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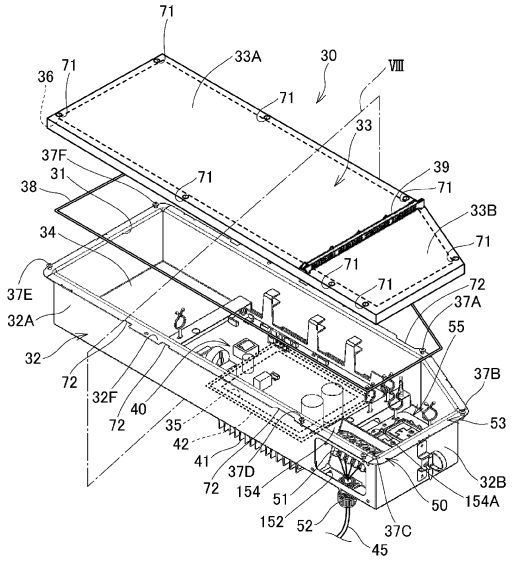
(54) HEAT PUMP APPARATUS

(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 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 an O-ring groove 36 is included in the electrical equipment box body 32 or the cover member 33, the cover member 33 and the electrical equipment box body 32 are fixed with fixing screws 37A to 37D in a state in which an O-ring 38, which is inserted in the O-ring groove 36, is sandwiched between the cover member 33 and the electrical equipment box body 32.

FIG.5



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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, a blower room, and an electrical equipment box 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: the electrical equipment box includes an electrical equipment box body and a cover member; and an O-ring groove is included in the electrical equipment box body or the cover member, and the cover member and the electrical equipment box body are fixed by at least one fixing screw in a state in which an O-ring inserted in the O-ring groove is sandwiched between the cover member and the electrical equipment box body.

[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;
FIG. 8 is a diagram schematically showing a cross section cut along a plane VIII in FIG. 5; and
FIG. 9 is a diagram schematically showing a state in which the cover member and the electrical equipment box body of FIG. 8 are fixed to each other.

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. 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.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] 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)

[0012] Embodiment 1 is to be described below with reference to the drawings.

[1-1. Configuration]

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

[0013] 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.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] The front panel 16 is provided with a ventilation portion 18 that is formed like a mesh and allows air to pass through.

[0019] The blower room 12 has a heat exchanger 20 and a blower device 21.

[0020] 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.

[0021] The heat exchanger 20 to be used is, for example, a fin-tube heat exchanger.

[0022] 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.

[0023] 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.

[0024] The water heat exchanger 23 to be used is, for example, a plate heat exchanger.

[0025] 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]

[0026] FIG. 4 is a circuit diagram showing a refrigerant circuit according to Embodiment 1.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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]

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] The electrical equipment box body 32 has the blower-side portion 32A provided with a control board 40 including a printed wiring board and other electronic components 43 electrically connected to the control board 40.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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, the cover member 33 has a lower surface having a circumferential portion in which an O-ring groove 36 is formed. The cover member 33 is fixed to the flange 32F with six fixing screws 37A to 37F with the O-ring 38 fitted in O-ring groove 36.

[0045] As shown in FIG. 7, the flange 32F is provided with a plurality of screw holes 70 in which the fixing screws 37A to 37F are screwed.

[0046] As shown in FIG. 5, the cover member 33 is provided with a plurality of screw holes 71 in which the fixing screws 37A to 37F are screwed. Each screw hole 71 is provided at a position substantially identical in plan view to a position where each screw hole 70 is provided when the cover member 33 is laid on top of the electrical equipment box body 32. The electrical equipment box body 32 and the cover member 33 are fixed by screwing the fixing screws 37A to 37F in the respective screw holes 71 and the respective screw holes 70.

[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 ratio 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] As shown in FIGS. 5 and 7, the flange 32F is provided with a plurality of cutouts 72. Each cutout 72 is formed by cutting out the flange 32F in the width direction extending away from the electrical-equipment-box bottom surface 34 in plan view. The cutout 72 is formed by cutting out the flange 32F by a dimension shorter than the width dimension of the flange 32F. At least one cutout 72 is provided between each two screw holes 70.

[0052] FIG. 8 is a diagram schematically showing a cross section cut along a plane VIII in FIG. 5.

[0053] As shown in FIG. 8, the O-ring groove 36 has a groove shape formed from a recess from the lower surface side of the cover member 33 to the upper surface side thereof. The O-ring groove 36 is disposed at a position where the groove overlaps the flange 32F in plan view when the cover member 33 is laid on top of the electrical equipment box body 32.

[0054] The lower surface of the cover member 33 is provided with a plurality of engaging pieces 74 at its end in the circumferential portion. Each engaging piece 74 is formed in a claw shape, and is provided at a position where the engaging piece overlaps each cutout 72 in plan view when the cover member 33 is laid on top of the electrical equipment box body 32. When the cover member 33 is attached to the electrical equipment box body 32, each engaging piece 74 engages with each cutout 72. In other words, the electrical equipment box body 32 and the cover member 33 are fixed to each other by screw fastening with fixing screws 37A to 37F and engagement of the engaging pieces 74 with the respective cutouts 72.

[0055] The electrical equipment box body 32 and the cover member 33 are thus fixed to each other by the engagement of the engaging pieces 74 and the respective cutouts 72 with a tightening force equivalent to screw fastening. This allows the electrical equipment box 30 to reduce the number of screw fastening portions without lowering the airtightness and to improve work efficiency at the time of assembling the electrical equipment box body 32 and the cover member 33. Hereinafter, a structure in which each engaging piece 74 is fixed by each cutout 72 is referred to as a pawl mechanism.

[0056] As shown in FIG. 8, the O-ring 38 has a circular cross section. The length dimension of the O-ring 38 in the radial direction is formed longer than the depth dimension of the O-ring groove 36 in the up-down direction of the electrical equipment box 30.

[0057] The O-ring 38 is made of foam rubber inside which cavities S containing air are provided. In the present embodiment, the O-ring 38 is made of chloroprene rubber. Chloroprene rubber has a relatively lower permeability of propane, among flammable gases, than other resin materials. This allows the electrical equipment box 30 to reduce the amount of propane permeating the O-ring 38 and improve airtightness.

[0058] The O-ring 38 of the present embodiment is formed in an annular shape. The O-ring 38 has a shorter length dimension in the circumferential direction than the O-ring groove 36.

[0059] As a result, when the O-ring 38 is fitted into the O-ring groove 36 in the electrical equipment box 30, the O-ring 38, which has a length dimension shorter than the actual circumferential length of the O-ring groove 36, is fitted into the O-ring groove 36, so that the O-ring 38 is likely to come into close contact with the O-ring groove 36. This causes the electrical equipment box 30 to bring the O-ring 38 into closer contact with the O-ring groove 36 and further improve the airtightness.

[0060] FIG. 9 is a diagram schematically showing a state in which the cover member 33 and the electrical equipment box body 32 of FIG. 8 are fixed to each other.

[0061] As shown in FIG. 9, when the cover member 33 is attached to the electrical equipment box body 32, the O-ring 38 is sandwiched between the O-ring groove 36 and the flange 32F and elastically deforms inside the O-ring groove 36.

[0062] As described above, the O-ring 38 is made of foam rubber. The electrical equipment box 30 thus uses the O-ring 38 made of foam material as a sealing material, to prevent the repulsive force of the O-ring 38 from becoming too strong and to increase the compressibility ratio. Therefore, the electrical equipment box 30 allows the design value of the compressibility ratio of the O-ring 38 to be set higher and allows the length dimension in the radial direction of the O-ring 38 to be set longer than the depth dimension of the O-ring groove 36. Then, the screwing margin for the O-ring groove 36 increases, enabling enhancement in contact force and elasticity capable of maintaining the contact force. In other words, the electrical equipment box 30 allows the design value of the compressibility ratio of the O-ring 38 to be set higher. This makes it possible to reduce the amount of change in compressibility ratio due to variations in the parts, compared to a case in which the O-ring 38 is made of a material called solid rubber.

[0063] 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 (for example, foam rubber).

[0064] 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.

[0065] 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]

[0066] Next, the operation of the heat pump apparatus 1 configured as above is to be described.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] These air flows allow 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.

[0074] 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.

[0075] 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 machine room 13 may have a refrigerant concentration equal to or more than a predetermined value.

[0076] In the electrical equipment box 30 of the present embodiment, when the cover member 33 is attached to the electrical equipment box body 32, the O-ring 38 is sandwiched between the O-ring groove 36 and the flange 32F and elastically deforms inside the O-ring groove 36. This seals the gap between the cover member 33 and the electrical equipment box body 32.

[0077] In the electrical equipment box 30, when the cover member 33 and the electrical equipment box body 32 are tightened, the repulsive force of the O-ring 38 fitted in the O-ring groove 36 strengthens the contact force between the cover member 33, the O-ring 38, and the electrical equipment box body 32, improving the sealing property. In addition, in the electrical equipment box 30, when the cover member 33 is attached to the electrical equipment box body 32, the O-ring 38 is not squashed more than necessary. This makes it possible to ensure the airtightness and maintain the durability of the O-ring 38 over a long period of time.

[0078] In the heat pump apparatus 1, the electrical equipment box 30 is thus sealed, so that the refrigerant having leaked from the refrigerant circuit is prevented from entering the electrical equipment box 30.

[1-3. Effects]

[0079] As described above, in the present embodiment, the heat pump apparatus 1 includes a machine room 13 in which a compressor 22 and an expansion device 24 are disposed, and a blower room 12 in which a heat exchanger 20 and a blower device 21 are disposed, each in a housing 10. The heat pump apparatus 1 has an electrical equipment box 30 disposed therein. The electrical equipment box 30 includes an electrical equipment box body 32 and a cover member 33. In the electrical equipment box 30, the O-ring groove 36 is disposed in the electrical equipment box body 32 or the cover member 33, and the cover member 33 and the electrical equipment box body 32 are fixed with fixing screws 37A to 37D in a state in which the O-ring 38, which is inserted in the O-ring groove 36, is sandwiched between the cover member 33 and the electrical equipment box body 32.

[0080] In the electrical equipment box 30, the cover member 33 and the electrical equipment box body 32 are thus fixed with fixing screws 37A to 37D. This causes the repulsive force of the O-ring 38 fitted in the O-ring groove 36 to strengthen the contact force between the cover member 33, the O-ring 38, and the electrical equipment box body 32, improving the sealing property. This allows the electrical equipment box 30 to ensure airtightness and prevent the O-ring 38 from being squashed more than necessary when the cover member 33 is attached to the electrical equipment box body 32, enabling the durability of the O-ring 38 to be maintained over a long period of time.

[0081] The present embodiment may be configured such that: the electrical equipment box body 32 is made of sheet metal, and has an upper end having a circumferential portion provided with a flange 32F; the cover member 33 is made of resin, and is provided with an O-ring groove 36; and the O-ring 38 is sandwiched between the cover member 33 and the flange 32F of the electrical equipment box body 32.

[0082] This allows the electrical equipment box 30 to seal the gap between the cover member 33 and the electrical equipment box body 32, on the outer side of the interior of the electrical equipment box body 32 that houses electrical components such as the control board 40. Therefore, the electrical equipment box 30 can have the interior of the electrical equipment box body 32 made into a sealed space.

[0083] The present embodiment may be configured such that: an engaging piece 74 formed on the cover member 33 and a cutout 72 formed on the flange 32F of the electrical equipment box body 32 form a pawl mechanism; and one or more pawl mechanisms are disposed between the fixing screws 37A to 37D.

[0084] As a result, the electrical equipment box body 32 and the cover member 33 are fixed to each other by the pawl mechanism with a tightening force equivalent to screw fastening. This allows the electrical equipment box 30 to reduce the number of screw fastening portions without lowering the airtightness and to improve work efficiency at the time of assembling the electrical equipment box body 32 and the cover member 33.

[0085] The present embodiment may be configured such that: the electrical equipment box body 32 is disposed across the machine room 13 and the blower room 12; and the electrical equipment box body 32 has a smaller ratio of a volume occupied by the machine-side portion 32B than a ratio of a volume occupied by the blower-side portion 32A to shorten the length of the O-ring 38 in the machine-side portion 33B.

[0086] This allows the electrical equipment box 30 to shorten the circumferential length dimension of the O-ring 38 in the area where the O-ring 38 is disposed in the machine room 13. 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.

[0087] In the present embodiment, the O-ring 38 may be made of foam rubber.

[0088] This prevents the repulsive force of the O-ring 38 from becoming too strong, and increases the compressibility ratio. This allows the electrical equipment box 30 to increase screwing margin for the O-ring groove 36, enabling enhancement in contact force and elasticity capable of maintaining the contact force.

[0089] In the present embodiment, the O-ring 38 may be made of chloroprene rubber.

[0090] This allows the electrical equipment box 30 to reduce the amount of propane permeating the O-ring 38. This then allows the electrical equipment box 30 to improve airtightness.

[0091] In the present embodiment, the length of the O-ring 38 is set shorter than the length of the O-ring groove 36.

[0092] As a result, when the O-ring 38 is fitted into the O-ring groove 36 in the electrical equipment box 30, the O-ring 38, which has a length dimension shorter than the actual circumferential length of the O-ring groove 36, is fitted into the O-ring groove 36, so that the O-ring 38 is likely to come into close contact with the O-ring groove 36. This causes the electrical equipment box 30 to bring the O-ring 38 into closer contact with the O-ring groove 36 and further improve the airtightness.

(Other Embodiments)

[0093] 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.

[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] 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]

[0096] The above embodiments support the following configurations.

(Supplement)

(Technique 1)

[0097] A heat pump apparatus including a machine room, a blower room, and an electrical equipment box 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: the electrical equipment box includes an electrical equipment box body and a cover member; and an O-ring groove is included in the electrical equipment box body or the cover member, and the cover member and the electrical equipment box body are fixed by at least one fixing screw in a state in which an O-ring inserted in the O-ring groove is sandwiched between the cover member and the electrical equipment box body.

[0098] According to this configuration, the electrical equipment box has the cover member and the electrical equipment box body, which are fixed with fixing screws. This causes the repulsive force of the O-ring fitted in the O-ring groove to strengthen the contact force between the cover member, the O-ring, and the electrical equipment box body, improving the sealing property. This allows the electrical equipment box to ensure airtightness and prevent the O-ring from being squashed more than necessary when the cover member is attached to the electrical equipment box body, enabling the durability of the O-ring to be maintained over a long period of time.

(Technique 2)

[0099] The heat pump apparatus according to Technique 1, wherein: the electrical equipment box body is made of sheet metal and has an upper end having a circumferential portion provided with a flange; and the cover member is made of resin and is provided with an O-ring groove, and the O-ring is sandwiched between the cover member and the flange of the electrical equipment box body.

[0100] This configuration allows the electrical equipment box to seal the gap between the cover member and the electrical equipment box body, on the outer side of the interior of the electrical equipment box body that houses electrical components such as the control board. Therefore, the electrical equipment box can have the interior of the electrical equipment box body made into a sealed space.

(Technique 3)

[0101] The heat pump apparatus according to Technique 2, wherein at least one pawl mechanism is formed from a hook portion and a receiving portion for the hook portion, and one or more of the pawl mechanisms are disposed between the fixing screws, the hook portion being formed on the cover member, the receiving portion being formed on the flange of the electrical equipment box body.

[0102] According to this configuration, the electrical equipment box body and the cover member are fixed to each other by the pawl mechanism with a tightening force equivalent to screw fastening. This allows the electrical equipment box to reduce the number of screw fastening portions without lowering the airtightness and to improve the work efficiency at the time of assembling the electrical equipment box body and the cover member.

(Technique 4)

[0103] The heat pump apparatus according to any one of Techniques 1 to 3, wherein the electrical equipment box body is disposed above the machine room and the blower room across the rooms, 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 a length of the O-ring in the machine-side portion is made shorter.

[0104] This configuration allows the electrical equipment box to shorten the circumferential length dimension of the O-ring in the area where the O-ring is disposed in the machine room. This makes it possible to reduce the area where the O-ring is exposed to the leaked refrigerant at a concentration equal to or higher than a predetermined value and improve the long-term durability of the O-ring.

(Technique 5)

[0105] The heat pump apparatus according to any one of Techniques 1 to 4, wherein the O-ring is made of foam rubber.

[0106] This configuration prevents the repulsive force of the O-ring from becoming too strong, and increases the compressibility ratio. This allows the electrical equipment box to increase screwing margin for the O-ring groove, enabling enhancement in contact force and elasticity capable of maintaining the contact force.

(Technique 6)

[0107] The heat pump apparatus according to any one of Techniques 1 to 5, wherein the O-ring is made of chloroprene rubber.

[0108] This configuration makes it possible to reduce the amount of propane permeating the O-ring. This then allows the electrical equipment box to improve airtightness.

(Technique 7)

[0109] The heat pump apparatus according to any one of Techniques 1 to 6, wherein a length of the O-ring is set shorter than a length of the O-ring groove.

[0110] According to this configuration, when the O-ring

is fitted into the O-ring groove, the O-ring, which has a length dimension shorter than the actual circumferential length of the O-ring groove, is fitted into the O-ring groove, so that the O-ring is likely to come into close contact with the O-ring groove. This causes the electrical equipment box to bring the O-ring into closer contact with the O-ring groove and further improve the airtightness.

[0111] 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

[0112]

1 heat pump apparatus
10 housing
12 blower room
13 machine room
20 heat exchanger
21 blower device (blower)
22 compressor
23 water heat exchanger
24 expansion device
30 electrical equipment box
32 electrical equipment box body
33 cover member
34 electrical-equipment-box bottom surface
35 bottom surface opening
36 O-ring groove
37A, 37D, 37E, 37F fixing screws
38 O-ring
39A upper surface
70 screw hole
71 screw hole

Claims

1. A heat pump apparatus comprising a machine room (13), a blower room (12), and an electrical equipment box (30) 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,

   characterized in that: the electrical equipment box includes an electrical equipment box body (32) and a cover member (33); and
   an O-ring groove (36) is included in the electrical equipment box body or the cover member, and the cover member and the electrical equipment box body are fixed by at least one fixing screw (37A to 37F) in a state in which an O-ring (38) inserted in the O-ring groove is sandwiched between the cover member and the electrical equipment box body.

2. The heat pump apparatus according to claim 1, wherein: the electrical equipment box body is made of sheet metal and has an upper end having a circumferential portion provided with a flange (32F); the cover member is made of resin and is provided with an O-ring groove; and the O-ring is sandwiched between the cover member and the flange of the electrical equipment box body.

3. The heat pump apparatus according to claim 2, wherein at least one pawl mechanism is formed from a hook portion (74) and a receiving portion (72) for the hook portion, and one or more of the pawl mechanisms are disposed between the fixing screws, the hook portion being formed on the cover member, the receiving portion being formed on the flange of the electrical equipment box body.

4. The heat pump apparatus according to claim 1, wherein the electrical equipment box body is disposed across the machine room and the blower room, 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 a length of the O-ring in the machine-side portion is made shorter.

5. The heat pump apparatus according to claim 1, wherein the O-ring is made of foam rubber.

6. The heat pump apparatus according to claim 1, wherein the O-ring is made of chloroprene rubber.

7. The heat pump apparatus according to claim 1, wherein a length of the O-ring is set shorter than a length of the O-ring groove.

FIG.1

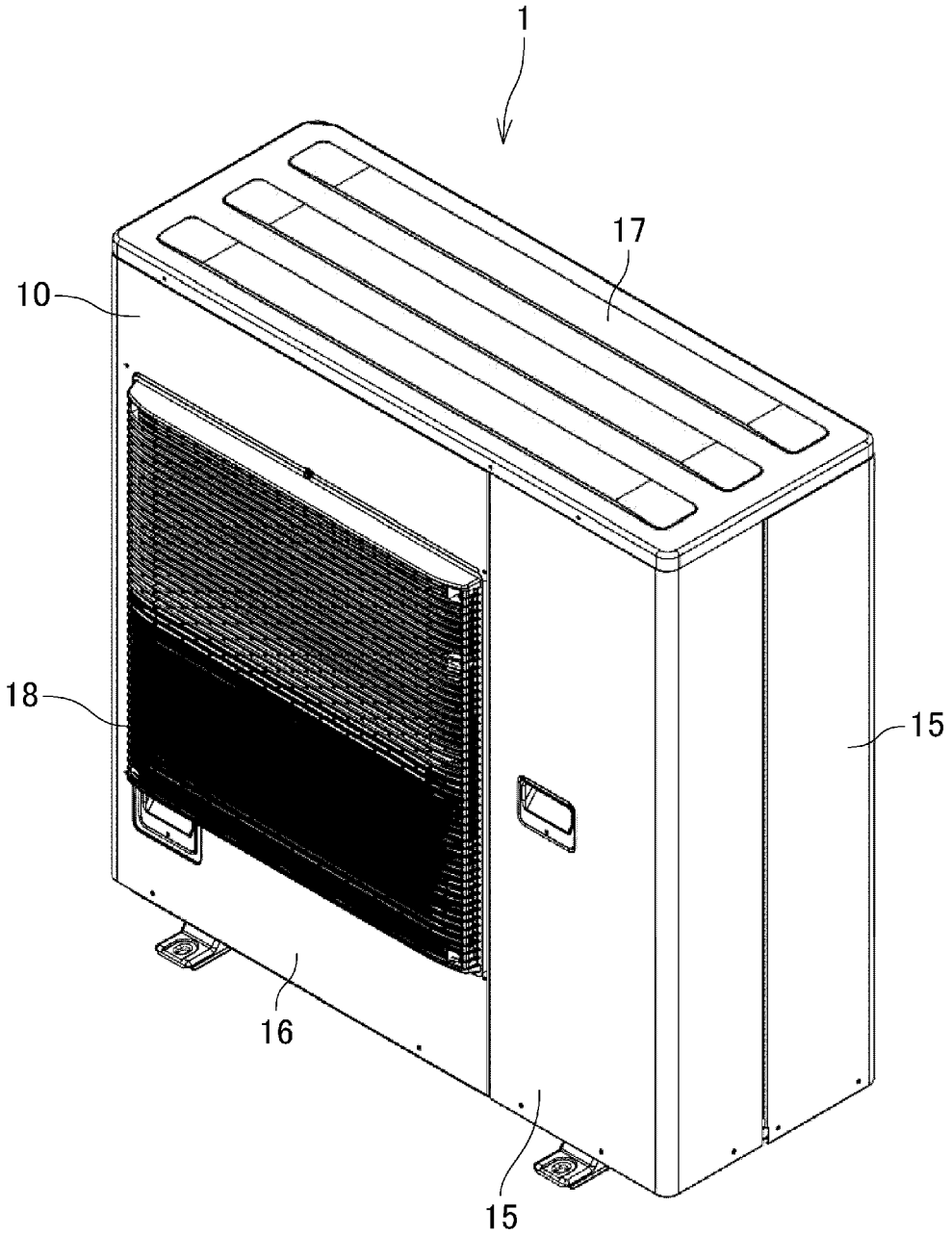


FIG.2

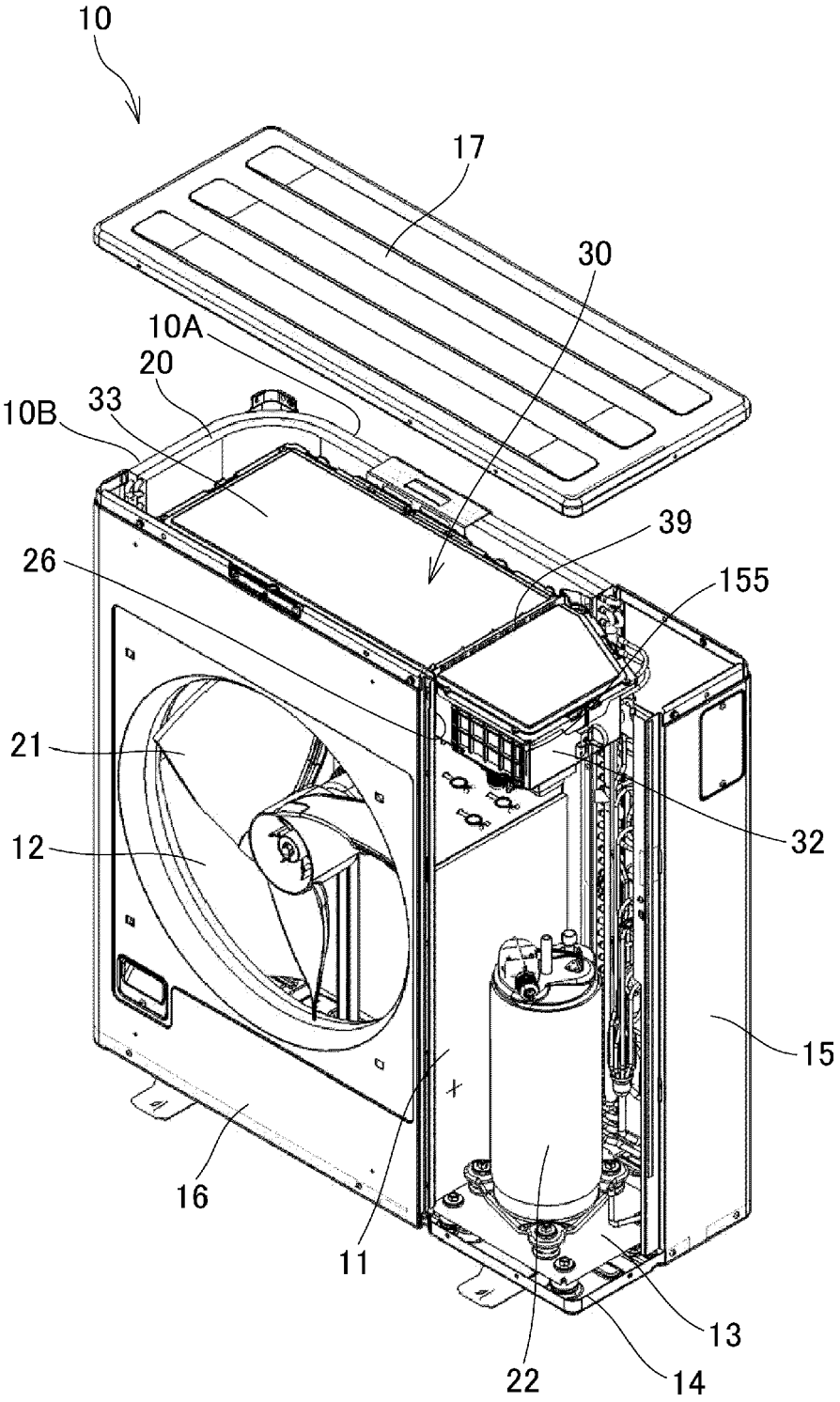


FIG.3

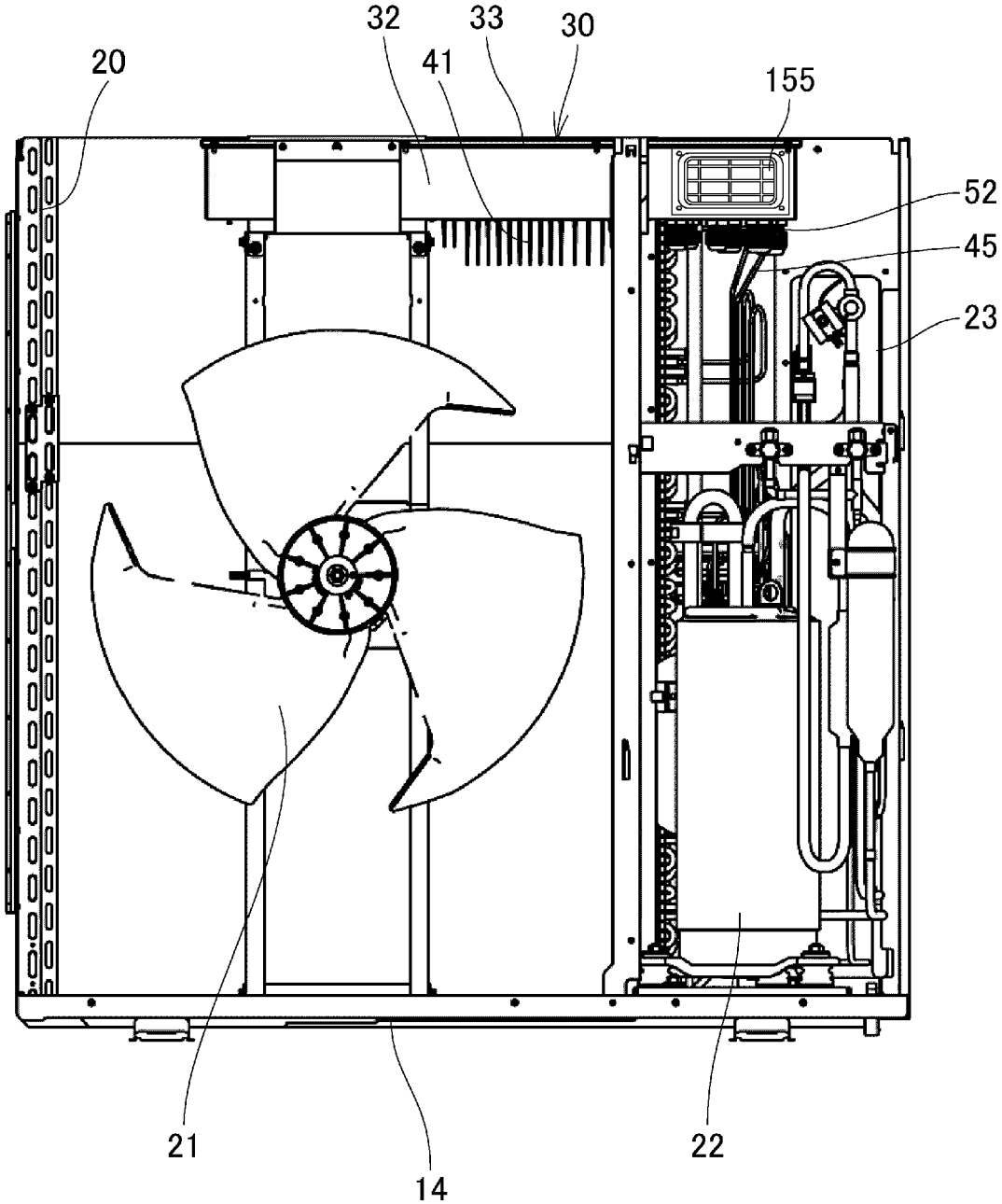
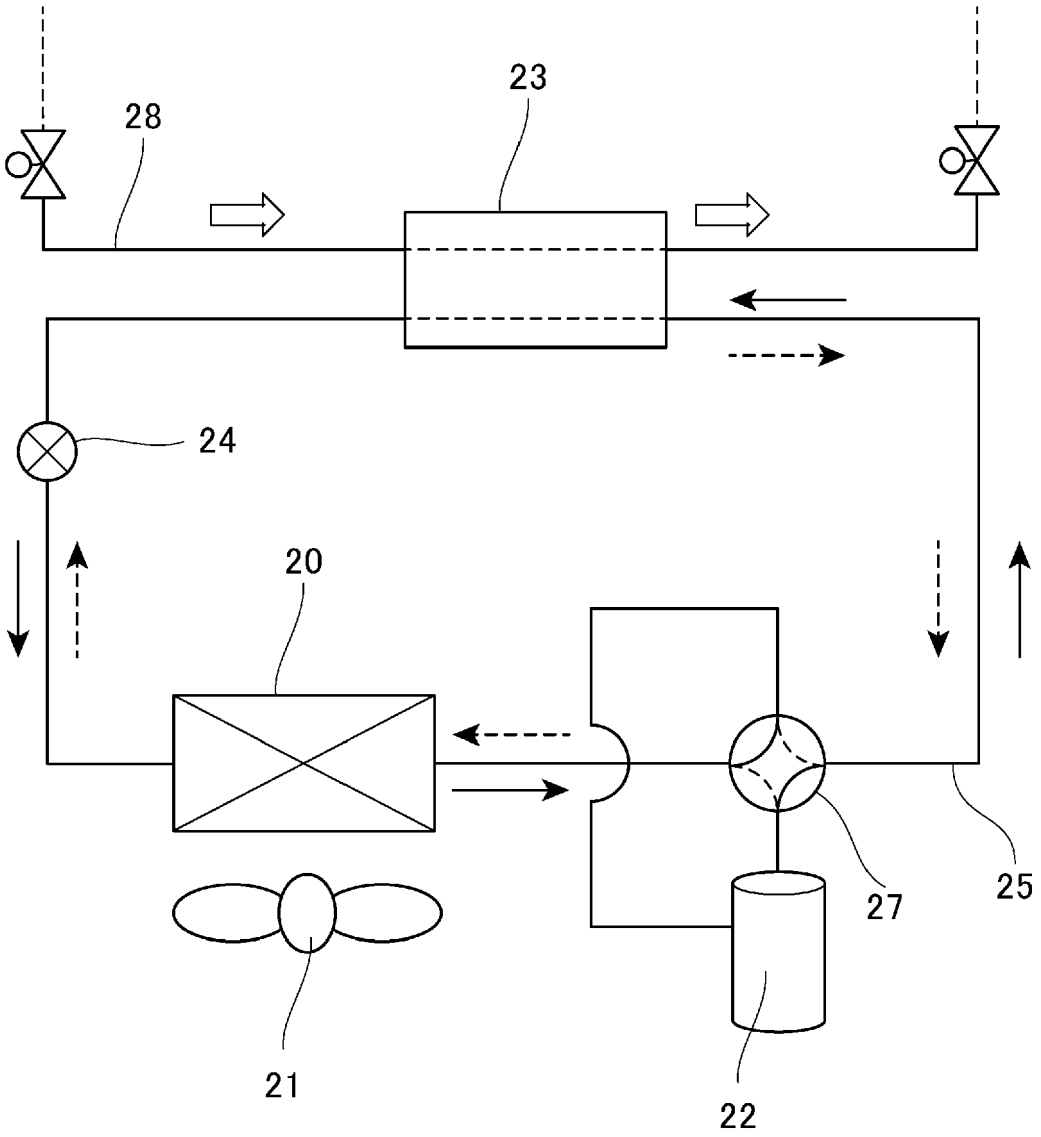


FIG.4



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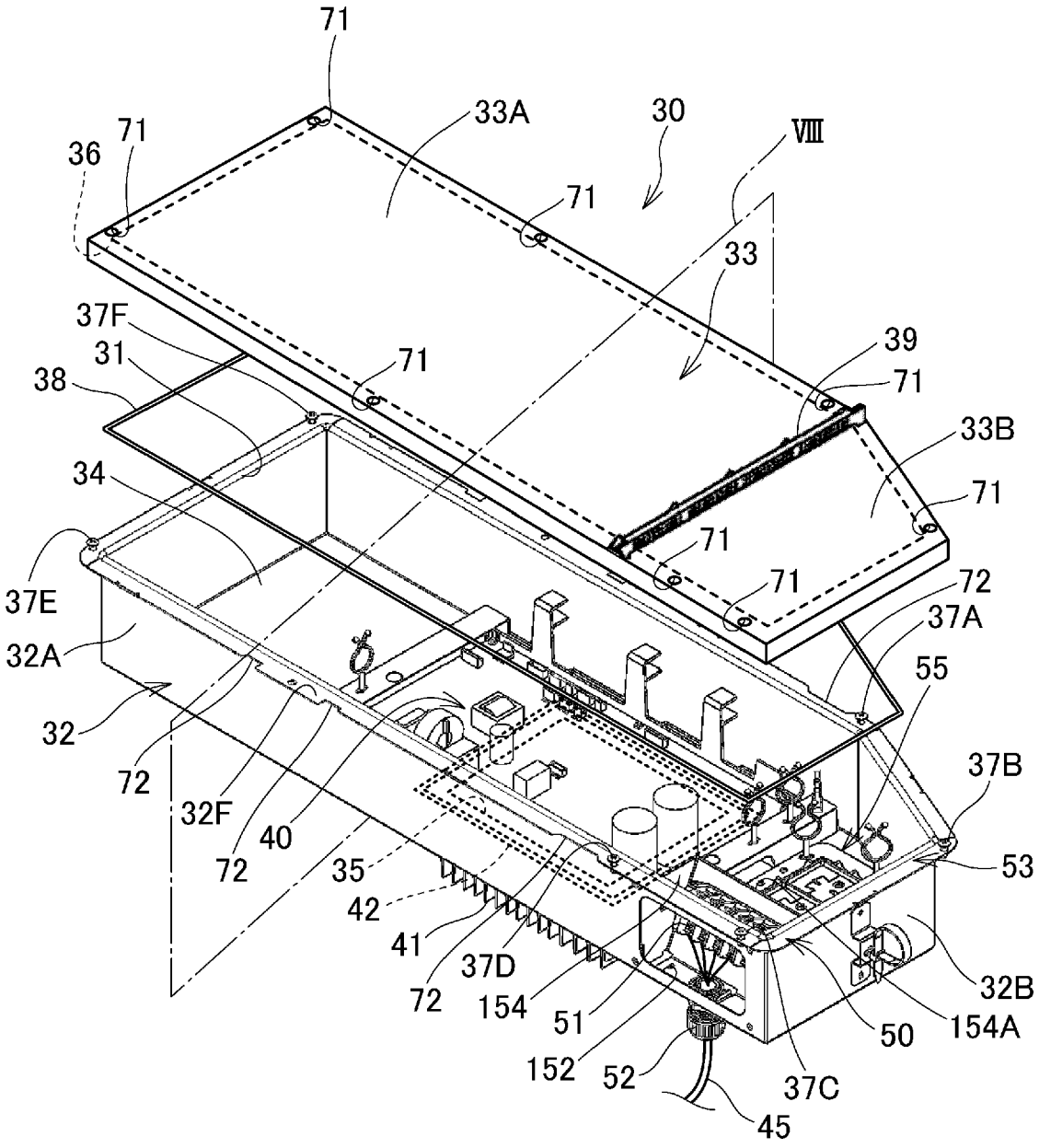
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FIG.6

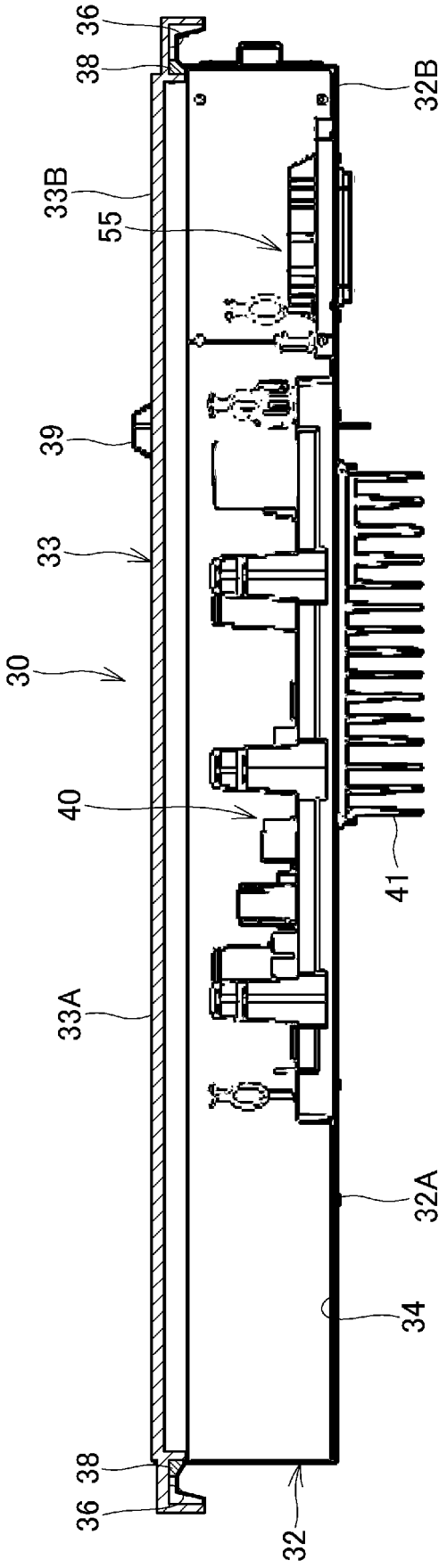

FIG.7

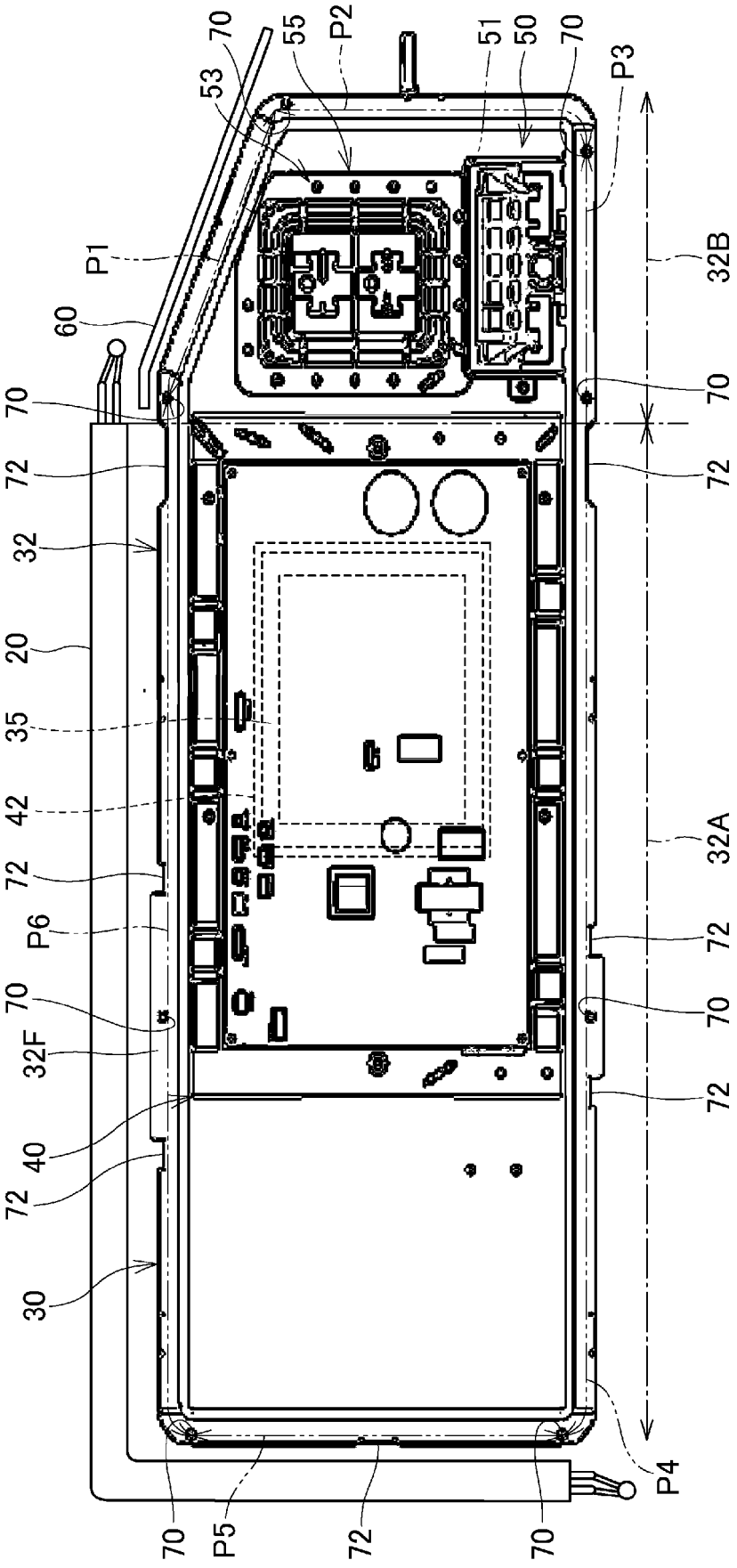
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FIG.8

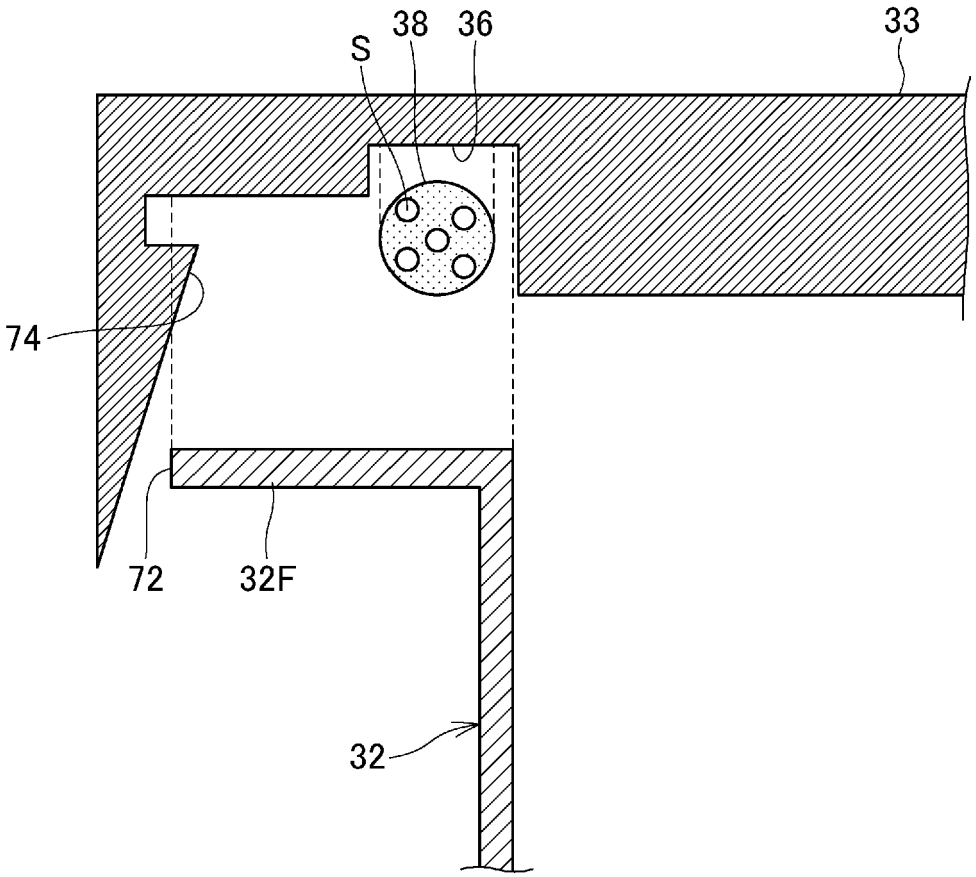
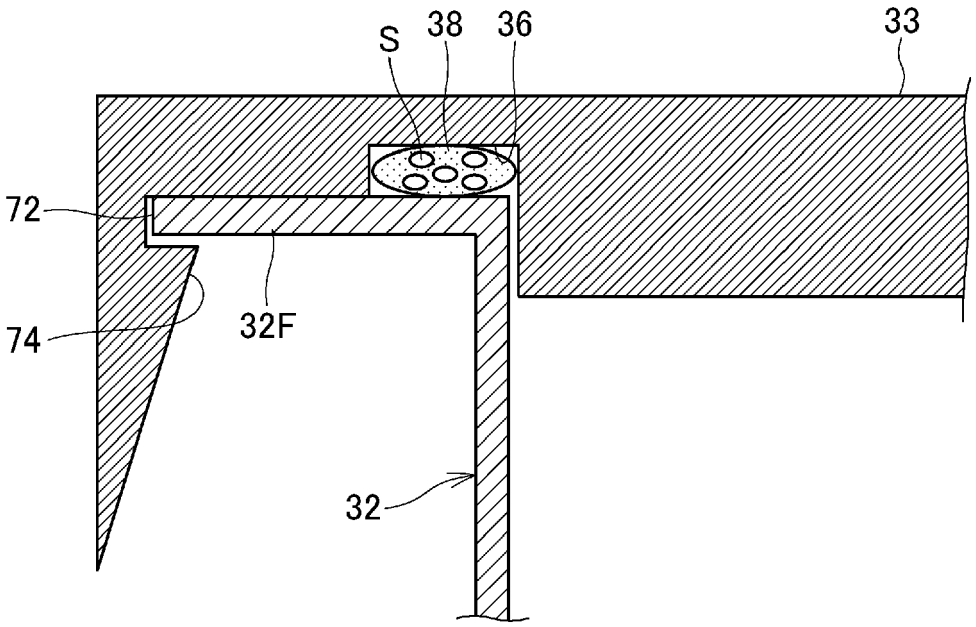


FIG.9



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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 9814

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Place of search	Date of completion of the search	Examiner
Munich	16 February 2024	Valenza, Davide

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