a motor-operated valve coil, the electric wire (47) connected to the fourth terminal (84) for a thermistor, and the electric wire (47) connected to the fifth terminal (85) for a pressure sensor belong to Group B.

[0102] The low-voltage electric wires (47) of the inverter circuit are bundled with a bundling band (68) as Group C. In the example shown in FIG. 10, the electric wire (47) connected to the sixth terminal (86) for a thermostat (metal type) and the electric wire (47) connected to the seventh terminal (87) for a high-voltage pressure switchgear belong to Group C.

[0103] The electric wires (47) of the AC200 system are bundled with a bundling band (68) as Group D. In the example illustrated in FIG. 10, the electric wire (47) connected to the eighth terminal (88) for a motor-operated valve coil and the electric wire (47) connected to the ninth terminal (89) for a PHE heater belong to Group D.

[0104] The number of the electric wires (47) in each group is merely an example, and is not limited thereto.

[0105] Since the plurality of electric wires (47) are divided into a plurality of groups and bundled as described above, the plurality of electric wires (47) can be drawn out of the substrate casing (50) while maintaining sealability of the housing space (52), and it is possible to facilitate a connection operation for connecting the electric wires (47) to devices.

«Other Embodiments»

[0106] The above-described embodiments may be modified as follows.

[0107] In the embodiments described above, the refrigeration cycle apparatus (1) is described as an air-conditioning device including a single refrigerant circuit. However, the refrigeration cycle apparatus (1) is not limited to this configuration.

[0108] Specifically, as illustrated in FIG. 11, the refrigeration cycle apparatus (1) includes an air conditioner

unit (100) and an outdoor unit (20). The outdoor unit (20) includes a refrigerant circuit (5). The refrigerant circuit (5) is filled with a flammable, natural refrigerant. The refrigerant circuit (5) performs a refrigeration cycle by circulating the refrigerant. The air conditioner unit (100) includes an air conditioner (106) connected to a fluid circuit (105). A temperature adjustment fluid flows through the fluid circuit (105). The temperature adjustment fluid is, for example, water. The air conditioner (106) is installed in an indoor space to be air-conditioned.

[0109] Although the number of air conditioners (106) is one in FIG. 11, the number is not limited to one, and a plurality of air conditioners (106) may be provided. When a plurality of air conditioners (106) are provided, the air conditioner unit (100) may be provided with a valve or the like for individually switching between supply and non-supply of the temperature adjustment fluid to the air conditioners (106).

[0110] The fluid circuit (105) is configured by connecting a water heat exchanger (101), a fluid pump (107), and the air conditioner (106) by a fluid pipe (108). The fluid pump (107) circulates water in the fluid circuit (105).

[0111] The water heat exchanger (101) is connected to the refrigerant pipe (28) of the refrigerant circuit (5). The water heat exchanger (101) causes heat exchange between the flammable refrigerant flowing through the refrigerant pipe (28) and water flowing through the fluid pipe (108).

[0112] The four-way switching valve (25) is in a state (indicated by the solid line in FIG. 11) where the first port (P1) and the third port (P3) are in communication with each other, and the second port (P2) and the fourth port (P4) are in communication with each other.

[0113] The air conditioner (106) is a heat exchanger that functions as a radiator of the temperature adjustment fluid circulating in the fluid circuit (105). The air conditioner (106) is an example of a target for temperature adjustment. The air conditioner (106) is specifically a radiator, a floor cooling/heating panel, or the like. For example, in a case in which the air conditioner (106) is a radiator, the air conditioner (106) is provided near a wall or the like in the room. For example, in a case in which the air conditioner (106) is a floor cooling/heating panel, the air conditioner (106) is provided under the floor or the like of the room.

[0114] While the embodiments and variations have been described above, it will be understood that various changes in form and details can be made without departing from the spirit and scope of the claims. The elements according to embodiments, the variations thereof, and the other embodiments may be combined and replaced with each other. In addition, the expressions of "first," "second," "third," ... , in the specification and claims are used to distinguish the terms to which these expressions are given, and do not limit the number and order of the terms.

INDUSTRIAL APPLICABILITY

[0115] As can be seen in the foregoing, the present disclosure is useful for a refrigeration cycle apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0116]

10	1	Refrigeration Cycle Apparatus
	21	Outdoor Heat Exchanger (Heat Exchanger)
	21a	Fin
	21b	Heat Transfer Tube
	22	Outdoor Fan (Fan)
15	24	Compressor
	26	Refrigerant Pipe
	30	Body Casing
	31	Partitioning Member
	32	Machine Chamber
20	33	Fan Chamber
	34	Fan Support Base
	37	Electric Component Support Base
	38	Heat Dissipation Space
	40	Electric Component
25	41	Heat-Generating Component
	42	Substrate
	45	Sealing Member
	47	Electric Wire
	50	Substrate Casing
30	51	First Member
	52	Housing Space
	53	Opening
	54	Flange
	55	Second Member
35	60	Cooling Unit
	61	Heat Pipe (Working Fluid Channel)
	62	Heat Sink (Evaporator)
	63	Refrigerant Jacket (Condenser)
	66	Wiring Hole
40	70	Coating Material

Claims

- 45 1. A refrigeration cycle apparatus comprising:
- 50 a body casing (30); a partitioning member (31) partitioning an inside of the body casing (30) into a machine chamber (32) and a fan chamber (33); a compressor (24) disposed in the machine chamber (32); and a fan (22) disposed in the fan chamber (33), wherein
- 55 a refrigerant pipe (26) which is connected to the compressor (24) and through which a flammable refrigerant flows is disposed in the machine chamber (32),
- an electric component (40) is disposed in the fan chamber (33), and

- the electric component (40) includes a substrate (42) on which a heat-generating component (41) is mounted, and a sealing member (45) for sealing the substrate (42).
2. The refrigeration cycle apparatus of claim 1, wherein the sealing member (45) is a substrate casing (50) having a housing space (52) for housing the substrate (42).
 3. The refrigeration cycle apparatus of claim 2, wherein
 - a heat exchanger (21) having a heat transfer tube (21b) is disposed in the fan chamber (33), the heat transfer tube (21b) including multiple sections in an up-down direction, and the substrate casing (50) includes: a first member (51) having an opening (53) communicating with the housing space (52); and a second member (55) in contact with the first member (51) to close the opening (53) and seal the housing space (52) from an outside of the substrate casing (50), and
 - a contact portion between the first member (51) and the second member (55) is located above an uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b).
 4. The refrigeration cycle apparatus of claim 3, wherein
 - the first member (51) is provided with a flange (54) extending outward along a peripheral portion of the opening (53),
 - the second member (55) is attached to the flange (54), and
 - the flange (54) is placed on a fin (21a) of the heat exchanger (21).
 5. The refrigeration cycle apparatus of claim 1, wherein the sealing member (45) is a coating material (70) covering an entire surface of the substrate (42).
 6. The refrigeration cycle apparatus of any one of claims 1 to 5, wherein
 - a heat exchanger (21) having a heat transfer tube (21b) is disposed in the fan chamber (33), the heat transfer tube (21b) including multiple sections in an up-down direction, and
 - the substrate (42) is disposed above an uppermost section of the heat transfer tube (21b) among the multiple sections of the heat transfer tube (21b).
 7. The refrigeration cycle apparatus of any one of claims 1 to 6, further comprising:
 - a cooling unit (60) including a working fluid channel (61) through which a working fluid flows, an evaporator (62) configured to evaporate the working fluid, and a condenser (63) configured to condense the working fluid, wherein in the working fluid channel (61), the working fluid is circulated between the evaporator (62) and the condenser (63),
 - the evaporator (62) causes heat exchange between the heat-generating component (41) and the working fluid, and
 - the condenser (63) causes heat exchange between the flammable refrigerant flowing through the refrigerant pipe (26) and the working fluid.
 8. The refrigeration cycle apparatus of any one of claims 1 to 7, further comprising:
 - a fan support base (34) supporting the fan (22), wherein
 - the fan support base (34) is provided with an electric component support base (37) supporting the electric component (40).
 9. The refrigeration cycle apparatus of any one of claims 1 to 8, wherein
 - the sealing member (45) is a substrate casing (50) having a housing space (52) for housing the substrate (42), and
 - a heat dissipation space (38) for dissipating heat generated in the heat-generating component (41) is provided between a top panel of the body casing (30) and an upper surface of the substrate casing (50).
 10. The refrigeration cycle apparatus of any one of claims 1 to 9, wherein the electric component (40) is disposed away from the partitioning member (31).
 11. The refrigeration cycle apparatus of any one of claims 1 to 10, wherein the flammable refrigerant is R290.
 12. The refrigeration cycle apparatus of claim 2, wherein
 - the substrate casing (50) includes: a first member (51) having an opening (53) communicating with the housing space (52); and a second member (55) in contact with the first member (51) to close the opening (53) and seal the housing space (52) from an outside of the substrate casing (50),
 - the substrate (42) is located in the first member (51) on a surface opposite to the opening (53), and
 - the substrate casing (50) is disposed in the fan chamber (33) such that the second member (55)

is located below the first member (51).

- 13.** The refrigeration cycle apparatus of claim 12, further comprising:

an electric wire (47) drawn out of the substrate (42), wherein
a wiring hole (66) for drawing the electric wire (47) out of the substrate casing (50) is formed in a sidewall of the first member (51) at a position below the substrate (42).

- 14.** The refrigeration cycle apparatus of claim 13, wherein

the electric wire (47) includes a plurality of electric wires (47),
the wiring hole (66) includes a plurality of wiring holes (66), and
the plurality of electric wires (47) are bundled into a plurality of groups, and the plurality of groups of the electric wires (47) are drawn out through the respective wiring holes (66).

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FIG.1

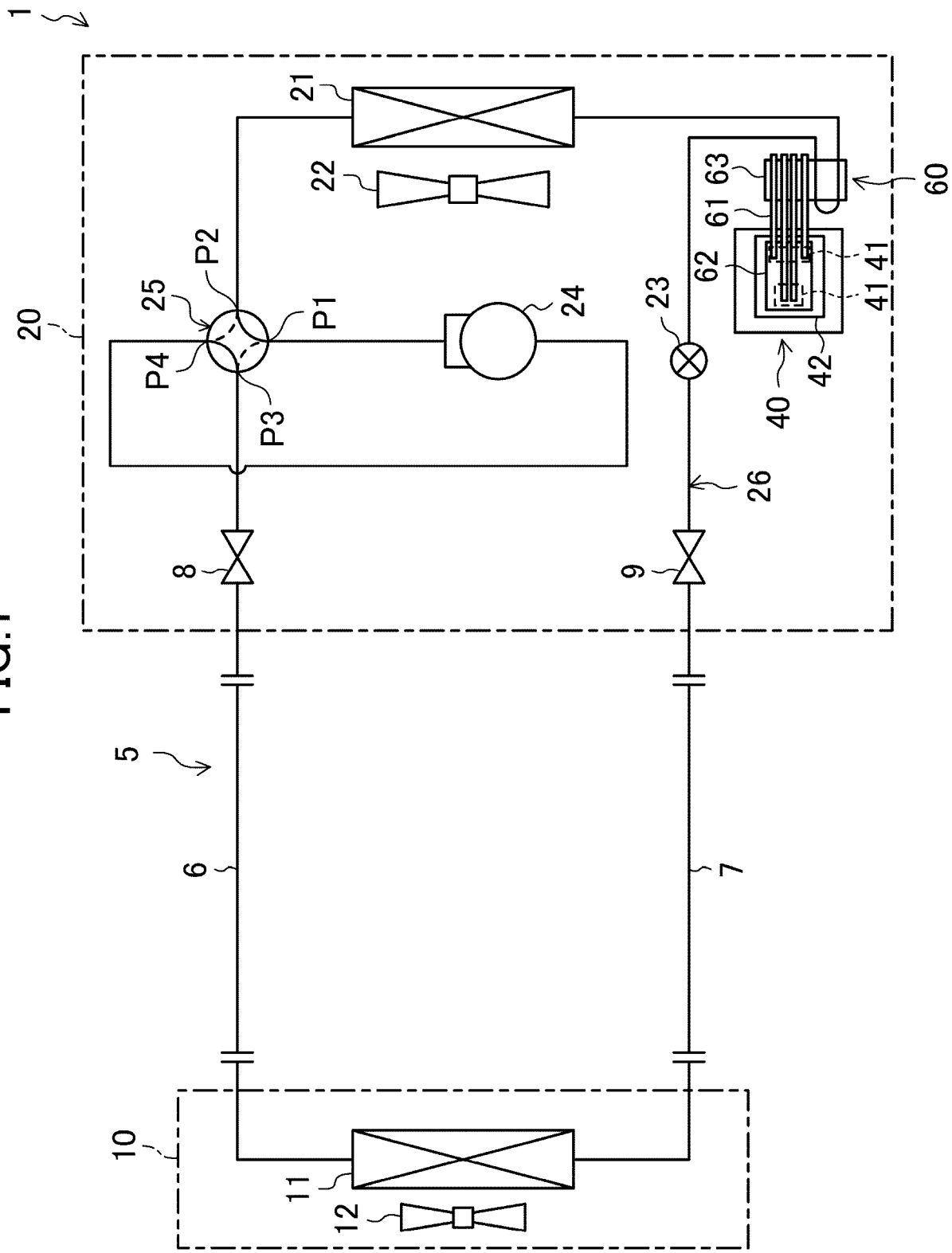


FIG.2

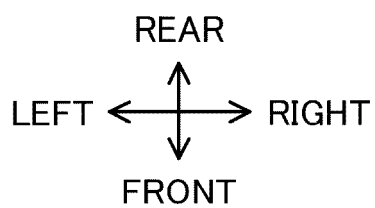
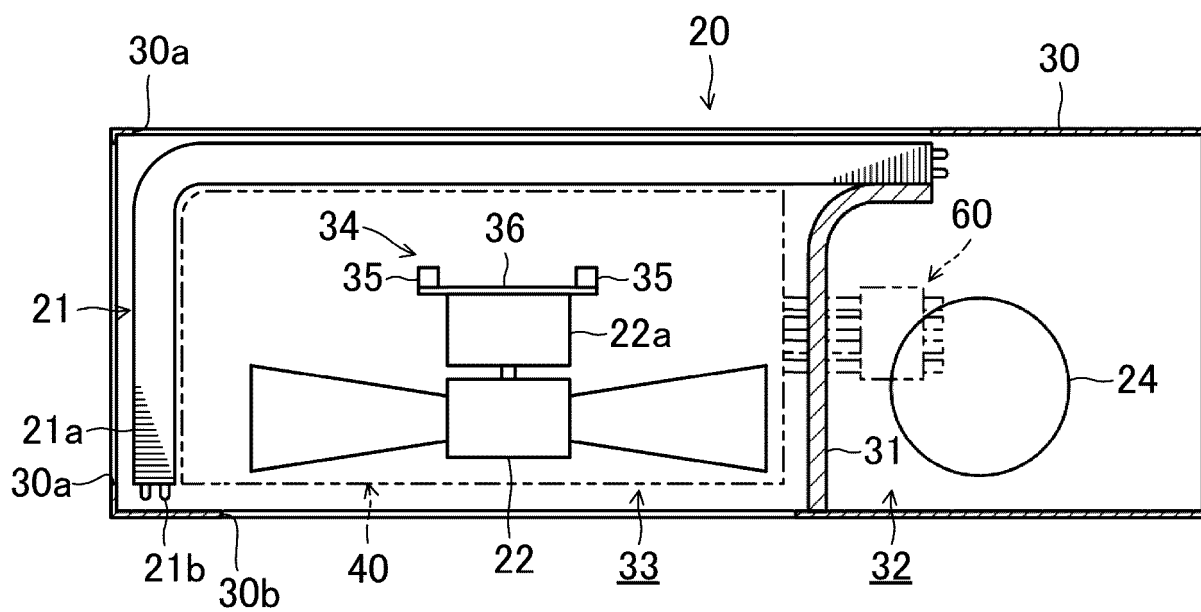


FIG.3

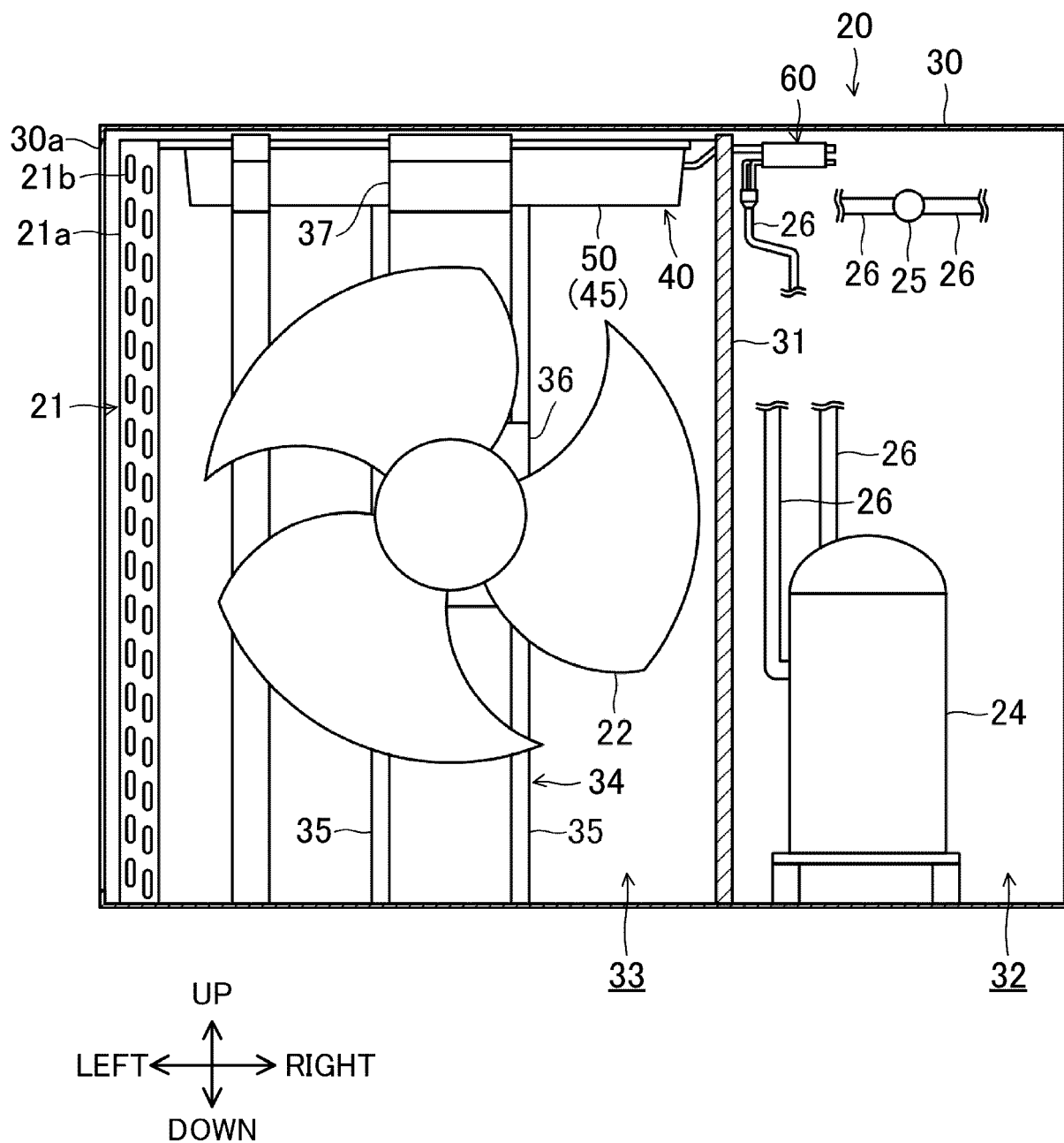


FIG.4

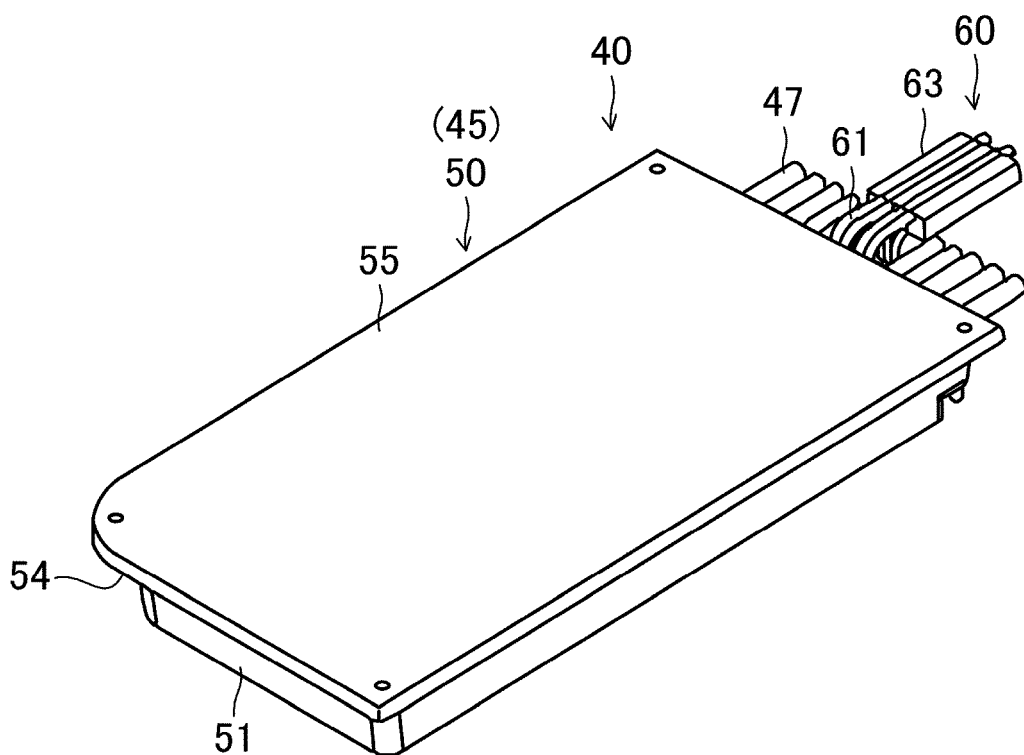


FIG. 5

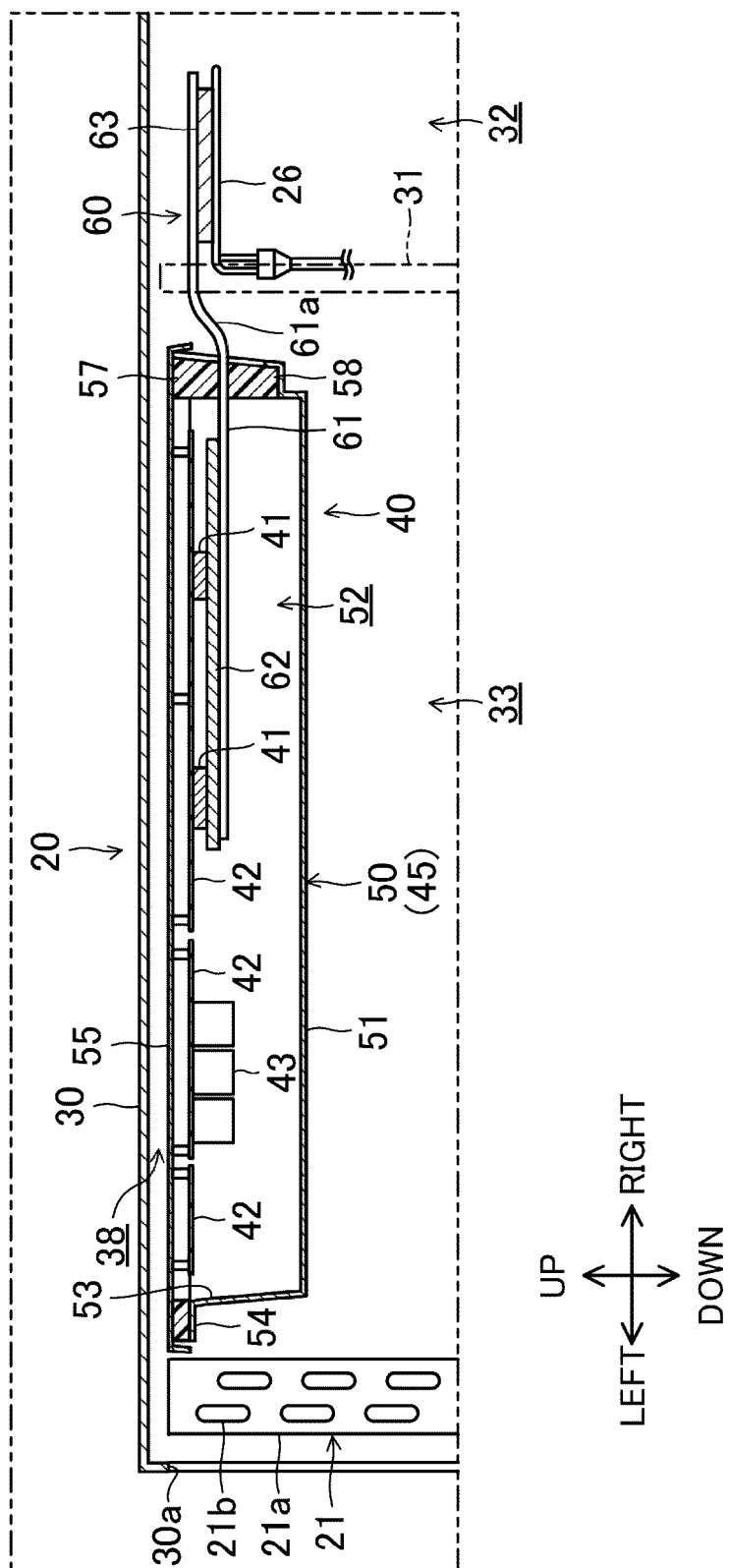


FIG.6

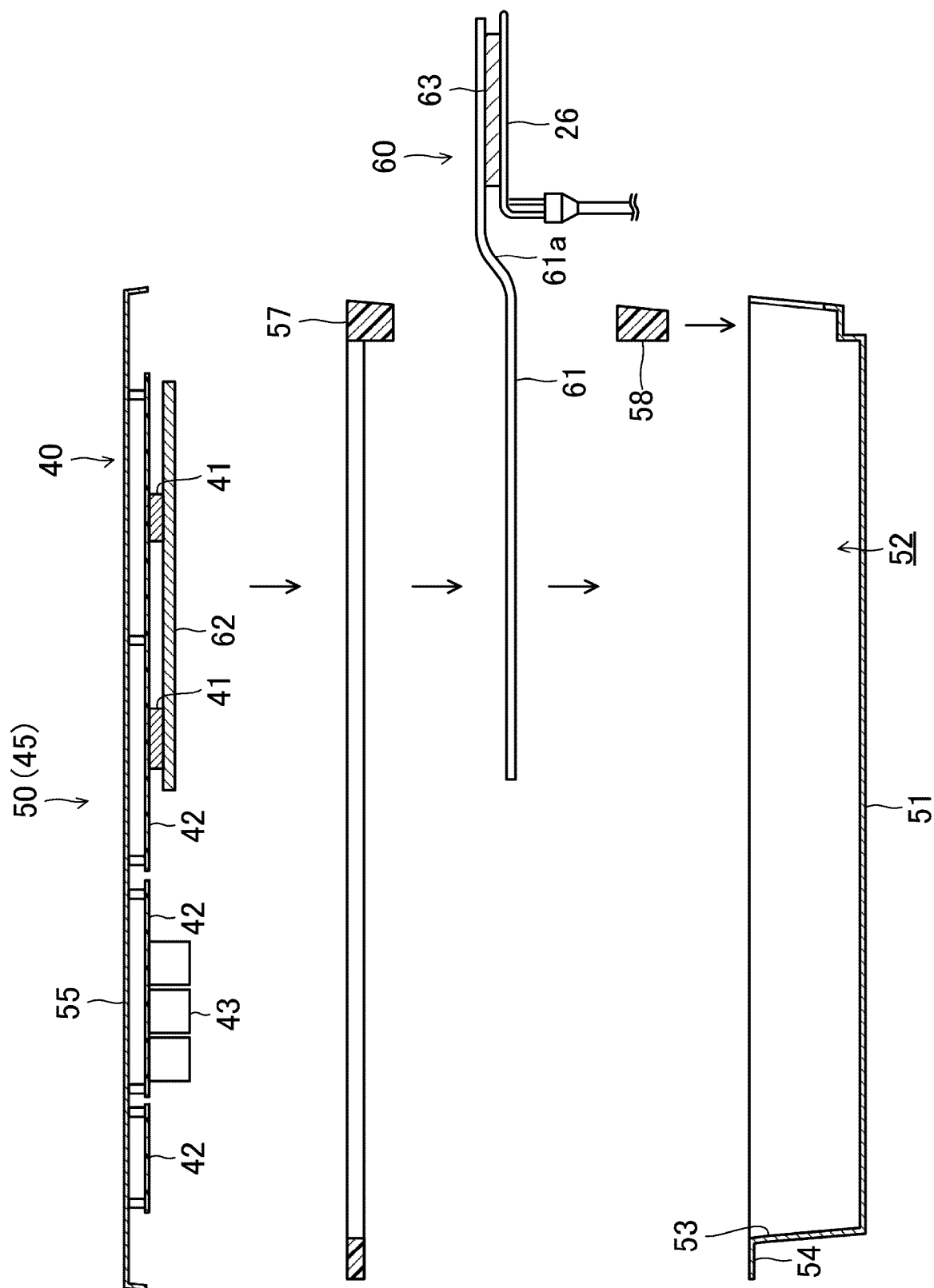


FIG.7

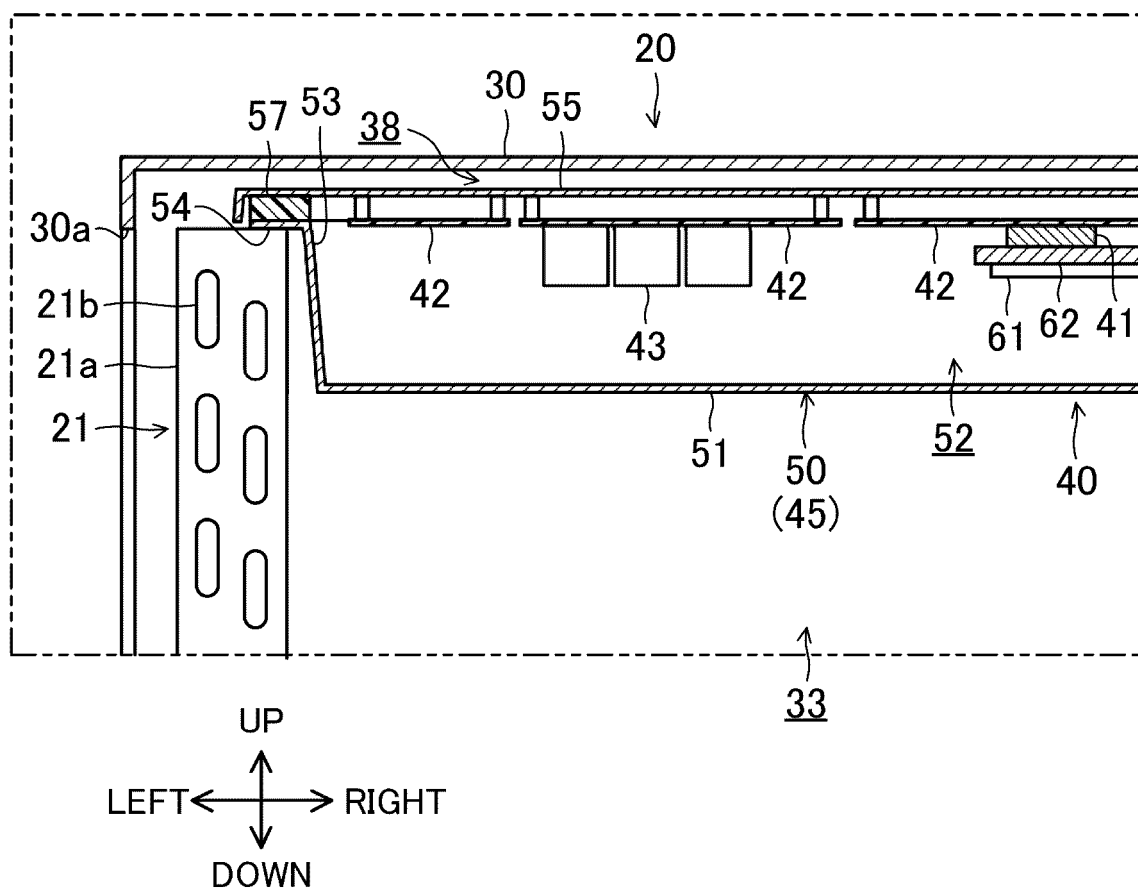


FIG.8

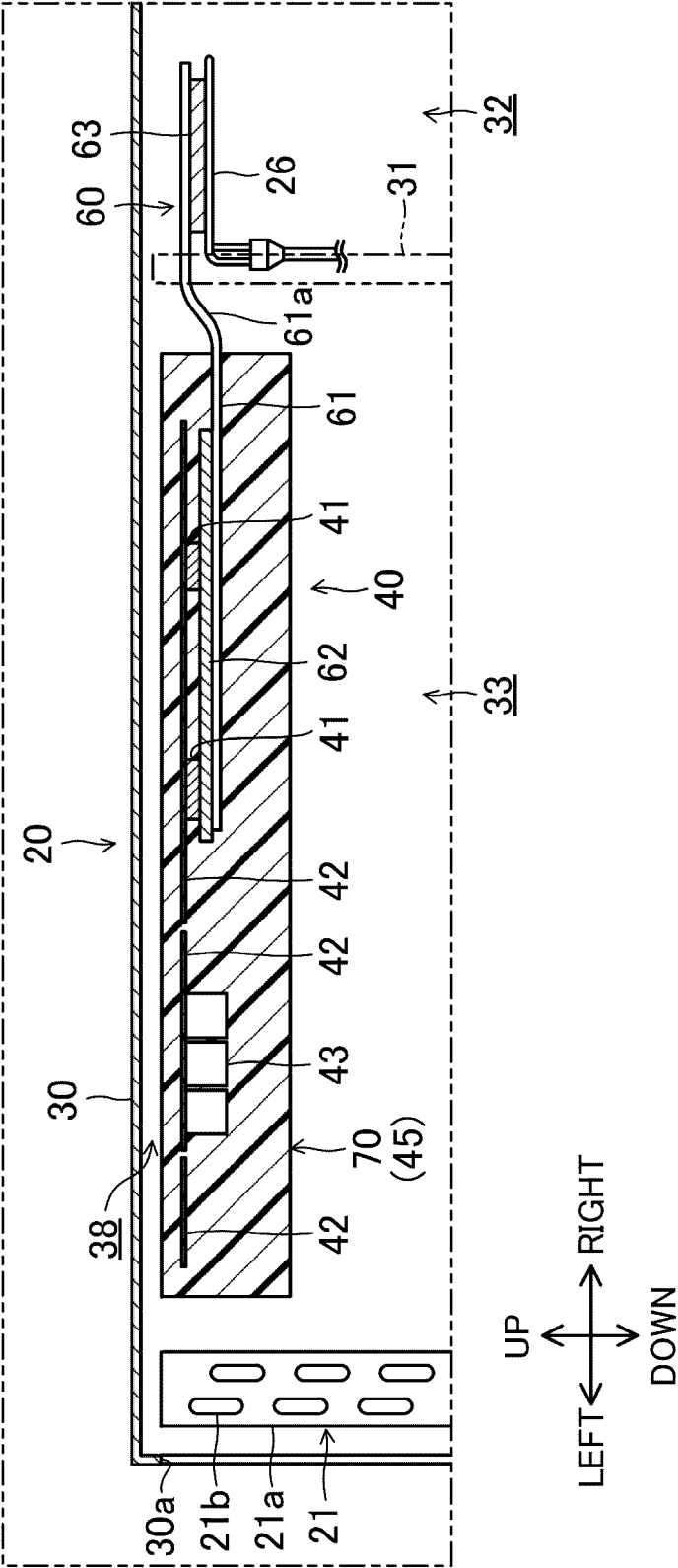


FIG. 9

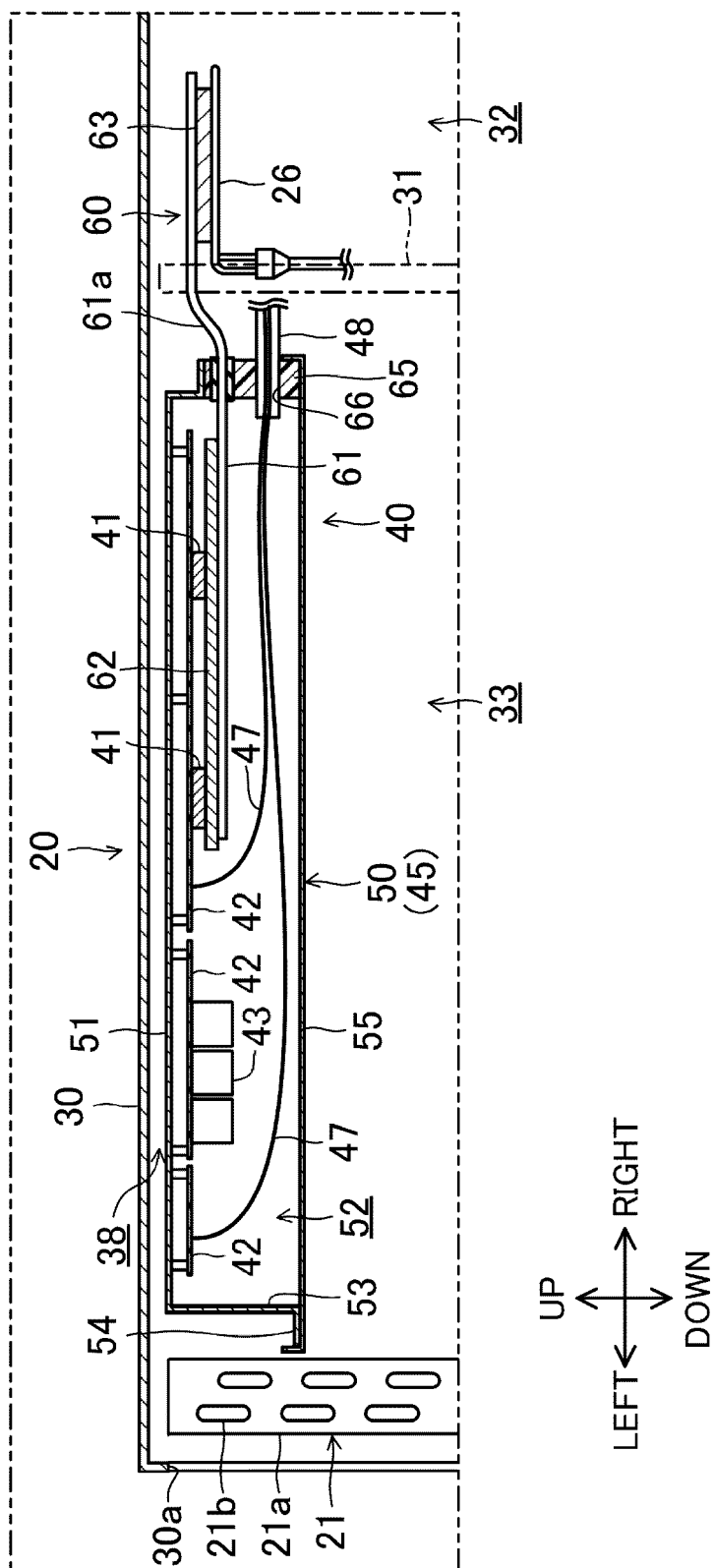


FIG.10

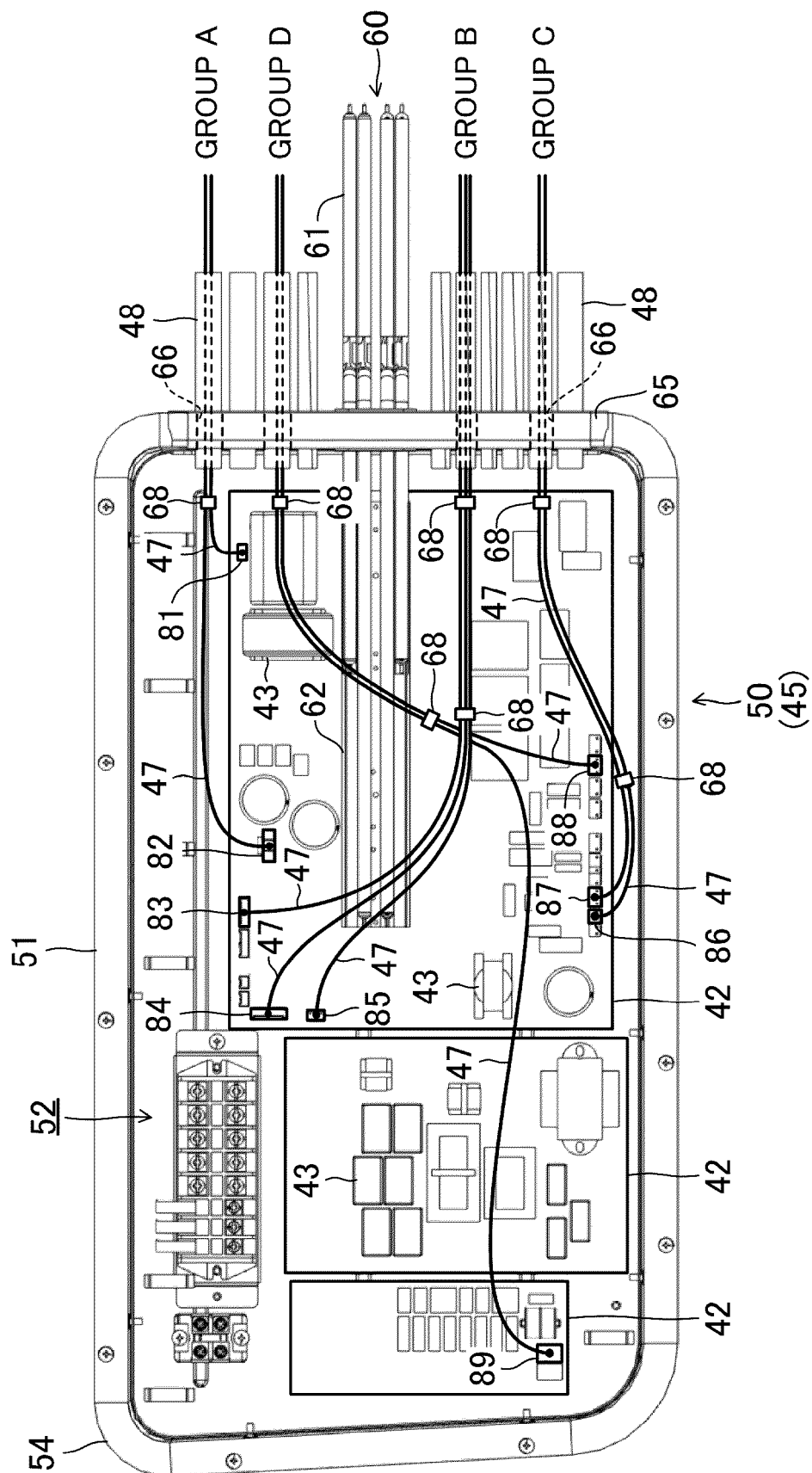
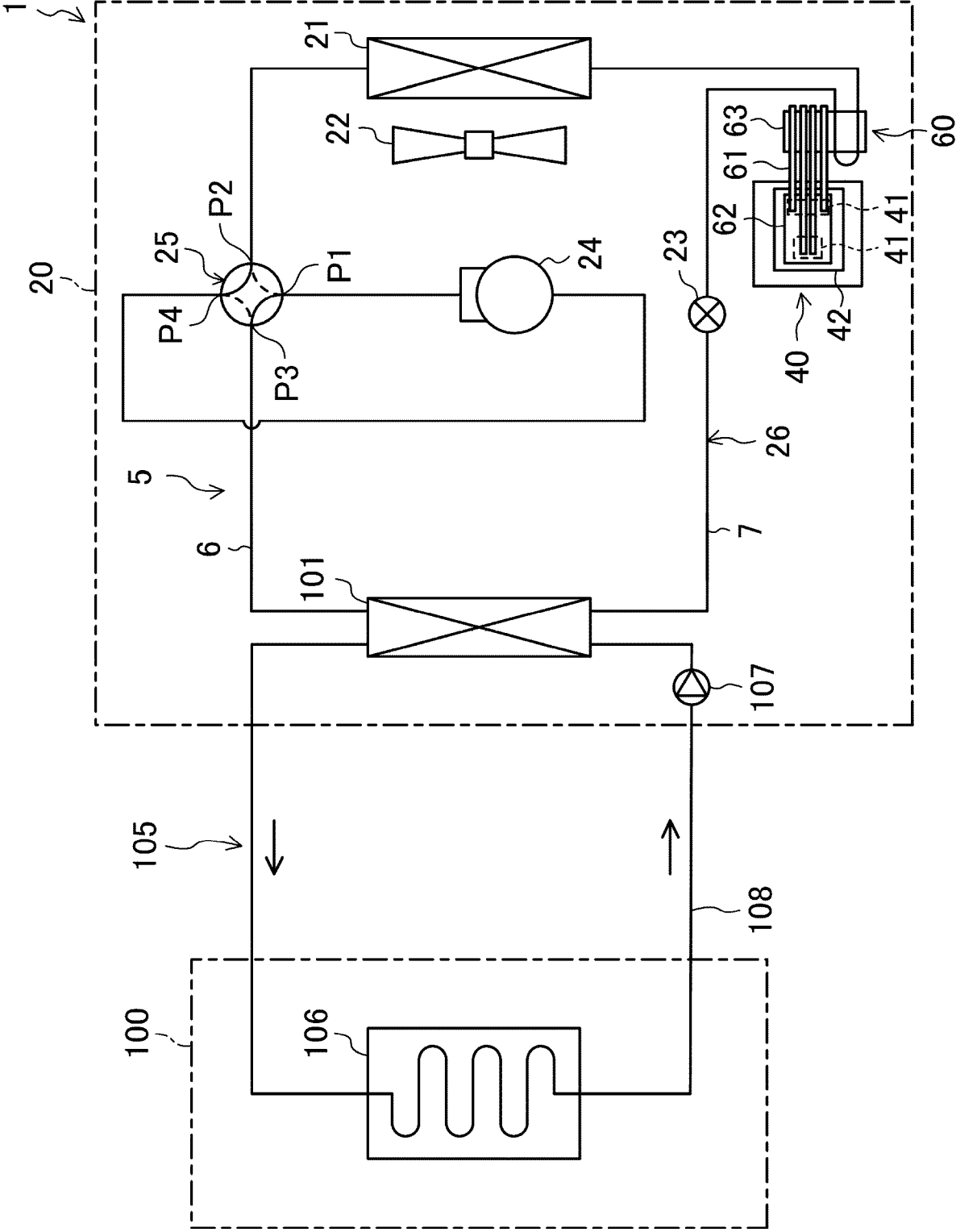


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/046212

A. CLASSIFICATION OF SUBJECT MATTER <i>F24F 1/22</i> (2011.01)i; <i>F24F 1/24</i> (2011.01)i FI: F24F1/22; F24F1/24 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) F24F1/20-1/24 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2023 Registered utility model specifications of Japan 1996-2023 Published registered utility model applications of Japan 1994-2023 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																								
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>JP 2017-83148 A (DAIKIN IND., LTD.) 18 May 2017 (2017-05-18) paragraphs [0020]-[0021], [0029], [0034], [0069], fig. 3</td> <td>1-14</td> </tr> <tr> <td>Y</td> <td>JP 2010-14340 A (DAIKIN IND., LTD.) 21 January 2010 (2010-01-21) paragraph [0003]</td> <td>1-14</td> </tr> <tr> <td>Y</td> <td>JP 10-220824 A (DAIKIN IND., LTD.) 21 August 1998 (1998-08-21) paragraphs [0041]-[0043], fig. 3</td> <td>1-14</td> </tr> <tr> <td>Y</td> <td>JP 2001-201110 A (FUJITSU GENERAL LTD.) 27 July 2001 (2001-07-27) paragraph [0011], fig. 4</td> <td>4, 6-11</td> </tr> <tr> <td>Y</td> <td>WO 2020/208670 A1 (MITSUBISHI ELECTRIC CORP.) 15 October 2020 (2020-10-15) paragraphs [0024]-[0025], fig. 4</td> <td>5-11</td> </tr> <tr> <td>Y</td> <td>WO 2019/124359 A1 (DAIKIN IND., LTD.) 27 June 2019 (2019-06-27) paragraphs [0436]-[0439], fig. 20</td> <td>7-11</td> </tr> <tr> <td>Y</td> <td>JP 2010-38514 A (CORONA CORP.) 18 February 2010 (2010-02-18) paragraphs [0014]-[0019], fig. 2-5</td> <td>8-14</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	JP 2017-83148 A (DAIKIN IND., LTD.) 18 May 2017 (2017-05-18) paragraphs [0020]-[0021], [0029], [0034], [0069], fig. 3	1-14	Y	JP 2010-14340 A (DAIKIN IND., LTD.) 21 January 2010 (2010-01-21) paragraph [0003]	1-14	Y	JP 10-220824 A (DAIKIN IND., LTD.) 21 August 1998 (1998-08-21) paragraphs [0041]-[0043], fig. 3	1-14	Y	JP 2001-201110 A (FUJITSU GENERAL LTD.) 27 July 2001 (2001-07-27) paragraph [0011], fig. 4	4, 6-11	Y	WO 2020/208670 A1 (MITSUBISHI ELECTRIC CORP.) 15 October 2020 (2020-10-15) paragraphs [0024]-[0025], fig. 4	5-11	Y	WO 2019/124359 A1 (DAIKIN IND., LTD.) 27 June 2019 (2019-06-27) paragraphs [0436]-[0439], fig. 20	7-11	Y	JP 2010-38514 A (CORONA CORP.) 18 February 2010 (2010-02-18) paragraphs [0014]-[0019], fig. 2-5	8-14
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Y	JP 2017-83148 A (DAIKIN IND., LTD.) 18 May 2017 (2017-05-18) paragraphs [0020]-[0021], [0029], [0034], [0069], fig. 3	1-14																						
Y	JP 2010-14340 A (DAIKIN IND., LTD.) 21 January 2010 (2010-01-21) paragraph [0003]	1-14																						
Y	JP 10-220824 A (DAIKIN IND., LTD.) 21 August 1998 (1998-08-21) paragraphs [0041]-[0043], fig. 3	1-14																						
Y	JP 2001-201110 A (FUJITSU GENERAL LTD.) 27 July 2001 (2001-07-27) paragraph [0011], fig. 4	4, 6-11																						
Y	WO 2020/208670 A1 (MITSUBISHI ELECTRIC CORP.) 15 October 2020 (2020-10-15) paragraphs [0024]-[0025], fig. 4	5-11																						
Y	WO 2019/124359 A1 (DAIKIN IND., LTD.) 27 June 2019 (2019-06-27) paragraphs [0436]-[0439], fig. 20	7-11																						
Y	JP 2010-38514 A (CORONA CORP.) 18 February 2010 (2010-02-18) paragraphs [0014]-[0019], fig. 2-5	8-14																						
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Date of the actual completion of the international search 27 January 2023	Date of mailing of the international search report 07 February 2023																							
Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.																							

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INTERNATIONAL SEARCH REPORT

International application No.
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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 109340929 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 15 February 2019 (2019-02-15) fig. 1-4	1-2

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2022/046212

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