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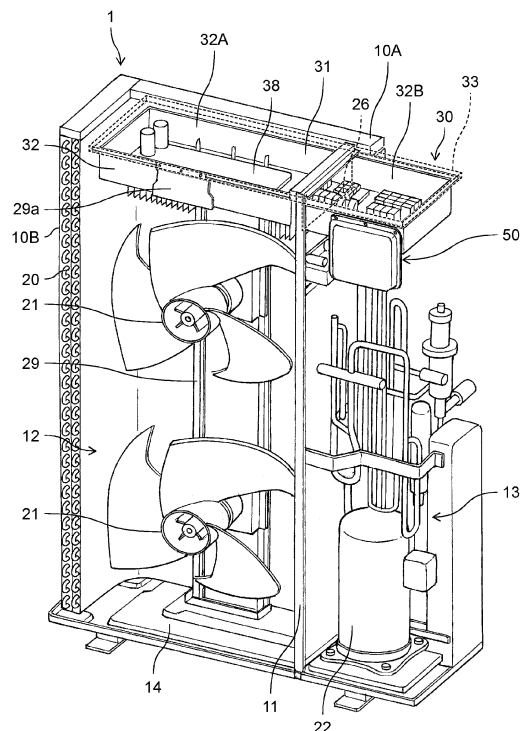
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(54) **HEAT PUMP DEVICE**

(57) A heat pump device of the present disclosure includes a housing internally provided with a machine chamber in which a compressor is disposed, and a blower chamber in which a heat exchanger and a blower are disposed. The heat pump device uses a flammable refrigerant and includes an electric box including an electric box body in which a first opening is formed, a first lid member, and a terminal block box. The terminal block box includes a terminal block that connects a first power supply line to a second power supply line, a terminal block box body having a window opening from which the terminal block is exposed, a second lid member that seals the window opening with a first sealant interposed between the terminal block box body and the second lid member, and a second opening. The second opening overlaps the first opening at a position where the terminal block box is attached to the electric box body from outside while a second sealant surrounding the first opening and the second opening is interposed between the terminal block box and the electric box body. Then, the second power supply line is drawn into the electric box body through the first opening.

FIG. 2



Description**BACKGROUND**

1. Technical Field

[0001] The present disclosure relates to a heat pump device.

2. Description of the Related Art

[0002] PTL 1 discloses a heat pump device capable of preventing ignition of a combustible refrigerant. The heat pump device includes a heat medium circuit through which a heat medium flows, and a refrigerant release valve disposed outside an outdoor unit, the refrigerant release valve being configured to release pressure of the heat medium circuit when the refrigerant is mixed in the heat medium circuit, so that the refrigerant released from the refrigerant release valve is less likely to be ignited.

Citation List

Patent Literature

[0003] PTL 1: European Patent No. 3312531

SUMMARY

[0004] The present disclosure provides a heat pump device capable of suppressing ignition of a refrigerant.

[0005] A heat pump device according to the present disclosure uses a flammable refrigerant and includes a housing including a machine chamber including a compressor disposed in the machine chamber and a blower chamber including a heat exchanger and a blower, an electric box including an electric box body in which a first opening is formed, a first lid member, and a terminal block box. The terminal block box includes a terminal block that connects a first power supply line to a second power supply line, a terminal block box body including a window opening from which the terminal block is exposed, a second lid member that seals the window opening with a first sealant interposed between the terminal block box body and the second lid member, and a second opening. The second opening overlaps the first opening at a position where the terminal block box is attached to the electric box body from outside while a second sealant surrounding the first opening and the second opening is interposed between the terminal block box and the electric box body. Then, the second power supply line is drawn into the electric box body through the first opening.

[0006] The heat pump device of the present disclosure is capable of suppressing intrusion of the refrigerant into the electric box even when the refrigerant leaks from the refrigerant circuit. Thus, ignition of the refrigerant can be suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS**[0007]**

Fig. 1 is a front view of a heat pump device according to a first exemplary embodiment;

Fig. 2 is a perspective view illustrating an internal structure of the heat pump device according to the first exemplary embodiment;

Fig. 3 is a circuit diagram illustrating a refrigerant circuit of the heat pump device according to the first exemplary embodiment;

Fig. 4 is a perspective view of an electric box of the heat pump device according to the first exemplary embodiment;

Fig. 5 is an exploded perspective view of a terminal block box of the heat pump device according to the first exemplary embodiment;

Fig. 6 is a perspective view illustrating an internal structure of the terminal block box of the heat pump device according to the first exemplary embodiment; and

Fig. 7 is a sectional view of the terminal block box of the heat pump device according to the first exemplary embodiment.

DETAILED DESCRIPTIONS

(Underlying knowledge and the like of the present disclosure)

[0008] At the time when the present inventors have conceived the present disclosure, a technique called a heat pump device is required to use a low global warming potential (GWP) refrigerant. Thus, the industry of a heat pump device has proposed a technique of isolating a refrigerant and an ignition source with a problem that a refrigerant having a low GWP is generally highly reactive and flammable. For example, a technique has been proposed in which a refrigerant release valve that releases pressure from a heat medium circuit is provided outside an outdoor unit so that a refrigerant released from the refrigerant release valve is less likely to be ignited when the refrigerant leaking from a refrigerant circuit enters the heat medium circuit.

[0009] Unfortunately, the technique has a problem that the refrigerant having leaked from the refrigerant circuit fills a space in which an electric box is installed, and the refrigerant may enter the inside of the electric box. The inventors have found the problem, and have constructed the subject matter of the present disclosure to solve the problem.

[0010] Thus, the present disclosure provides a heat pump device capable of suppressing intrusion of a refrigerant into an electric box and suppressing ignition of the refrigerant.

[0011] Hereinafter, an exemplary embodiment will be described in detail with reference to the accompanying

drawings. Unnecessarily detailed description may not be described. For example, a detailed description of already well-known matters or a duplicated description of a substantially identical configuration may not be described. This is to avoid an unnecessary redundancy in the following description and to facilitate understanding by those skilled in the art.

[0012] The accompanying drawings and the following description are only presented to help those skilled in the art fully understand the present disclosure and are not intended to limit the subject matters described in the scope of claims.

(First exemplary embodiment)

[0013] A first exemplary embodiment will be described below with reference to the accompanying drawings.

[1-1. Configuration]

[1-1-1. Configuration of heat pump device]

[0014] Fig. 1 is a front view of heat pump device 1 according to the first exemplary embodiment, and illustrates heat pump device 1 viewed from a front side. Fig. 2 is a perspective view illustrating an internal structure of heat pump device 1, and illustrates heat pump device 1 as viewed from the right front. Heat pump device 1 illustrated in Figs. 1 and 2 is an outdoor unit available for a so-called heat pump hot-water heater.

[0015] As illustrated in Fig. 1, heat pump device 1 includes housing 10 in a substantially rectangular parallelepiped shape. Each part of housing 10 according to the present exemplary embodiment is formed of a steel plate.

[0016] Housing 10 includes bottom plate 14 forming a bottom surface of housing 10, a pair of side panels 15 covering a right side of housing 10 from front and rear, front panel 16 covering a left side of a front surface of housing 10, and top plate 17 covering an upper surface of housing 10. Front panel 16 is provided with two openings 16a disposed vertically side by side, and blower 21 is exposed from each opening 16a. Although not illustrated in Fig. 1, opening 16a is covered from outside by a grid capable of ventilation in heat pump device 1 in use.

[0017] As illustrated in Fig. 2, housing 10 is provided inside with partition plate 11 extending in a vertical direction. Partition plate 11 horizontally partitions an internal space of housing 10 into blower chamber 12 and machine chamber 13.

[0018] Blower chamber 12 is provided with heat exchanger 20 and two blowers 21 disposed vertically side by side. Blower chamber 12 in housing 10 has a front surface covered with front panel 16.

[0019] Heat exchanger 20 of the present exemplary embodiment extends substantially fully along housing 10 in its height direction. Heat exchanger 20 is formed in a substantially L shape in plan view of housing 10 to be exposed to back surface 10A and side surface 10B of

housing 10.

[0020] As heat exchanger 20, a fin-tube heat exchanger is used, for example.

[0021] As blower 21, an axial fan including an impeller in a propeller-like shape is used, for example. Blower 21 is disposed with an axial-flow direction toward opening 16a of front panel 16.

[0022] Machine chamber 13 internally accommodates various devices constituting a refrigerant circuit, such as compressor 22, water heat exchanger 23, and expansion device 24 illustrated in Fig. 3 to be described later, and refrigerant pipe 25 connecting these devices to each other.

[0023] As water heat exchanger 23, a plate heat exchanger is used, for example.

[0024] Partition plate 11 has an upper part provided with cutout 26, and electric box 30 is installed in cutout 26. Electric box 30 is attached to an upper part of housing 10 across blower chamber 12 and machine chamber 13 by cutout 26 and electric box support plate 29a provided at an upper end of fan support frame 29 that supports blower 21. Disposing electric box 30 in the upper part of housing 10 as described above allows electric box 30 to be less likely to be wetted with water. As will be described later, a flammable refrigerant having larger specific gravity than air is used in the present exemplary embodiment. Thus, disposing electric box 30 in the upper part of housing 10 enables electric box 30 to be less likely to be exposed to the flammable refrigerant at high concentration when the refrigerant leaks.

[0025] Electric box 30 includes control board 38 inside electric box body 32 having opening 31 that is open upward. Control board 38 includes electric components such as a capacitor, a relay, and an inverter element for controlling blower 21, compressor 22, expansion device 24, four-way valve 27 to be described later, and the like. Details of electric box 30 will be described later.

[1-1-2. Configuration of refrigerant circuit]

[0026] Fig. 3 is a circuit diagram illustrating a refrigerant circuit of heat pump device 1 according to the first exemplary embodiment.

[0027] As illustrated in Fig. 3, compressor 22, four-way valve 27, water heat exchanger 23, expansion device 24, and heat exchanger 20 are annularly connected using predetermined refrigerant pipe 25 to constitute a refrigerant circuit.

[0028] Water heat exchanger 23 is connected to predetermined water supply pipe 28 to perform heat exchange between a refrigerant circulating through the refrigerant circuit and water flowing through water supply pipe 28 in water heat exchanger 23.

[0029] The refrigerant compressed by compressor 22 to be at high temperature and under high pressure flows as indicated by solid arrows in Fig. 3 to be fed to water heat exchanger 23. The refrigerant then exchanges heat with water flowing through water supply pipe 28 using

water heat exchanger 23 to be cooled and condensed. The water receives heat of the refrigerant to become hot water, and is fed to a utilization device (not illustrated) that uses the hot water, such as a heating device or a water heater.

[0030] The refrigerant discharged from water heat exchanger 23 is decompressed by expansion device 24 and is subjected to heat exchange with external air by heat exchanger 20. The refrigerant then becomes a gas refrigerant, and is returned to compressor 22 again.

[0031] Then, when four-way valve 27 is switched, the refrigerant is allowed to flow as indicated by broken line arrows in Fig. 3 to exchange heat with external air in heat exchanger 20 and to be decompressed by expansion device 24. The refrigerant is then fed to water heat exchanger 23, so that water flowing through water supply pipe 28 can be cooled. The cold water is fed to a utilization device (not illustrated) that uses cold water, such as a cooling device.

[0032] The present exemplary embodiment allows a flammable refrigerant to be used as the refrigerant. The flammable refrigerant is R32 or a mixed refrigerant containing R32 at 70 weight percent or more, or propane or a mixed refrigerant containing propane. The R32 and the propane are each a refrigerant having a low GWP, and each have a small environmental load. These refrigerants used in the present exemplary embodiment have larger specific gravity than air.

[0033] As the refrigerant, a non-flammable refrigerant may be used instead of the flammable refrigerant.

[1-1-3. Configuration of electric box]

[0034] Fig. 4 is a perspective view of electric box 30 of heat pump device 1 of the first exemplary embodiment.

[0035] As illustrated in Fig. 4, electric box 30 includes electric box body 32 made of sheet metal in a box shape, and first lid member 33 made of resin and formed in a substantially rectangular flat plate shape, first lid member 33 being configured to close opening 31 (see Fig. 2) of electric box body 32. Electric box body 32 is formed of a material having high thermal conductivity, such as a metal material.

[0036] Although the whole of electric box body 32 is formed of a metal material, only a part located in blower chamber 12 may be formed of a metal material.

[0037] As illustrated in Fig. 4, electric box body 32 includes blower side part 32A in a rectangular shape located facing blower chamber 12 and machine side part 32B in a rectangular shape located facing machine chamber 13. First lid member 33 includes blower side part 33A in a rectangular shape located facing blower chamber 12 and machine side part 33B in a rectangular shape located facing machine chamber 13.

[0038] Electric box body 32 is formed in a box shape by bending a sheet metal, and joint parts at four corners of the box are welded to form the box having airtightness.

[0039] Electric box body 32 has an upper end to which

first lid member 33 is fixed with fixing small screw 37 with an electric box sealant interposed between the upper end and first lid member 33. This structure causes opening 31 to be sealed by first lid member 33 and the electric box sealant. The electric box sealant is an annular rubber packing formed of foamed rubber, chloroprene rubber, ethylene propylene rubber (EPDM), nitrile rubber (NBR), hydrogenated nitrile rubber (H-NBR), or the like.

[0040] Electric box body 32 is disposed at a position allowing machine side part 32B to have a smaller ratio of occupied volume than blower side part 32A.

[0041] As a result, a seal length (a length of the electric box sealant) between electric box body 32 and first lid member 33 in machine side part 32B of electric box body 32 is set to be short.

[1-1-4. Configuration of terminal block box]

[0042] Fig. 5 is an exploded perspective view of terminal block box 50. Fig. 6 is a perspective view illustrating internal structure of terminal block box 50. Fig. 7 is a sectional view of terminal block box 50, and illustrates a section perpendicular to a left-right direction of terminal block box 50.

[0043] As illustrated in Figs. 4 and 5, electric box 30 includes terminal block box 50 attached to electric box body 32 from outside.

[0044] As illustrated in Fig. 5, terminal block box 50 includes metal frame 51, terminal block box body 53, second lid member 55, and terminal block 57.

[0045] Metal frame 51 is a metal member for fixing terminal block box 50 to electric box body 32, and is fixed to machine side part 32B of electric box body 32. Metal frame 51 includes fixing part 51a fixed to electric box body 32 and frame part 51b for fixing terminal block box body 53.

[0046] Fixing part 51a is fixed to side surface part 32B1 of machine side part 32B of electric box body 32, side surface part 32B1 facing forward, by welding from outside electric box body 32. Two fixing parts 51a are disposed at respective positions across first opening 32B2 in the left-right direction, first opening 32B2 being formed in side surface part 32B1 while passing through side surface part 32B1 in a front-rear direction.

[0047] Frame part 51b has a hollow substantially rectangular shape in front view, and is formed along an outer shape of terminal block box body 53. Frame part 51b extends from fixing part 51a to below lower surface 32C of electric box body 32. Frame part 51b has four sides with respective outer edges bent forward. Frame part 51b is also provided with a pair of left and right protrusions 51b1 extending rearward. Each of protrusions 51b1 has an upper end along lower surface 32C of electric box body 32 to prevent a part of frame part 51b from being bent backward, the part being below lower surface 32C. Frame part 51b are also provided with eight fastening holes 51c passing through frame part 51b in the front-rear direction. Each of fastening holes 51c has a spiral

screw groove to enable fastening member 59a to be fastened. Fastening member 59a is a screw, a bolt, or a small screw, for example, and is a screw in the present exemplary embodiment.

[0048] Terminal block box body 53 is a resin case that houses terminal block 57, and is fitted into frame part 51b inside its outer edges from the front. Terminal block box body 53 is provided with window opening 53a that is open forward, second opening 53b that is open rearward, and flange part 53c that overlaps frame part 51b.

[0049] Window opening 53a is open over substantially the entire front surface of terminal block box body 53. Second opening 53b passes through an upper part of terminal block box body 53 in the front-rear direction. Second opening 53b overlaps first opening 32B2 in front view in a state where terminal block box body 53 is fitted into frame part 51b.

[0050] Flange part 53c is formed in a shape expanding outward from window opening 53a. Flange part 53c is provided with eight fixing holes 53c1 passing through flange part 53c in the front-rear direction. Fixing holes 53c1 overlap respective eight fastening holes 51c in front view in a state where terminal block box body 53 is fitted into frame part 51b.

[0051] As illustrated in Figs. 5 and 6, terminal block box body 53 is fastened to side surface part 32B1 of electric box body 32 by fastening members 59b. Fastening member 59b is a screw, a bolt, or a small screw, for example, and is a screw in the present exemplary embodiment. Side surface part 32B1 is provided with two pairs of fastening holes 32B3 across first opening 32B2 in the left-right direction, fastening holes 32B3 passing through side surface part 32B1 in the front-rear direction and each having a thread groove. Terminal block box body 53 is provided with four fixing holes 53e at respective positions overlapping fastening holes 32B3 in front view, fixing holes 53e passing through terminal block box body 53 in the front-rear direction. Fastening member 59b is inserted into fixing hole 53e from the front and is fastened to fastening hole 32B3. As a result, terminal block box body 53 and electric box body 32 are fixed to each other.

[0052] Terminal block box body 53 is attached to side surface part 32B1 of electric box body 32 from outside with second sealant 52 interposed therebetween. Second sealant 52 is an annular rubber packing made of foamed rubber, chloroprene rubber, EPDM, NBR, H-NBR, or the like, and is an O-ring acquired by forming a string of foamed rubber having a circular section into an annular shape in the present exemplary embodiment. As second sealant 52, a flat rubber packing along side surface part 32B1 and terminal block box body 53 may be used.

[0053] As illustrated in Fig. 6, second sealant 52 is disposed surrounding first opening 32B2 and second opening 53b in front view. This structure enables suppressing intrusion of a refrigerant into electric box 30 from a gap between side surface part 32B1 and terminal block box

body 53 through first opening 32B2 or second opening 53b.

[0054] Electric box body 32 and terminal block box body 53 are fastened to each other with second sealant 52 interposed between peripheral end parts of first opening 32B2 and second opening 53b. That is, the two pairs of fastening holes 32B3 and the two pairs of fixing holes 53e are located inside second sealant 52 in front view, so that a refrigerant is less likely to enter the inside of electric box body 32 and terminal block box 50 through fastening holes 32B3 and fixing holes 53e.

[0055] As illustrated in Fig. 7, terminal block box body 53 is provided with second guide part 53f1 surrounding second opening 53b and second annular rubber packing groove 53f2 in which second sealant 52 is disposed, second annular rubber packing groove 53f2 surrounding second guide part 53f1.

[0056] Second guide part 53f1 is formed in a shape protruding rearward from the periphery of second opening 53b. Terminal block box body 53 is positioned with respect to electric box body 32 when second guide part 53f1 is inserted into first opening 32B2 from the front.

[0057] Second annular rubber packing groove 53f2 is an annular groove surrounding the periphery of second guide part 53f1, and is recessed forward. Second sealant 52 is disposed in second annular rubber packing groove 53f2 while being wound around second guide part 53f1. As described above, disposing second sealant 52 in second annular rubber packing groove 53f2 enables second sealant 52 to be prevented from being squeezed more than necessary when terminal block box body 53 is attached to electric box body 32. Thus, second sealant 52 is likely to be reduced in deterioration in sealing performance for a long period of time.

[0058] As illustrated in Figs. 5 and 7, second lid member 55 is a plate-like member made of resin, and closes window opening 53a of terminal block box body 53 from the front. Second lid member 55 covering window opening 53a has a smaller area than first lid member 33 covering opening 31 of electric box body 32. In other words, window opening 53a has a smaller area than opening 31 of electric box body 32. This structure reduces a part requiring sealing for maintaining airtightness of terminal block box 50, so that a refrigerant can be prevented from entering the inside of terminal block box 50 through window opening 53a after completion of work of connecting first power supply line 58a to terminal block 57. Thus, ignition of the refrigerant in electric box 30 and terminal block box 50 can be prevented.

[0059] Second lid member 55 includes eight fixing holes 55a. When second lid member 55 closes window opening 53a, eight fixing holes 55a overlap corresponding eight fixing holes 53c1 formed in flange part 53c of terminal block box body 53 and corresponding eight fastening holes 51c formed in frame part 51b of metal frame 51 in front view.

[0060] Fastening member 59a is inserted into fixing holes 55a, 53c1 and fastening hole 51c, which overlap

each other in the front-rear direction, from the front. Fastening member 59a is fastened to fastening hole 51c having the thread groove while passing through fixing holes 55a, 53c1 having no thread groove. As described above, terminal block box body 53 and second lid member 55 are fastened to metal frame 51 by fastening member 59a. Terminal block box body 53 and second lid member 55, which are made of resin, are fastened to metal frame 51 in the present exemplary embodiment, so that terminal block box body 53 and second lid member 55 can be firmly fixed. Then, fastening hole 51c having the thread groove for fastening is formed in metal frame 51 made of metal, terminal block box body 53, second lid member 55, and a female thread groove, which are made of resin, are less likely to be damaged at the time of fastening. Additionally, terminal block box body 53 is fastened to electric box body 32 and second lid member 55 is fastened to metal frame 51, so that no fastening hole for fastening member 59a is required to be formed in electric box body 32, and thus airtightness of electric box body 32 is likely to be ensured.

[0061] Second lid member 55 is attached to terminal block box body 53 from forward with first sealant 54 interposed therebetween. First sealant 54 is an annular rubber packing made of foamed rubber, chloroprene rubber, EPDM, NBR, H-NBR, or the like, and is an O-ring acquired by forming a string of foamed rubber having a circular section into an annular shape in the present exemplary embodiment. As first sealant 54, a flat rubber packing along second lid member 55 may be used.

[0062] As illustrated in Fig. 7, second lid member 55 is provided with first guide part 55b1 that protrudes rearward, and first annular rubber packing groove 55b2 that surrounds first guide part 55b1 and in which first sealant 54 is disposed.

[0063] First guide part 55b1 is formed in a shape along an inner edge of window opening 53a of terminal block box body 53, and is inserted into window opening 53a to position second lid member 55 with respect to terminal block box body 53.

[0064] First annular rubber packing groove 55b2 is an annular groove surrounding first guide part 55b1, and is recessed forward. First sealant 54 is disposed in first annular rubber packing groove 55b2 while being wound around first guide part 55b1. As described above, disposing first sealant 54 in first annular rubber packing groove 55b2 enables first sealant 54 to be prevented from being squeezed more than necessary when second lid member 55 is attached to terminal block box body 53. Thus, first sealant 54 is likely to be reduced in deterioration in sealing performance for a long period of time. First guide part 55b1 and first annular rubber packing groove 55b2 may be formed in terminal block box body 53 instead of second lid member 55.

[0065] As illustrated in Fig. 6, terminal block 57 is a device that connects first power supply line 58a and second power supply line 58b. Terminal block 57 holds distal ends of power supply lines 58a, 58b by fastening screws,

and electrically connects power supply lines 58a, 58b to each other. For example, a crimp terminal or the like is connected to each of the distal ends of power supply lines 58a, 58b.

[0066] First power supply line 58a is a cable with a conductor covered with an insulator, and is connected to an external power supply such as a commercial power supply. First power supply line 58a is drawn into terminal block box 50 through cable gland 56 attached to terminal block box body 53. Cable gland 56 is provided at a lower end of terminal block box body 53 while extending downward, and allows the inside of tube 56a through which first power supply line 58a passes to communicate with the inside of terminal block box 50 while sealing them. First power supply line 58a connected to an external power supply is connected to terminal block 57 mainly by work through window opening 53a after heat pump device 1 is installed.

[0067] Second power supply line 58b is a cable with a conductor covered with an insulator, and extends from terminal block 57 to pass through second opening 53b and first opening 32B2, and then is drawn into electric box body 32. Second power supply line 58b is connected to various boards and circuits inside electric box body 32 to supply electric power as a power source to various devices of heat pump device 1 such as compressor 22.

[0068] As illustrated in Figs. 6 and 7, terminal block 57 is disposed at a position exposed forward through window opening 53a in terminal block box body 53. Terminal block 57 is exposed forward from window opening 53a, so that work of connecting first power supply line 58a and terminal block 57 can be easily performed by removing second lid member 55.

[0069] More specifically, terminal block 57 is attached to recess 53d recessed rearward in terminal block box body 53. Recess 53d is positioned below lower surface 32C of electric box body 32 and overlaps lower surface 32C in plan view. Similarly, terminal block 57 is located below lower surface 32C and overlaps lower surface 32C in plan view. Thus, terminal block 57 can be disposed in a compact manner in plan view.

[0070] Terminal block 57 can be disposed at a position lower than electric box body 32, so that work of connecting first power supply line 58a and terminal block 57 is facilitated. In particular, heat pump device 1 according to the present exemplary embodiment includes a plurality of blowers 21 disposed side by side in the vertical direction. As a result, sufficient air blowing capacity is secured to cause a leaking refrigerant to be less likely to stay in housing 10, and housing 10 is compact in plan view and has a large shape in the vertical direction. Due to the large shape in the vertical direction, a general heat pump device is sometimes configured such that electric box body 32 disposed in an upper part of housing 10 to suppress exposure to water or a leaking refrigerant is disposed at a position higher than a preferable height (80% or less of a height of a worker, such as 150 cm or less) for performing connection work between terminal block

57 and first power supply line 58a. In contrast, terminal block 57 is disposed at a position lower than electric box body 32 in the present exemplary embodiment, so that the connection work between terminal block 57 and first power supply line 58a can be easily performed even in heat pump device 1 having a large dimension in the vertical direction.

[0071] As illustrated in Fig. 7, terminal block 57 includes terminal holder 57a to which power supply lines 58a, 58b are connected, terminal holder 57a being located substantially directly below second opening 53b. Thus, second power supply line 58b can be shortened in length.

[1-2. Operation]

[0072] Operation and action of heat pump device 1 configured as described above will be described.

[0073] When a flammable refrigerant leaks from heat exchanger 20 or the like in heat pump device 1, the flammable refrigerant diffuses inside housing 10. Heat pump device 1 here uses a flammable refrigerant having a larger specific gravity than air, so that a concentration of the refrigerant near electric box 30 located in the upper part of housing 10 is less likely to increase.

[0074] Even when the concentration of the refrigerant around electric box 30 increases, the refrigerant is less likely to enter electric box 30 or terminal block box 50 because electric box 30 is sealed by an electric box sealant, second sealant 52, and first sealant 54.

[1-3. Effects and the like]

[0075] As described above, heat pump device 1 in the present exemplary embodiment includes housing 10 internally provided with machine chamber 13 in which compressor 22 is disposed, and blower chamber 12 in which heat exchanger 20 and blower 21 are disposed, and uses a flammable refrigerant. Heat pump device 1 includes electric box 30 having electric box body 32 provided with first opening 32B2, first lid member 33, and terminal block box 50. Terminal block box 50 includes terminal block 57 that connects first power supply line 58a to second power supply line 58b, window opening 53a through which terminal block 57 is exposed, second lid member 55 that seals window opening 53a with first sealant 54 interposed therebetween, and second opening 53b, and is attached to electric box body 32 from outside with second sealant 52 surrounding first opening 32B2 and second opening 53b and being interposed between terminal block box 50 and electric box body 32 at a position where second opening 53b overlaps first opening 32B2. Second power supply line 58b is drawn into electric box body 32 through first opening 32B2.

[0076] This structure enables not only performing connection work of first power supply line 58a only by opening and closing second lid member 55 of terminal block box 50 without opening and closing first lid member 33

of electric box 30, but also securing airtightness of terminal block box 50 after the connection work. Thus, even when a refrigerant leaks from a refrigerant circuit, the refrigerant can be prevented from entering near terminal block 57 housed in terminal block box 50 and from increasing in concentration, and thus ignition of the refrigerant in electric box 30 and terminal block box 50 can be prevented.

[0077] As in the present exemplary embodiment, electric box body 32 may include blower side part 32A located facing blower chamber 12 and machine side part 32B located facing machine chamber 13, terminal block box 50 may be disposed in machine side part 32B, and second lid member 55 may have a smaller area than first lid member 33.

[0078] This structure reduces a part requiring sealing for maintaining airtightness of terminal block box 50, so that a refrigerant can be prevented from entering the inside of terminal block box 50 through window opening 53a after completion of work of connecting first power supply line 58a to terminal block 57. Thus, ignition of the refrigerant in electric box 30 and terminal block box 50 can be prevented. The present exemplary embodiment enables terminal block box 50 located in machine chamber 13 to be easily exposed to the outside of housing 10 by detaching side panel 15 from housing 10. Thus, the connection work between terminal block 57 and first power supply line 58a can be easily performed.

[0079] As in the present exemplary embodiment, terminal block box 50 may be configured to be fastened to electric box body 32 in a region between second sealant 52 and first opening 32B2 or in a region between second sealant 52 and second opening 53b.

[0080] This structure enables fixing hole 53e and fastening hole 32B3 for fastening terminal block box 50 and electric box body 32 to be disposed inside second sealant 52, so that an external refrigerant is less likely to enter electric box 30 and terminal block box 50 through fixing hole 53e and fastening hole 32B3. Thus, ignition of the refrigerant in electric box 30 and terminal block box 50 can be prevented.

[0081] As in the present exemplary embodiment, terminal block box 50 may be made of resin and supported by metal frame 51 fixed to electric box body 32, and terminal block box body 53 and second lid member 55 may be fastened to metal frame 51.

[0082] This structure enables suppressing cracking, crushing of a thread groove, and the like during fastening by fastening terminal block box 50 made of resin to metal frame 51. Thus, terminal block box 50 can be made of resin to be able to be easily manufactured, thereby enabling reduction in manufacturing cost. Using metal frame 51 enables terminal block box body 53 and second lid member 55 to be fixed without forming a fastening hole in electric box body 32. Thus, terminal block box body 53 and second lid member 55 can be fixed without adversely affecting airtightness of electric box 30. Metal frame 51 in the present exemplary embodiment is at-

tached to side surface part 32B1 of electric box body 32 by welding. Thus, metal frame 51 can be fixed to electric box body 32 without forming a hole in side surface part 32B1, and the airtightness of electric box 30 is less likely to be impaired.

[0083] As in the present exemplary embodiment, terminal block 57 may be disposed below lower surface 32C of electric box body 32 and at a position overlapping electric box body 32 in plan view.

[0084] Thus, terminal block 57 can be disposed in a compact manner in plan view. As a result, heat pump device 1 is likely to be reduced in outer dimension in plan view. Terminal block 57 in the present exemplary embodiment includes terminal holder 57a located substantially directly below second opening 53b, so that second power supply line 58b is likely to be shortened.

[0085] As in the present exemplary embodiment, terminal block box 50 may include cable gland 56 that draws first power supply line 58a from the outside and seals terminal block box 50.

[0086] This structure enables securing airtightness when first power supply line 58a is drawn into terminal block box 50 using cable gland 56, and enables preventing a leaking refrigerant from entering terminal block box 50. Thus, ignition of the refrigerant in terminal block box 50 can be prevented.

[0087] As in the present exemplary embodiment, first sealant 54 and second sealant 52 may be annular rubber packing or plate-like rubber packing.

[0088] As a result, adhesion between terminal block box 50 and electric box body 32 and adhesion between terminal block box body 53 and second lid member 55 are improved to enable improvement in airtightness. Thus, ignition of the refrigerant in electric box 30 and terminal block box 50 can be prevented.

[0089] As in the present exemplary embodiment, terminal block box body 53 or second lid member 55 may be provided with first annular rubber packing groove 55b2, and second lid member 55 and terminal block box body 53 may be fixed by fastening member 59a with first sealant 54 inserted into first annular rubber packing groove 55b2, first sealant 54 being sandwiched between second lid member 55 and terminal block box body 53.

[0090] This structure enables improvement in sealability using first sealant 54 sandwiched between second lid member 55 and terminal block box body 53. Disposing first sealant 54 in first annular rubber packing groove 55b2 prevents first sealant 54 from being squeezed more than necessary. Thus, first sealant 54 is likely to be reduced in deterioration in sealing performance for a long period of time.

[0091] As in the present exemplary embodiment, a plurality of blowers 21 may be disposed in the vertical direction in blower chamber 12.

[0092] This configuration enables securing air blowing capacity to cause a leaking refrigerant to be less likely to stay in housing 10. Heat pump device 1 is then reduced in external dimension in plan view and increased in ex-

ternal dimension in the vertical direction. When terminal block 57 is located below lower surface 32C of electric box body 32 as in the present exemplary embodiment, terminal block 57 is likely to be located at a desired height for performing the connection work between terminal block 57 and first power supply line 58a. Thus, ignition is less likely to occur in heat pump device 1 when the refrigerant leaks, and the connection work between terminal block 57 and first power supply line 58a can be facilitated.

[0093] As in the present exemplary embodiment, the flammable refrigerant may be composed of R32 or a mixed refrigerant containing 70 weight percent or more of R32, or propane or a mixed refrigerant containing propane.

[0094] As a result, the flammable refrigerant has a larger specific gravity than air, so that the leaking flammable refrigerant is less likely to have a high concentration near electric box 30 and terminal block box 50 located in an upper part of heat pump device 1. Thus, ignition of the refrigerant due to electric box 30 and terminal block box 50 can be prevented.

(Other exemplary embodiments)

[0095] The first exemplary embodiment has been described above as an example of the technique disclosed in the present application. However, the technique in the present disclosure is not limited to the above exemplary embodiment, and can also be applied to exemplary embodiments in which change, substitution, addition, omission, and the like are made. Alternatively, the components described in the above first exemplary embodiment may be combined to make an additional exemplary embodiment.

[0096] Thus, other exemplary embodiments will be described below.

[0097] Although the first exemplary embodiment is described in which heat pump device 1 includes two blowers 21 disposed side by side vertically, this is an example. The number of blowers 21 may be three or more, or may be one. The plurality of blowers 21 may be disposed side by side horizontally without being disposed side by side vertically, for example.

[0098] Although the first exemplary embodiment is described in which terminal block box 50 includes recess 53d below lower surface 32C of electric box body 32, recess 53d overlapping electric box body 32 in plan view, and terminal block 57 is provided in recess 53d, this is an example. For example, recess 53d may be formed above first lid member 33 and formed in a shape overlapping electric box body 32 in plan view. Alternatively, terminal block box body 53 may not include recess 53d located below lower surface 32C, and terminal block 57 may be provided at the same height as electric box body 32.

[0099] Although the first exemplary embodiment is described in which heat pump device 1 is an outdoor unit

available for a so-called heat pump hot-water heater, this is an example. For example, heat pump device 1 may be an outdoor unit of an air conditioner that performs air conditioning by circulating a refrigerant between heat pump device 1 and an indoor unit.

[0100] The exemplary embodiment described above is to exemplify the techniques in the present disclosure, and thus, various modifications, replacements, additions, omissions, and the like can be made in the scope of claims or in an equivalent scope of the claims.

[Configuration supported by the above exemplary embodiment]

[0101] The above exemplary embodiment supports configurations below.

(Note)

[0102] (Technique 1) A heat pump device uses a flammable refrigerant and includes a housing including a machine chamber including a compressor disposed in the machine chamber and a blower chamber including a heat exchanger and a blower, an electric box including an electric box body in which a first opening is formed, a first lid member, and a terminal block box. The terminal block box includes a terminal block that connects a first power supply line to a second power supply line, a terminal block box body including a window opening from which the terminal block is exposed, a second lid member that seals the window opening with a first sealant interposed between the terminal block box body and the second lid member, and a second opening. The second opening overlaps the first opening at a position where the terminal block box is attached to the electric box body from outside while a second sealant surrounding the first opening and the second opening is interposed between the terminal block box and the electric box body. Then, the second power supply line is drawn into the electric box body through the first opening.

[0103] This structure enables not only performing connection work of the first power supply line only by opening and closing the second lid member of the terminal block box without opening and closing the first lid member of the electric box, but also securing airtightness of the terminal block box after the connection work. Thus, even when a refrigerant leaks from a refrigerant circuit, the refrigerant can be prevented from entering near the terminal block housed in the terminal block box and from increasing in concentration, and thus ignition of the refrigerant in the electric box and the terminal block box can be prevented.

[0104] (Technique 2) The heat pump device described in Technique 1 is configured such that the electric box body includes a blower side part located facing the blower chamber and a machine side part located facing the machine chamber, the terminal block box is disposed in the machine side part, and the second lid member has a

smaller area than the first lid member.

[0105] This structure reduces a part requiring sealing for maintaining airtightness of the terminal block box, so that a refrigerant can be prevented from entering the inside of the terminal block box through the window opening after completion of work of connecting the first power supply line to the terminal block. Thus, ignition of the refrigerant in the electric box and the terminal block box can be prevented.

[0106] (Technique 3) The heat pump device described in Technique 1 or 2 is configured such that the terminal block box is fastened to the electric box body in a region between the second sealant and the first opening or in a region between the second sealant and the second opening.

[0107] This structure enables a fastening hole for fastening the terminal block box and the electric box body to be disposed inside the second sealant, so that an external refrigerant is less likely to enter the electric box and the terminal block box through the fastening hole. Thus, ignition of the refrigerant in the electric box and the terminal block box can be prevented.

[0108] (Technique 4) The heat pump device described in any one of Techniques 1 to 3 is configured such that the terminal block box is made of resin and supported by a metal frame fixed to the electric box body, and the terminal block box body and the second lid member are fastened to the metal frame.

[0109] This structure enables suppressing cracking, crushing of a thread groove, and the like during fastening by fastening the terminal block box made of resin to the metal frame. Thus, the terminal block box can be made of resin to be able to be easily manufactured, thereby enabling reduction in manufacturing cost. Using the metal frame enables the terminal block box body and the second lid member to be fixed without forming a fastening hole in the electric box body. Thus, the terminal block box body and the second lid member can be fixed without adversely affecting airtightness of the electric box.

[0110] (Technique 5) The heat pump device described in any one of Techniques 1 to 4 is configured such that the terminal block is disposed below a lower surface of the electric box body and at a position overlapping the electric box body in plan view.

[0111] Thus, terminal block can be disposed in a compact manner in plan view. As a result, the heat pump device is likely to be reduced in outer dimension in plan view.

[0112] (Technique 6) The heat pump device described in any one of Techniques 1 to 5 is configured such that the terminal block box includes a cable gland that draws the first power supply line from an outside and seals the terminal block box.

[0113] This structure enables securing airtightness when the first power supply line is drawn into the terminal block box using the cable gland, and enables preventing a leaking refrigerant from entering the terminal block box. Thus, ignition of the refrigerant in the terminal block box

can be prevented.

[0114] (Technique 7) The heat pump device described in any one of Techniques 1 to 6 is configured such that the first sealant and the second sealant are each annular rubber packing or plate-like rubber packing.

[0115] As a result, adhesion between the terminal block box and the electric box body and adhesion between the terminal block box body and the second lid member are improved to enable improvement in airtightness. Thus, ignition of the refrigerant in the electric box and the terminal block box can be prevented.

[0116] (Technique 8) The heat pump device described in any one of Techniques 1 to 7 is configured such that the terminal block box body or the second lid member includes an annular rubber packing groove, and the second lid member and the terminal block box body are fixed by a fixing member with the first sealant inserted into the annular rubber packing groove, the first sealant being sandwiched between the second lid member and the terminal block box body.

[0117] This structure enables improvement in sealability using the first sealant sandwiched between the second lid member and the terminal block box body. Disposing the first sealant in the first annular rubber packing groove prevents the first sealant from being squeezed more than necessary. Thus, the first sealant is likely to be reduced in deterioration in sealing performance for a long period of time.

[0118] (Technique 9) The heat pump device described in Technique 5 is configured such that a plurality of blowers each being the blower is disposed in the vertical direction in the blower chamber.

[0119] This configuration enables securing air blowing capacity to cause a leaking refrigerant to be less likely to stay in the housing. The heat pump device is then reduced in external dimension in plan view and increased in external dimension in the vertical direction. When the terminal block is located below the lower surface of the electric box body, the terminal block is likely to be located at a desired height for performing connection work between the terminal block and the first power supply line. Thus, ignition is less likely to occur in the heat pump device when the refrigerant leaks, and the connection work between the terminal block and the first power supply line can be facilitated.

[0120] (Technique 10) The heat pump device described in any one of Techniques 1 to 9 is configured such that the flammable refrigerant is composed of R32 or a mixed refrigerant containing 70 weight percent or more of R32, or propane or a mixed refrigerant containing propane.

[0121] As a result, the flammable refrigerant has a larger specific gravity than air, so that the leaking flammable refrigerant is less likely to have a high concentration near the electric box and the terminal block box located in an upper part of the heat pump device. Thus, ignition of the refrigerant due to the electric box and the terminal block box can be prevented.

[0122] The present disclosure is applicable to a heat pump device. Specifically, the present disclosure is applicable to an outdoor unit of an air conditioner, a heat pump hot-water heater, and the like.

Claims

1. A heat pump device that uses a flammable refrigerant, the heat pump device comprising:

a housing including:

a machine chamber including a compressor disposed in the machine chamber; and
a blower chamber including a heat exchanger and a blower; and

an electric box including:

an electric box body in which a first opening is formed;
a first lid member; and
a terminal block box,

the terminal block box including:

a terminal block that connects a first power supply line to a second power supply line;
a terminal block box body including a window opening from which the terminal block is exposed;
a second lid member that seals the window opening with a first sealant interposed between the terminal block box body and the second lid member; and
a second opening,

the second opening overlapping the first opening at a position where the terminal block box is attached to the electric box body from outside while a second sealant surrounding the first opening and the second opening is interposed between the terminal block box and the electric box body, and
the second power supply line being drawn into the electric box body through the first opening.

2. The heat pump device according to Claim 1, wherein

the electric box body includes a blower side part located facing the blower chamber and a machine side part located facing the machine chamber,
the terminal block box is disposed in the machine side part, and
the second lid member has a smaller area than the first lid member.

3. The heat pump device according to Claim 1, wherein the terminal block box is fastened to the electric box body in a region between the second sealant and the first opening or in a region between the second sealant and the second opening. 5

4. The heat pump device according to Claim 1, wherein

the terminal block box is made of resin and supported by a metal frame fixed to the electric box body, and 10
 the terminal block box body and the second lid member are fastened to the metal frame.

5. The heat pump device according to Claim 1, wherein the terminal block is disposed below a lower surface of the electric box body and at a position overlapping the electric box body in plan view. 15

6. The heat pump device according to Claim 1, wherein the terminal block box includes a cable gland that draws the first power supply line from an outside and seals the terminal block box. 20

7. The heat pump device according to Claim 1, wherein the first sealant and the second sealant are each annular rubber packing or plate-like rubber packing. 25

8. The heat pump device according to Claim 1, wherein

the terminal block box body or the second lid member includes an annular rubber packing groove, and 30
 the second lid member and the terminal block box body are fixed by a fixing member with the first sealant inserted into the annular rubber packing groove, the first sealant being sandwiched between the second lid member and the terminal block box body. 35

9. The heat pump device according to Claim 5, wherein a plurality of blowers each being the blower is disposed in a vertical direction in the blower chamber. 40

10. The heat pump device according to Claim 1, wherein the flammable refrigerant is composed of R32 or a mixed refrigerant containing 70 weight percent or more of R32, or propane or a mixed refrigerant containing propane. 45

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FIG. 1

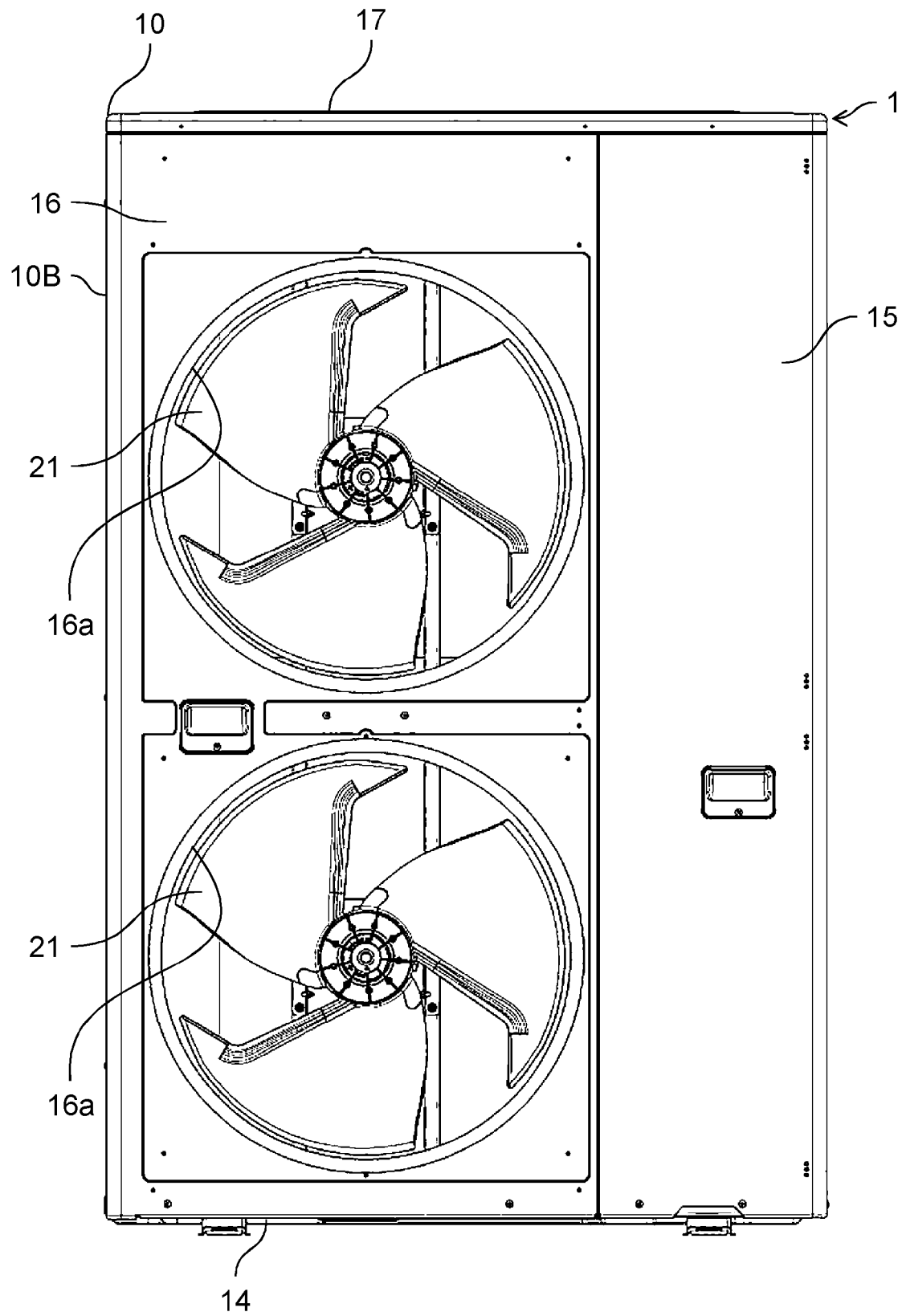


FIG. 2

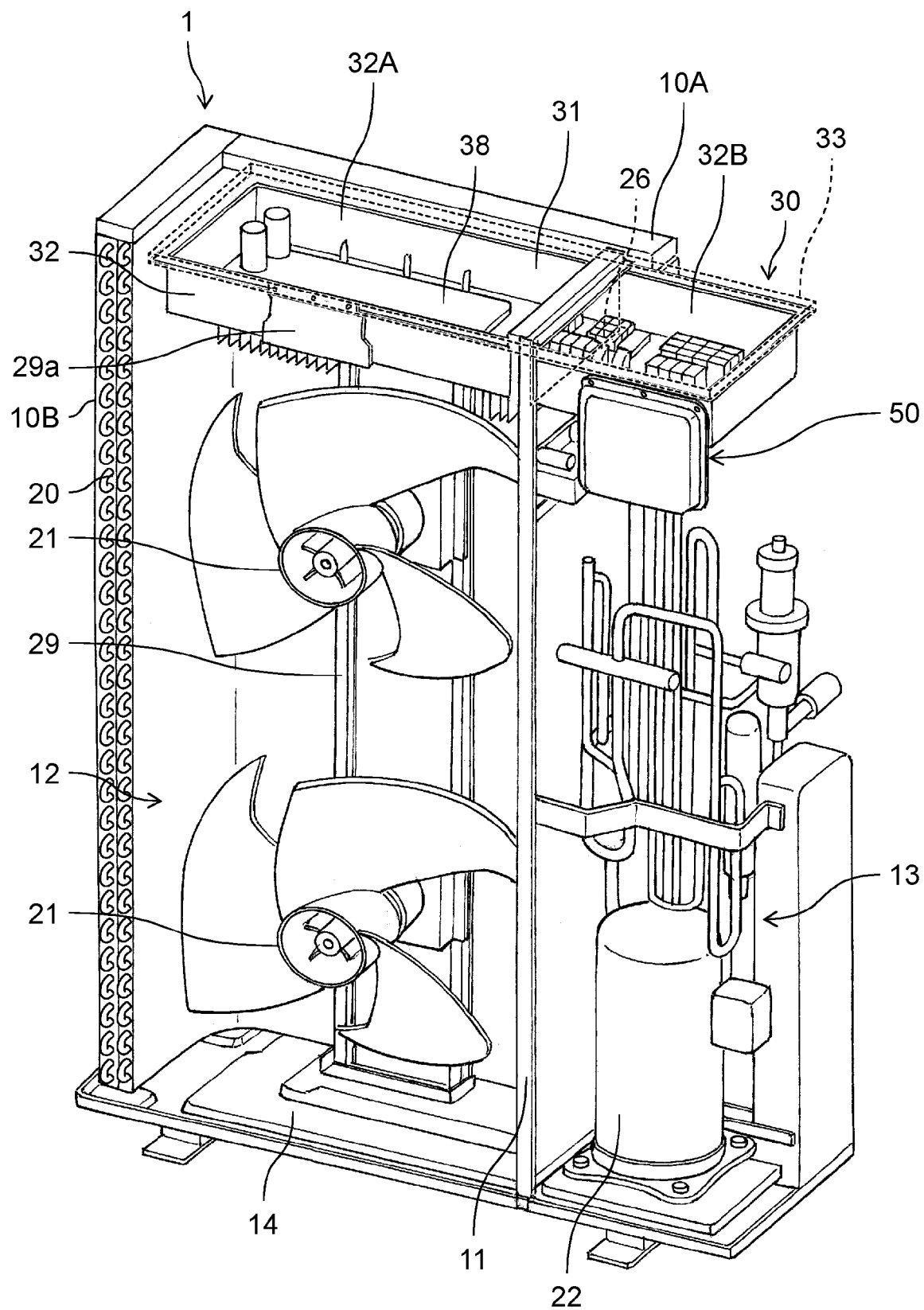


FIG. 3

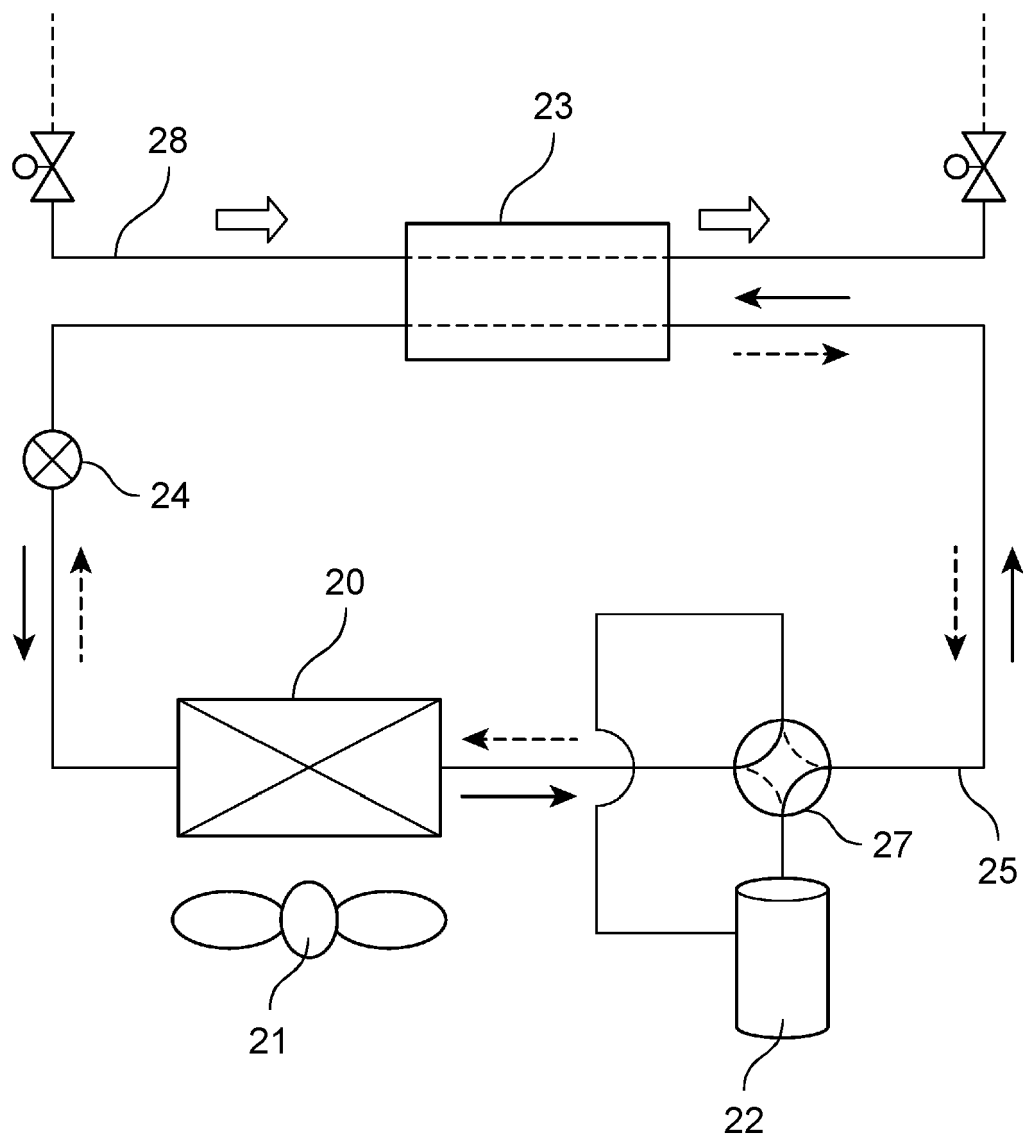


FIG. 4

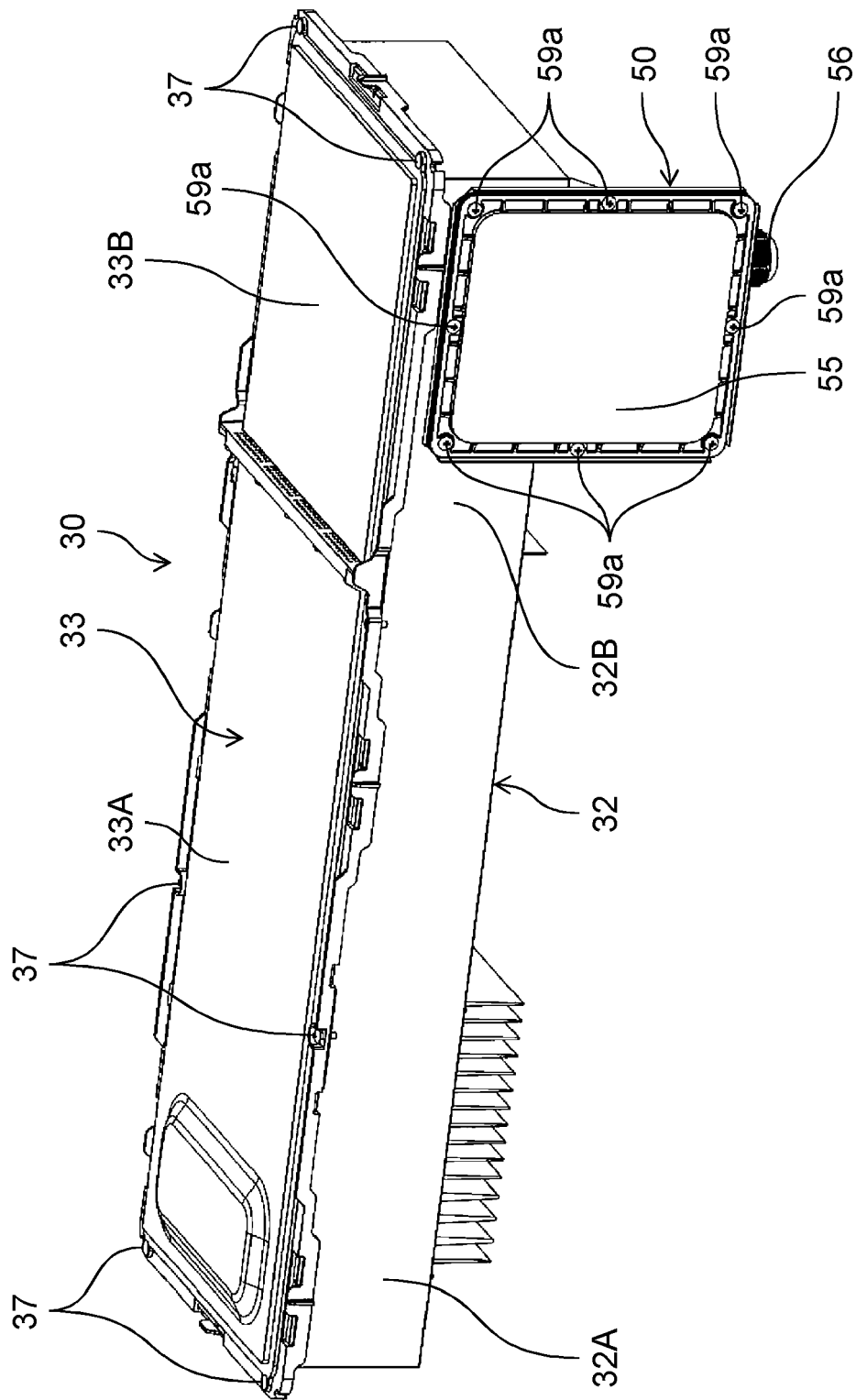


FIG. 5

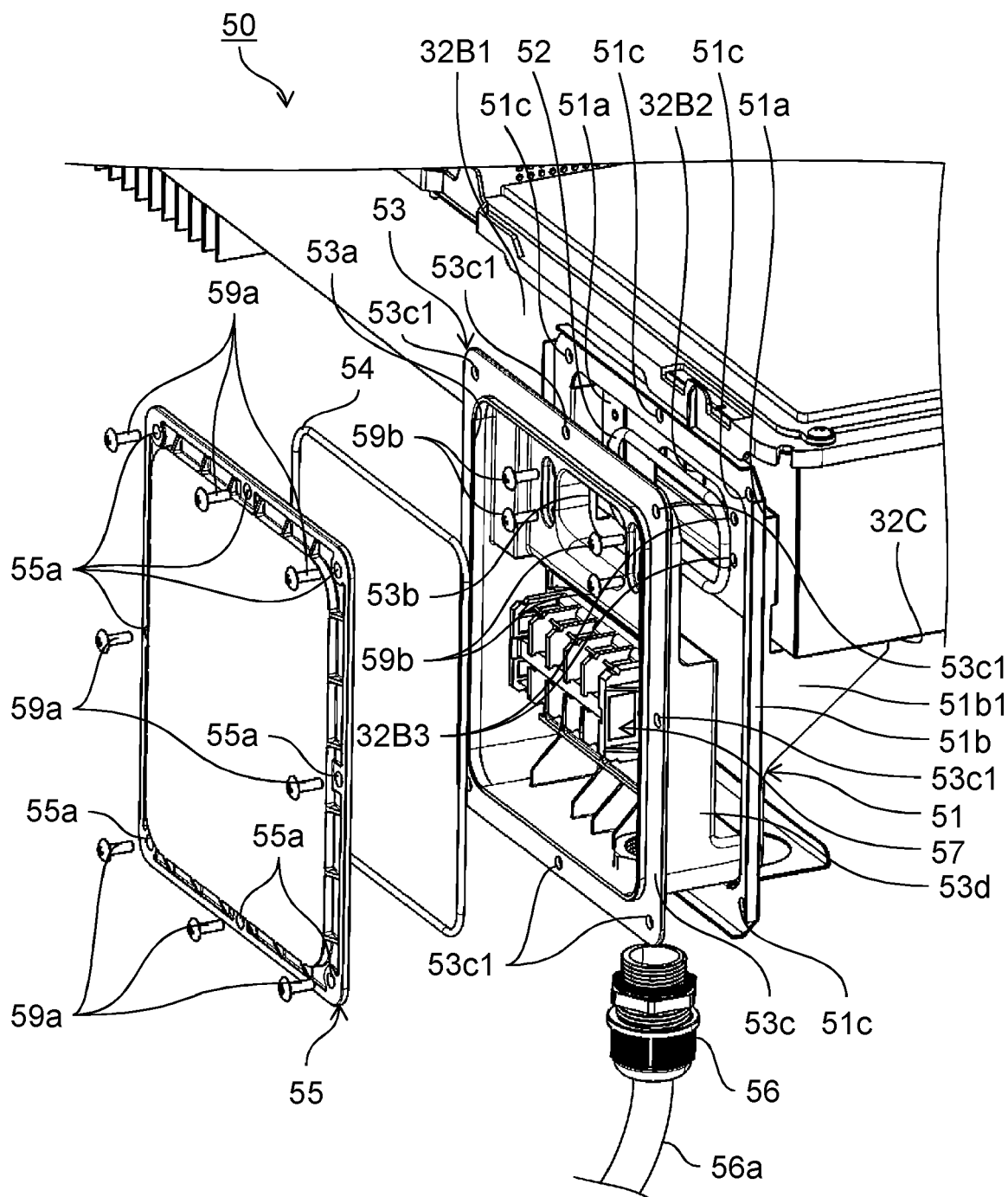


FIG. 6

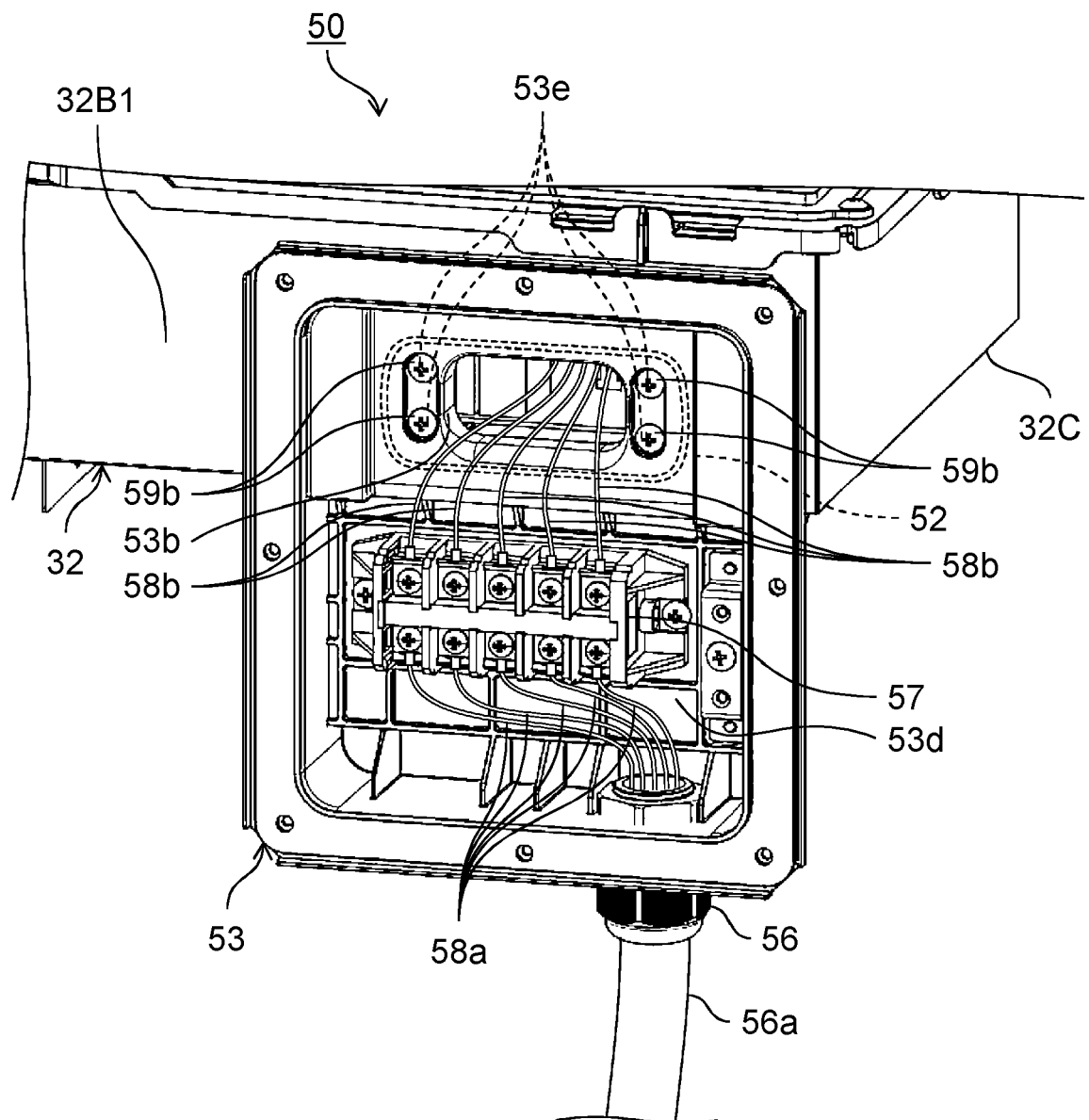
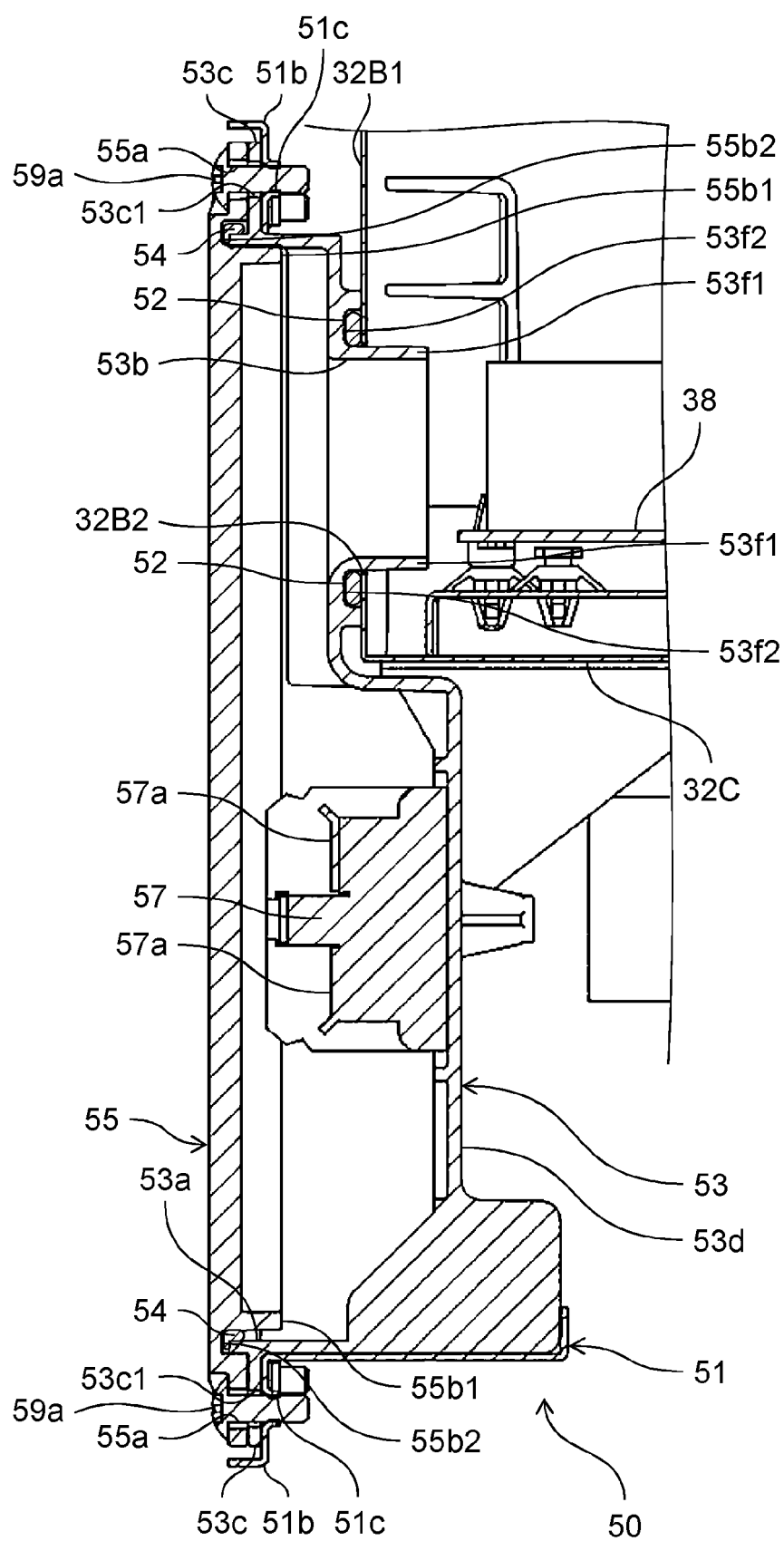


FIG. 7





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