(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 345 388 A1**

(12) EUROPEAN PATENT APPLICATION

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

(21) Application number: **23199807.1**

(22) Date of filing: **26.09.2023**

(51) International Patent Classification (IPC):
F24F 1/22 *(2011.01)* ***F24F 1/46*** *(2011.01)*
F24F 11/88 *(2018.01)* ***F24F 11/89*** *(2018.01)*

(52) Cooperative Patent Classification (CPC):
F24F 1/22; F24F 1/46; F24F 11/88; 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 2022158738**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka 571-0057 (JP)

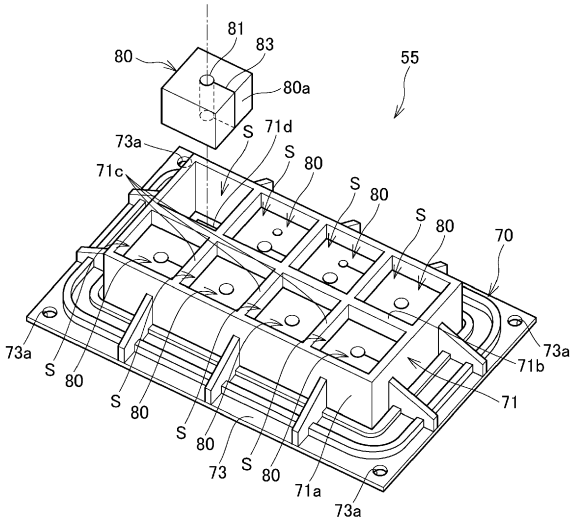
(72) Inventors:
- **Kitagaki, Masaomi**
  Osaka, 571-0057 (JP)
- **Tsuru, Kakeru**
  Osaka, 571-0057 (JP)
- **Kobayashi, Tatuhiro**
  Osaka, 571-0057 (JP)
- **Matsunami, Yohei**
  Osaka, 571-0057 (JP)
- **Aoyama, Shigeo**
  Osaka, 571-0057 (JP)
- **Nagai, Masaaki**
  Osaka, 571-0057 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(54) HEAT PUMP APPARATUS

(57) The present disclosure provides a heat pump apparatus capable of preventing a refrigerant from entering an electrical equipment box when the refrigerant leaks from a refrigerant circuit. 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 disposed, the blower room being a room in which a heat exchanger and a blower device are disposed, the heat pump apparatus including an electrical equipment box, wherein the electrical equipment box includes an electrical equipment box body and a cover member, the electrical equipment box body having a through opening, the through opening is provided with a lead wire relay module that draws in a plurality of lead wires, and the lead wire relay module includes a fixing frame and sleeves for insertion, the fixing frame having a plurality of insertion openings, the sleeves for insertion being inserted into the respective insertion openings, the sleeves for insertion thereby coming into close contact with the fixing frame so as to seal and hold the lead wires to be drawn into the electrical equipment box body.

FIG.8



EP 4 345 388 A1

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 heat medium circuit that causes a heat medium to flow; a heat medium heat exchanger that exchanges heat between the refrigerant and the heat medium; an outdoor unit that houses the refrigerant circuit and the heat medium heat exchanger; and an indoor unit that houses part of the heat medium circuit, in which: the outdoor unit has at least one of the pressure relief valve and the air vent valve provided in the heat medium circuit as a refrigerant release valve; and the refrigerant release valve is provided outside the housing of the outdoor unit.

[0003] The present disclosure provides a heat pump apparatus capable of preventing a refrigerant from entering an electrical equipment box when the refrigerant leaks from a refrigerant circuit.

SUMMARY OF THE INVENTION

[0004] A heat pump apparatus 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 disposed, the blower room being a room in which a heat exchanger and a blower device are disposed, and the heat pump apparatus includes an electrical equipment box, wherein the electrical equipment box includes an electrical equipment box body and a cover member, the electrical equipment box body having a through opening, the through opening is provided with a lead wire relay module that draws in a plurality of lead wires, and the lead wire relay module includes a fixing frame and sleeves for insertion, the fixing frame having a plurality of insertion openings, the sleeves for insertion being inserted into the respective insertion openings, the sleeves for insertion thereby coming into close contact with the fixing frame so as to seal and hold lead wires to be drawn into the electrical equipment box body.

[0005] The present disclosure makes it possible to prevent the 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 a 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;
FIG. 8 is a perspective view of a lead wire relay module of Embodiment 1;
FIG. 9 is a cross-sectional view of the lead wire relay module of Embodiment 1;
and
FIG. 10 is a bottom view of lead wire relay module of 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 the flammable refrigerant; a heat medium circuit that causes a heat medium to flow; a heat medium heat exchanger that exchanges heat between the refrigerant and the heat medium; an outdoor unit that houses the refrigerant circuit and the heat medium heat exchanger; and an indoor unit that houses part of the heat medium circuit. The outdoor unit has at least one of a pressure relief valve and an air vent valve provided in the heat medium circuit as a refrigerant release valve, and the refrigerant release valve is provided outside the housing of the outdoor unit.

[0009] The above heat pump apparatus is further provided with a machine room in the outdoor unit. The machine room is provided with devices such as a compressor and a heat medium heat exchanger that form a refrigerant circuit, and an electrical component box that is an electrical equipment box that houses electrical components. The electrical components in the electrical component box are electrically connected to various devices in the machine room by lead wires.

[0010] However, the inventors have found a problem with such a configuration that, if the refrigerant leaks from the refrigerant circuit, the refrigerant may fill the machine room and may enter the electrical equipment box through a part where the lead wires are drawn into the electrical equipment box, and have come to constitute the subject

of the present disclosure to solve the problem.

[0011] Therefore, the present disclosure provides a heat pump apparatus capable of preventing a refrigerant from entering an electrical equipment box when the refrigerant leaks from a refrigerant circuit.

[0012] 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.

[0013] 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)

[0014] Embodiment 1 is to be described below with reference to the drawings.

[1-1. Configuration]

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

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] The front panel 16 is provided with a ventilation portion 18 that is formed like a mesh and allows air to pass through.

[0021] The blower room 12 has a heat exchanger 20 and a blower device 21.

[0022] 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.

[0023] The heat exchanger 20 to be used is, for example, a fin-tube heat exchanger.

[0024] 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.

[0025] 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.

[0026] The water heat exchanger 23 to be used is, for example, a plate heat exchanger.

[0027] 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]

[0028] FIG. 4 is a circuit diagram showing a refrigerant circuit according to Embodiment 1.

[0029] 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.

[0030] 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.

[0031] 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 (not shown).

[0032] 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.

[0033] 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 (not shown).

[0034] 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.

[0035] 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]

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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, and a substantially trapezoidal machine-side portion 32B located on the side of the machine room 13. The cover member 33 includes a rectangular blower-side portion 33A located on the side of the blower room 12 and a substantially trapezoidal machine-side portion 33B located on the side of the machine room 13.

[0040] The blower-side portion 32A of the electrical equipment box body 32 is provided with a control board 40 made of a printed wiring board.

[0041] 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.

[0042] The lower surface of the control board 40 is provided with a heat sink 41 including a plurality of fins, and the control board 40 is installed so as to protrude 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] In the electrical equipment box body 32, the ra-

tio of the volume occupied by the machine-side portion 32B is smaller than the 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 into a trapezoidal shape by cutting a corner of the machine-side portion 32B.

[0049] 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.

[0050] 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.

[0051] The heat exchanger 20 is formed in an L-shape facing the rear surface 10A and the side surface 10B of the housing 10. There is a shielding member 60 provided between the header pipe of the heat exchanger 20 facing the rear surface 10A of the housing 10 and the machine-side portion 32B of the electrical equipment box body 32, as shown in FIG. 7. The shielding member 60 is thus provided in the vicinity of the sealing portion of the machine-side portion 32B near the header pipe, 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 can reduce the mass transfer coefficient of the refrigerant permeating into the O-ring 38.

[0052] As shown in FIG. 3, 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. As shown in FIG. 2, the upper surface of the cover member 33 is provided with a partition member 39. 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. The partition member 39 has a plurality of openings (not shown) at equal intervals, which allows ventilation between the machine room 13 and the blower room 12.

[0053] During operation of the heat pump apparatus 1, the inside of the blower room 12 has a negative pressure due to operation of the blower device 21. As a result, the air on the side of the machine room 13 flows to the side of the blower room 12 through the plurality of openings of the partition member 39. The air flow causes the air to cool the entire upper surface of the cover member 33.

[1-1-4. Configuration of Lead Wire Relay Module]

[0054] As shown in FIGS. 5 to 7, the lead wire relay portion 53 has an electrical-equipment-box bottom surface 34 having a through opening 34a. The through opening 34a is a hole communicating between the inside and the outside of the electrical equipment box 30, and has a substantially rectangular shape in plan view. The through opening 34a is covered with the lead wire relay module 55 from above, that is, from the inside of the electrical equipment box 30.

[0055] FIG. 8 is a perspective view of the lead wire relay module 55. The lead wire relay module 55 is a module that draws a plurality of lead wires, which connect the control board 40 and various devices such as the compressor 22, into the electrical equipment box. The lead wire relay module 55 has a fixing frame 70 fixed to the electrical-equipment-box bottom surface 34 and sleeves for insertion 80 to be inserted into the fixing frame 70. The lead wire relay module 55 brings sleeves for insertion 80 into close contact with lead wires, to seal and hold the lead wires, thereby preventing the refrigerant from entering the electrical equipment box 30.

[0056] The fixing frame 70 is a frame made of resin and has a substantially rectangular shape in plan view. The fixing frame 70 has a frame portion 71 and a flange portion 73.

[0057] The frame portion 71 is provided in the center of the fixing frame 70 and is a portion into which the sleeves for insertion 80 are inserted. The frame portion 71 has an outer frame portion 71a that is erected upward and is a rectangular tubular portion in plan view, a plate-shaped partition plate portion 71b that divides the outer frame portion 71a into two in the left-right direction, and a partition plate portion 71c that divides the outer frame portion 71a into four in the front-rear direction. The outer frame portion 71a and the partition plate portions 71b, 71c surround eight areas that respectively have eight insertion openings S penetrating through the fixing frame 70 in the up-down direction. The upper end of the insertion openings S open into the electrical equipment box 30, and the lower end thereof communicates with the through opening 34a. The outer frame portion 71a and the partition plate portions 71b, 71c have lower ends having edges 71d each protruding toward the insertion opening S.

[0058] The flange portion 73 is a plate-shaped portion that surrounds the frame portion 71 and has fixing holes 73a for screwing. The flange portion 73 is screwed on the electrical-equipment-box bottom surface 34, so that the fixing frame 70 is fixed to the electrical equipment box 30.

[0059] The sleeves for insertion 80 are sleeves made of rubber, and are respectively disposed for the eight insertion openings S of the frame portion 71. Each sleeve for insertion 80 has a hole 81 penetrating the sleeve for insertion 80 in the up-down direction and a slit 83 that causes a side surface 80a to communicate with the hole 81. Each hole 81 is a portion of sleeve for insertion 80 that seals and holds a lead wire. The eight sleeves for insertion 80 each have a hole 81 that has a cross-sec-

tional shape that matches the cross-sectional shape of the lead wire to be held. The slit 83 is formed through the sleeve for insertion 80 in the up-down direction. Therefore, the sleeve for insertion 80 can hold the intermediate part of the lead wire in the hole 81 with the slit 83.

[0060] FIG. 9 is a cross-sectional view of the lead wire relay module 55.

[0061] As shown in FIG. 9, the sleeve for insertion 80 is inserted downward into the insertion opening S, and is fitted into the fixing frame 70 with the lower end in contact with the edge 71d.

[0062] The side surfaces (outer circumferential portion) 80a of each sleeve for insertion 80 incline so as to narrow from the upper side to the lower side. In other words, the sleeve for insertion 80 has a tapered structure that narrows in the insertion direction of the sleeve for insertion 80. Therefore, the cross-sectional area of the sleeve for insertion 80 decreases in the insertion direction of the sleeve for insertion 80. In the fixing frame 70, the inner side surfaces 71e of the outer frame portion 71a and the partition plate portions 71b, 71c, each of which faces each insertion opening S, has a tapered structure that inclines along the side surfaces 80a of the sleeve for insertion 80. As a result, the insertion opening S narrows in the insertion direction of the sleeve for insertion 80. Therefore, when the sleeve for insertion 80 is inserted into the insertion opening S and is then pushed in the insertion direction, the side surfaces 80a are pushed inward by the inner side surfaces 71e of the outer frame portion 71a and the partition plate portions 71b, 71c. As a result, the sleeve for insertion 80 is horizontally compressed, so that the inner surface of the hole 81 easily comes into close contact with the lead wire. In addition, surface pressure is applied between the side surfaces 80a of the sleeve for insertion 80 and the inner side surfaces 71e of the outer frame portion 71a and the partition plate portions 71b, 71c, so that the side surfaces 80a come into closer contact with the inner side surfaces 71e.

[0063] As shown in FIG. 9, the fixing frame 70 has a guide portion 76 that is inserted into the through opening 34a. The guide portion 76 is a tubular portion that is formed to have substantially the same shape as the inner circumferential edge of the through opening 34a in plan view and protrudes downward. The guide portion 76 is formed at a position surrounding the frame portion 71 in plan view. Therefore, when the guide portion 76 is inserted into the through opening 34a downward from above, the frame portion 71 is positioned at a position overlaying the through opening 34a from above. As a result, the insertion openings S in the frame portion 71 communicates with the through opening 34a, and a lead wires can be routed inside and outside the electrical equipment box 30.

[0064] FIG. 10 is a bottom view of the lead wire relay module 55. As shown in FIGS. 9 and 10, an O-ring groove 77 recessed upward is formed outside the guide portion 76 at the lower end of the fixing frame 70. The inner circumferential side surface of the O-ring groove 77 is formed along the outer surface of the guide portion 76.

[0065] The O-ring groove 77 has a rubber O-ring 77a disposed therein. The O-ring 77a is positioned at a position surrounding the through opening 34a by the guide portion 76 inserted into the through opening 34a downward from above. The O-ring 77a is fixed to the electrical-equipment-box bottom surface 34 of the fixing frame 70, to be squashed between the O-ring groove 77 and the electrical-equipment-box bottom surface 34, which closes the gap between the fixing frame 70 and the electrical-equipment-box bottom surface 34. This makes it difficult for the refrigerant to enter the electrical equipment box 30 through the gap between the fixing frame 70 and the electrical-equipment-box bottom surface 34.

[0066] In addition, the rubber used for the O-ring 77a is chloroprene rubber, which has a particularly low permeability to propane contained in the refrigerant. Therefore, the refrigerant is less likely to enter the electrical equipment box 30.

[0067] Further, the chloroprene rubber used for the O-ring 77a is foam rubber made through foaming. Therefore, when the O-ring 77a is squashed, the O-ring 77a is easily deformed along the O-ring groove 77 and the electrical-equipment-box bottom surface 34, and can come into closer contact with the O-ring groove 77 and the electrical-equipment-box bottom surface 34. In addition, the O-ring 77a, which is made of foam rubber, easily fits in the O-ring groove 77 when squashed if the cross-sectional area of the O-ring 77a is increased. Therefore, in the present embodiment, the cross section of the O-ring 77a is set to a size that protrudes downward from the O-ring groove 77, increasing the force of close contact.

[0068] Also, the length of the O-ring 77a is set shorter than the length of the O-ring groove 77. Specifically, the length of the inner circumference of the O-ring 77a is shorter than the length of the inner circumference of the O-ring groove 77 when the O-ring 77a is not stretched. Therefore, the inner circumference of the O-ring 77a placed in the O-ring groove 77 comes into close contact with the side surface of the inner circumference of the O-ring groove 77, so that a gap is less likely to occur between the O-ring 77a and the O-ring groove 77.

[1-2. Operation]

[0069] Next, the operation of the heat pump apparatus 1 configured as above is to be described.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] 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.

[0074] 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.

[0075] 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.

[0076] 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 housed inside the electrical equipment box 30.

[0077] Also, the operation of the blower device 21 causes the air to flow to the heat sink 41. Thereby, the heat sink 41 can be cooled, and the control board 40 can be cooled.

[1-3. Effects]

[0078] As described above, in the present embodiment, the heat pump apparatus 1 includes an electrical equipment box 30; the electrical equipment box 30 includes an electrical equipment box body 32 having a through opening 34a, and a cover member 33; the through opening 34a is provided with a lead wire relay module 55 for drawing in a plurality of lead wires; and the lead wire relay module 55 includes: a fixing frame 70 having a plurality of insertion openings S; and sleeves for insertion 80 that are inserted into the respective insertion openings S, come into close contact with the fixing frame 70, and seal and hold the lead wires drawn into the electrical equipment box body 32.

[0079] This makes it possible to improve the airtightness while the lead wires are drawn into the electrical equipment box 30.

[0080] Further, in the present embodiment, the fixing frame 70 and each sleeve for insertion 80 have a tapered structure that brings the side surfaces 80a of the sleeve for insertion 80 into closer contact with the fixing frame 70 as the sleeve for insertion 80 is inserted into the fixing frame 70.

[0081] Thereby, the sleeve for insertion 80 can come into closer contact with the fixing frame 70.

[0082] Further, in the present embodiment, the fixing frame 70 is made of resin, includes an O-ring groove 77 into which an O-ring 77a is inserted, and is fixed to the through opening 34a of the electrical equipment box body 32 with the O-ring 77a interposed therebetween.

[0083] Thereby, the airtightness between the fixing frame 70 and the electrical equipment box body 32 can be improved.

[0084] Also, in the present embodiment, the O-ring 77a is made of foam rubber.

[0085] This allows the O-ring 77a to easily come into close contact with the O-ring groove 77 and the electrical equipment box body 32 to improve the airtightness between the fixing frame 70 and the electrical equipment box body 32.

[0086] Also, in the present embodiment, the O-ring 77a is made of chloroprene rubber.

[0087] This makes it difficult for a flammable refrigerant such as propane gas to permeate the O-ring 77a. Therefore, the refrigerant is less likely to enter the electrical equipment box 30.

[0088] In the present embodiment, the length of the O-ring 77a is set shorter than the length of the O-ring groove 77.

[0089] Thereby, the O-ring 77a is inserted into the O-ring groove 77 in a stretched state. Therefore, the O-ring 77a is not loosened and can easily come into close contact with the O-ring groove 77, so that the refrigerant can be prevented from entering the electrical equipment box 30.

[0090] In the present embodiment, the electrical equipment box 30 is disposed above the machine room 13 and the blower room 12 across the machine room 13 and the blower room 12.

[0091] As a result, the portion of the electrical equipment box 30 located on the blower room 12 is easily cooled by the blown air, and the lead wires extending from devices in the machine room 13 can be drawn into the electrical equipment box 30 via the lead wire relay module 55.

(Other Embodiments)

[0092] 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.

[0093] Here, other embodiments are to be illustrated below.

[0094] 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.

[0095] In the above-described embodiment, the O-ring 77a is made of foamed chloroprene rubber, but this is just an example. For example, the O-ring 77a may be made of rubber other than chloroprene rubber, and does not have to be foamed. However, when foamed chloroprene rubber is used for the O-ring 77a as in the present embodiment, the O-ring 77a easily comes into close contact with the O-ring groove 77 and the electrical equipment box body 32 and does not cause propane to easily pass therethrough.

[0096] In the above-described embodiment, eight insertion openings S and eight sleeves for insertion 80 are provided in the lead wire relay module 55, but this is just an example. It is just needed that there are provided one or more insertion openings S and sleeves for insertion 80. Also, there is no limit to the number of the holes 81 that one sleeve for insertion 80 has. Furthermore, a configuration may be such that two or more lead wires are sealed and held in one hole 81.

[0097] 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]

[0098] The above embodiments support the following configurations.

(Supplement)

(Technique 1)

[0099] 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 disposed, the blower room being a room in which a heat exchanger and a blower device are disposed, the heat pump apparatus including an electrical equipment box, wherein the electrical equipment box includes an electrical equipment box body and a cover member, the electrical equipment box body having a through opening, the through opening is provided with a lead wire relay module that draws in a plurality of lead wires, and the lead wire relay module includes a fixing frame and sleeves for insertion, the fixing frame having a plurality of insertion openings, the sleeves for insertion being inserted into the respective insertion openings, the sleeves for insertion thereby coming into close contact with the fixing frame so as to seal and hold lead wires to be drawn into the electrical equipment box body.

[0100] This configuration makes it possible to improve the airtightness of the electrical equipment box while drawing the lead wires into the electrical equipment box.

(Technique 2)

[0101] The heat pump apparatus according to Technique 1, wherein the fixing frame and each sleeve for insertion have a tapered structure that brings an outer circumferential portion of each sleeve for insertion into closer contact with the fixing frame as the sleeve for insertion is inserted into the fixing frame.

[0102] This configuration makes it possible to bring the sleeve for insertion into closer contact with the fixing frame.

(Technique 3)

[0103] The heat pump apparatus according to Technique 1 or 2, wherein the fixing frame is made of resin, has an O-ring groove into which an O-ring is inserted, and is fixed to the through opening of the electrical equipment box body with the O-ring interposed therebetween.

[0104] This configuration makes it possible to improve the airtightness between the fixing frame and the electrical equipment box body.

(Technique 4)

[0105] The heat pump apparatus according to Technique 3, wherein the O-ring is foam rubber.

[0106] This configuration allows O-ring to easily to come into close contact with the O-ring groove and the electrical equipment box body, thereby improving the airtightness between the fixing frame and the electrical equipment box body.

(Technique 5)

[0107] The heat pump apparatus according to Technique 3 or 4, wherein the O-ring is chloroprene rubber.

[0108] This configuration prevents a flammable refrigerant such as propane gas from easily permeating the O-ring. Therefore, the refrigerant is less likely to enter the electrical equipment box.

(Technique 6)

[0109] The heat pump apparatus according to any of Techniques 3 to 5, wherein a length of the O-ring is set shorter than a length of the O-ring groove.

[0110] This configuration allows the O-ring to be prevented from loosening and to easily come into close contact with the O-ring groove, thereby preventing the refrigerant from entering the electrical equipment box.

(Technique 7)

[0111] The heat pump apparatus according to any of Techniques 1 to 6, wherein the electrical equipment box is disposed above the machine room and the blower room across the machine room and the blower room.

[0112] This configuration allows the electrical equipment box to be cooled easily in a part located above the blower room by the blown air and to draw the lead wires extending from devices in the machine room into the electrical equipment box via the lead wire relay module.

[0113] 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

1 heat pump apparatus
10 housing
11 partition plate
12 blower room
13 machine room
14 bottom plate
15 side panel
16 front panel
17 top plate
18 ventilation portion
20 heat exchanger
21 blower device
22 compressor
23 water heat exchanger
24 expansion device
25 refrigerant piping
26 cutout portion
27 four-way valve
28 water supply piping
30 electrical equipment box
31 opening
32 electrical equipment box body
33 cover member
34 electrical-equipment-box bottom surface
34a through opening
35 bottom surface opening
36 O-ring groove
38 O-ring
39 partition member
40 control board
41 heat sink
42 sealing material
45 cable
50 power line relay portion
51 terminal block
52 cable gland
53 lead wire relay portion
55 lead wire relay module
60 shielding member
70 fixing frame
71 frame portion
71d edge
71e inner side surface
73 flange portion
73a fixing hole
76 guide portion
77 O-ring groove
77a O-ring
80 sleeve for insertion
80a side surface (outer circumferential portion)
81 hole
83 slit
152 window opening
154 partition plate
155 window cover body
S insertion opening

Claims

1. A heat pump apparatus (1) including 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 disposed, the blower room being a room in which a heat exchanger (20) and a blower device (21) are disposed, the heat pump apparatus comprising an electrical equipment box (30), **characterized in that**

   the electrical equipment box includes an electrical equipment box body (32) and a cover member (33), the electrical equipment box body having a through opening (31),
   the through opening is provided with a lead wire relay module (55) that draws in a plurality of lead wires, and
   the lead wire relay module includes a fixing frame (70) and sleeves for insertion (80), the fixing frame having a plurality of insertion openings (S), the sleeves for insertion being inserted into the respective insertion openings, the sleeves for insertion thereby coming into close contact with the fixing frame so as to seal and hold lead wires to be drawn into the electrical equipment box body.

2. The heat pump apparatus according to claim 1, wherein the fixing frame and each sleeve for insertion have a tapered structure that brings an outer circumferential portion of each sleeve for insertion into closer contact with the fixing frame as the sleeve for insertion is inserted into the fixing frame.

3. The heat pump apparatus according to claim 1 or 2, wherein the fixing frame is made of resin, has an O-ring groove (36) into which an O-ring (38) is inserted, and is fixed to the through opening of the electrical equipment box body with the O-ring interposed therebetween.

4. The heat pump apparatus according to claim 3, wherein the O-ring is made of foam rubber.

5. The heat pump apparatus according to claim 3, wherein the O-ring is made of chloroprene rubber.

6. The heat pump apparatus according to claim 3, wherein a length of the O-ring is set shorter than a length of the O-ring groove.

7. The heat pump apparatus according to claim 1 or 2, wherein the electrical equipment box is disposed above the machine room and the blower room across the machine room and the blower room.

FIG.1

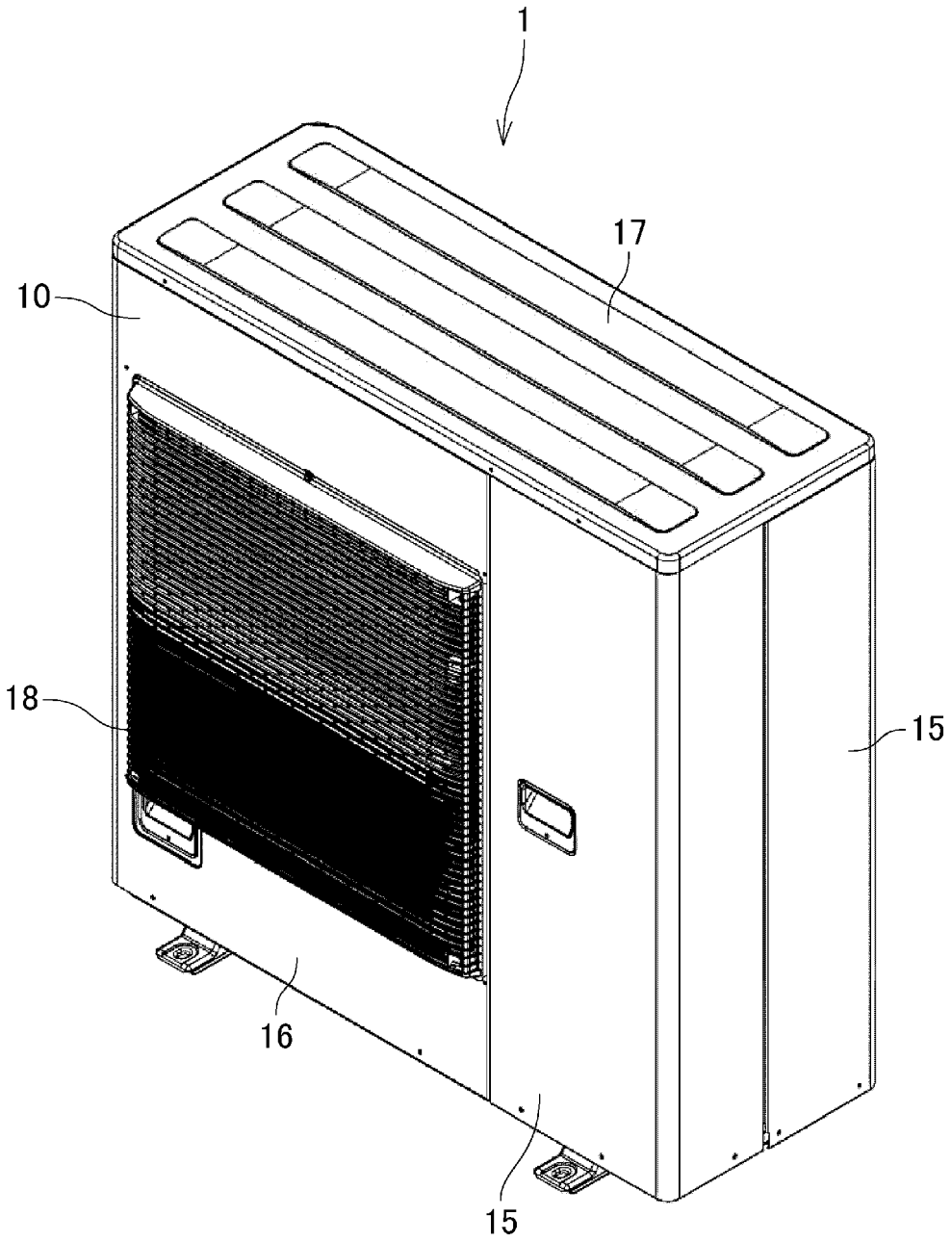


FIG.2

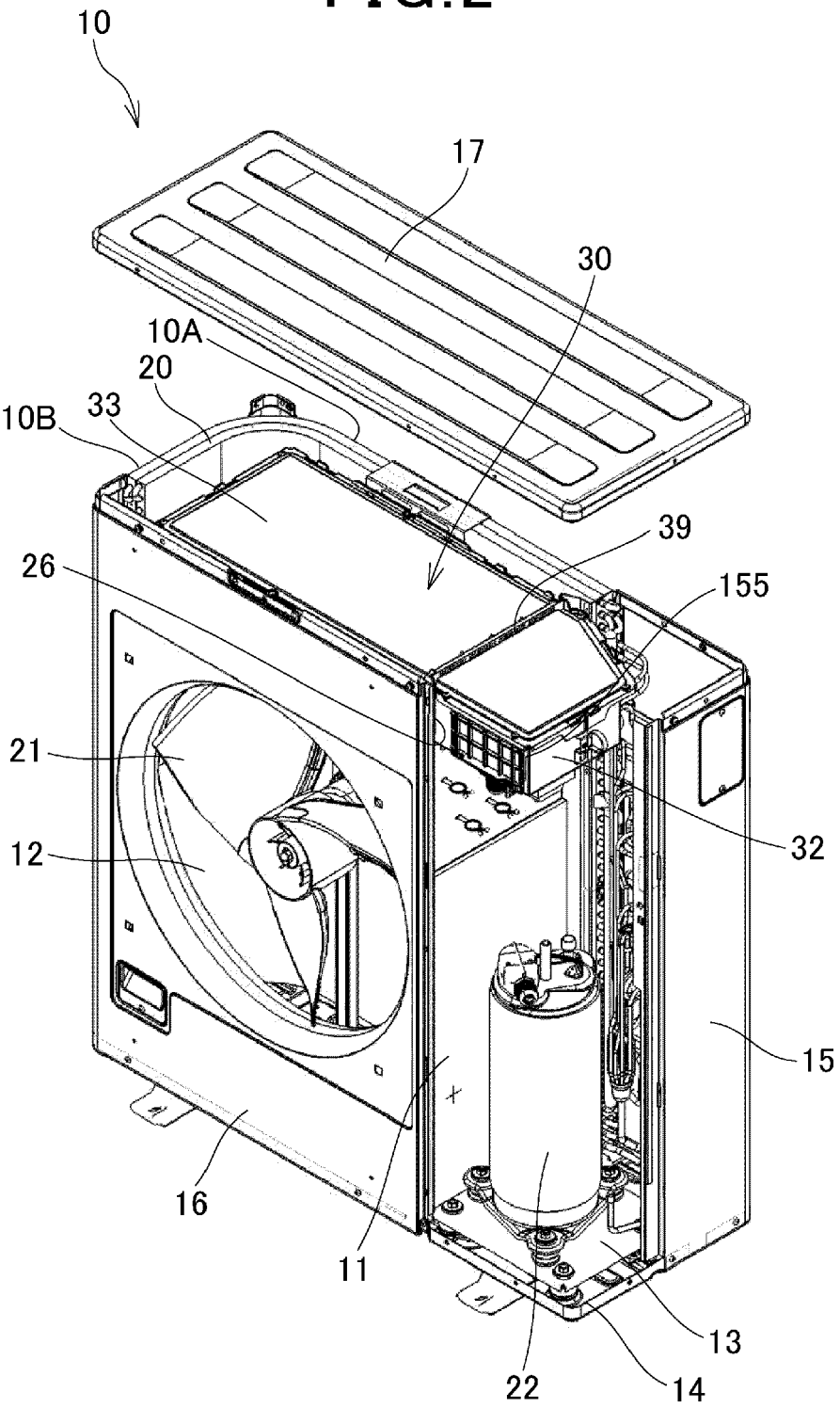


FIG.3

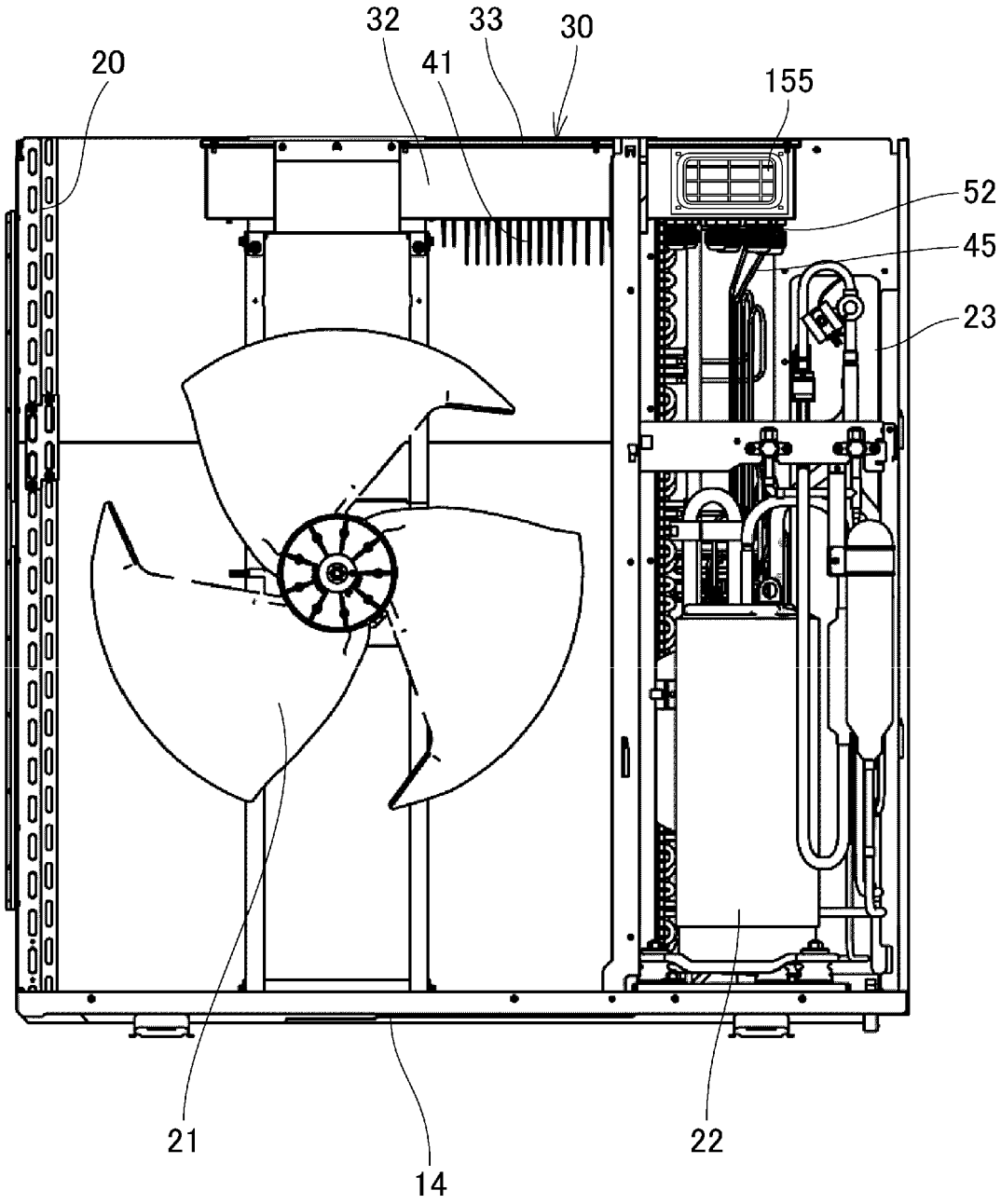


FIG.4

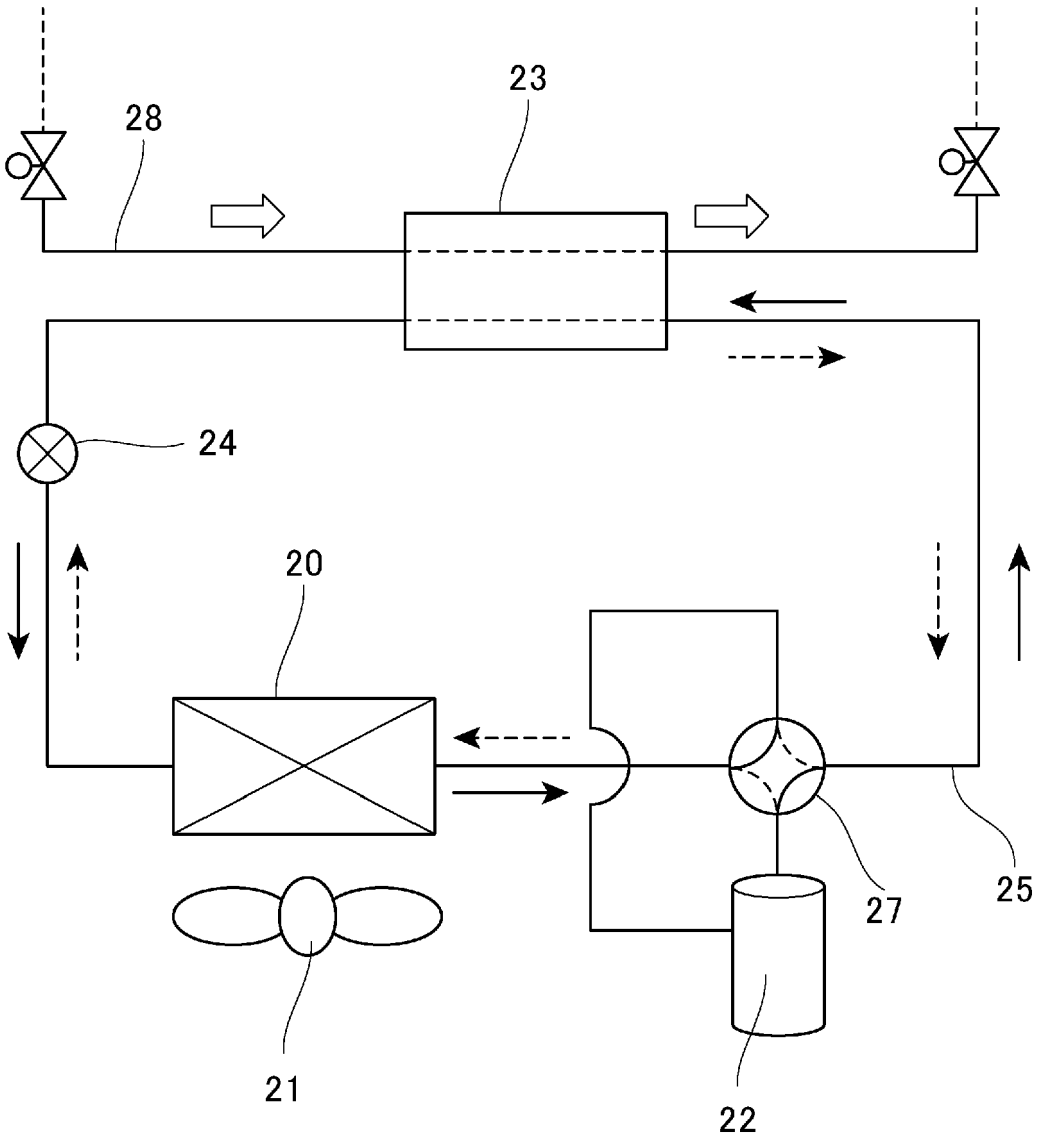


FIG.5

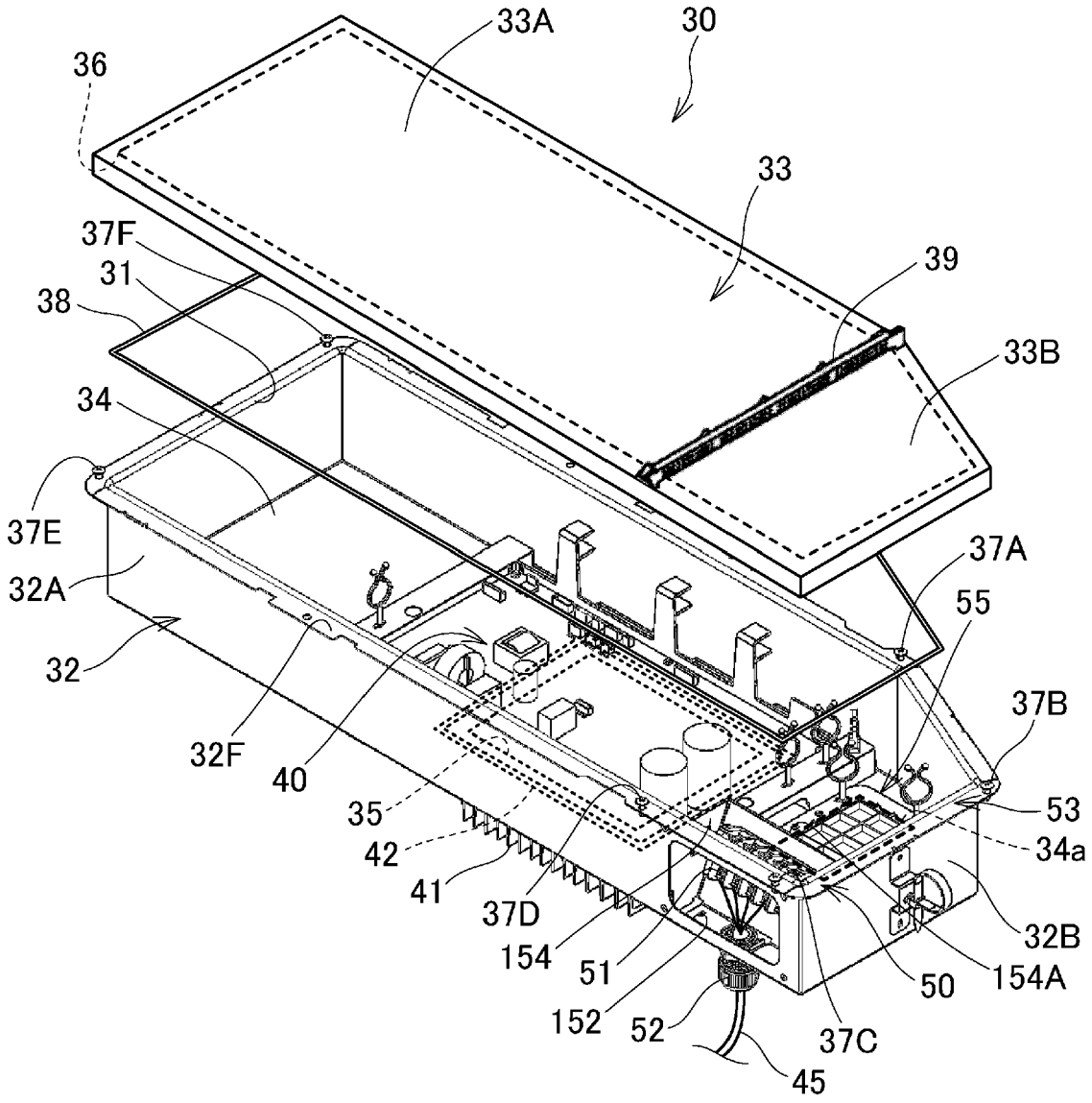

33A
30
36
33
37F
31
39
38
33B
34
37E
37A
32A
55
32
37B
32F
40
53
35
34a
42
41
37D
32B
154
51
50
154A
152
52
37C
45

FIG.6

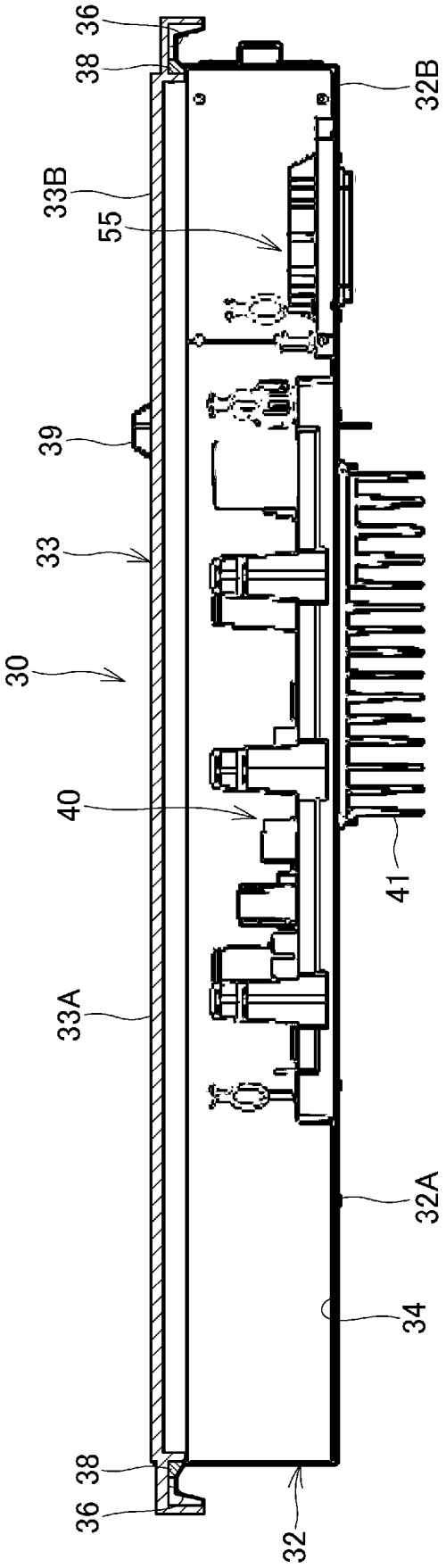


FIG. 7

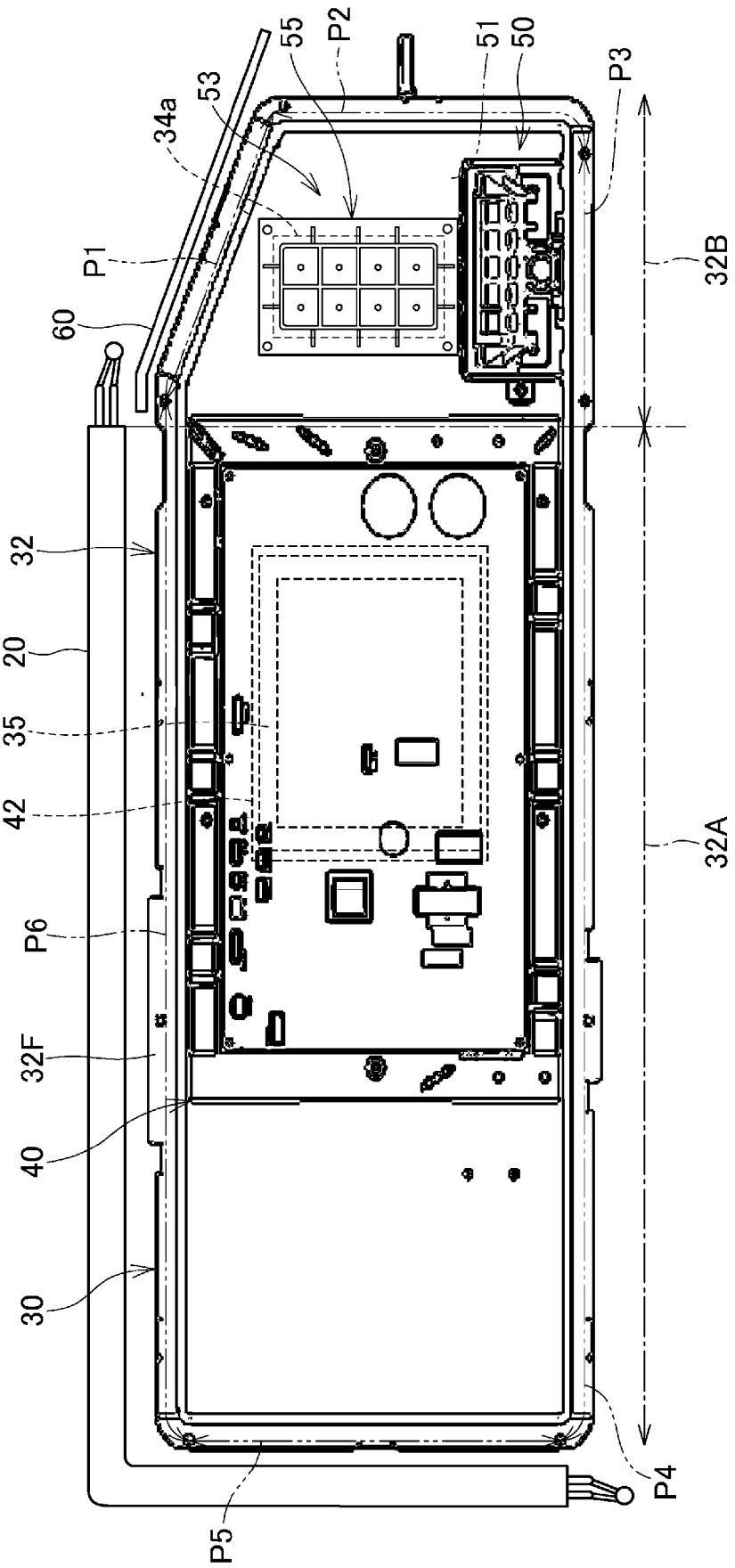


FIG.8

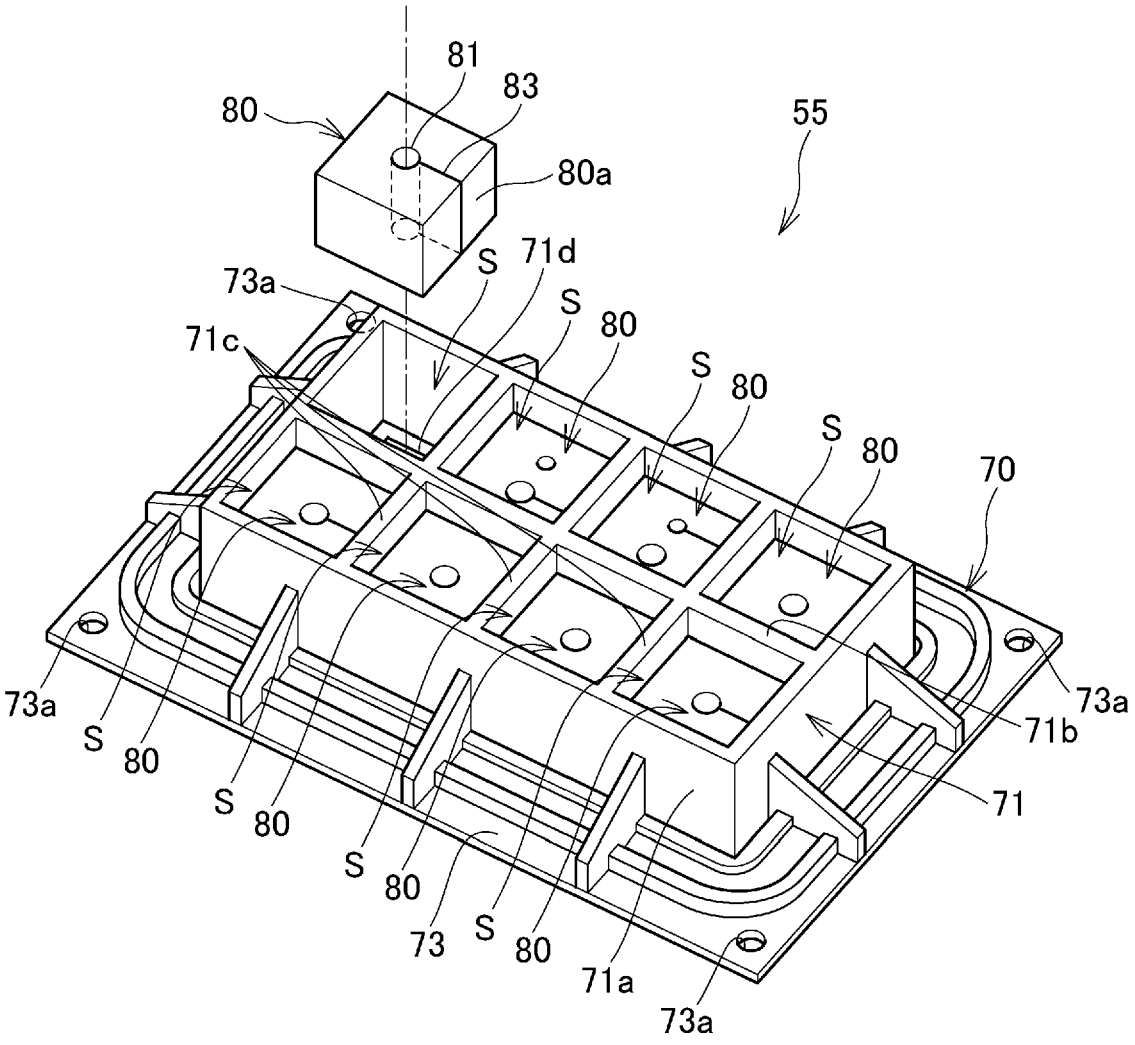


FIG.9

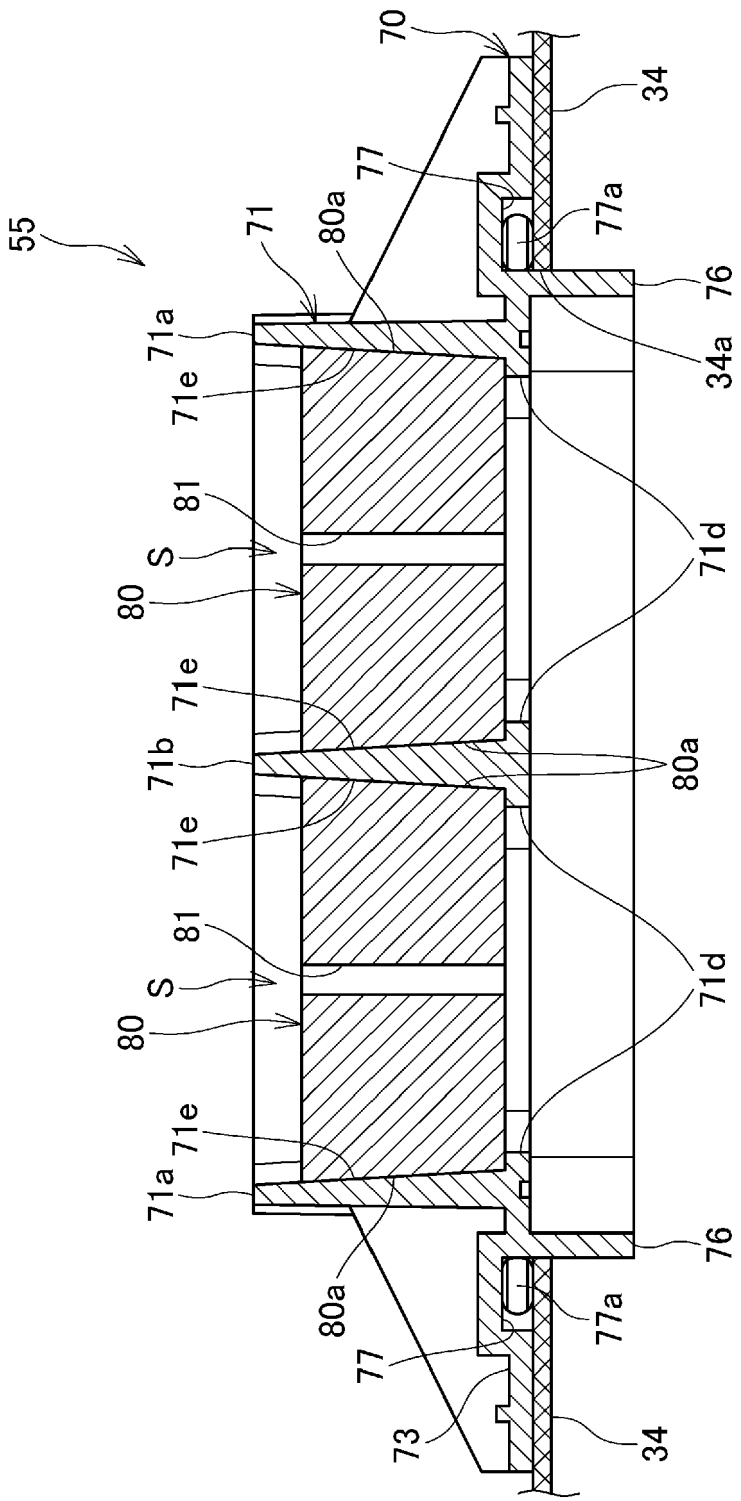
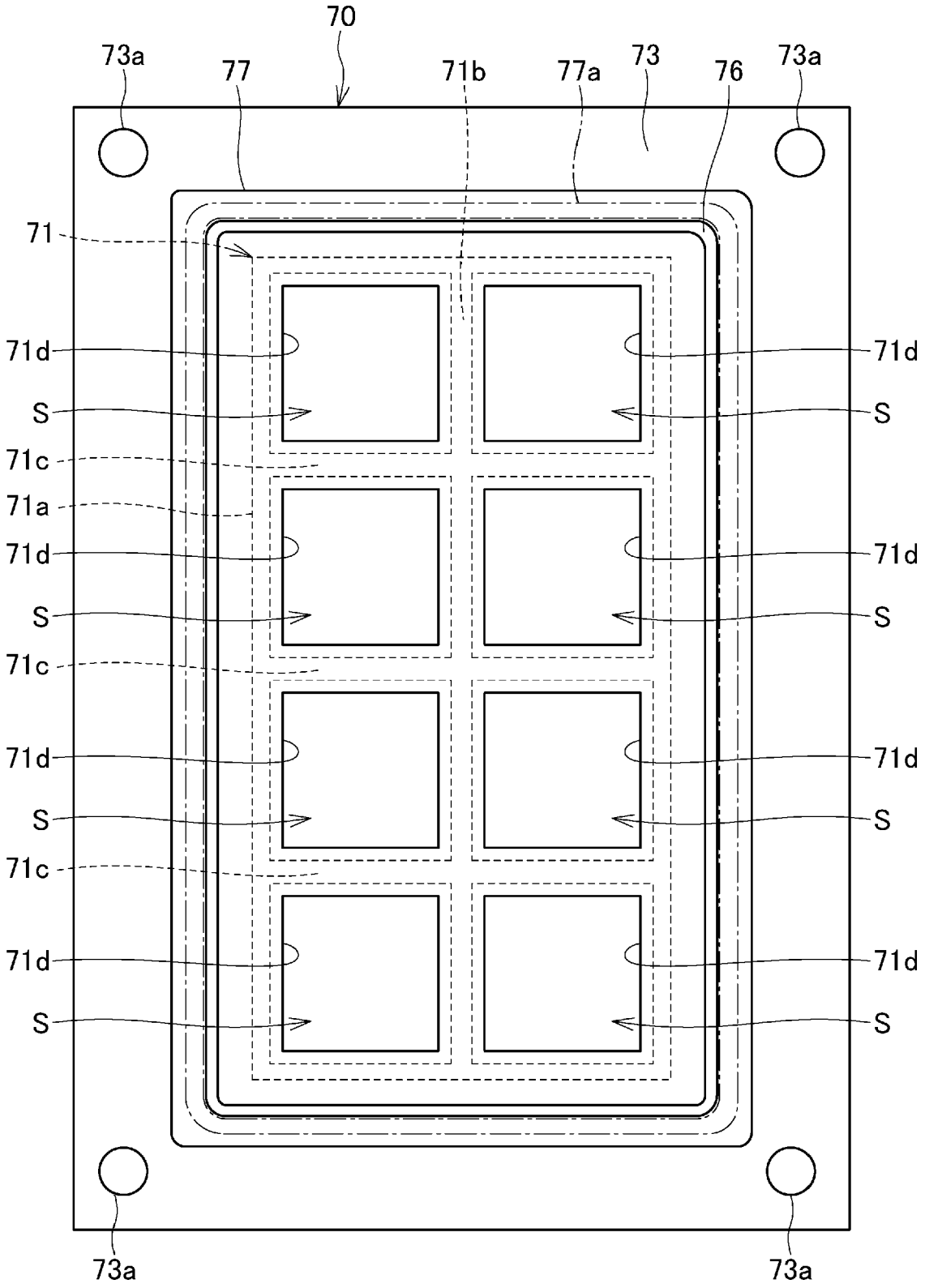

55
70
34
77
77a
71
80a
76
71a
34a
71e
81
S
80
71d
71e
71b
80a
71e
81
S
80
71d
71e
71a
76
80a
77a
77
73
34

FIG.10


70
73a
77
71b
77a
73
76
73a
71
71d
71d
S
S
71c
71a
71d
71d
S
S
71c
71d
71d
S
S
71c
71d
71d
S
S
73a
73a

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 19 9807

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2022/179161 A1 (QINGDAO HAIER AIR CONDITIONER GENERAL CORP LTD [CN] ET AL.) 1 September 2022 (2022-09-01) * figures 11-20 *	1-7	INV. F24F1/22 F24F1/46 F24F11/88 F24F11/89
A	CN 1 782 643 A (LG ELECTRONICS TIANJIN [CN]) 7 June 2006 (2006-06-07) * abstract; figures 1-7 *	1-7	
A	CN 113 280 408 A (WUHAN REFRIGERATION EQUIPMENT CO LTD OF MIDEA GROUP ET AL.) 20 August 2021 (2021-08-20) * abstract; figures 1-10 *	1-7	
A	CN 107 110 555 A (DAIKIN IND LTD) 29 August 2017 (2017-08-29) * abstract; figure 5 *	1-7	
A,D	EP 3 312 531 A1 (MITSUBISHI ELECTRIC CORP [JP]) 25 April 2018 (2018-04-25) * abstract *	1-7	TECHNICAL FIELDS SEARCHED (IPC) F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 February 2024	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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 19 9807

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.

14-02-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022179161 A1	01-09-2022	CN 113015371 A	22-06-2021
		WO 2022179161 A1	01-09-2022
CN 1782643 A	07-06-2006	NONE	
CN 113280408 A	20-08-2021	NONE	
CN 107110555 A	29-08-2017	AU 2015364800 A1	15-06-2017
		BR 112017008638 A2	19-12-2017
		CN 107110555 A	29-08-2017
		EP 3236172 A1	25-10-2017
		ES 2849729 T3	20-08-2021
		JP 6020543 B2	02-11-2016
		JP 2016114336 A	23-06-2016
		KR 20170057447 A	24-05-2017
		US 2017276396 A1	28-09-2017
		WO 2016098728 A1	23-06-2016
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 WO2018047265 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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 3312531 A **[0002]**