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

(11) **EP 4 502 481 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.02.2025 Bulletin 2025/06

(21) Application number: **24192041.2**

(22) Date of filing: **31.07.2024**

(51) International Patent Classification (IPC):
F24F 11/36 *(2018.01)* ***F24F 13/20*** *(2006.01)*
F24F 140/00 *(2018.01)*

(52) Cooperative Patent Classification (CPC):
F24F 11/36; F24F 13/20; F25B 49/005;
F24F 2140/00; F25B 2400/12; F25B 2500/22;
F25B 2500/222

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

(30) Priority: **31.07.2023 JP 2023124459**

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

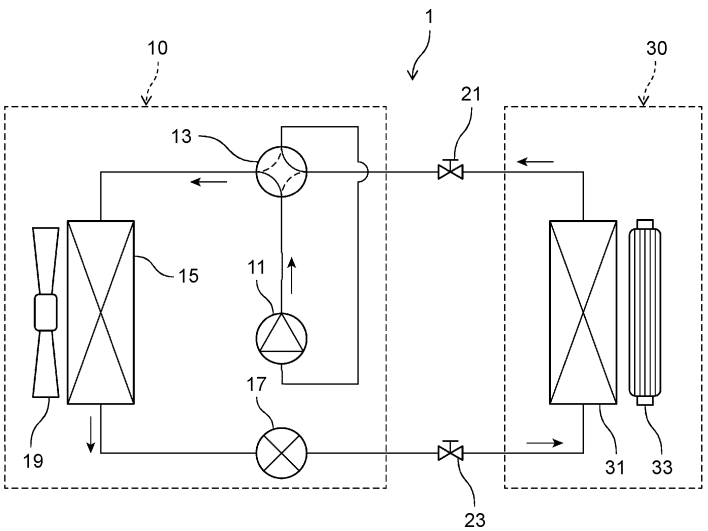
(72) Inventors:
- **SATOH, Keiji**
  Kadoma-shi, Osaka, 571-0057 (JP)
- **KOBAYASHI, Hideyuki**
  Kadoma-shi, Osaka, 571-0057 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Gollierstraße 4
80339 München (DE)

(54) **AIR CONDITIONER**

(57) An air conditioner includes an outdoor unit and an indoor unit connected to each other by a refrigerant pipe and has a refrigeration cycle circuit filled with a flammable refrigerant. The indoor unit includes a machine compartment where an electric box is provided, a connection pipe storage storing a connection pipe connected to the refrigerant pipe, a blower path allowing an air that has exchanged heat with the flammable refrigerant in an indoor heat exchanger to flow in the blower path by driving of an indoor blower, and a leak detection sensor that detects leakage of the flammable refrigerant, the machine compartment and the blower path communicate with each other by a first path, the machine compartment and the connection pipe storage communicate with each other by a second path, and the leak detection sensor is provided near the second path.

FIG. 1



EP 4 502 481 A1

Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to an air conditioner.

2. Description of the Related Art

[0002] PTL 1 discloses an air conditioner using a flammable refrigerant. The air conditioner includes a leak detection sensor in an indoor unit to detect leakage of the flammable refrigerant. The leak detection sensor is disposed in a blower passage where an indoor heat exchanger is provided in the indoor unit. The indoor unit includes a communication path through which a pipe connection space in which a pipe connection is disposed communicates with the blower passage.

[0003] PTL 2 discloses an indoor unit using a flammable refrigerant. The indoor unit includes a refrigerant sensor that detects leakage of the refrigerant. The refrigerant sensor is disposed in an air path for a short-circuit operation. When the concentration of the refrigerant detected by the refrigerant sensor is higher than a first threshold, the indoor unit starts the short-circuit operation. The indoor unit then compares the concentration of the refrigerant detected by the refrigerant sensor with a second threshold to determine whether there is a leakage of refrigerant.

Citation List

Patent Literatures

[0004]

PTL 1: Unexamined Japanese Patent Publication No. 2022-112061
PTL 2: Japanese Patent No. 6431339

SUMMARY

[0005] The present disclosure provides an air conditioner capable of detecting refrigerant leakage early in case when a flammable refrigerant leaks in an indoor unit.

[0006] An air conditioner according to one aspect of the present disclosure is an air conditioner including an outdoor unit and an indoor unit connected to each other by a refrigerant pipe and having a refrigeration cycle circuit filled with a flammable refrigerant, wherein the indoor unit includes a machine compartment where an electric box is provided, a connection pipe storage storing a connection pipe connected to the refrigerant pipe, a blower path allowing an air that has exchanged heat with the flammable refrigerant in an indoor heat exchanger to flow in the blower path by driving of an indoor blower, and a leak detection sensor that detects leakage of the flammable refrigerant, the machine compartment and the blower path communicate with each other by a first path, the machine compartment and the connection pipe storage communicate with each other by a second path, and the leak detection sensor is provided near the second path.

[0007] The air conditioner according to the present disclosure includes the leak detection sensor provided at a place where the flammable refrigerant readily passes in case when the flammable refrigerant leaks in the indoor unit. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a refrigeration cycle diagram of an air conditioner according to a first exemplary embodiment;
Fig. 2 is a perspective view of an indoor unit according to the first exemplary embodiment;
Fig. 3 is a cross-sectional view of the indoor unit according to the first exemplary embodiment;
Fig. 4 is a front view illustrating an internal structure of the indoor unit according to the first exemplary embodiment;
Fig. 5 is a cross-sectional view taken along line V-V in Fig. 4;
Fig. 6 is a rear view of the indoor unit according to the first exemplary embodiment;
Fig. 7 is a perspective view of the indoor unit taken along line VII-VII in Fig. 6;
Fig. 8 is a perspective view of the indoor unit taken along line VIII-VIII in Fig. 6;
Fig. 9 is a cross-sectional view of an indoor unit according to a second exemplary embodiment;
Fig. 10 is a cross-sectional view of an indoor unit according to a third exemplary embodiment; and
Fig. 11 is a front view illustrating an internal structure of an indoor unit according to a fourth exemplary embodiment.

DETAILED DESCRIPTIONS

(Underlying knowledge and the like of present disclosure)

[0009] At the time when the inventors have arrived at the idea of the present disclosure, R32 refrigerant has widely been used as refrigerants for air conditioners. However, R32 has high global warming potential (GWP), and there has been a concern about an influence on climate change. Thus, using natural refrigerants having low GWP, such as isobutane and propane, as refrigerants for air conditioners has been proposed. These low GWP refrigerants are flammable, so that a technique has been proposed in which a leak detection sensor capable

of detecting leakage of a refrigerant is provided in an indoor unit. Under such circumstances, the inventors have found the problem that when a flammable refrigerant has leaked in a room, the leakage of the refrigerant needs to be detected early, and to solve the problem, have constructed the subject matters of the present disclosure.

[0010] According to the present disclosure, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0011] An exemplary embodiment will now be described in detail with reference to the drawings. However, unnecessarily detailed description may be omitted. For example, detailed descriptions of already known matters and redundant descriptions of substantially identical configurations may be omitted. This is to avoid unnecessary redundancy in the following description and to facilitate understanding of those skilled in the art.

[0012] The accompanying drawings and the following description are 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 claims.

(First exemplary embodiment)

[0013] A first exemplary embodiment will be described with reference to Figs. 1 to 6.

[1-1. Configuration]

[1-1-1. Configuration of refrigeration cycle circuit]

[0014] Fig. 1 is a refrigeration cycle diagram of air conditioner 1 according to the first exemplary embodiment, schematically illustrating a refrigeration cycle circuit that air conditioner 1 has. The refrigeration cycle circuit of air conditioner 1 includes outdoor unit 10 and indoor unit 30. R290 (i.e., propane), which is a flammable refrigerant, as a refrigerant is filled in the refrigeration cycle circuit of air conditioner 1.

[0015] Outdoor unit 10 is installed outdoors, and includes compressor 11, four-way valve 13, outdoor heat exchanger 15, and expansion valve 17 that are sequentially connected by refrigerant pipes. Compressor 11 compresses the refrigerant sucked from a suction port and discharges the compressed refrigerant from a discharge port. Four-way valve 13 is connected to the suction port and the discharge port of compressor 11, and causes the suction port and the discharge port to communicate with outdoor heat exchanger 15 or indoor heat exchanger 31 by switching the flow paths. Outdoor heat exchanger 15 is a fin-tube heat exchanger, for example, and exchanges heat between external air and the inside refrigerant by driving outdoor blower 19. Outdoor blower 19 is an axial fan, for example. Expansion valve 17 decompresses the refrigerant.

[0016] Indoor unit 30 is installed indoors, and includes indoor heat exchanger 31 and indoor blower 33. Indoor heat exchanger 31 communicates with four-way valve 13 and expansion valve 17 via refrigerant pipe connections 21, 23. Indoor heat exchanger 31 is a fin-tube heat exchanger, for example. Indoor blower 33 is a device that is driven to exchange heat between indoor air and the refrigerant inside indoor heat exchanger 31, and is a cross-flow fan, for example.

[0017] Air conditioner 1 performs air conditioning by circulating the refrigerant in the refrigeration cycle circuit by driving compressor 11 and returning the indoor air that has exchanged heat with the refrigerant by indoor heat exchanger 31 to the room. Air conditioner 1 can also switch between a heating operation and a cooling operation by switching the flow paths of four-way valve 13.

[1-1-2. Configuration of indoor unit]

[0018] Fig. 2 is a perspective view of indoor unit 30. Fig. 3 is a cross-sectional view of indoor unit 30, illustrating a section perpendicular to the left-right direction of indoor unit 30. Reference sign X in the drawings indicates the rightward direction of indoor unit 30, reference sign Y indicates the frontward direction of indoor unit 30, and reference sign Z indicates the upward direction of indoor unit 30. Directions such as up, down, left, right, front, and rear in the following description indicate directions with respect to indoor unit 30 unless otherwise specified.

[0019] Indoor unit 30 is a wall-mounted indoor unit attached to wall surface W in a room. Indoor unit 30 includes cover member 35 having a box shape elongated in the left-right direction. Cover member 35 is a housing that houses indoor heat exchanger 31 and indoor blower 33 illustrated in Fig. 1, and is made of a resin or the like. Cover member 35 covers indoor heat exchanger 31 and indoor blower 33 from the left, right, up, down, and front sides, and opens the rear side, or a back side. The opening on the back side of cover member 35 is closed by back panel 38. Back panel 38 is a member made of resin or the like. Indoor unit 30 is attached to wall surface W by fixing back panel 38 to metal installation plate 40 fixed to wall surface W.

[0020] Cover member 35 has air outlet 36 through which the inside and the outside of cover member 35 communicate. Air outlet 36 is an opening extending in the left-right direction across substantially the entire length of cover member 35. Indoor unit 30 blows the air that has exchanged heat with the refrigerant in indoor heat exchanger 31 into the room from air outlet 36 to perform air conditioning of the room.

[0021] As illustrated in Fig. 3, blower path 30A is provided between air outlet 36 and indoor blower 33. Blower path 30A is a path between front drain pan 32 on the front side and back panel 38. The air that has exchanged heat with the flammable refrigerant in indoor heat exchanger 31 flows through blower path 30A by the driving of indoor blower 33. The air flowing through blower path 30A is blown into the room from air outlet 36.

[0022] Plate-shaped flap 37 is disposed at air outlet 36 to change the flow direction of the air blown out from air outlet 36. When air conditioner 1 as illustrated in Figs. 2 and 4 is in a stopped state, flap 37 is held to fit along the profile of cover member 35 to close substantially the entire area of air outlet 36.

[0023] Fig. 4 is a front view illustrating an internal structure of indoor unit 30. Partition plate 31a is provided at right end 31R of indoor heat exchanger 31. Partition plate 31a is a plate member that separates blower path 30A from machine compartment 30B. Electric box 39 is provided in machine compartment 30B. In the present exemplary embodiment, blower path 30A is on the left side of partition plate 31a, and machine compartment 30B is on the right side of partition plate 31a. Portions of U-shaped bent pipes 31R1 brazed at right end 31R of indoor heat exchanger 31 are exposed in machine compartment 30B on the right side of partition plate 31a. In the inner side of cover member 35, U-shaped bent pipes 31L1 that have been bent are provided at left end 31L of indoor heat exchanger 31.

[0024] As illustrated in Figs. 3 and 4, drain pan 32 is provided below indoor heat exchanger 31. Drain pan 32 is a member that receives dew condensation water, defrosting water, and the like resulting from condensation in indoor heat exchanger 31. As illustrated in Fig. 3, two drain pans 32 are provided in front of and behind indoor blower 33. As illustrated in Fig. 4, drain pan 32 extends across the entire length in the left-right direction of indoor heat exchanger 31 and into machine compartment 30B.

[0025] First path 31a1 is formed in partition plate 31a. First path 31a1 extends through partition plate 31a in the left-right direction. First path 31a1 is a hole that connects blower path 30A and machine compartment 30B. In the present exemplary embodiment, first path 31a1 is provided higher than drain pan 32 (see Fig. 3).

[0026] Fig. 5 is a cross-sectional view taken along line V-V in Fig. 4, and illustrates a cross section of indoor unit 30 in machine compartment 30B. Electric box 39 is disposed in machine compartment 30B. Electric box 39 is a box-shaped part, and stores therein a control board and the like for controlling the components of indoor unit 30.

[0027] Fig. 6 is a rear view of indoor unit 30, and illustrates back panel 38 as viewed from the rear side. As illustrated in Figs. 5 and 6, connection pipe storage 38a is on the rear side of back panel 38. Connection pipe storage 38a is a space between installation plate 40 and a lower portion of back panel 38 that is bent toward the front side. In other words, back panel 38 is a member that separates blower path 30A and machine compartment 30B from connection pipe storage 38a. Connection pipe storage 38a extends in the left-right direction across substantially the entire length of back panel 38, from blower path 30A to machine compartment 30B.

[0028] Connection pipe 31b and drain hose 32a are stored in connection pipe storage 38a. Connection pipe 3 1b is a pipe in which liquid connection pipe 31b1 and gas connection pipe 31b2 are bundled, and is integrated with indoor unit 30.

[0029] Liquid connection pipe 31b1 has one end connected to indoor heat exchanger 31 and the other end connected to an external refrigerant pipe via refrigerant pipe connection 23. Liquid connection pipe 31b1 is connected to expansion valve 17 via the external refrigerant pipe connected by refrigerant pipe connection 23.

[0030] Gas connection pipe 31b2 has one end connected to indoor heat exchanger 31 and the other end connected to an external refrigerant pipe via refrigerant pipe connection 21. Gas connection pipe 31b2 is connected to four-way valve 13 via the external refrigerant pipe connected by refrigerant pipe connection 21.

[0031] Drain hose 32a is a hose connected to drain pan 32 inside machine compartment 30B. Drain hose 32a drains dew condensation water, defrosting water, and the like received by drain pan 32 to the outside.

[0032] As illustrated in Figs. 5 and 6, second path 38b connecting machine compartment 30B and connection pipe storage 38a is formed in back panel 38. Second path 38b is a hole for allowing drain hose 32a to pass from the inside of machine compartment 30B to connection pipe storage 38a. Second path 38b is located in a lower portion of machine compartment 30B. Second path 38b is located near a lower portion of right end 31R of indoor heat exchanger 31.

[0033] As illustrated in Fig. 5, leak detection sensor 50 that detects leaked flammable refrigerant is provided near second path 38b. The meaning of "near second path 38b" includes at a place inside second path 38b and at a place outside but near second path 38b. In the present exemplary embodiment, leak detection sensor 50 is provided inside second path 38b. Thus, leak detection sensor 50 has a smaller cross-sectional area than second path 38b. Specifically, in cross section C perpendicular to the direction from machine compartment 30B to connection pipe storage 38a, the cross-sectional area of leak detection sensor 50 is smaller than the cross-sectional area of second path 38b.

[0034] Fig. 7 is a perspective view of indoor unit 30 with a cross section taken along line VII-VII in Fig. 6, illustrating indoor unit 30 as viewed from the right rear side. Fig. 8 is a perspective view of indoor unit 30 with a cross section taken along line VIII-VIII in Fig. 6, illustrating indoor unit 30 as viewed from the left rear side. The cross section taken along line VII-VII is about 10 cm to the left from the right end of indoor unit 30, and the cross section taken along line VIII-VIII is about 1 cm to the right from the left end of indoor unit 30.

[0035] As described above, second path 38b is a hole for allowing mainly drain hose 32a and connection pipe 31b to pass from the inside of machine compartment 30B to connection pipe storage 38a. Thus, the dimension of the opening of second path 38b has a size that allows drain hose 32a and connection pipe 31b to pass through. As illustrated in Fig. 7, the opening area of second path 38b is partially closed by drain hose 32a and connection pipe 31b passing inside second path 38b.

[0036] As illustrated in Fig. 8, third path 38c that allows left end 31L of indoor heat exchanger 31 to communicate with connection pipe storage 38a is formed at the left end of back panel 38. The opening area of third path 38c is larger than the opening area of second path 38b. Connection pipe 31b and a wiring (not illustrated) pass through second path 38b but do not pass through third path 38c. Third path 38c has a larger unblocked area than second path 38b. When the refrigerant leaks at left end 31L of indoor heat exchanger 31, the refrigerant flows into connection pipe storage 38a via third path 38c by a first amount. When the refrigerant leaks at right end 31R, the refrigerant flows into connection pipe storage 38a via second path 38b by a second amount. The first amount of the refrigerant tends to be larger than the second amount of the refrigerant.

[1-2. Operation]

[0037] For air conditioner 1 configured as described above, the flow of the flammable refrigerant that has leaked in indoor unit 30 in a stopped state will be described. A case where the flammable refrigerant leaks at a brazed portion of bent pipe 31R1 at right end 31R of indoor heat exchanger 31, a case where the flammable refrigerant leaks at a bent portion of U-shaped bent pipe 31L1 at left end 31L of indoor heat exchanger 31, and a case where the flammable refrigerant leaks at connection pipe 31b will be described below. In particular, leakage of the flammable refrigerant is likely to occur at these places.

[1-2-1. Case where leakage occurs at right end of indoor heat exchanger]

[0038] An example of a flow of the flammable refrigerant that has leaked at a brazed portion of bent pipe 31R1 at right end 31R of indoor heat exchanger 31 will be described. In this case, the flammable refrigerant leaks from indoor heat exchanger 31 to around partition plate 31a.

[0039] In the present exemplary embodiment, the flammable refrigerant is R290, which has a larger specific gravity than air, so that the flammable refrigerant that has leaked at the left side of partition plate 31a is received by drain pan 32. The flammable refrigerant flows rightward along the drain pan 32, and flows into the machine compartment 30B via the first path 31a1 or directly from drain pan 32.

[0040] The flammable refrigerant that flows along drain pan 32 into machine compartment 30B and the flammable refrigerant that directly leaks into machine compartment 30B through right end 31R flow into a space below electric box 39 and into second path 38b. The flammable refrigerant that has flown into second path 38b flows into connection pipe storage 38a. The flammable refrigerant that has flown into connection pipe storage 38a flows downward through the gap between wall surface W and back panel 38 with cover member 35 to flow out into the room.

[0041] In the present exemplary embodiment, leak detection sensor 50 is provided near second path 38b, more specifically, inside second path 38b. Thus, leak detection sensor 50 can detect leakage of the refrigerant when the flammable refrigerant flows into second path 38b.

[0042] The refrigerant that has flown into second path 38b then flows into connection pipe storage 38a. As described above, since the opening area of second path 38b is smaller than that of third path 38c and drain hose 32a and connection pipe 31b pass through second path 38b, the amount of the flammable refrigerant flowing into connection pipe storage 38a is small. The small amount of flammable refrigerant that has flown into connection pipe storage 38a slowly spreads leftward in connection pipe storage 38a and arrives at third path 38c. Thus, when leak detection sensor 50 is provided in the left part of indoor unit 30 such as at third path 38c, it takes time to detect the flammable refrigerant that has leaked at right end 31R far from leak detection sensor 50.

[1-2-2. Case where leakage occurs at left end of indoor heat exchanger]

[0043] An example of a flow of the flammable refrigerant that has leaked at a bent portion of bent pipe 31L1 at left end 31L of indoor heat exchanger 31 will be described. In this case, the leaked flammable refrigerant flows from left end 31L to drain pan 32 below left end 31L. The leaked flammable refrigerant flows from left end 31L to connection pipe storage 38a through the gap between cover member 35 and back panel 38. As described above, the amount of the flammable refrigerant that has leaked from left end 31L flowing into connection pipe storage 38a is larger than the amount of the flammable refrigerant that would leak from right end 31R and flow into connection pipe storage 38a.

[0044] In the present exemplary embodiment, the flammable refrigerant is R290, which has a larger specific gravity than air. Thus, the flammable refrigerant that has flown into machine compartment 30B from drain pan 32 arrives at a space below electric box 39 and at second path 38b. Then, the flammable refrigerant flows into connection pipe storage 38a via second path 38b.

[0045] A portion of the flammable refrigerant that has flown into connection pipe storage 38a from left end 31L of indoor heat exchanger 31 flows downward through the gap between wall surface W and back panel 38 with cover member 35 to flow out into the room. The remaining portion of the flammable refrigerant that has flown into connection pipe storage 38a flows rightward in connection pipe storage 38a and arrives at second path 38b. When the refrigerant leaks from left end 31L, the amount of the flammable refrigerant flowing into connection pipe storage 38a is larger than a case where the refrigerant leaks from the right end 31R, so that the speed of the

flammable refrigerant spreading rightward in connection pipe storage 38a is high. Thus, the leaked flammable refrigerant quickly arrives also at second path 38b far from left end 31L where the leakage has occurred. Then, the flammable refrigerant flows into machine compartment 30B via second path 38b.

[0046] In the present exemplary embodiment, leak detection sensor 50 is provided near second path 38b, more specifically, inside second path 38b. Thus, the leakage of the refrigerant can be detected when the leaked flammable refrigerant arrives at second path 38b via drain pan 32 and machine compartment 30B, or when the leaked flammable refrigerant arrives at second path 38b via connection pipe storage 38a.

[1-2-3. Case where leakage occurs at connection pipe]

[0047] When the flammable refrigerant leaks at connection pipe 3 1b, the flammable refrigerant leaks into connection pipe storage 38a. A portion of the flammable refrigerant that has leaked into connection pipe storage 38a flows downward through the gap between wall surface W and back panel 38 with cover member 35 to flow out into the room. The remaining portion of the flammable refrigerant that has flown into connection pipe storage 38a spreads in the left-right direction in connection pipe storage 38a and arrives at second path 38b. The flammable refrigerant that has arrived at second path 38b flows into machine compartment 30B.

[0048] In the present exemplary embodiment, leak detection sensor 50 is provided near second path 38b, more specifically, inside second path 38b. Thus, leak detection sensor 50 can detect leakage of the refrigerant when the flammable refrigerant flows into second path 38b.

[0049] As described above, in the present exemplary embodiment, leak detection sensor 50 is disposed near second path 38b where the leaked flammable refrigerant readily passes, so that the leakage of the refrigerant can be detected early. It may be configured that, after detection of leakage of the refrigerant, the control board or the like in electric box 39 drives indoor blower 33 to diffuse the flammable refrigerant that has leaked from indoor unit 30 into the room, thereby hindering formation of a flammable region.

[1-3. Effects]

[0050] As described in the present exemplary embodiment, indoor unit 30 of air conditioner 1 includes machine compartment 30B where electric box 39 is provided, connection pipe storage 38a storing connection pipe 31b connected to the refrigerant pipe, blower path 30A allowing the air that has exchanged heat with the flammable refrigerant in indoor heat exchanger 31 to flow in blower path 30A by driving of indoor blower 33, and leak detection sensor 50 that detects leakage of the flammable refrigerant, machine compartment 30B and blower path 30A communicate with each other by first path 31a1, machine compartment 30B and connection pipe storage 38a communicate with each other by second path 38b, and leak detection sensor 50 is provided near second path 38b.

[0051] With this configuration, in case when the flammable refrigerant leaks in indoor unit 30, the leakage of the refrigerant can be detected by the leak detection sensor 50 provided near second path 38b where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in indoor unit 30, the leakage of the refrigerant can be detected early.

[0052] As in the present exemplary embodiment, leak detection sensor 50 may be provided inside second path 38b in indoor unit 30 of air conditioner 1.

[0053] With this configuration, in case when the flammable refrigerant leaks in indoor unit 30, the leakage of the refrigerant can be detected by leak detection sensor 50 provided inside second path 38b where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in indoor unit 30, the leakage of the refrigerant can be detected early.

[0054] Second to fourth exemplary embodiments will be described below. In the following description, only differences from the first exemplary embodiment will be described, and description similar to that of the first exemplary embodiment will be omitted.

(Second exemplary embodiment)

[0055] A second exemplary embodiment will be described below with reference to Fig. 9.

[2-1. Configuration]

[0056] Fig. 9 is a cross-sectional view of the machine compartment 30B of indoor unit 130 according to the second exemplary embodiment, illustrating a cross section corresponding to Fig. 5 of the first exemplary embodiment.

[0057] Unlike the first exemplary embodiment, leak detection sensor 50 is provided outside second path 38b in indoor unit 130 according to the second exemplary embodiment. Specifically, leak detection sensor 50 is provided near second path 38b in machine compartment 30B. Leak detection sensor 50 is located below electric box 39.

[2-2. Operation]

[0058] As described in the first exemplary embodiment, when the flammable refrigerant leaks in indoor unit 130, the flammable refrigerant arrives at second path 38b early. Thus, leak detection sensor 50 provided near the second path 38b can detect the leakage of the refrigerant early. In the second exemplary embodiment, the leakage of the refrigerant can be detected when the flammable refrigerant flows into the machine compartment 30B, so

that the leakage of the refrigerant, in particular leakage at right end 31R of indoor heat exchanger 31, is readily detected early as compared with the first exemplary embodiment.

[2-3. Effects]

[0059] As described above, in the present exemplary embodiment, leak detection sensor 50 is provided near second path 38b in machine compartment 30B.

[0060] With this configuration, in case when the flammable refrigerant leaks in indoor unit 130, the leakage of the refrigerant can be detected by leak detection sensor 50 provided near second path 38b where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in indoor unit 130, the leakage of the refrigerant can be detected early.

[0061] In the present exemplary embodiment, the leakage of the refrigerant in particular at right end 31R of indoor heat exchanger 31 is readily detected early.

(Third exemplary embodiment)

[0062] A third exemplary embodiment will be described below with reference to Fig. 10.

[3-1. Configuration]

[0063] Fig. 10 is a cross-sectional view of machine compartment 30B of indoor unit 230 according to the third exemplary embodiment, illustrating a cross section corresponding to Fig. 5 of the first exemplary embodiment. Unlike the first exemplary embodiment, leak detection sensor 50 is provided outside second path 38b in indoor unit 230 according to the third exemplary embodiment. Specifically, leak detection sensor 50 is provided near second path 38b in connection pipe storage 38a. Leak detection sensor 50 is located below second path 38b.

[3-2. Operation]

[0064] As described in the first exemplary embodiment, when the flammable refrigerant leaks in indoor unit 230, the flammable refrigerant arrives at second path 38b early. Thus, leak detection sensor 50 provided near the second path 38b can detect the leakage of the refrigerant early. In the third exemplary embodiment, leakage of the flammable refrigerant can be detected when the refrigerant flows into the vicinity of second path 38b in connection pipe storage 38a, so that the leakage of the refrigerant in particular at connection pipe 3 1b or left end 31L of indoor heat exchanger 31 is readily detected early as compared with the first exemplary embodiment.

[3-3. Effects]

[0065] As described above, in the present exemplary embodiment, leak detection sensor 50 is provided near second path 38b in connection pipe storage 38a.

[0066] With this configuration, in case when the flammable refrigerant leaks in indoor unit 230, the leakage of the refrigerant can be detected by leak detection sensor 50 provided near second path 38b where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in indoor unit 230, the leakage of the refrigerant can be detected early.

[0067] In the present exemplary embodiment, the leakage of the refrigerant in particular at connection pipe 3 1b or left end 31L of indoor heat exchanger 31 is readily detected early.

(Fourth exemplary embodiment)

[0068] A fourth exemplary embodiment will be described below with reference to Fig. 11.

[4-1. Configuration]

[0069] Fig. 11 is a front view illustrating an internal structure of indoor unit 330 according to the fourth exemplary embodiment, and is a view corresponding to Fig. 4 according to the first exemplary embodiment. Unlike the first to third exemplary embodiments, leak detection sensor 50 is provided not near second path 38b but near first path 31a1 and in blower path 30A in indoor unit 330 according to the fourth exemplary embodiment. More specifically, leak detection sensor 50 of the fourth exemplary embodiment is provided outside but near first path 31a1 and in blower path 30A. Leak detection sensor 50 is provided lower than first path 31a1 and drain pan 32.

[4-2. Operation]

[0070] As described in the first exemplary embodiment, when the flammable refrigerant leaks at left end 31L of indoor heat exchanger 31, the flammable refrigerant flows rightward along drain pan 32 and into machine compartment 30B via first path 31a1.

[0071] Thus, in the fourth exemplary embodiment in which leak detection sensor 50 is provided near first path 31a1 in blower path 30A, the leakage of the refrigerant in particular at left end 31L is readily detected early as compared with the first exemplary embodiment.

[4-3. Effects]

[0072] As described in the present exemplary embodiment, indoor unit 330 of air conditioner 1 includes machine compartment 30B where electric box 39 is provided, connection pipe storage 38a storing connection pipe 31b connected to the refrigerant pipe, blower path 30A allowing the air that has exchanged heat with the flammable refrigerant in indoor heat exchanger 31 to flow in blower path 30A by driving of indoor blower 33, and leak detection sensor 50 that detects leakage of the

flammable refrigerant, machine compartment 30B and blower path 30A communicate with each other by first path 31a1, machine compartment 30B and connection pipe storage 38a communicate with each other by second path 38b, and leak detection sensor 50 is provided near first path 31a1 in blower path 30A.

[0073] With this configuration, in case when the flammable refrigerant leaks in indoor unit 330, the leakage of the refrigerant can be detected by leak detection sensor 50 provided near first path 31a1 where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in indoor unit 330, the leakage of the refrigerant can be detected early.

[0074] In the present exemplary embodiment, the leakage of the refrigerant in particular at connection pipe 3 1b or left end 31L of indoor heat exchanger 31 is readily detected early.

(Other exemplary embodiments)

[0075] As described above, the first to fourth exemplary embodiments have been described as examples of the technique disclosed in the present application. However, the techniques according to the present disclosure are not limited to those of the above exemplary embodiments, 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 first to fourth exemplary embodiments may be combined to make another exemplary embodiment.

Other exemplary embodiments will be described below.

[0076] The above exemplary embodiments have been described that R290 is used as the flammable refrigerant, but the flammable refrigerant is not limited to R290. A flammable refrigerant having a larger specific gravity than air is desirably used. When such a flammable refrigerant leaks, the refrigerant behaves like R290 refrigerant. Examples of desirable flammable refrigerants include R600 and R600a.

[0077] These flammable refrigerants may be used singly, or may be used as a mixed refrigerant including two or more selected from the group including R32, R1234yf, R1234ze, R1132(E), and HFO-1123. Examples of the refrigerant to be mixed include a refrigerant having a higher density than air under atmospheric pressure (e.g., at room temperature (25°C)).

[0078] In the described examples in the above exemplary embodiments, one leak detection sensor 50 is provided in indoor unit 30, but the number of leak detection sensors 50 provided in indoor unit 30 is not limited to one. For example, indoor unit 30 may include one leak detection sensor 50 disposed at any of the places in the first to third exemplary embodiments and one leak detection sensor 50 disposed at the place in the fourth exemplary embodiment. As long as indoor unit 30 includes one or more leak detection sensors 50 each disposed at any of the places in the first to fourth exemplary embodiments, indoor unit 30 may include any number of other leak detection sensor 50 provided at any place.

[Configurations supported by exemplary embodiments described above]

[0079] The exemplary embodiments described above support the following configurations.

(Appendix)

[0080] (Technique 1) An air conditioner comprising an outdoor unit and an indoor unit, a refrigerant pipe connecting the outdoor unit to the indoor unit, a refrigeration cycle circuit filled with a flammable refrigerant, wherein the indoor unit includes a machine compartment including an electric box, a connection pipe storage storing a connection pipe connected to the refrigerant pipe, an indoor heat exchanger, an indoor blower, a blower path allowing an air that has exchanged heat with the flammable refrigerant in the indoor heat exchanger to flow in the blower path by driving of the indoor blower, a leak detection sensor that detects leakage of the flammable refrigerant, and a first path and a second path, the machine compartment and the blower path communicate with each other by the first path, the machine compartment and the connection pipe storage communicate with each other by the second path, and the leak detection sensor is provided near the second path.

[0081] With this configuration, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected by the leak detection sensor provided near the second path where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0082] (Technique 2) The air conditioner according to Technique 1, wherein the leak detection sensor is provided inside the second path.

[0083] With this configuration, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected by the leak detection sensor provided inside the second path where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0084] (Technique 3) The air conditioner according to Technique 1, wherein the leak detection sensor is provided near the second path in the machine compartment.

[0085] With this configuration, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected by the leak detection sensor provided near the second path where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0086] (Technique 4) The air conditioner according to Technique 1, wherein the leak detection sensor is provided near the second path in the connection pipe storage.

[0087] With this configuration, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected by the leak detection sensor provided near the second path where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0088] (Technique 5) An air conditioner comprising an outdoor unit and an indoor unit, a refrigerant pipe connecting the outdoor unit to the indoor unit, and a refrigeration cycle circuit filled with a flammable refrigerant, wherein the indoor unit includes a machine compartment including an electric box a connection pipe storage storing a connection pipe connected to the refrigerant pipe, an indoor heat exchanger, an indoor blower, a blower path allowing an air that has exchanged heat with the flammable refrigerant in the indoor heat exchanger to flow in the blower path by driving of the indoor blower, a leak detection sensor that detects leakage of the flammable refrigerant, and a first path and a second path, the machine compartment and the blower path communicate with each other by the first path, the machine compartment and the connection pipe storage communicate with each other by the second path, and the leak detection sensor is provided near the first path in the blower path.

[0089] With this configuration, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected by the leak detection sensor provided near the first path where the flammable refrigerant readily passes. Thus, in case when the flammable refrigerant leaks in the indoor unit, the leakage of the refrigerant can be detected early.

[0090] The present disclosure can be applied to air conditioners. Specifically, the present disclosure is applicable to air conditioners for household use, air conditioners for business use, and the like.

Claims

1. An air conditioner comprising:

an outdoor unit and an indoor unit;
a refrigerant pipe connecting the outdoor unit to the indoor unit; and
a refrigeration cycle circuit filled with a flammable refrigerant,
wherein the indoor unit includes

a machine compartment including an electric box,
a connection pipe storage storing a connection pipe connected to the refrigerant pipe,
an indoor heat exchanger,
an indoor blower,
a blower path allowing an air that has exchanged heat with the flammable refrigerant in the indoor heat exchanger to flow in the blower path by driving of the indoor blower,
a leak detection sensor that detects leakage of the flammable refrigerant, and
a first path and a second path,

the machine compartment and the blower path communicate with each other by the first path,
the machine compartment and the connection pipe storage communicate with each other by the second path, and
the leak detection sensor is provided near the second path.

2. The air conditioner according to Claim 1, wherein the leak detection sensor is provided inside the second path.

3. The air conditioner according to Claim 1, wherein the leak detection sensor is provided near the second path in the machine compartment.

4. The air conditioner according to Claim 1, wherein the leak detection sensor is provided near the second path in the connection pipe storage.

5. An air conditioner comprising:

an outdoor unit and an indoor unit;
a refrigerant pipe connecting the outdoor unit to the indoor unit; and
a refrigeration cycle circuit filled with a flammable refrigerant,
wherein the indoor unit includes

a machine compartment including an electric box,
a connection pipe storage storing a connection pipe connected to the refrigerant pipe,
an indoor heat exchanger,
an indoor blower,
a blower path allowing an air that has exchanged heat with the flammable refrigerant in the indoor heat exchanger to flow in the blower path by driving of the indoor blower,
a leak detection sensor that detects leakage of the flammable refrigerant, and
a first path and a second path,

the machine compartment and the blower path communicate with each other by the first path,
the machine compartment and the connection pipe storage communicate with each other by

the second path, and
the leak detection sensor is provided near the first path in the blower path.

FIG. 1

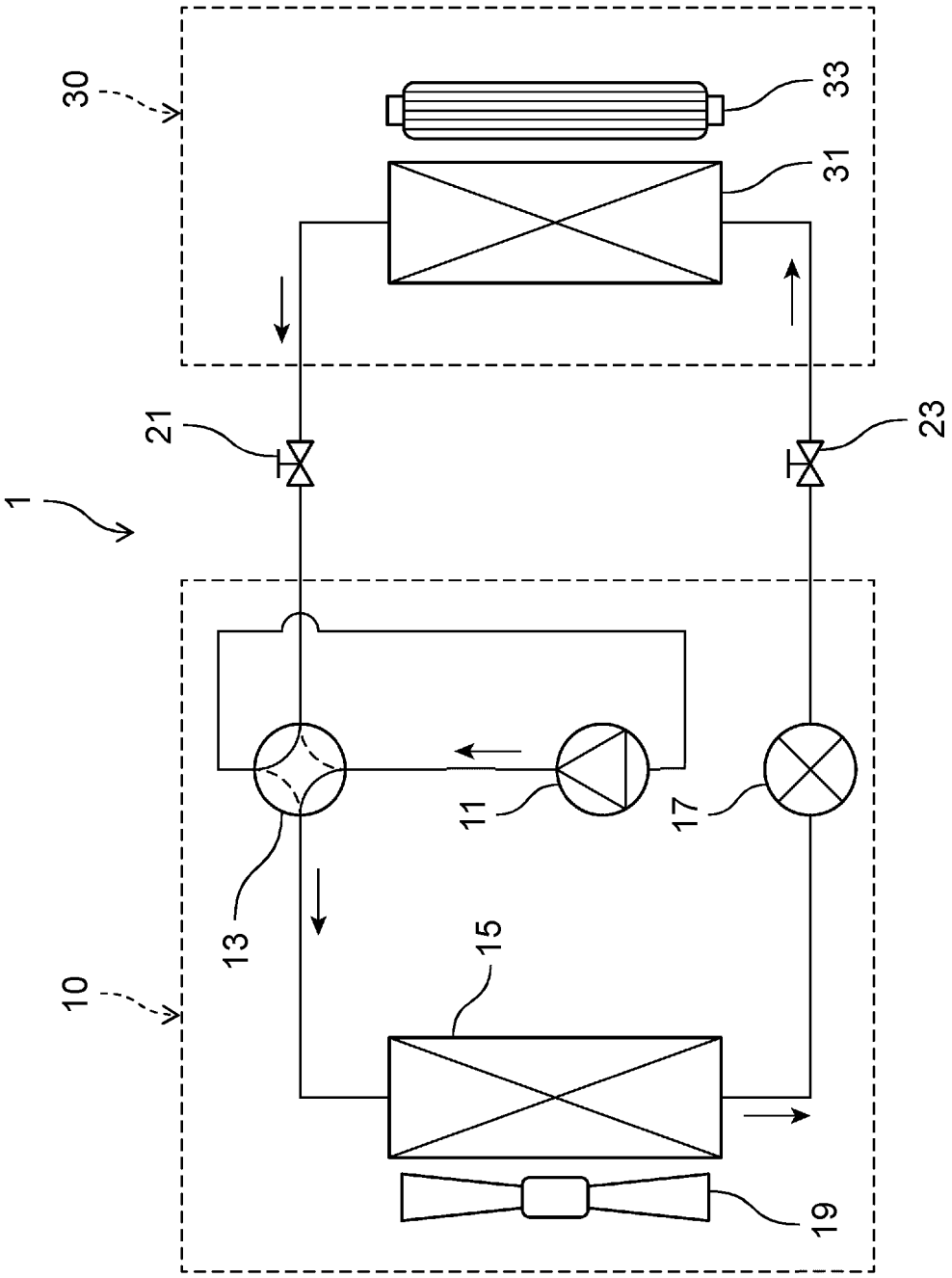


FIG. 2

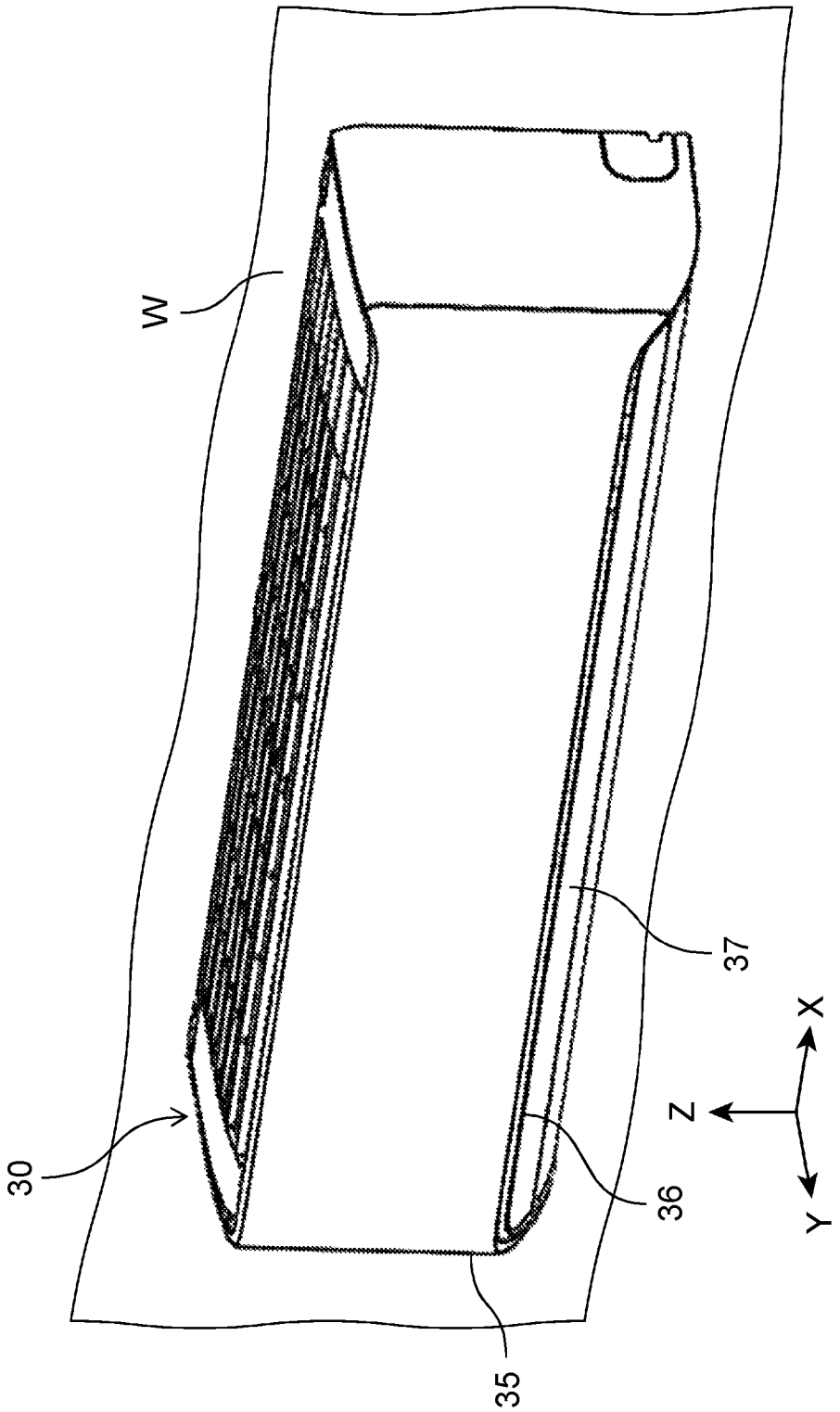


FIG. 3

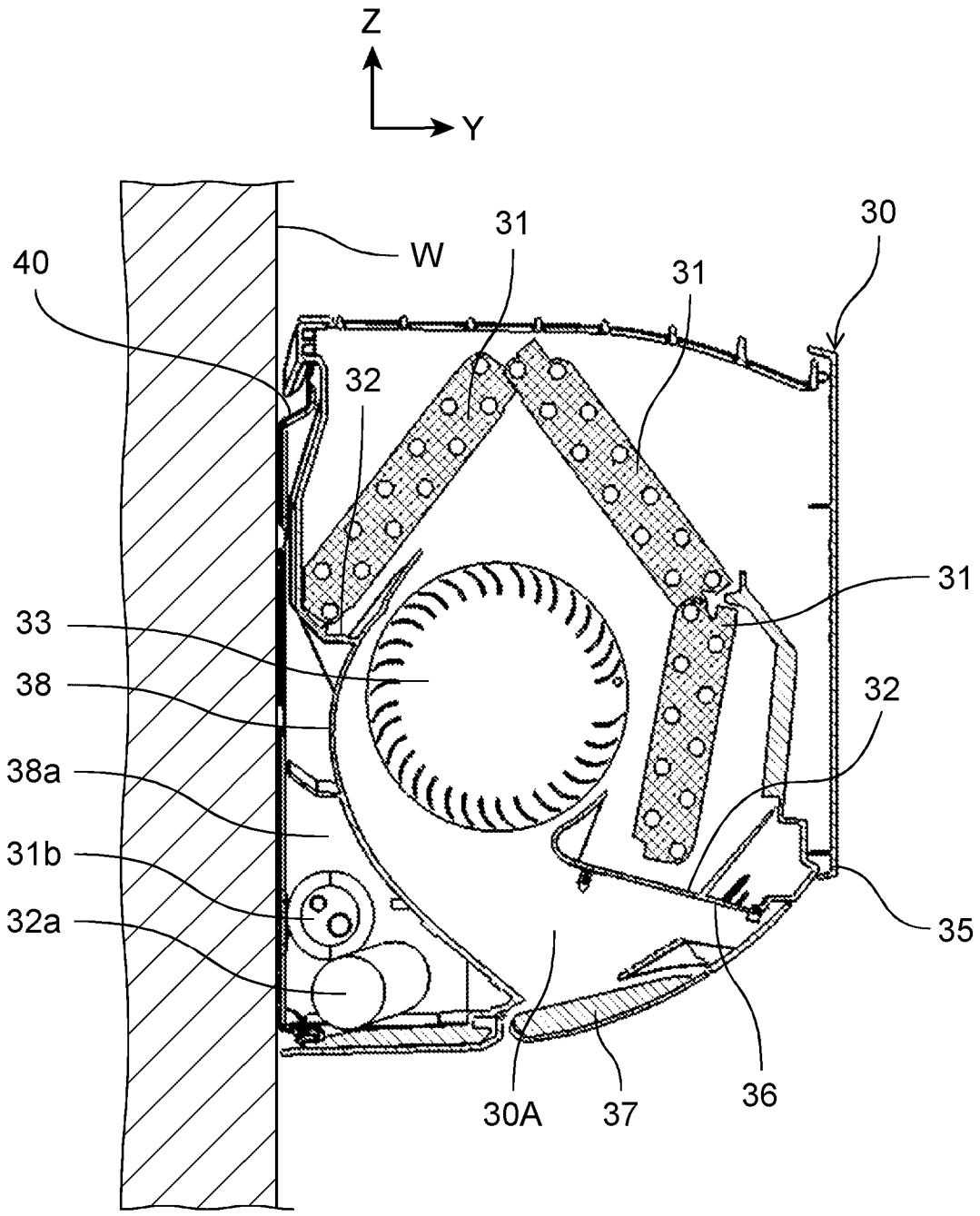


FIG. 4

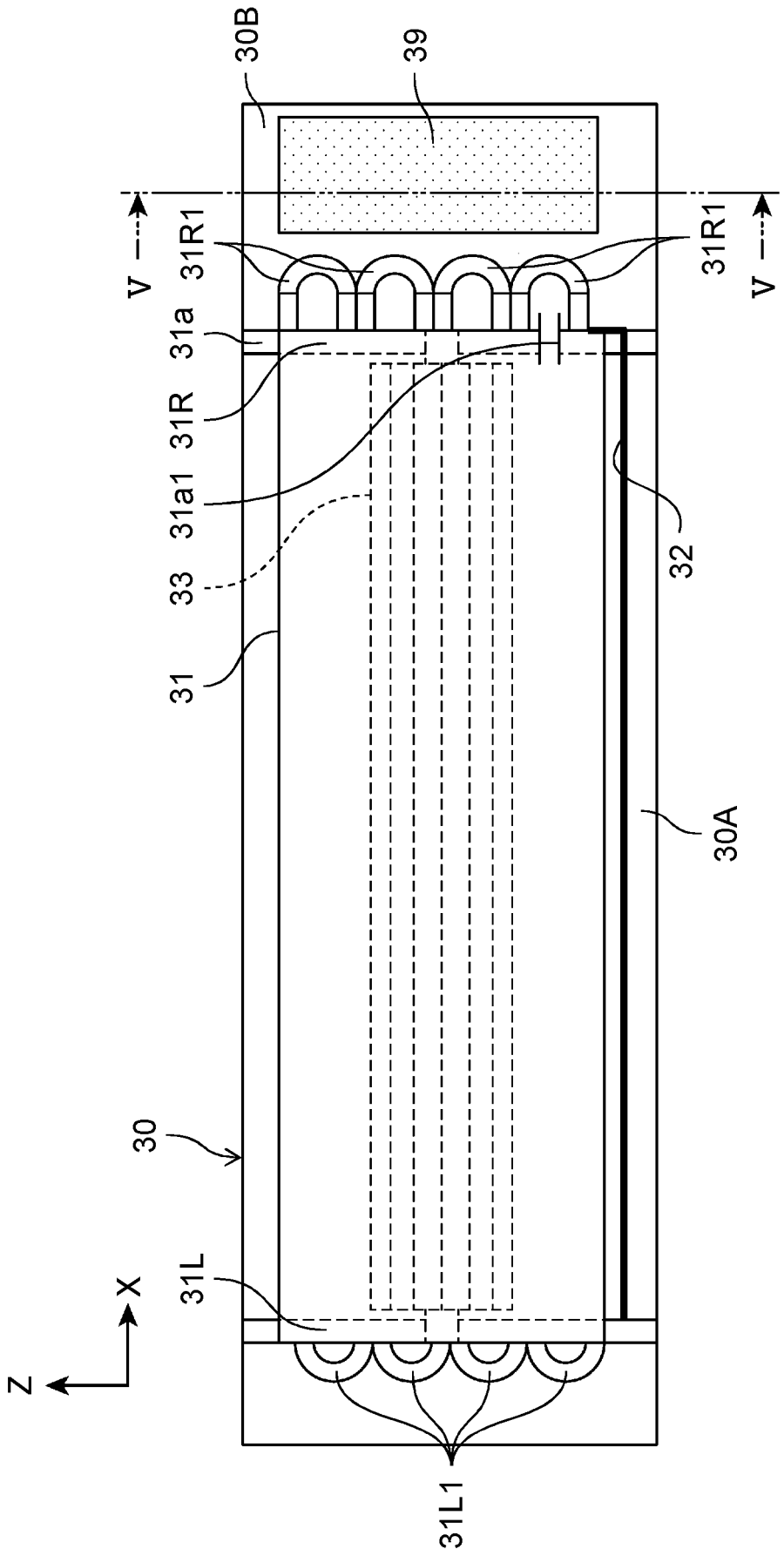


FIG. 5

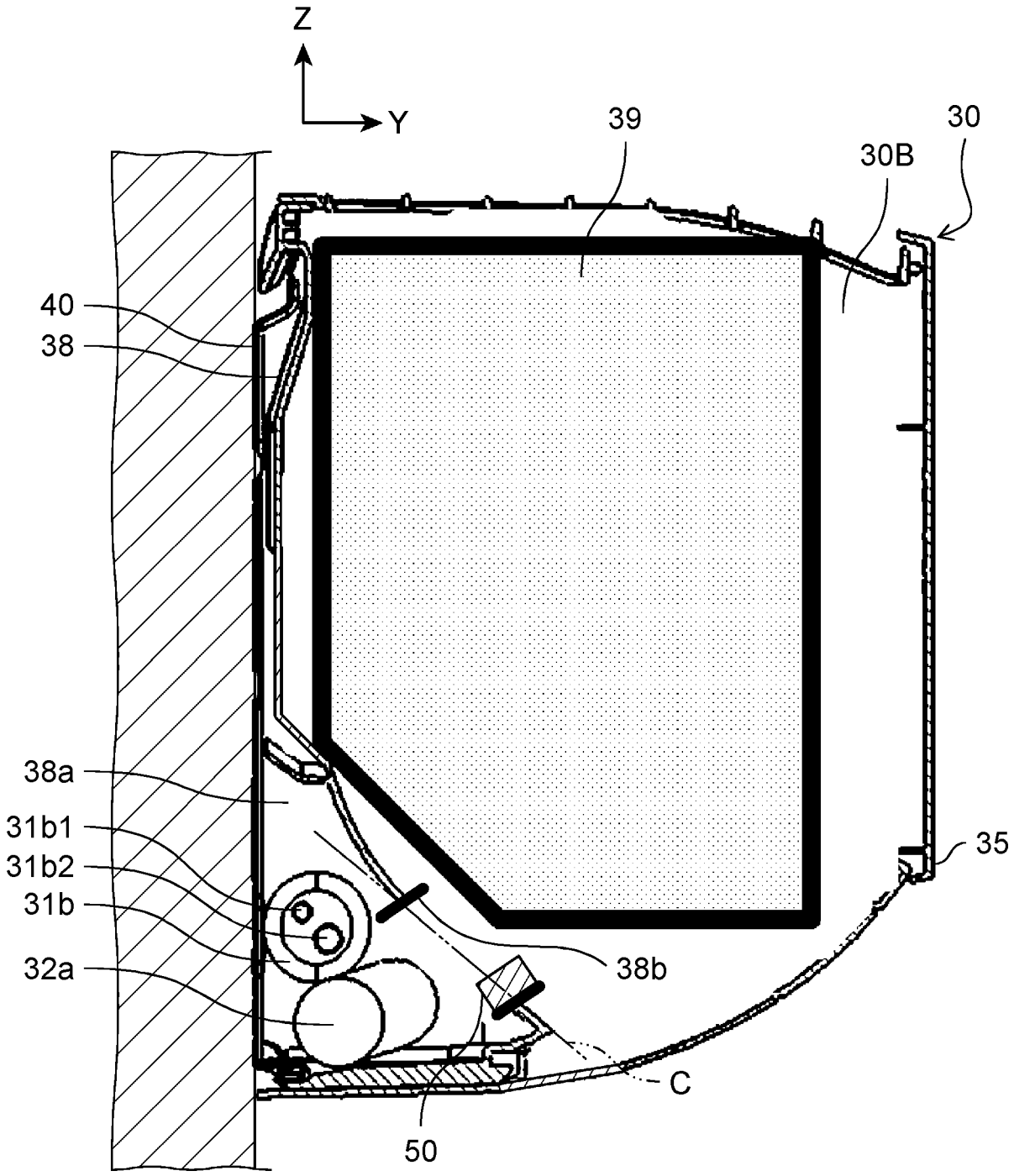


FIG. 6

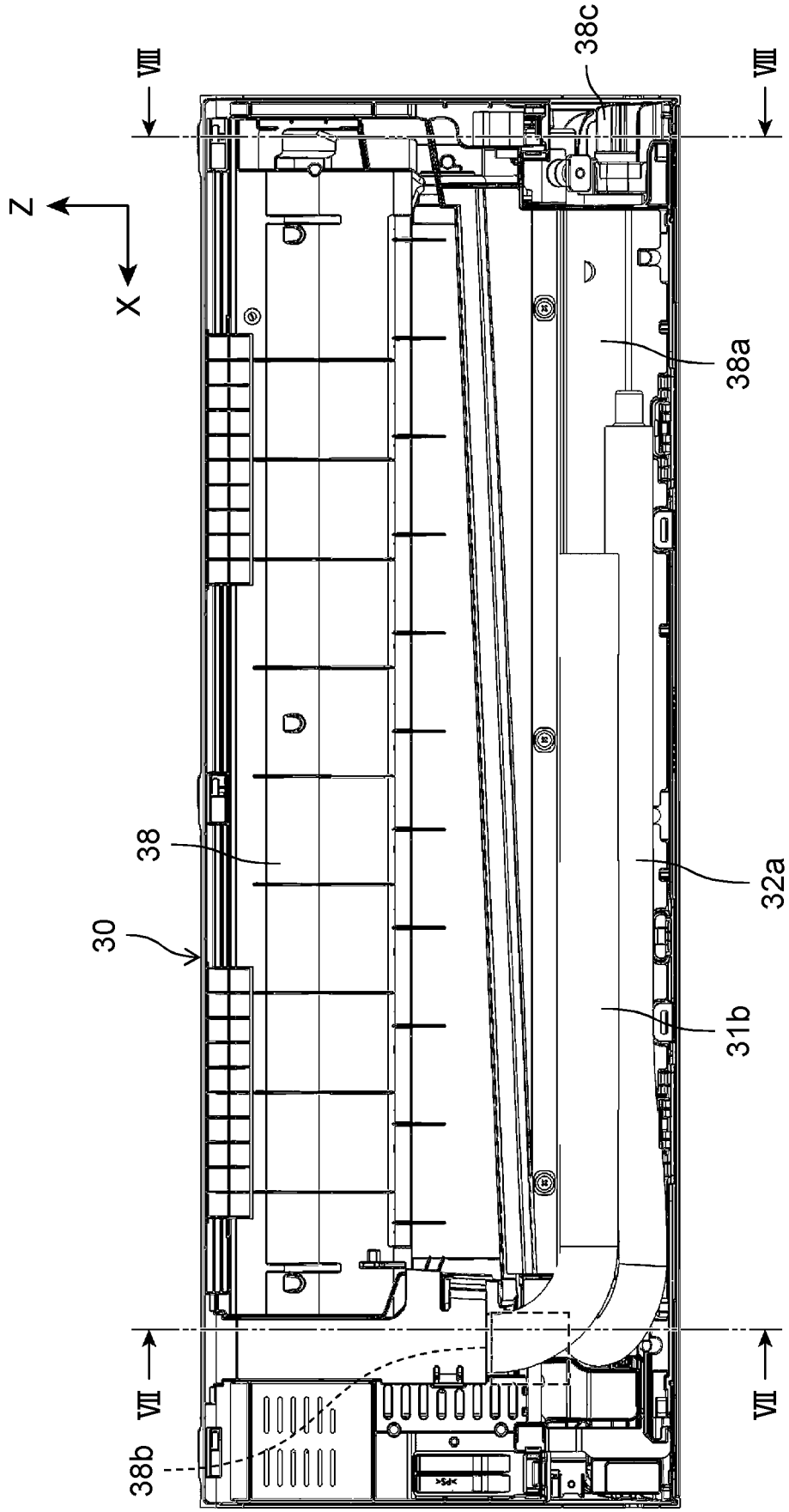


FIG. 7

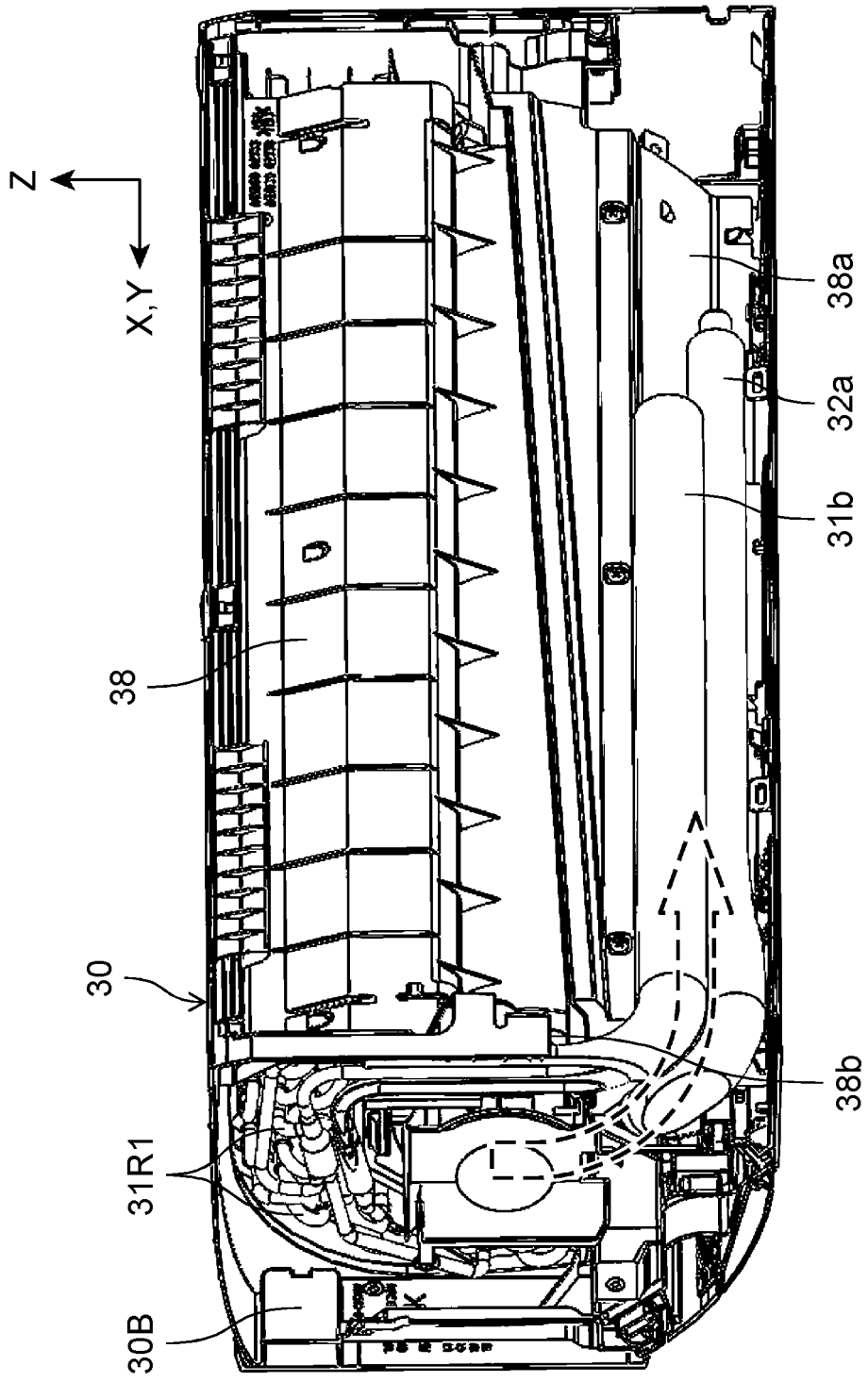


FIG. 8

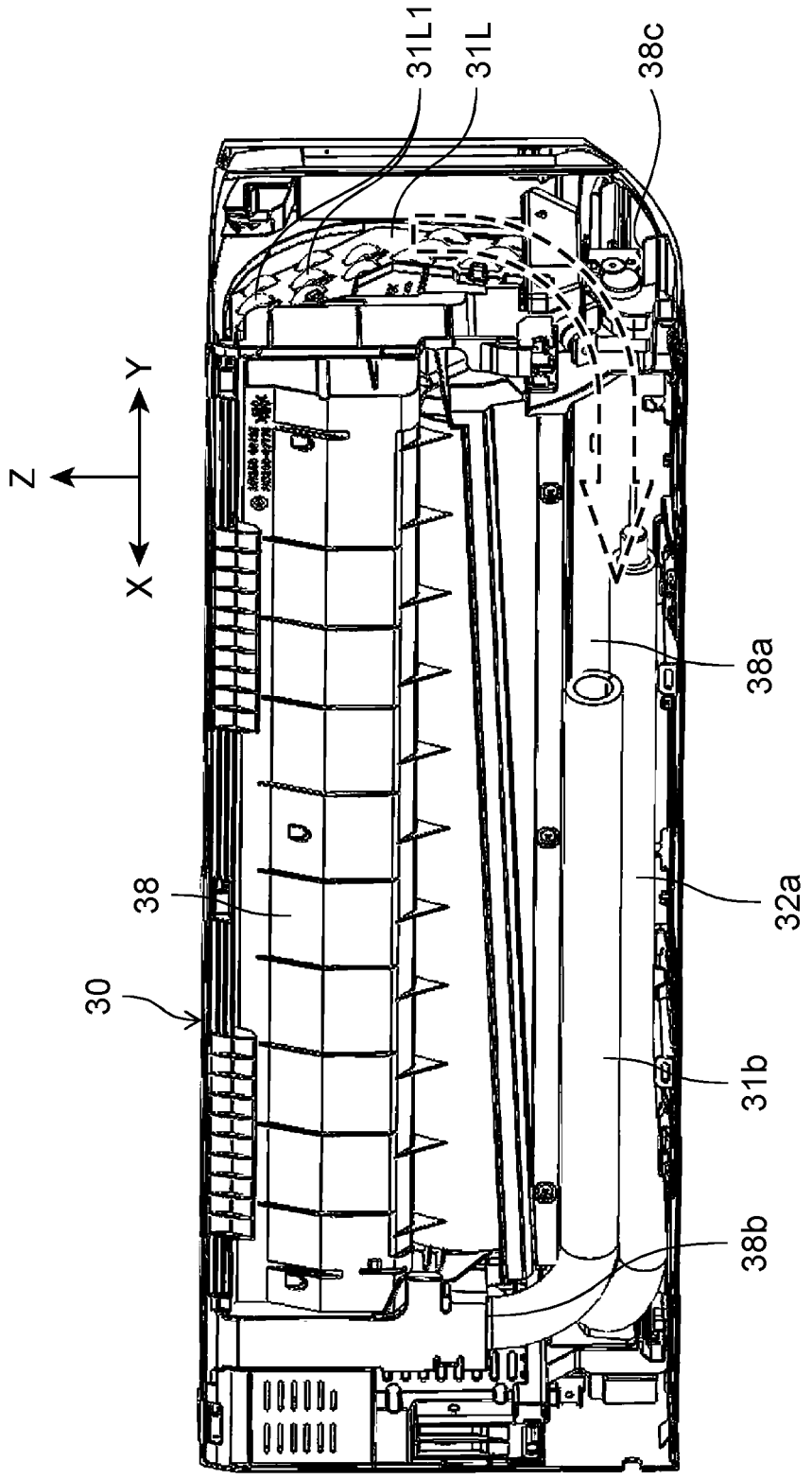


FIG. 9

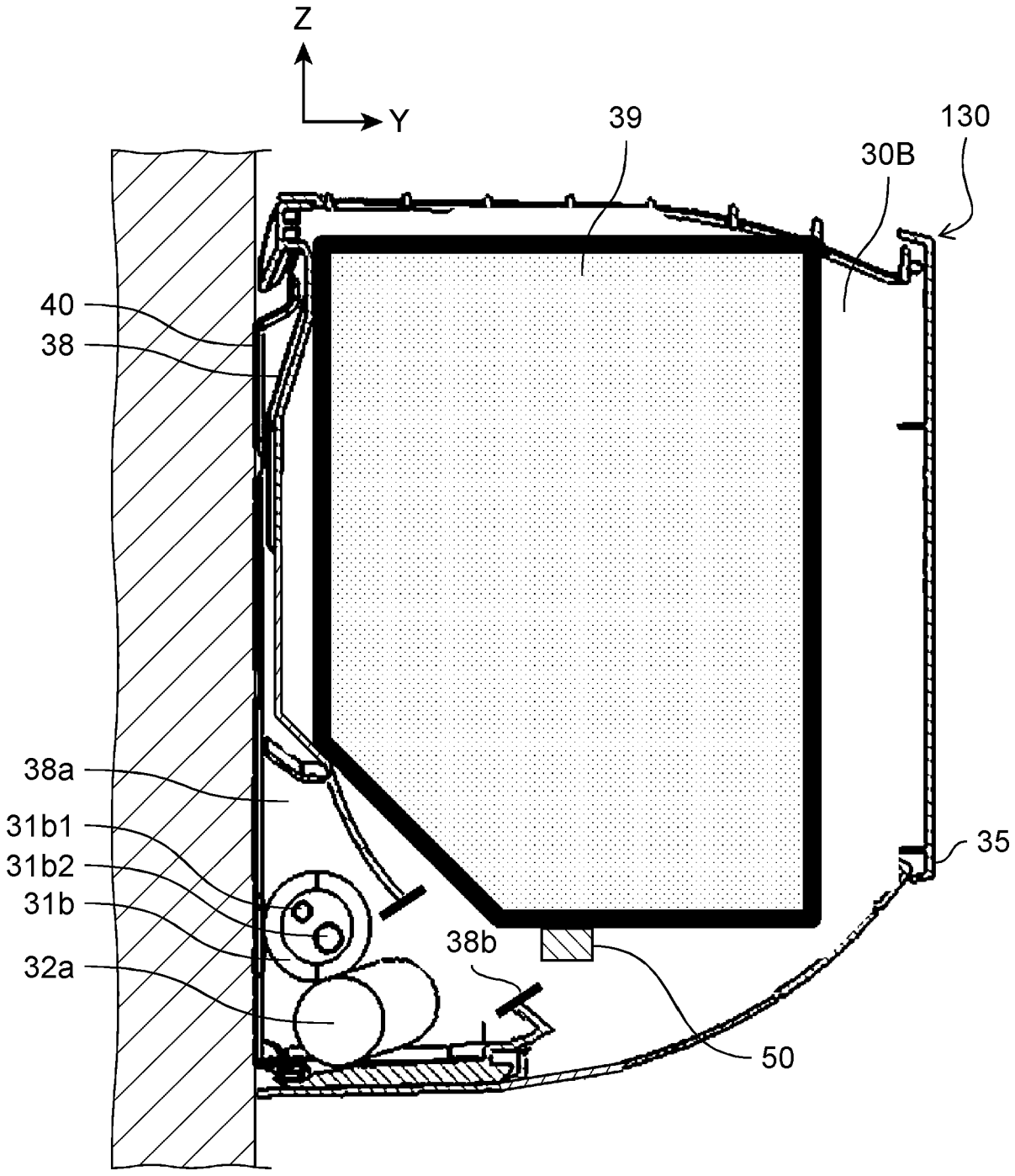


FIG. 10

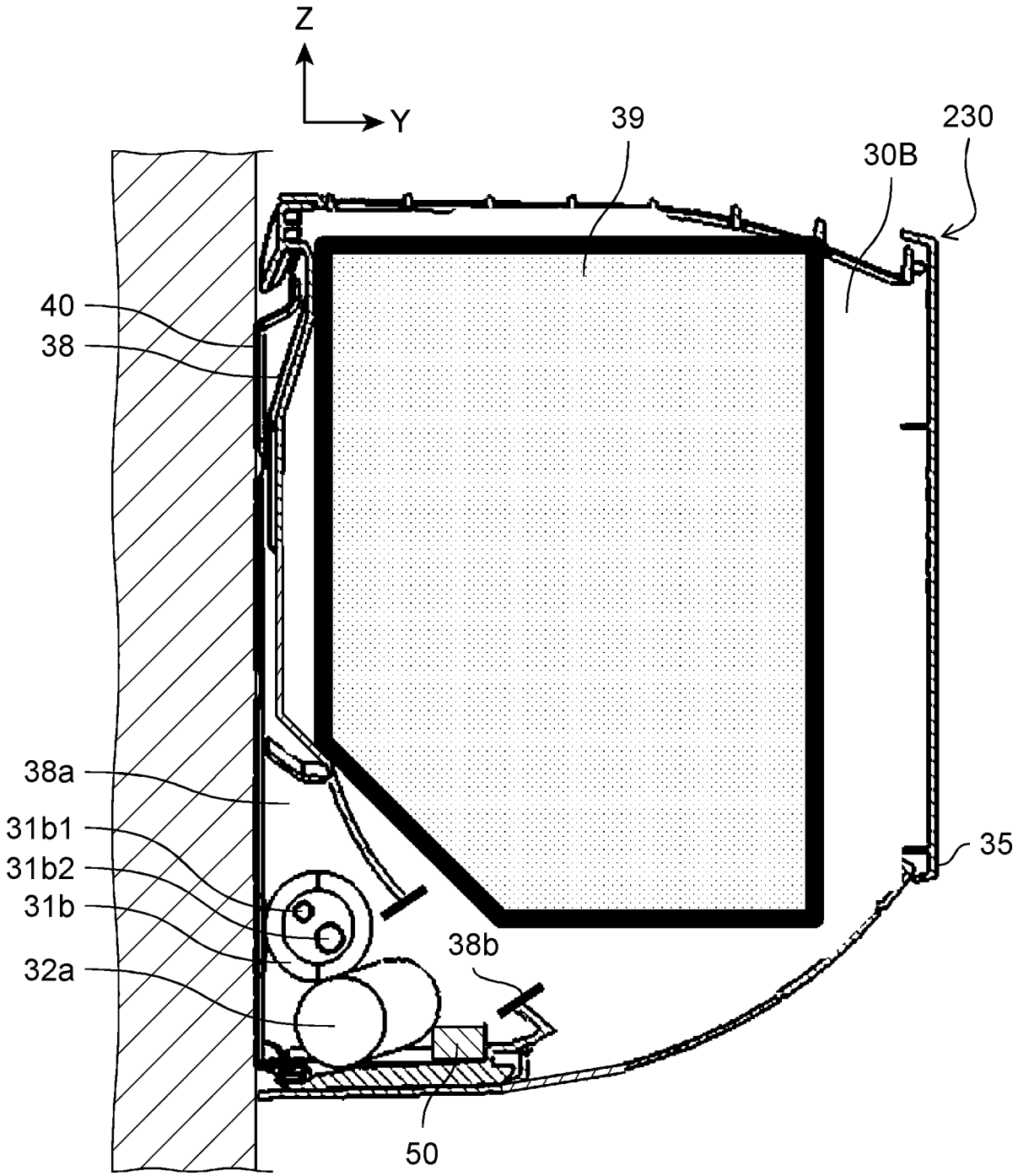
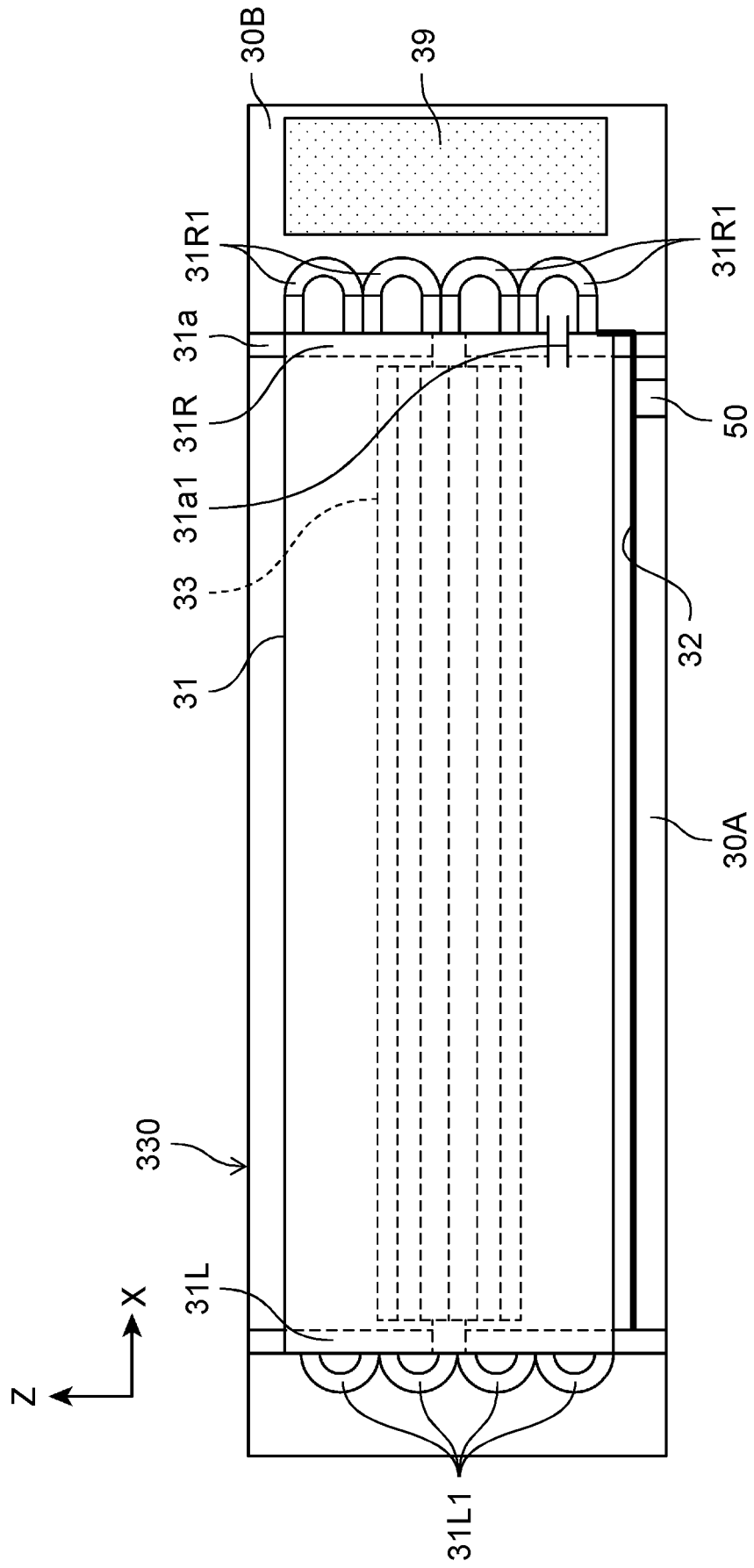


FIG. 11



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 19 2041

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2016 080220 A (HITACHI APPLIANCES INC) 16 May 2016 (2016-05-16) * paragraph [0015] - paragraph [0020] * * paragraph [0028] - paragraph [0040] * * figures *	1-5	INV. F24F11/36 F24F13/20 F24F140/00
X	JP 2015 230136 A (HITACHI APPLIANCES INC) 21 December 2015 (2015-12-21) * paragraph [0030] - paragraph [0047] * * figures *	1,2,4	
X	US 10 060 645 B2 (MITSUBISHI ELECTRIC CORP [JP]) 28 August 2018 (2018-08-28) * column 7, line 15 - column 11, line 39 * * figures 3,4, 6-19 *	5	
X	US 2017/343258 A1 (YAMAGUCHI KOUJI [JP] ET AL) 30 November 2017 (2017-11-30) * paragraph [0023] - paragraph [0033] * * figures *	1	
X	US 2017/370605 A1 (MAKINO HIROAKI [JP] ET AL) 28 December 2017 (2017-12-28) * paragraph [0090] - paragraph [0092] * * paragraph [0153] - paragraph [0219] * * figures *	1	TECHNICAL FIELDS SEARCHED (IPC) F24F F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 December 2024	Mattias Grenbäck

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 19 2041

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

12-12-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2016080220 A	16-05-2016	JP 6412395 B2	24-10-2018
		JP 2016080220 A	16-05-2016
JP 2015230136 A	21-12-2015	JP 6452961 B2	16-01-2019
		JP 2015230136 A	21-12-2015
US 10060645 B2	28-08-2018	AU 2015277826 A1	05-01-2017
		EP 3159633 A1	26-04-2017
		JP 6355734 B2	11-07-2018
		JP WO2015194596 A1	20-04-2017
		US 2017198936 A1	13-07-2017
		WO 2015194596 A1	23-12-2015
US 2017343258 A1	30-11-2017	AU 2015388399 A1	13-07-2017
		EP 3264000 A1	03-01-2018
		JP 6332552 B2	30-05-2018
		JP WO2016151642 A1	29-06-2017
		NZ 733257 A	28-06-2019
		US 2017343258 A1	30-11-2017
		WO 2016151642 A1	29-09-2016
US 2017370605 A1	28-12-2017	AU 2016237157 A1	13-07-2017
		EP 3276284 A1	31-01-2018
		JP 6233546 B2	22-11-2017
		JP WO2016153021 A1	22-06-2017
		US 2017370605 A1	28-12-2017
		WO 2016151641 A1	29-09-2016
		WO 2016153021 A1	29-09-2016

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2022112061 A **[0004]**
- JP 6431339 B **[0004]**