



EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.04.2024 Bulletin 2024/14

(21) Application number: **23199422.9**

(22) Date of filing: **25.09.2023**

(51) International Patent Classification (IPC):
F24F 1/22 ^(2011.01) **F24F 1/46** ^(2011.01)
F24F 11/36 ^(2018.01) **F24F 11/89** ^(2018.01)
F24F 1/24 ^(2011.01) **F24F 1/029** ^(2019.01)

(52) Cooperative Patent Classification (CPC):
F24F 1/22; F24F 1/029; F24F 1/24; F24F 1/46;
F24F 11/36; F24F 11/89

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **30.09.2022 JP 2022158749**

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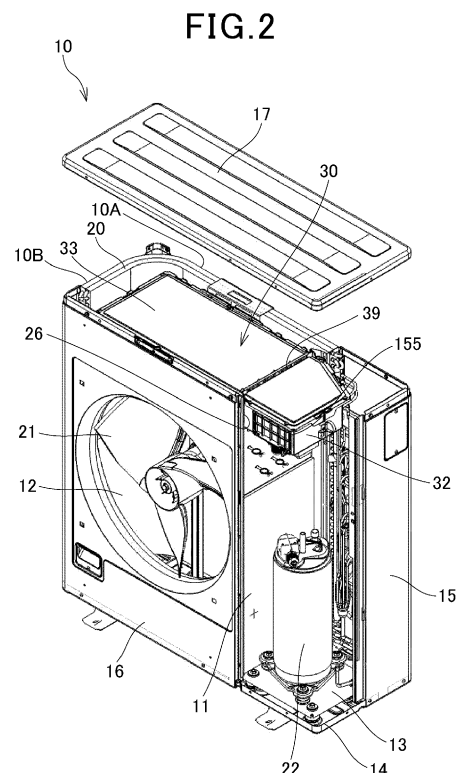
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(54) **HEAT PUMP APPARATUS**

(57) The present disclosure provides a heat pump apparatus that prevents a refrigerant, which has leaked from a refrigerant circuit, from entering an electrical equipment box. A heat pump apparatus 1 includes a machine room 13 and a blower room 12 each in a housing 10, the machine room 13 being a room in which a compressor 22 and an expansion device 24 are included, the blower room 12 being a room in which a heat exchanger 20 and a blower are included, wherein an electrical equipment box 30 is disposed above the machine room 13 and the blower room 12 across the rooms, the electrical equipment box 30 includes an electrical equipment box body 32 and a cover member 33, and the electrical equipment box body 32 has a smaller ratio of a volume occupied by a machine-side portion 32B than a ratio of a volume occupied by a blower-side portion 32A, so that the machine-side portion 32B has a shorter sealing portion length of the electrical equipment box body 32 and the cover member 33.



Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates to a heat pump apparatus.

Description of the Related Art

[0002] European Patent Application Publication No. 3312531 discloses a heat pump apparatus that includes a refrigerant circuit that circulates a flammable refrigerant, a water circuit (heat medium circuit) that causes water (heat medium) to flow, and a water heat exchanger (heat medium heat exchanger) that exchanges heat between the refrigerant and the water, each in a housing. The housing has an upper part in which an electrical equipment box that houses a control board, etc. is disposed.

[0003] The present disclosure provides a heat pump apparatus that prevents a refrigerant, which has leaked from the refrigerant circuit, from entering an electrical equipment box.

SUMMARY OF THE INVENTION

[0004] A heat pump apparatus of the present disclosure includes a machine room and a blower room each in a housing, the machine room being a room in which a compressor and an expansion device are included, the blower room being a room in which a heat exchanger and a blower are included, wherein an electrical equipment box is disposed above the machine room and the blower room across the rooms, the electrical equipment box includes an electrical equipment box body and a cover member, and the electrical equipment box body has a smaller ratio of a volume occupied by a machine-side portion than a ratio of a volume occupied by a blower-side portion, so that the machine-side portion has a shorter sealing portion length of the electrical equipment box body and the cover member.

[0005] The present disclosure makes it possible to prevent a refrigerant from entering the electrical equipment box when the refrigerant leaks from the refrigerant circuit.

BRIEF DESCRIPTION OF THE DRAWINGS**[0006]**

FIG. 1 is a perspective view showing a heat pump apparatus according to Embodiment 1;
FIG. 2 is an exploded perspective view showing the heat pump apparatus of Embodiment 1;
FIG. 3 is a front view showing a state in which a front panel of the heat pump apparatus of Embodiment 1 is removed;

FIG. 4 is a circuit diagram showing a refrigerant circuit according to Embodiment 1;

FIG. 5 is an exploded perspective view showing an electrical equipment box of Embodiment 1;

FIG. 6 is a vertical cross-sectional view showing the electrical equipment box of Embodiment 1;

FIG. 7 is a plan view showing the electrical equipment box of Embodiment 1; and

FIG. 8 is a perspective view showing the heat pump apparatus according to Embodiment 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Knowledge on Which the Present Disclosure Is Based)

[0007] At the time when the inventors came up with the present disclosure, there was a technique for preventing ignition of a flammable refrigerant in a heat pump apparatus.

[0008] The heat pump apparatus includes a refrigerant circuit that circulates a flammable refrigerant, a water circuit that causes water to flow, and a water heat exchanger that exchanges heat between the refrigerant and water, each in a housing. The water circuit is provided with refrigerant release valves, such as a pressure relief valve and an air vent valve, which release refrigerant to the outside of the water circuit. With this configuration, if the partition wall that separates the refrigerant circuit and the water circuit in the water heat exchanger is destroyed and a flammable refrigerant mixes into the water circuit, the flammable refrigerant can be discharged to the water circuit via the pressure relief valve or the air vent valve.

[0009] However, the inventors have found a problem with the above heat pump apparatus that, when the refrigerant leaks, the inside of the housing may be filled with the refrigerant and the refrigerant may enter the electrical equipment box, and have come to constitute the subject of the present disclosure to solve the problem.

[0010] Therefore, the present disclosure provides a heat pump apparatus that prevents a refrigerant, which has leaked from the refrigerant circuit, from entering an electrical equipment box.

[0011] Hereinafter, embodiments will be described in detail with reference to the drawings. However, more detailed description than necessary may be omitted. For example, detailed description of well-known matters or redundant description of substantially the same configurations may be omitted. This is to avoid the following description from becoming more redundant than necessary and to facilitate understanding of those skilled in the art.

[0012] Note that the accompanying drawings and the following description are provided to allow those skilled in the art to sufficiently understand the present disclosure, and are not intended to limit the subject described in the claims.

(Embodiment 1)

[0013] Embodiment 1 is to be described below with reference to the drawings.

[1-1. Configuration]

[1-1-1. Configuration of Heat Pump Apparatus]

[0014] FIG. 1 is a perspective view of a heat pump apparatus 1 according to Embodiment 1. FIG. 2 is an exploded perspective view of the heat pump apparatus 1 according to Embodiment 1. FIG. 3 is a front view showing a state in which a front panel 16 of the heat pump apparatus 1 according to Embodiment 1 is removed.

[0015] The heat pump apparatus 1 shown in FIG. 1 is an outdoor unit that can be used for a what is called heat-pump hot-water heater.

[0016] As shown in FIGS. 1 to 3, the heat pump apparatus 1 includes a box-shaped housing 10. In the present embodiment, each part of housing 10 is made of a steel plate.

[0017] Inside the housing 10, there is provided a partition plate 11 extending in the up-down direction. The partition plate 11 partitions the internal space of the housing 10 into a blower room 12 and a machine room 13.

[0018] The housing 10 includes a bottom plate 14 that forms the bottom surface of the housing 10, a pair of side panels 15 that covers the machine room 13 of the housing 10 from the front and rear, a front panel 16 that covers the front surface of the blower room 12, and a top plate 17 that covers the upper surface of the housing 10.

[0019] The front panel 16 is provided with a ventilation portion 18 that is formed like a mesh and allows air to pass through.

[0020] The blower room 12 has a heat exchanger 20 and a blower device 21.

[0021] The heat exchanger 20 of the present embodiment extends almost fully in the height direction of the housing 10, and is formed in a substantially L-shape in plan view of the housing 10 so as to face the rear surface 10A and the side surface 10B of the housing 10.

[0022] The heat exchanger 20 to be used is, for example, a fin-tube heat exchanger.

[0023] The blower device 21 to be used is, for example, an axial fan having a propeller-shaped impeller. The air blower device 21 is disposed so that the axial flow direction faces the ventilation portion 18.

[0024] The machine room 13 houses various devices forming a refrigerant circuit, such as a compressor 22, a water heat exchanger (heat medium heat exchanger) 23, and an expansion device 24 (see FIG. 4), and refrigerant piping 25 connecting these to each other.

[0025] The water heat exchanger 23 to be used is, for example, a plate heat exchanger.

[0026] The upper part of the partition plate 11 has a cutout portion 26, and the cutout portion 26 has the electrical equipment box 30 installed therein.

[1-1-2. Configuration of Refrigerant Circuit]

[0027] FIG. 4 is a circuit diagram showing a refrigerant circuit according to Embodiment 1.

[0028] As shown in FIG. 4, a compressor 22, a four-way valve 27, a water heat exchanger 23, an expansion device 24, and a heat exchanger 20 are annularly connected via predetermined refrigerant piping 25 to form the refrigerant circuit.

[0029] The water heat exchanger 23 is connected to predetermined water supply piping 28, and the water supply piping 28, in the water heat exchanger 23, exchanges heat with the refrigerant that circulates in the refrigerant circuit.

[0030] The refrigerant, which has been compressed by the compressor 22 to have a high-temperature and a high-pressure, flows as indicated by solid arrows in FIG. 4 and is sent to the water heat exchanger 23. The refrigerant then exchanges heat with the water flowing through the water supply piping 28 in the water heat exchanger 23, and is cooled and condensed. The water receives the heat of the refrigerant and turns into hot water, which is supplied to, for example, a device on the use side.

[0031] The refrigerant discharged from the water heat exchanger 23 is depressurized by the expansion device 24 to evaporate, undergoes heat exchange in the heat exchanger 20, turns into a gas refrigerant, and is returned to the compressor 22 again.

[0032] The refrigerant circuit is also configured so that it can switch the four-way valve 27 to cause the refrigerant to: flow as indicated by dashed arrows in FIG. 4; exchange heat with the outside air in the heat exchanger 20; be depressurized with expansion device 24; and then be sent to the water heat exchanger 23, so that the water flowing through the water supply piping 28 is cooled. The cooled water is supplied to a use side device.

[0033] Here, in the present embodiment, the refrigerant to be used is a flammable refrigerant. The flammable refrigerant is R32 or a mixed refrigerant containing 70 weight percent or more of R32, or propane or a mixed refrigerant containing propane.

[0034] Note that the refrigerant to be used may be a nonflammable refrigerant instead of a flammable refrigerant.

[1-1-3. Configuration of Electrical Equipment Box]

[0035] FIG. 5 is an exploded perspective view showing the electrical equipment box 30 of Embodiment 1. FIG. 6 is a vertical cross-sectional view showing the electrical equipment box 30 of Embodiment 1. FIG. 7 is a plan view showing the electrical equipment box 30 of Embodiment 1. As shown in FIG. 2, an electrical equipment box 30 is disposed above the blower room 12 and the machine room 13 across the machine room 13 and the blower room 12.

[0036] The electrical equipment box 30 is installed in the cutout portion 26 at the upper part of the partition

plate 11 and is supported by the partition plate 11. As shown in FIGS. 5 and 6, the electrical equipment box 30 includes a box-shaped electrical equipment box body 32 made of sheet metal and having an opening 31 with an open upper surface, and a cover member 33 formed in a substantially rectangular flat plate shape and made of resin for closing the opening 31. The electrical equipment box body 32 is made of a material with high thermal conductivity, such as a metal material. The cover member 33 is attached to the electrical equipment box body 32 via an O-ring 38.

[0037] Note that, in the present embodiment, the electrical equipment box body 32 is entirely made of a metal material, but may be made of a metal material only in a part located above the blower room 12.

[0038] As shown in FIGS. 5 to 7, the electrical equipment box body 32 includes a rectangular blower-side portion 32A located on the side of the blower room 12 in plan view, and a substantially trapezoidal machine-side portion 32B located on the side of the machine room 13 in plan view. The cover member 33 includes a rectangular blower-side portion 33A located on the side of the blower room 12 in plan view and a substantially trapezoidal machine-side portion 33B located on the side of the machine room 13 in plan view.

[0039] The electrical equipment box body 32 has a control board 40 including a printed wiring board and other electronic components 43 electrically connected to the control board 40, both of which are installed in the blower-side portion 32A.

[0040] Although not shown, the control board 40 has electronic components including a semiconductor chip such as a CPU, transistors, capacitors, and resistors, mounted thereon to form an electric circuit.

[0041] The control board 40 has a lower surface provided with a heat sink 41 having a plurality of fins. The control board 40 is installed so that the heat sink 41 protrudes downward from a bottom surface opening 35 provided on the bottom surface of the blower-side portion 32A. The heat sink 41 is disposed on the bottom surface of the electrical equipment box body 32 in the blower-side portion 32A located near the machine-side portion 32B. In the present embodiment, one end of the heat sink 41 is located at the boundary between the machine-side portion 32B and the blower-side portion 32A. In other words, the one end is located at the boundary partitioned by the partition plate 11.

[0042] The circumferential portion of the bottom surface opening 35 has a sealing material 42 disposed thereon, and the control board 40 is fixed via the sealing material 42 so that the bottom surface opening 35 is closed.

[0043] The machine-side portion 32B of the electrical equipment box body 32 has a main power line relay portion 50 located on the front side and a lead wire relay portion 53 located on the rear side. The main power line relay portion 50 has a terminal block 51 for connecting the main power line, and a cable gland 52 that draws in

and seals the main power line. A cable 45 drawn into the cable gland 52 is connected to a predetermined device such as the compressor 22. The lead wire relay portion 53 has a lead wire relay module 55 for drawing in a lead wire.

[0044] The main power line relay portion (space) 50 has the terminal block 51 for connecting a cable (main power line) 45. The main power line relay portion 50 in which the terminal block 51 is disposed is partitioned off by a partition plate 154, and the main power line relay portion 50 is sealed inside the electrical equipment box body 32. The terminal block 51 is disposed on a partition plate 154A formed obliquely and faces a window opening 152 formed on a side surface of the electrical equipment box body 32. The window opening 152 has a window cover body 155 screwed thereto with a sealing material (not shown) interposed therebetween. The window cover body 155 seals off the main power line relay portion 50.

[0045] The cover member 33 is fixed to the upper end of the electrical equipment box body 32 with fixing screws 37A to 37F via an O-ring 38. Thereby, the inside of the electrical equipment box body 32 is made into a sealed space. More specifically, as shown in FIG. 5, the electrical equipment box body 32 has an upper end having a circumferential portion. The circumferential portion has a flange 32F formed by bending a sheet metal. As shown in FIG. 5, an O-ring groove 36 is formed in the circumferential portion of the lower surface of the cover member 33. The O-ring 38 is fitted into the O-ring groove 36, and the cover member 33 is fixed to the flange 32F with six fixing screws 37A to 37F. The O-ring 38 is made of foam rubber or chloroprene rubber.

[0046] The cover member 33 is fixed to the flange 32F of the machine-side portion 32B of the electrical equipment box body 32 with four fixing screws 37A to 37D, and is fixed to the flange 32F of the blower-side portion 32A of the electrical equipment box body 32 with two fixing screws 37E and 37F.

[0047] The electrical equipment box body 32 has a smaller ratio of the volume occupied by the machine-side portion 32B than a ratio of the volume occupied by the blower-side portion 32A. The machine-side portion 32B of the electrical equipment box body 32 is formed in a trapezoidal shape in plan view by cutting a corner of the machine-side portion 32B.

[0048] This causes the machine-side portion 32B of the electrical equipment box body 32 to have a shorter length of the sealing portion (the length of the O-ring 38) between the electrical equipment box body 32 and the cover member 33.

[0049] Further, the intervals P1 to P3 between fixing screws 37A to 37D, which fix the machine-side portion 32B, are set shorter than the intervals P4 to P6 between the fixing screws 37D to 37F which fix the blower-side portion 32A. Thus, the machine-side portion 32B has a shorter sealing portion length and has shorter intervals P1 to P3 between the fixing screws 37A to 37D. This can improve the sealing performance between the electrical

equipment box body 32 and the cover member 33 in the machine-side portion 32B.

[0050] Note that, in the present embodiment, the machine-side portion 32B of the electrical equipment box body 32 is formed in a trapezoidal shape in plan view by cutting a corner of the machine-side portion 32B. However, the shape is not limited to this, and the machine-side portion 32B may have another polygonal shape as long as the shape shortens the sealing portion length. In other words, the electrical equipment box body 32 may be formed in any shape in plan view as long as the shape causes the machine-side portion 32B to have a shorter circumferential length.

[0051] FIG. 8 is a perspective view showing a heat pump apparatus according to Embodiment 1. FIG. 8 is a view of the heat pump apparatus 1 as seen from the rear surface 10A and the side of the machine room 13. FIG. 8 omits the pair of side panels 15, the front panel 16 covering the front surface of the blower room 12, and the panels forming the rear surface 10A and the side surface 10B.

[0052] As shown in FIGS. 7 and 8, the heat exchanger 20 is formed in an L-shape facing the rear surface 10A and the side surface 10B of the housing 10 in plan view. The heat exchanger 20 has one end portion in the longitudinal direction provided with a header pipe 29A and a bend portion 29B of the refrigerant piping. The header pipe 29A and the bend portion 29B of the refrigerant piping are disposed in the machine room 13 and face the rear surface 10A of the housing 10.

[0053] The machine room 13 has the header pipe 29A and the bend portion 29B of the refrigerant piping, both disposed in a position adjacent to the machine-side portion 32B of the electrical equipment box 30, the machine-side portion 33B thereof, and the sealing portion of the machine-side portion 32B.

[0054] The machine room 13 is provided with a shielding member 60 between: the header pipe 29A and the bend portion 29B; and the machine-side portion 32B and the machine-side portion 33B. The shielding member 60 is a plate-shaped member made of a resin material. The shielding member 60 is attached to the partition plate 11 and extends along the cut corner of the machine-side portion 32B in the circumferential direction of the electrical equipment box body 32 in plan view.

[0055] The shielding member 60 of the present embodiment has a longer height dimension in the up-down direction of the housing 10 than the electrical equipment box 30. Therefore, the electrical equipment box 30 is shielded from the header pipe 29A and the bend portion 29B in overall height direction of the machine-side portion 32B and the machine-side portion 33B adjacent to the header pipe 29A and bend portion 29B.

[0056] The shielding member 60 is thus provided at a position adjacent to the sealing portion of the machine-side portion 32B in a position close to the header pipe 29A. This prevents the refrigerant from directly colliding with the vicinity of the sealing portion even if the refrigerant

blows out from the refrigerant circuit (for example, from the bend portion). This allows the heat pump apparatus 1 to reduce the mass transfer coefficient of the refrigerant permeating into the O-ring 38 (for example, foam rubber).

[0057] Note that the shielding member 60 is not limited to a resin material, and may be made of a foam material such as sponge or urethane, or a film-like material. Further, for example, the shielding member 60 may be attached not only to the partition plate 11 but also to the electrical equipment box 30, the heat exchanger 20, or the like. Alternatively, for example, the shielding member 60 may be provided at a position covering the window cover body 155 or the cable gland 52. In addition, the shielding member 60 may be provided so as to cover the entire machine-side portion 32B of the electrical equipment box body 32 in the circumferential direction.

[0058] The electrical equipment box 30 is disposed so that the upper surface height of the cover member 33 is lower than the upper end height of the heat exchanger 20. The upper surface of the cover member 33 and the lower surface of the top plate 17 of the housing 10 have a space formed therebetween where ventilation is allowed.

[0059] The cover member 33 has a partition member 39 provided on the upper surface thereof, as shown in FIG. 2. The partition member 39 is disposed at the boundary between the blower-side portion 33A and the machine-side portion 33B so as to close the space. In other words, the upper surface 39A of the partition member 39 is in contact with the lower surface of the top plate 17. The partition member 39 has a plurality of openings 100 at equal intervals, which partially allow ventilation between the machine room 13 and the blower room 12.

[1-2. Operation]

[0060] Next, the operation of the heat pump apparatus 1 configured as above is to be described.

[0061] When the heat pump apparatus 1 is driven, the compressor 22 and the blower device 21 are operated, and the axial fan is also started to operate.

[0062] When hot water is used, the refrigerant, which has been compressed by the compressor 22 to have a high-temperature and a high-pressure, flows as indicated by the solid arrows in FIG. 4. Then, the refrigerant is sent to the water heat exchanger 23, and is cooled in the water heat exchanger 23 by exchanging heat with the water flowing through the water supply piping 28. Meanwhile, the water receives the heat of the refrigerant and turns into hot water and is supplied to a predetermined location.

[0063] The refrigerant discharged from the water heat exchanger 23 is depressurized by the expansion device 24, exchanges heat in the heat exchanger 20, is turned into a gas refrigerant, and is returned to the compressor 22 again.

[0064] When cooled water is used, the four-way valve 27 is switched, so that the refrigerant flows as indicated

by the dashed arrows in FIG. 4. Then, the refrigerant exchanges heat with outside air in the heat exchanger 20, is depressurized in the expansion device 24, and is sent to the water heat exchanger 23, to cool the water flowing through the water supply piping 28.

[0065] Operation of the blower device 21 during these operations causes air to flow to the electrical equipment box 30 located in the blower room 12.

[0066] In addition, a space where ventilation is allowed is formed between the lower surface of the top plate 17 of the housing 10 and the upper surface of the cover member 33 of the electrical equipment box 30, so that air also flows through the upper surface of the cover member 33.

[0067] These air flows can cause air to cool the entire surface of the electrical equipment box 30, and can prevent the temperature rise of the electronic components 43 housed inside the electrical equipment box 30.

[0068] The operation of the blower device 21 causes air to flow to the heat sink 41. Thereby, the heat sink 41 can be cooled, and the control board 40 can be cooled via the heat sink 41.

[0069] The machine room 13 houses many connections of refrigerant piping and is separated from the blower device 21. In the heat pump apparatus 1, if the refrigerant leaks in the machine room 13, the refrigerant concentration in the machine room 13 may reach a predetermined value or more.

[0070] In the electrical equipment box 30 of the present embodiment, the electrical equipment box body 32 has a smaller ratio of the volume occupied by the machine-side portion 32B than a ratio of the volume occupied by the blower-side portion 32A.

[0071] This causes the machine-side portion 32B of the electrical equipment box body 32 to have a shorter sealing portion length (the length of the O-ring 38) of the electrical equipment box body 32 and the cover member 33. This allows the heat pump apparatus 1 to reduce the amount of a flammable refrigerant that enters the electrical equipment box 30 from the machine room 13. This then allows the heat pump apparatus 1 to prevent increase in the refrigerant concentration inside the electrical equipment box 30.

[1-3. Effects]

[0072] As described above, the heat pump apparatus 1 of the present embodiment includes, in the housing 10, the machine room 13 in which the compressor 22 and the expansion device 24 are disposed, and a blower room 12 in which the heat exchanger 20 and the blower device 21 are disposed. The heat pump apparatus 1 has an electrical equipment box 30 disposed above the machine room 13 and the blower room 12 across the rooms. The electrical equipment box 30 includes an electrical equipment box body 32 and a cover member 33. The electrical equipment box 30 has a smaller ratio of the volume occupied by the machine-side portion 32B than a ratio of

the volume occupied by the blower-side portion 32A, resulting in a shorter length of the O-ring 38 in the machine-side portion 33B.

[0073] Thereby, the electrical equipment box 30 can have a shorter length of the O-ring 38 between the electrical equipment box body 32 and the cover member 33 in the machine-side portion 32B of the electrical equipment box body 32. This causes the heat pump apparatus 1 to reduce the probability that the flammable refrigerant enters the electrical equipment box 30 from the machine room 13.

[0074] In the present embodiment, the electrical equipment box body 32 may be formed in a trapezoidal or polygonal shape by cutting one or more corners of the machine-side portion 32B, to shorten the sealing portion length of the electrical equipment box body 32 and the cover member 33 in the machine-side portion 32B.

[0075] This causes the machine-side portion 32B of the electrical equipment box body 32 to have a shorter sealing portion length (the length of the O-ring 38) of the electrical equipment box body 32 and the cover member 33. This makes it possible to reduce the area where the O-ring 38 is exposed to the leaked refrigerant at a concentration higher than a predetermined value and to improve long-term durability of the O-ring 38.

[0076] In the present embodiment, the intervals P1 to P3 of the fixing screws 37A to 37D, which fix the machine-side portion 32B of electrical equipment box body 32 and cover member 33, may be set shorter than the intervals P4 to P6 of the fixing screws 37D to 37, which fix the blower-side portion 32A thereof.

[0077] As a result, the machine-side portion 32B has a shorter sealing portion length and shorter intervals P1 to P3 of the fixing screws 37A to 37D. This allows electrical equipment box 30 to have improved sealing performance of the electrical equipment box body 32 and the cover member 33 in the machine-side portion 32B.

[0078] In the present embodiment, the heat exchanger 20 may be formed in an L-shape facing the rear surface 10A and the side surface 10B of the housing 10, and the shielding member 60 may be provided between the header pipe 29A of the heat exchanger facing the rear surface 10A of the housing and the machine-side portion 32B of the electrical equipment box body 32.

[0079] This causes heat pump apparatus 1 to prevent the refrigerant from directly colliding with the vicinity of the sealing portion even if the refrigerant blows out from the refrigerant circuit. This allows the heat pump apparatus 1 to reduce the mass transfer coefficient of the refrigerant permeating into the O-ring 38.

[0080] In the present embodiment, the electrical equipment box body 32 may be made of sheet metal, and the cover member 33 may be made of resin.

[0081] As a result, the electrical equipment box body 32 is made of a material with high thermal conductivity, and the cover member 33 is made of a material with high flexibility and workability. This allows the electrical equipment box 30 to have improved heat dissipation perform-

ance of electrical components such as the control board 40 and to cause the cover member 33 to be formed easily.

(Other Embodiments)

[0082] As described above, Embodiment 1 has been described as an example of the technique disclosed in the present application. However, the techniques in the present disclosure are not limited to this, and can also be applied to embodiments with modifications, replacements, additions, omissions, etc. It is also possible to combine the components described in above-described Embodiment 1 to form a new embodiment.

[0083] In Embodiment 1 described above, the heat pump apparatus 1 is an outdoor unit that can be used for a what is called heat pump hot water heater. However, the heat pump apparatus 1 is not limited to this, and can be applied to any other various apparatuses each having a refrigerant circuit, such as a water heater and an air conditioner.

[0084] Note that the above-described embodiments are for illustrating the techniques in the present disclosure, and various modifications, replacements, additions, omissions, etc. can be made within the scope of the claims or equivalents thereof.

[Configurations Supported by the Above Embodiments]

[0085] The above embodiments support the following configurations.

(Supplement)

[0086] (Technique 1) A heat pump apparatus including a machine room and a blower room each in a housing, the machine room being a room in which a compressor and an expansion device are included, the blower room being a room in which a heat exchanger and a blower are included, wherein an electrical equipment box is disposed above the machine room and the blower room across the rooms, the electrical equipment box includes an electrical equipment box body and a cover member, and the electrical equipment box body has a smaller ratio of a volume occupied by a machine-side portion than a ratio of a volume occupied by a blower-side portion, so that the machine-side portion has a shorter sealing portion length of the electrical equipment box body and the cover member.

[0087] This configuration allows the electrical equipment box to have a shorter length of the O-ring between the electrical equipment box body and the cover member in the machine-side portion of the electrical equipment box body. This allows the heat pump apparatus to reduce the probability that the flammable refrigerant enters the electrical equipment box from the machine room 13.

[0088] (Technique 2) The heat pump apparatus according to Technique 1, wherein the electrical equipment box body is formed in a polygonal shape by cutting one

or more corners of the machine-side portion, so that the machine-side portion has a shorter sealing portion length of the electrical equipment box body and the cover member.

[0089] This configuration sets a shorter sealing portion length (the length of the O-ring) of the electrical equipment box body and the cover member in the machine-side portion of the electrical equipment box body. This makes it possible to reduce the area where the O-ring is exposed to the leaked refrigerant at a concentration higher than a predetermined value and improve the long-term durability of the O-ring.

[0090] (Technique 3) The heat pump apparatus according to Technique 1 or 2, wherein the machine-side portion has a smaller interval of fixing screws than the blower-side portion, the fixing screws fixing the electrical equipment box body and the cover member.

[0091] This configuration causes the machine-side portion to have a shorter sealing portion length and causes the fixing screws to have shorter intervals. This allows the electrical equipment box to have improved sealing performance of the electrical equipment box body and the cover member in the machine-side portion.

[0092] (Technique 4) The heat pump apparatus according to any one of Techniques 1 to 3, wherein the heat exchanger is formed in an L-shape facing a rear surface and a side surface of the housing, and a shielding member is provided between a header pipe of the heat exchanger and the machine-side portion of the electrical equipment box body, the header pipe facing the rear surface of the housing.

[0093] This configuration enables the heat pump apparatus to prevent the refrigerant from directly colliding with the vicinity of the sealing portion even if the refrigerant blows out from the refrigerant circuit. This allows the heat pump apparatus to reduce the mass transfer coefficient of the refrigerant permeating the O-ring.

[0094] (Technique 5) The heat pump apparatus according to any one of Techniques 1 to 3, wherein the electrical equipment box body is made of sheet metal and the cover member is made of resin.

[0095] This configuration causes the electrical equipment box body to be made of a material with high thermal conductivity and causes the cover member to be made of a material with high flexibility and workability. This allows the electrical equipment box to have improved heat dissipation performance of electrical components such as the control board and to cause the cover member to be formed easily.

[0096] The present disclosure can be suitably used for heat pump apparatuses capable of preventing increase in refrigerant concentration around electrical components housed in an electrical equipment box when a refrigerant leaks.

Reference Signs List

[0097]

1 heat pump apparatus
 10 housing
 12 blower room
 13 machine room
 20 heat exchanger 5
 21 blower device (blower)
 22 compressor
 24 expansion device
 30 electrical equipment box
 32 electrical equipment box body 10
 32A blower-side portion
 32B machine-side portion
 33 cover member
 33A blower-side portion
 33B machine-side portion 15
 38 O-ring
 39 partition member

facing a rear surface (10A) and a side surface of the housing, and a shielding member (60) is provided between a header pipe (29A) of the heat exchanger and the machine-side portion of the electrical equipment box body, the header pipe facing the rear surface of the housing.

5. The heat pump apparatus according to claim 1 or 2, wherein the electrical equipment box body is made of sheet metal and the cover member is made of resin.

Claims 20

1. A heat pump apparatus comprising a machine room (13) and a blower room (12) each in a housing (10), the machine room being a room in which a compressor (22) and an expansion device (24) are included, the blower room being a room in which a heat exchanger (20) and a blower (21) are included, 25

characterized in that an electrical equipment box (30) is disposed above the machine room and the blower room across the rooms, the electrical equipment box includes an electrical equipment box body (32) and a cover member (33), and the electrical equipment box body has a smaller ratio of a volume occupied by a machine-side portion (32B) than a ratio of a volume occupied by a blower-side portion (32A), so that the machine-side portion has a shorter sealing portion length of the electrical equipment box body and the cover member. 30 35 40

2. The heat pump apparatus according to claim 1, wherein the electrical equipment box body is formed in a polygonal shape by cutting one or more corners of the machine-side portion, so that the machine-side portion has a shorter sealing portion length of the electrical equipment box body and the cover member. 45

3. The heat pump apparatus according to claim 1 or 2, wherein the machine-side portion has a smaller interval of fixing screws (37A to 37D) than the blower-side portion, the fixing screws fixing the electrical equipment box body and the cover member. 50 55

4. The heat pump apparatus according to claim 1 or 2, wherein the heat exchanger is formed in an L-shape

FIG.1

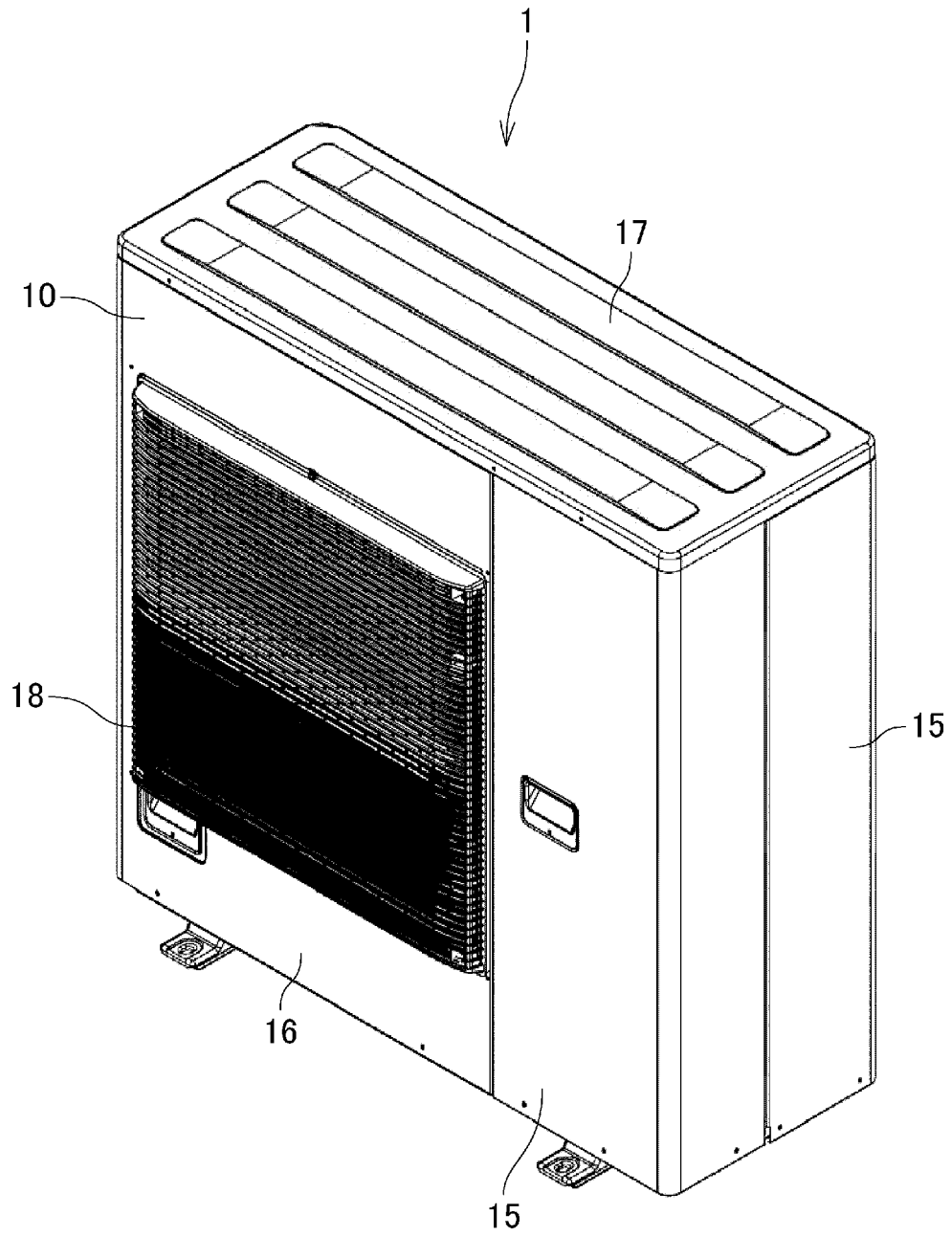


FIG.2

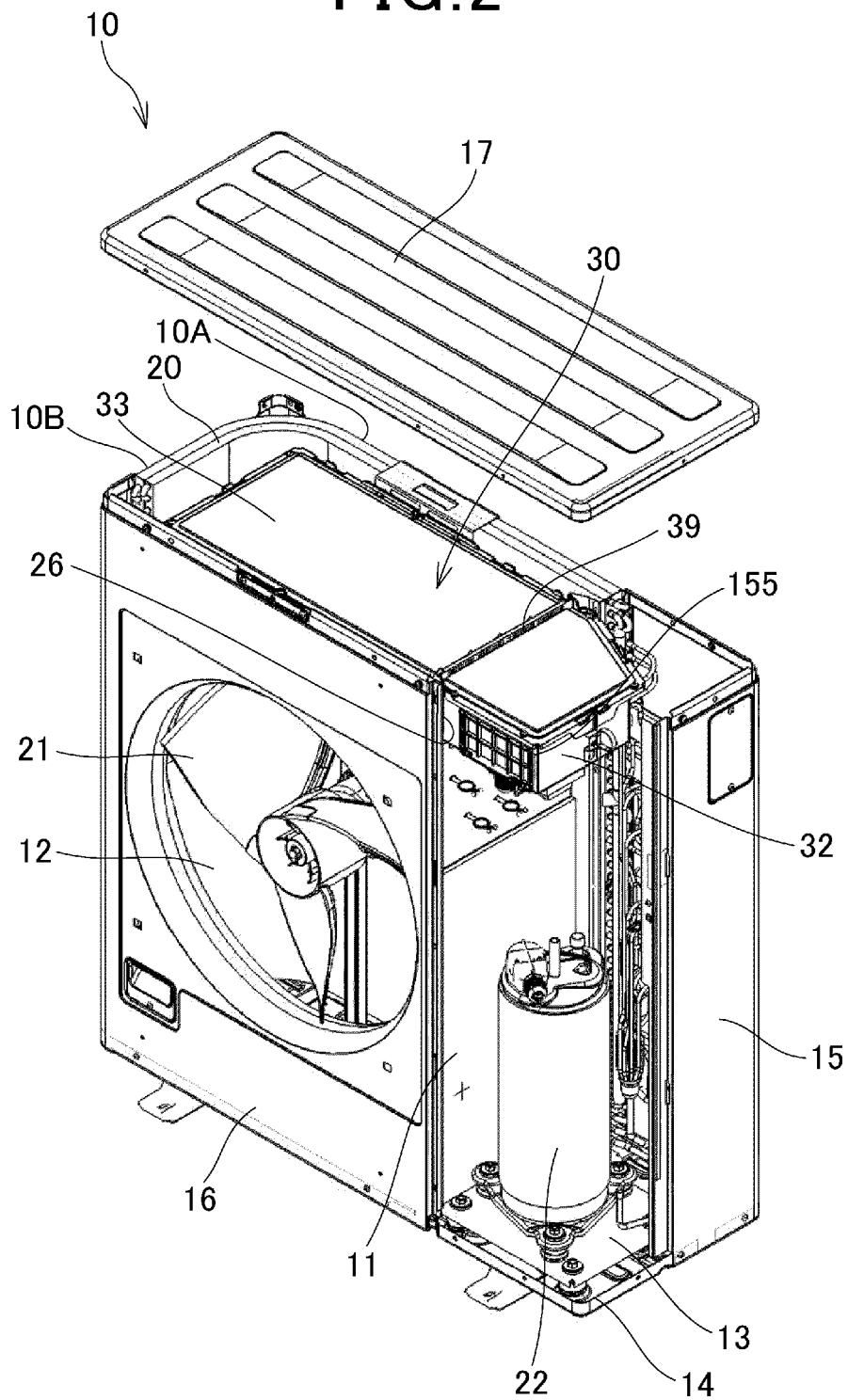


FIG.3

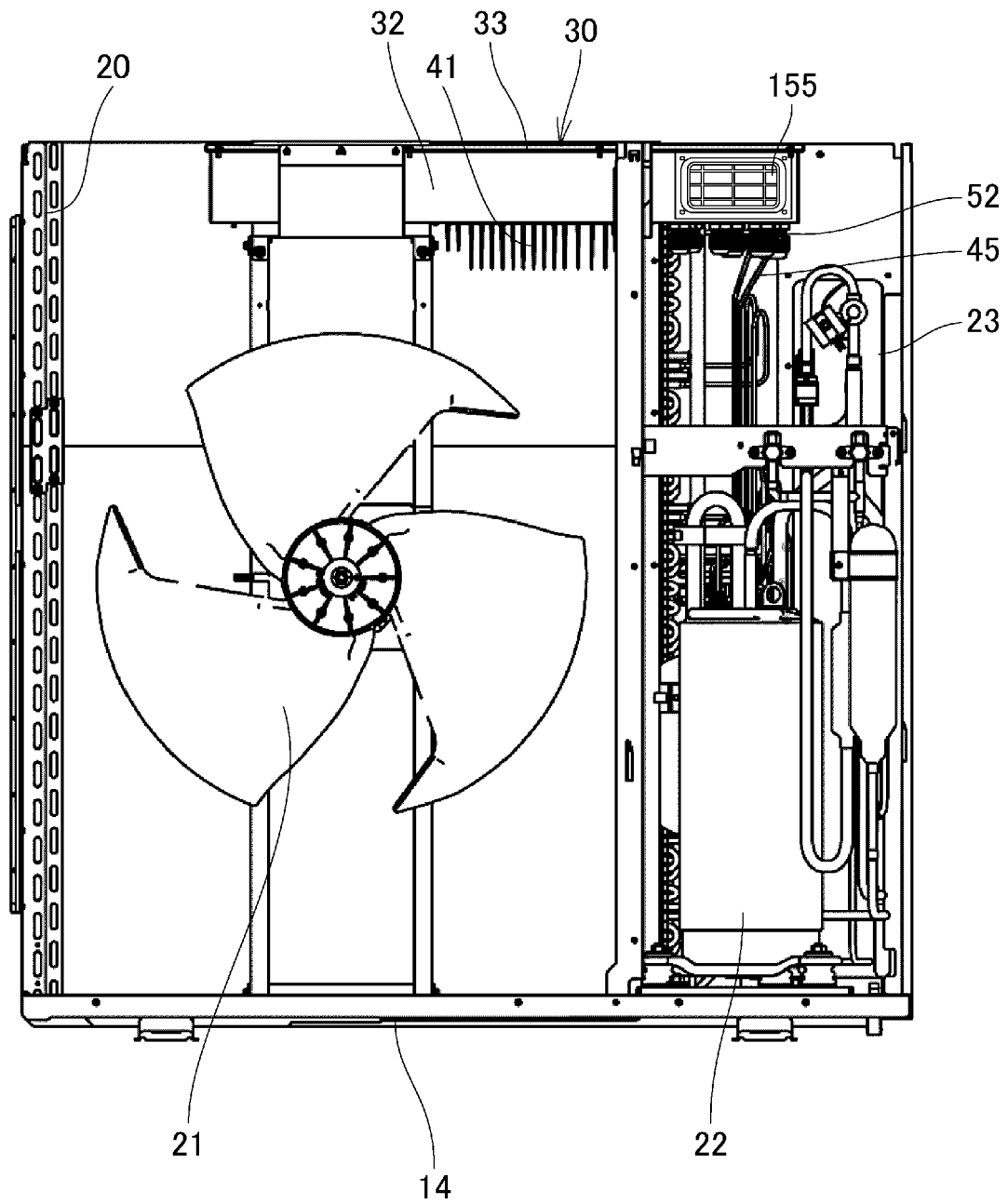


FIG.4

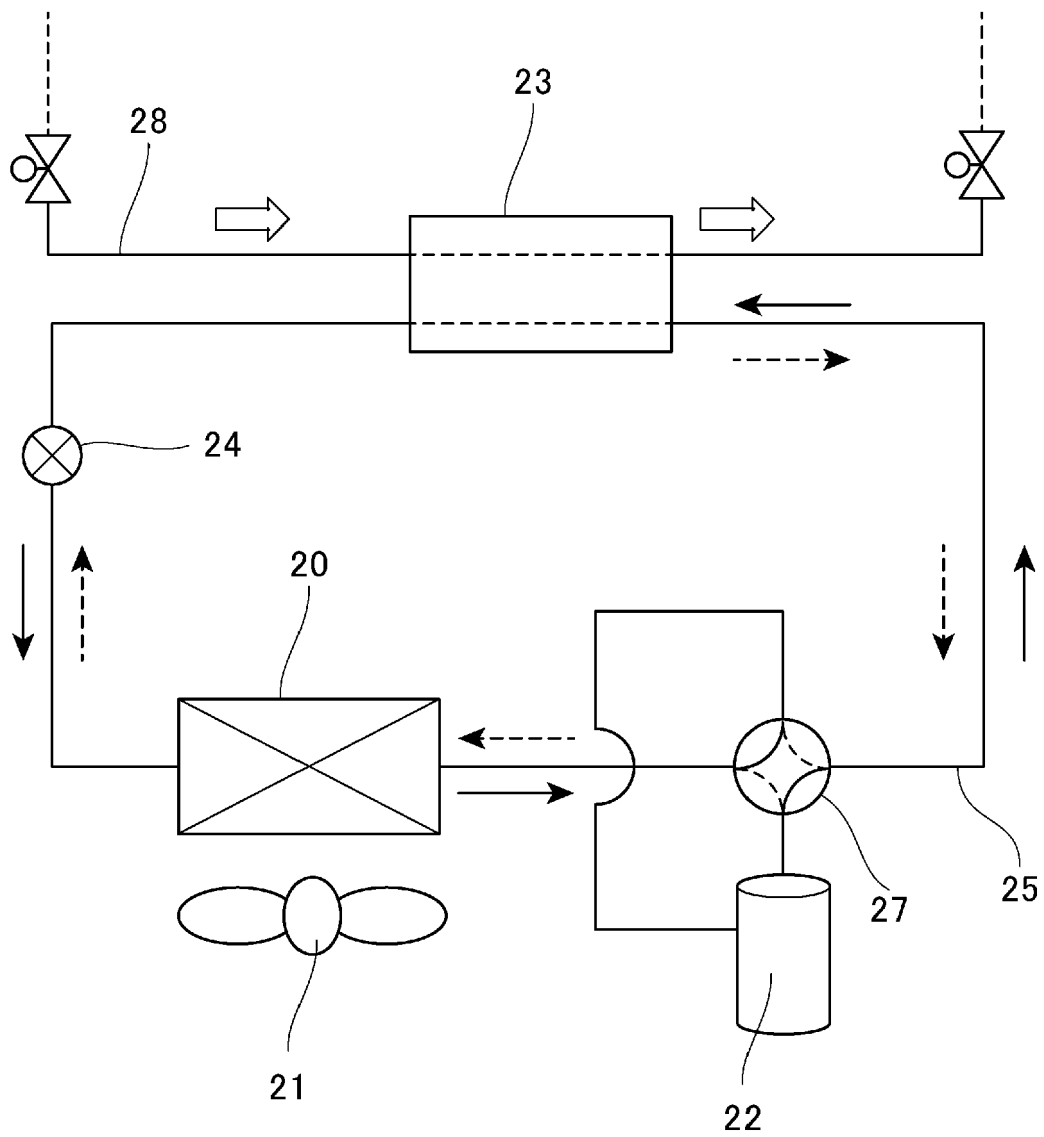


FIG.5

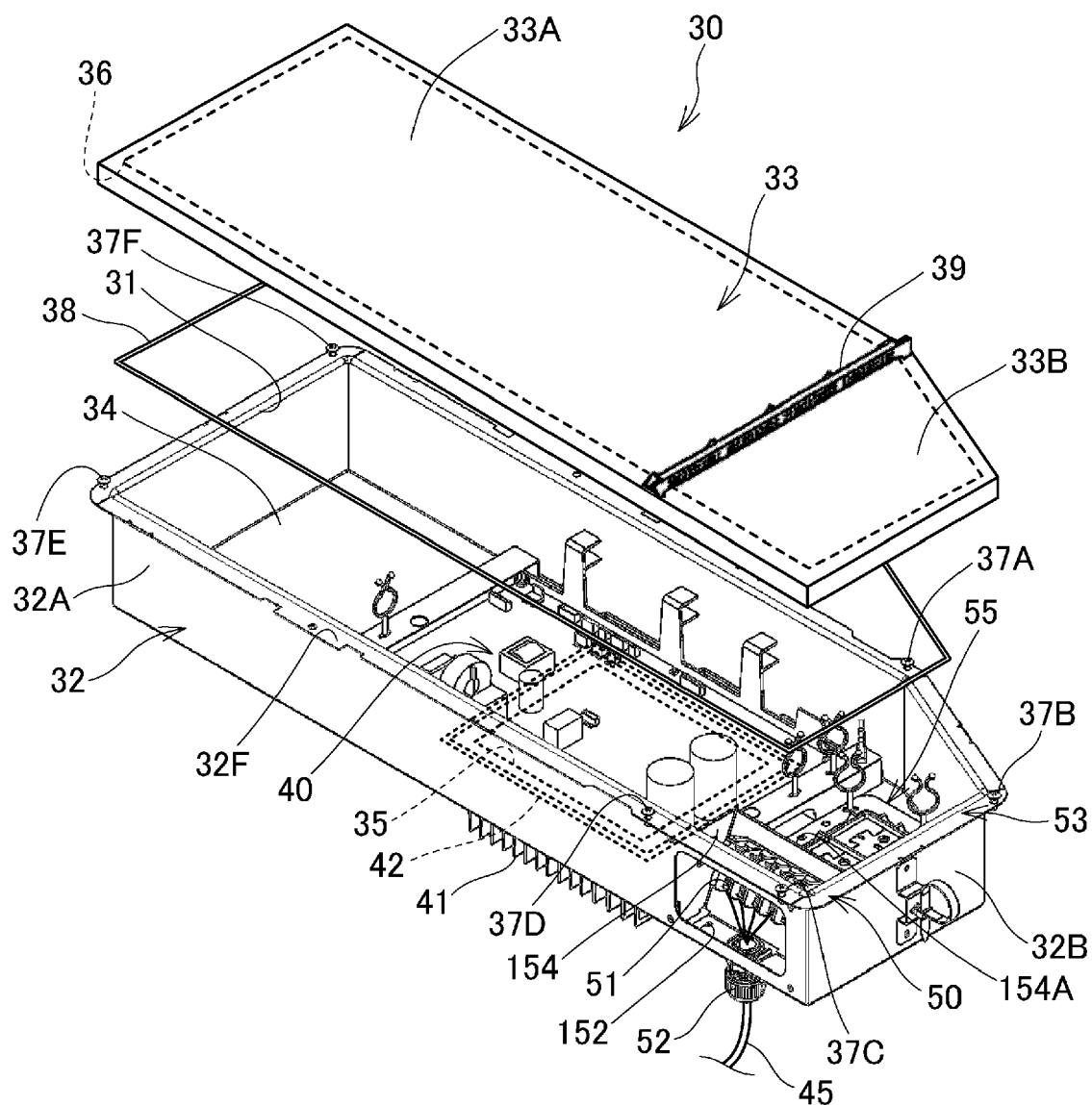


FIG. 6

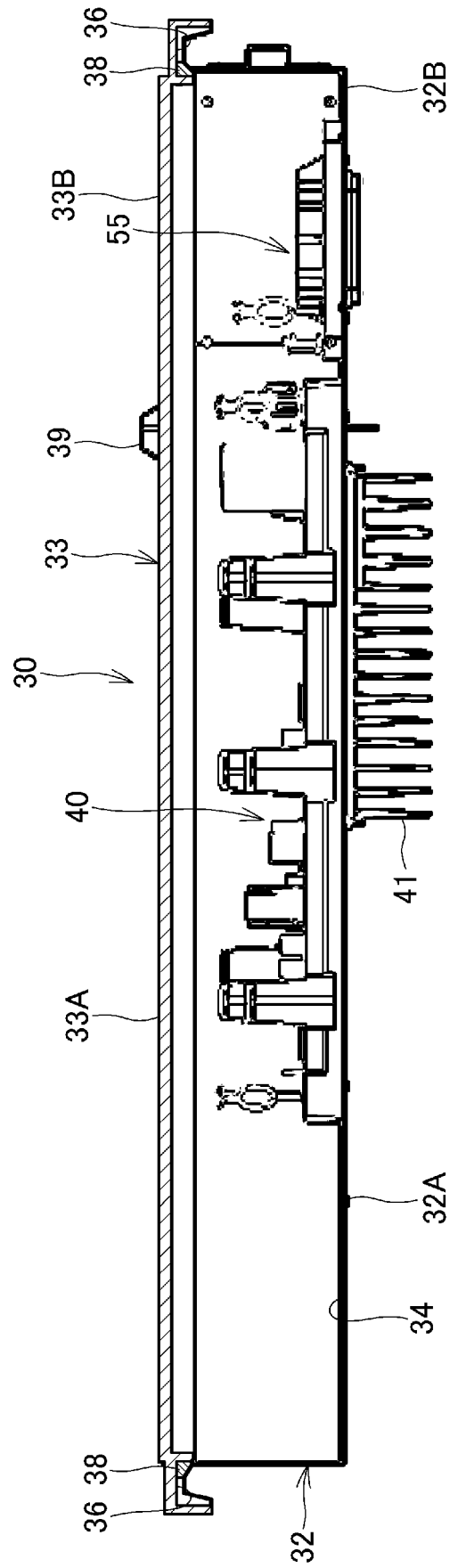


FIG.7

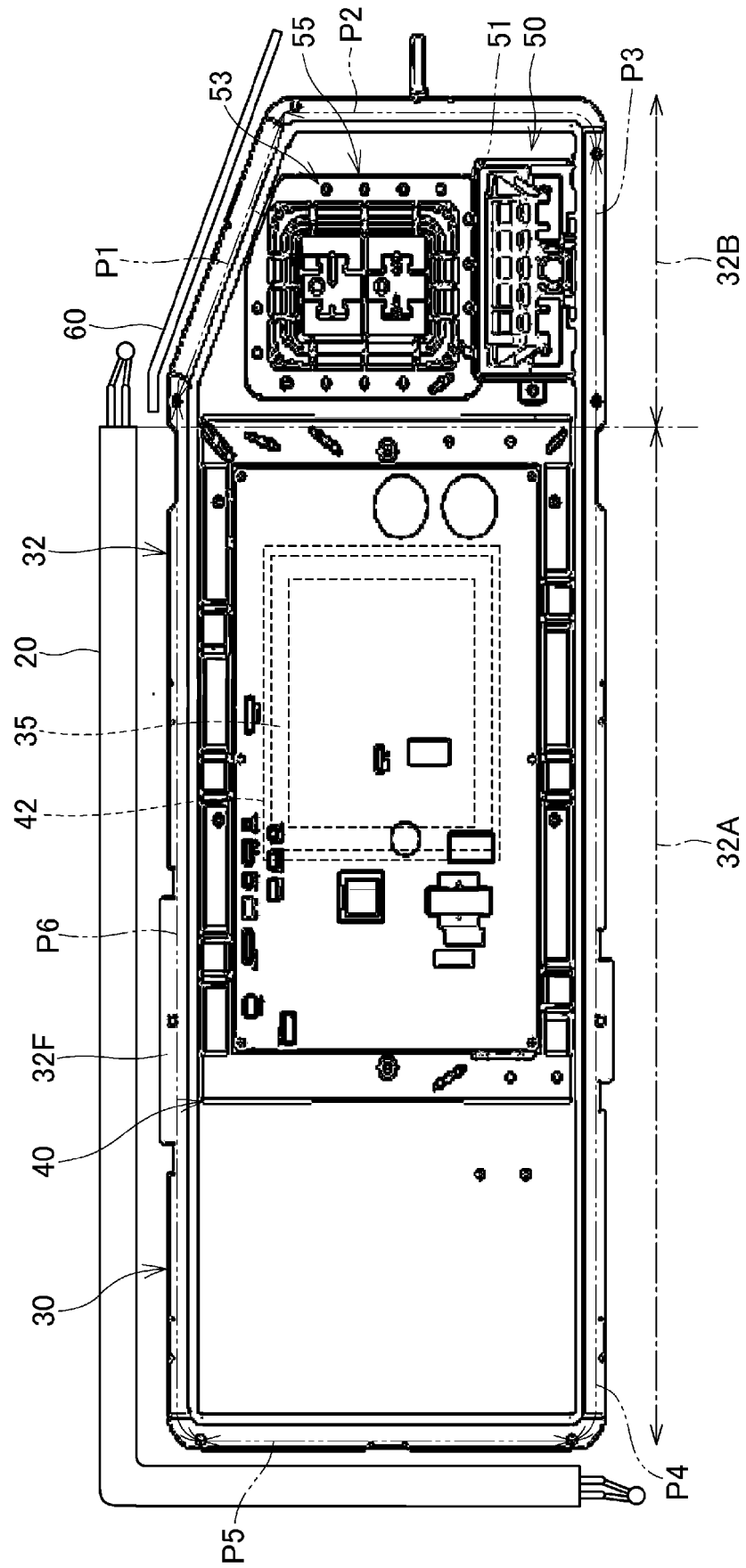
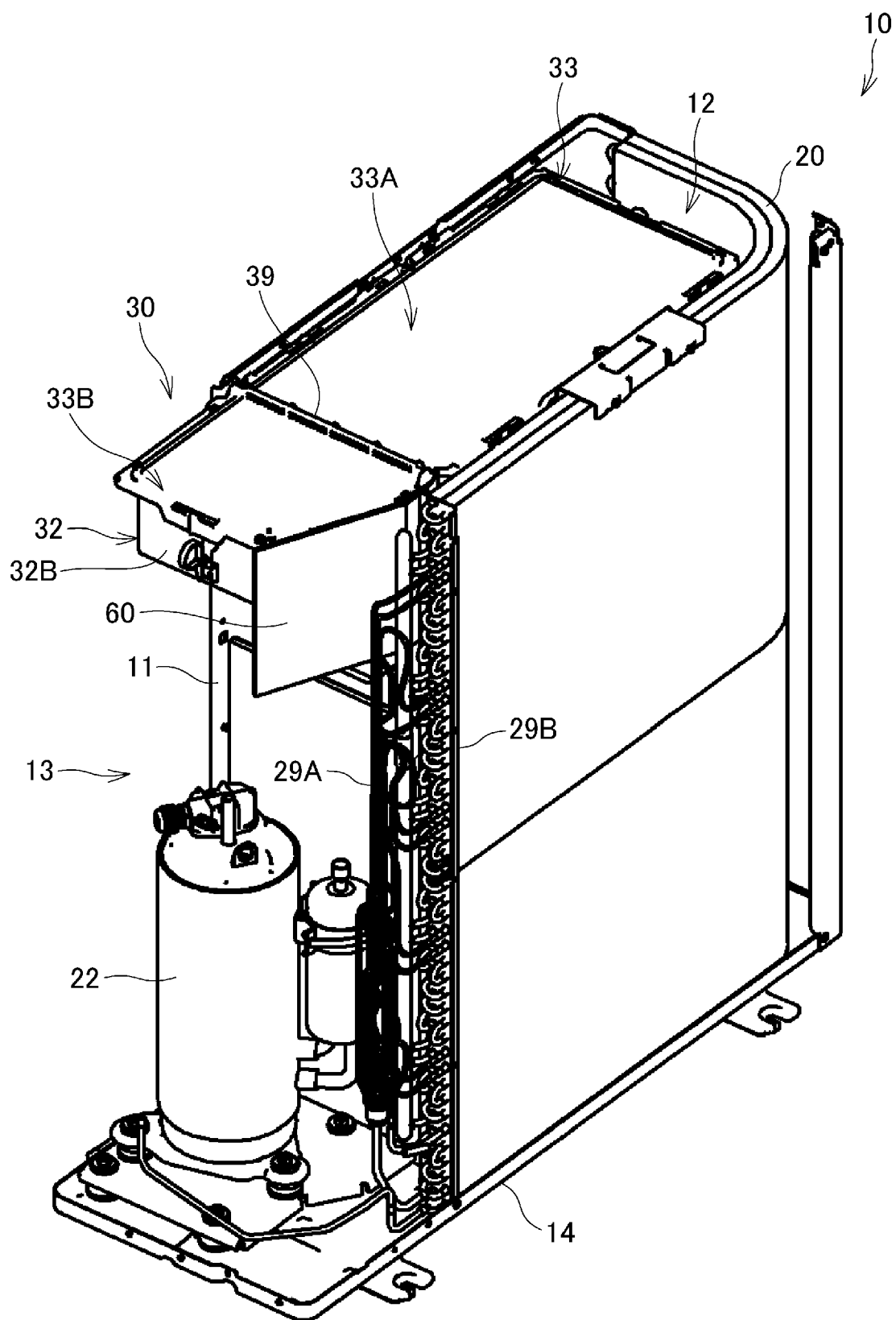


FIG.8





EUROPEAN SEARCH REPORT

Application Number

EP 23 19 9422

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 4 050 976 A1 (QINGDAO HISENSE HITACHI AIR CONDITIONING SYS CO LTD [CN]) 31 August 2022 (2022-08-31) * abstract; figures 1-6 * -----	1-5	INV. F24F1/22 F24F1/46 F24F11/36 F24F11/89 F24F1/24 F24F1/029
X	EP 0 887 598 A1 (MITSUBISHI HEAVY IND LTD [JP]) 30 December 1998 (1998-12-30) * abstract; figures 1-6 * -----	1-5	
Y	JP 5 160998 B2 (CORONA CORP) 13 March 2013 (2013-03-13) * abstract; figures 9-11 * -----	1-5	
Y	JP 4 660130 B2 (SANYO ELECTRIC CO; SANYO AIR CONDITIONERS KK) 30 March 2011 (2011-03-30) * abstract; figures 1-4 * -----	1-5	
Y	JP 6 828701 B2 (DAIKIN IND LTD) 10 February 2021 (2021-02-10) * abstract; figures 4-16 * -----	1-5	TECHNICAL FIELDS SEARCHED (IPC)
A,D	EP 3 312 531 A1 (MITSUBISHI ELECTRIC CORP [JP]) 25 April 2018 (2018-04-25) * abstract * -----	1-5	F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 January 2024	Examiner Valenza, Davide
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 19 9422

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 4050976	A1	31-08-2022	CN	112702884 A	23-04-2021
			CN	117006735 A	07-11-2023
			EP	4050976 A1	31-08-2022
			WO	2021077802 A1	29-04-2021

EP 0887598	A1	30-12-1998	EP	0887598 A1	30-12-1998
			ES	2206669 T3	16-05-2004

JP 5160998	B2	13-03-2013	JP	5160998 B2	13-03-2013
			JP	2010038514 A	18-02-2010

JP 4660130	B2	30-03-2011	CN	1603703 A	06-04-2005
			JP	4660130 B2	30-03-2011
			JP	2005127691 A	19-05-2005
			KR	20050031933 A	06-04-2005

JP 6828701	B2	10-02-2021	JP	6828701 B2	10-02-2021
			JP	2019148363 A	05-09-2019

EP 3312531	A1	25-04-2018	CN	109661546 A	19-04-2019
			EP	3312531 A1	25-04-2018
			JP	6671484 B2	25-03-2020
			JP WO	2018047265 A1	04-04-2019
			US	2019264964 A1	29-08-2019
			WO	2018047265 A1	15-03-2018

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

- EP 3312531 A [0002]