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(54) **INDOOR UNIT AND AIR CONDITIONING DEVICE COMPRISING SAME**

(57) An indoor unit (20) includes a case (50), a heat exchanger (23), a fan (24), an air guide member (70), a passage (75), and a refrigerant sensor (60). The case (50) has a suction port (51). The fan (24) sucks indoor air via the suction port (51) and sends the indoor air thus sucked to the heat exchanger (23). The air guide member (70) guides the indoor air sucked into the fan (24). The air guide member (70) divides an internal space of the case (50) into a first space (77) and a second space (78). The second space (78) is disposed downstream of the first space (77) in an air flow. The passage (75) is provided in the air guide member (70). The passage (75) allows a refrigerant (R) to pass through from the second space (78) to the first space (77). The refrigerant sensor (60) is disposed closer to the first space (77) in the passage (75). The refrigerant sensor (60) is configured to detect the refrigerant (R) having passed through the passage (75).

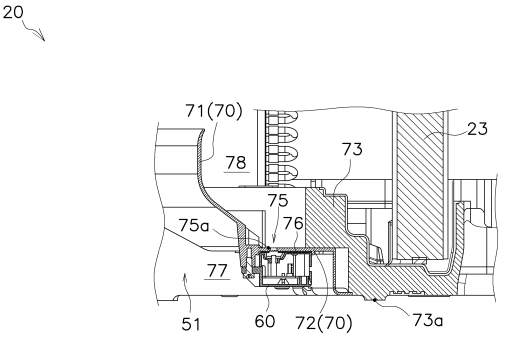

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air conditioner and particularly relates to an indoor unit including a refrigerant sensor configured to detect a refrigerant leaked from a refrigerant circuit.

BACKGROUND ART

[0002] Patent Literature 1 (WO 2019-234902) discloses an indoor unit to be embedded in a ceiling. This indoor unit includes a refrigerant sensor configured to detect a leaked refrigerant. The refrigerant sensor is disposed near a suction port of the indoor unit, and detects a refrigerant component contained in the air sucked into the indoor unit. This refrigerant component is the refrigerant that has leaked from the refrigerant circuit, then come out to the indoor space, and been diluted with the indoor air.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] It takes time for detection of a leaked refrigerant once having passed through an indoor space.

[0004] In order to detect the leaked refrigerant without passing through the indoor space, the refrigerant leaked from a refrigerant circuit disposed outside a bell mouth needs to reach a refrigerant sensor disposed inside the bell mouth. However, if there is adopted a refrigerant heavier than air, the refrigerant leaked from the refrigerant circuit needs to flow over the height of the bell mouth to reach the refrigerant sensor. It takes time for detection also in this case.

<Solution to Problem>

[0005] An indoor unit according to a first aspect is of a ceiling embedded type. The indoor unit includes a case, a heat exchanger, a fan, an air guide member, a passage, and a refrigerant sensor. The case has a suction port. The fan sucks indoor air via the suction port and sends the indoor air thus sucked to the heat exchanger. The air guide member guides the indoor air sucked into the fan. The air guide member divides an internal space of the case into a first space and a second space. The second space is disposed downstream of the first space in an air flow. The passage is provided in the air guide member. The passage allows a refrigerant to pass through from the second space to the first space. The refrigerant sensor is disposed closer to the first space in the passage. The refrigerant sensor is configured to detect the refrigerant having passed through the passage.

[0006] In this configuration, a refrigerant leaked around the heat exchanger passes through the passage to reach the refrigerant sensor. Accordingly, the leaked refrigerant to be detected does not need to flow over an upper end of the air guide member. This achieves quick detection of refrigerant leakage. The refrigerant sensor is positioned to be easily replaced, thereby also facilitating maintenance.

[0007] An indoor unit according to a second aspect is the indoor unit according to the first aspect, in which the refrigerant sensor is disposed to be directed upward in a lower portion of the passage.

[0008] In this configuration, the leaked refrigerant descends toward the refrigerant sensor directed upward, so that refrigerant leakage is detected more quickly.

[0009] An indoor unit according to a third aspect is the indoor unit according to the first or second aspect, and further includes a drain pan. The drain pan is disposed adjacent to the air guide member. The drain pan is disposed to face a lower end of the heat exchanger. The drain pan has a bottom positioned lower than an upper end of the passage.

[0010] In this configuration, the bottom of the drain pan is positioned lower than the passage. Drain water leaking from around the bottom of a cracked drain pan is thus less likely to reach the passage. This inhibits the drain water from damaging the refrigerant sensor.

[0011] An indoor unit according to a fourth aspect is the indoor unit according to any one of the first to third aspects, and further includes a sealing material. The sealing material seals a gap between the passage and the refrigerant sensor.

[0012] The gap between the passage and the refrigerant sensor is sealed in this configuration. This inhibits leakage of conditioned air to keep air conditioning efficiency.

[0013] An indoor unit according to a fifth aspect is the indoor unit according to any one of the first to fourth aspects, and further includes a filter. The filter is provided at the suction port.

[0014] In this configuration, dust contained in the indoor air sucked via the suction port is less likely to enter the case. This inhibits accumulation of dust on the refrigerant sensor.

[0015] An air conditioner according to a sixth aspect includes the indoor unit according to any one of the first to fifth aspects.

[0016] This configuration achieves quick detection of refrigerant leakage in the air conditioner. The refrigerant sensor is positioned to be easily replaced, thereby facilitating maintenance of the air conditioner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 is a schematic view of an air conditioner 100.
FIG. 2 is a schematic view of an indoor unit 20.
FIG. 3 is a perspective view of the indoor unit 20.
FIG. 4 is a sectional view of the indoor unit 20.

FIG. 5 is a schematic view of a refrigerant sensor 60.
FIG. 6 is a perspective view of the refrigerant sensor 60 fixed to an air guide member 70.

DESCRIPTION OF EMBODIMENTS

<Embodiment>

(1) Entire configuration

(1-1) Components constituting refrigerant circuit

[0018] FIG. 1 depicts an air conditioner 100 according to an embodiment. The air conditioner 100 is constituted by an outdoor unit 10, an indoor unit 20, and a refrigerant pipe group 30 connecting the outdoor unit 10 and the indoor unit 20. The air conditioner 100 includes a refrigerant circuit for circulation of a refrigerant R.

[0019] The outdoor unit 10 includes, as components of the refrigerant circuit, a compressor 11, a four-way switching valve 12, an outdoor heat exchanger 13, an outdoor expansion valve 15, an accumulator 16, a liquid shutoff valve 17, and a gas shutoff valve 18.

[0020] The indoor unit 20 includes an indoor heat exchanger 23 as a component of the refrigerant circuit.

[0021] The refrigerant pipe group 30 includes a liquid connection pipe 31 and a gas connection pipe 32 as components of the refrigerant circuit.

(1-2) Cooling operation

[0022] A cooling operation is an operation in which the air conditioner 100 provides a user with cold heat.

[0023] The compressor 11 sucks a low-pressure gas refrigerant from an suction tube 11a and compresses it to generate a high-pressure gas refrigerant to be discharged from a discharge tube 11b. During the cooling operation, the four-way switching valve 12 achieves connection indicated by solid lines. The outdoor heat exchanger 13 condenses the high-pressure gas refrigerant to generate a high-pressure liquid refrigerant. An outdoor fan 14 promotes heat exchange between the refrigerant and the air in the outdoor heat exchanger 13. The outdoor expansion valve 15 decompresses the high-pressure liquid refrigerant to generate a low-pressure gas-liquid two-phase refrigerant. The low-pressure gas-liquid two-phase refrigerant passes through the liquid shutoff valve 17 and the liquid connection pipe 31 to reach the indoor heat exchanger 23.

[0024] The indoor heat exchanger 23 evaporates the gas-liquid two-phase refrigerant to generate a low-pressure gas refrigerant, generating hot heat to be supplied to a user during this process. An indoor fan 24 promotes heat exchange between the refrigerant and the air in the indoor heat exchanger 23, and delivers, to a user, cold heat in the form of cool air. The low-pressure gas refrigerant passes through the gas connection pipe 32, the gas shutoff valve 18, and the four-way switching valve 12 to reach the accumulator 16.

[0025] The accumulator 16 separates a fluid component mixed in the low-pressure gas refrigerant and reserves the fluid component. The low-pressure gas refrigerant flowing out of the accumulator 16 is sucked from the suction tube 11a by the compressor 11.

(1-3) Heating operation

[0026] A heating operation in an operation in which the air conditioner 100 provides a user with hot heat.

[0027] The compressor 11 sucks a low-pressure gas refrigerant from an suction tube 11a and compresses it to generate a high-pressure gas refrigerant to be discharged from a discharge tube 11b. During heating operation, the four-way switching valve 12 achieves connection indicated by broken lines. The high-pressure gas refrigerant passes through the four-way switching valve 12, the gas shutoff valve 18, and the gas connection pipe 32 to reach the indoor heat exchanger 23.

[0028] The indoor heat exchanger 23 condenses the high-pressure gas refrigerant to generate a high-pressure liquid refrigerant, generating hot heat to be supplied to a user during this process. The indoor fan 24 promotes heat exchange between the refrigerant and the air in the indoor heat exchanger 23, and delivers, to a user, hot heat in the form of warm air. The high-pressure liquid refrigerant passes through the liquid connection pipe 31 and the liquid shutoff valve 17 to reach the outdoor expansion valve 15.

[0029] The outdoor expansion valve 15 decompresses the high-pressure liquid refrigerant to generate a low-pressure gas-liquid two-phase refrigerant. The outdoor heat exchanger 13 evaporates the low-pressure gas-liquid two-phase refrigerant to generate a low-pressure gas refrigerant. An outdoor fan 14 promotes heat exchange between the refrigerant and the air in the outdoor heat exchanger 13. The low-pressure gas refrigerant reaches the accumulator 16 via the four-way switching valve 12. The accumulator 16 separates a fluid component mixed in the low-pressure gas refrigerant and reserves the fluid component. The low-pressure gas refrigerant flowing out of the accumulator 16 is sucked from the suction tube 11a by the compressor 11.

(2) Detailed configuration of indoor unit 20

[0030] FIG. 2 is a schematic view of a structure of the indoor unit 20. The indoor unit 20 is designed to be embedded in a ceiling. The indoor unit 20 includes a case 50, the indoor heat exchanger 23, the indoor fan 24, an air guide member 70, a refrigerant sensor 60, and a drain pan 73.

(2-1) Case 50

[0031] FIG. 3 is a perspective view of the indoor unit 20. This figure depicts, in an upper side, a lower surface of the

indoor unit 20. This figure depicts, in a lower side, an upper surface of the indoor unit 20 as a portion to be embedded in a ceiling.

[0032] The case 50 accommodates components constituting the indoor unit 20 including the indoor heat exchanger 23 and the indoor fan 24. The case 50 is provided with a single suction port 51 for intake of air from an indoor space, and four blow-out ports 52 for supply of conditioned air into the indoor space. As depicted in FIG. 2, the suction port 51 is provided with a filter 53 configured to remove dust or dirt from intake air. FIG. 3 does not depict the filter 53.

(2-2) Indoor heat exchanger 23

[0033] The indoor heat exchanger 23 depicted in FIG. 2 functions as an evaporator for the refrigerant R during the cooling operation and functions as a condenser for the refrigerant R during the heating operation. The indoor heat exchanger 23 exemplarily includes a plurality of heat transfer tubes and a fin. An air flow passing through the indoor heat exchanger 23 exchanges heat with the refrigerant R.

(2-3) Indoor fan 24

[0034] When the indoor fan 24 operates, indoor air is sucked via the suction port 51 and passes through the filter 53 during the process. A flow of the air then passes through the indoor heat exchanger 23 and exchanges heat with the refrigerant R to be conditioned. Conditioned air flows from the indoor heat exchanger 23 to the blow-out ports 52 so as to blow into the indoor space.

(2-4) Air guide member 70

[0035] The air guide member 70 depicted in FIG. 2 guides the indoor air sucked into the indoor fan 24. The air guide member 70 includes a bell mouth 71 and a plate 72. The bell mouth 71 is a tubular member provided to concentrate an air flow path to the indoor fan 24. The plate 72 is a plate member having a tabular or bowl shape and provided to protect components constituting the indoor unit 20 disposed in a region that may be exposed via the blow-out ports 52. The plate 72 is disposed adjacent to the bell mouth 71 and is connected to the bell mouth 71.

[0036] The air guide member 70 divides an internal space of the case 50 into a first space 77 and a second space 78. The first space 77 is positioned upstream of the air flow and occupies a region expanding from the suction port 51 to the indoor fan 24. The second space 78 is positioned downstream of the air flow and occupies a region expanding from the indoor fan 24 to the blow-out ports 52.

[0037] FIG. 4 is a sectional view of the indoor unit 20. This figure indicates that the bell mouth 71 has a slant surface portion provided continuously to a horizontal portion of the plate 72. The air guide member 70 is provided with a passage 75 allowing the first space 77 and the second space 78 to communicate with each other. The actual form of the passage 75 may be a hole or a cutout provided in the bell mouth 71 or the plate 72. The passage 75 allows the refrigerant R leaked from the refrigerant circuit, such as the indoor heat exchanger 23, to pass through from the second space 78 to the first space 77. The passage 75 depicted in FIG. 4 has an upper end 75a, which is a surface of the air guide member 70 located on the side of the second space 78.

(2-5) Refrigerant sensor 60

[0038] The refrigerant sensor 60 depicted in FIG. 4 detects the refrigerant R leaked from the refrigerant circuit. The refrigerant sensor 60 is disposed at the passage 75 on the side of the first space 77. The refrigerant sensor 60 is disposed below the passage 75 and oriented upward. The refrigerant sensor 60 detects the refrigerant R that has passed through the passage 75.

[0039] The air guide member 70 has an upper end substantially as high as an upper end of the indoor heat exchanger 23. The air guide member 70 has a lower end substantially as high as a lower end of the indoor heat exchanger 23. The air guide member 70 can thus serve as a barrier against the refrigerant R that leaks from the indoor heat exchanger 23 to reach the refrigerant sensor 60. The passage 75 provided in the air guide member 70 enables the refrigerant R to quickly reach the refrigerant sensor 60.

[0040] The components constituting the refrigerant circuit, such as the indoor heat exchanger 23 and pipes connected thereto, are mainly disposed in the second space 78. The refrigerant R leaked from the refrigerant circuit thus initially drifts in the second space 78. The specific gravity of the refrigerant R is heavier than that of air, and the refrigerant R can be R32. The refrigerant R drifting in the second space 78 then passes through the passage 75 due to gravity or the like to reach the refrigerant sensor 60. There is provided a sealing material 76 to seal a gap between a portion of the air guide member 70 adjacent to the passage 75 and the refrigerant sensor 60.

[0041] FIG. 5 depicts a structure of the refrigerant sensor 60. The refrigerant sensor 60 includes an upper case 61, a lower case 62, a circuit board 63, a refrigerant detecting element 64, a connector 65, and a wire 66. The upper case 61 is provided with a detection window 61a. The detection window 61a allows a refrigerant leaked outside the upper case 61 to reach the refrigerant detecting element 64. The lower case 62 is provided with a screwing through hole 62a. The circuit board 63 is equipped with the refrigerant detecting element 64 and the connector 65. The wire 66 extending from the connector 65 extends to an unillustrated electric component box.

[0042] FIG. 6 depicts the refrigerant sensor 60 fixed to the air guide member 70. The refrigerant sensor 60 is

fixed to the air guide member 70 with use of a screw 67 attached to the screwing through hole 62a.

(2-6) Drain pan 73

[0043] The drain pan 73 depicted in FIG. 4 is a container configured to collect dew condensation water produced on a surface of the indoor heat exchanger 23. The dew condensation water thus collected is discarded outdoors via an unillustrated drainage path. The drain pan 73 is disposed adjacent to the air guide member 70. The drain pan 73 is disposed to face the lower end of the indoor heat exchanger 23. The drain pan 73 has a concave shape opened upward, and surrounds the lower end of the indoor heat exchanger 23. The drain pan 73 has a bottom 73a positioned lower than the upper end 75a of the passage 75.

(3) Characteristics

[0044]

(3-1) The refrigerant R leaked into the second space 78 passes through the passage 75 to reach the refrigerant sensor 60. Accordingly, the leaked refrigerant R to be detected does not need to flow over the upper end of the air guide member 70, leading to quick detection of refrigerant leakage. In addition, the refrigerant sensor 60 is disposed on a lower surface of the case 50 to facilitate replacement, and maintenance is thus executed easily.
(3-2) The refrigerant R leaked from the refrigerant circuit descends toward the refrigerant sensor 60 directed upward, so that refrigerant leakage is detected more quickly.
(3-3) The bottom 73a of the drain pan 73 is positioned lower than the upper end 75a of the passage 75. Drain water leaking from around the bottom 73a of the drain pan 73 being cracked is thus less likely to reach the passage 75. This inhibits the drain water from damaging the refrigerant sensor 60.
(3-4) The gap between the passage 75 and the refrigerant sensor 60 is sealed. This inhibits leakage of conditioned air to keep air conditioning efficiency.
(3-5) The filter 53 is provided so that dust or dirt contained in the indoor air sucked via the suction port 51 is less likely to enter the case 50. This inhibits accumulation of dust or dirt on the refrigerant sensor 60.

(4) Modification examples

[0045] The indoor unit 20 according to the above embodiment is designed to be embedded in a ceiling. Alternatively, the indoor unit 20 may be designed to be hung from a ceiling. Still alternatively, the indoor unit 20 may be of a wall mounted type or a floorstanding type.

<Conclusion>

[0046] The embodiment of the present disclosure has been described above. It is understood that various changes to modes and details should be available without departing from the object and the scope of the present disclosure recited in the claims.

REFERENCE SIGNS LIST

[0047]

10: outdoor unit
20: indoor unit
23: indoor heat exchanger (heat exchanger)
24: indoor fan (fan)
50: case
51: suction port
52: blow-out port
53: filter
60: refrigerant sensor
70: air guide member
71: bell mouth
72: plate
73: drain pan
73a: bottom
75: passage
75a: upper end
76: sealing material
77: first space
78: second space
100: air conditioner
R: refrigerant

CITATION LIST

PATENT LITERATURE

[0048] Patent Literature 1: WO 2019-234902

Claims

1. An indoor unit (20) of a ceiling embedded type, the indoor unit comprising:

a case (50) having a suction port (51);
a heat exchanger (23);
a fan (24) configured to suck indoor air via the suction port and send the indoor air thus sucked to the heat exchanger;
an air guide member (70) configured to guide the indoor air sucked into the fan and dividing an internal space of the case into a first space (77) and a second space (78) disposed downstream of the first space in an air flow;
a passage (75) provided in the air guide member and allowing a refrigerant (R) to pass through

from the second space to the first space; and
a refrigerant sensor (60) disposed closer to the first space in the passage and configured to detect the refrigerant having passed the passage.

2. The indoor unit according to claim 1, wherein the refrigerant sensor is disposed to be directed upward in a lower portion of the passage.

3. The indoor unit according to claim 1 or 2, the indoor unit further comprising a drain pan (73) disposed adjacent to the air guide member and facing a lower end of the heat exchanger,
wherein the drain pan has a bottom (73a) positioned lower than an upper end (75a) of the passage.

4. The indoor unit according to any one of claims 1 to 3, the indoor unit further comprising a sealing material (76) sealing a gap between the passage and the refrigerant sensor.

5. The indoor unit according to any one of claims 1 to 4, the indoor unit further comprising a filter (53) provided at the suction port.

6. An air conditioner (100) comprising the indoor unit according to any one of claims 1 to 5.

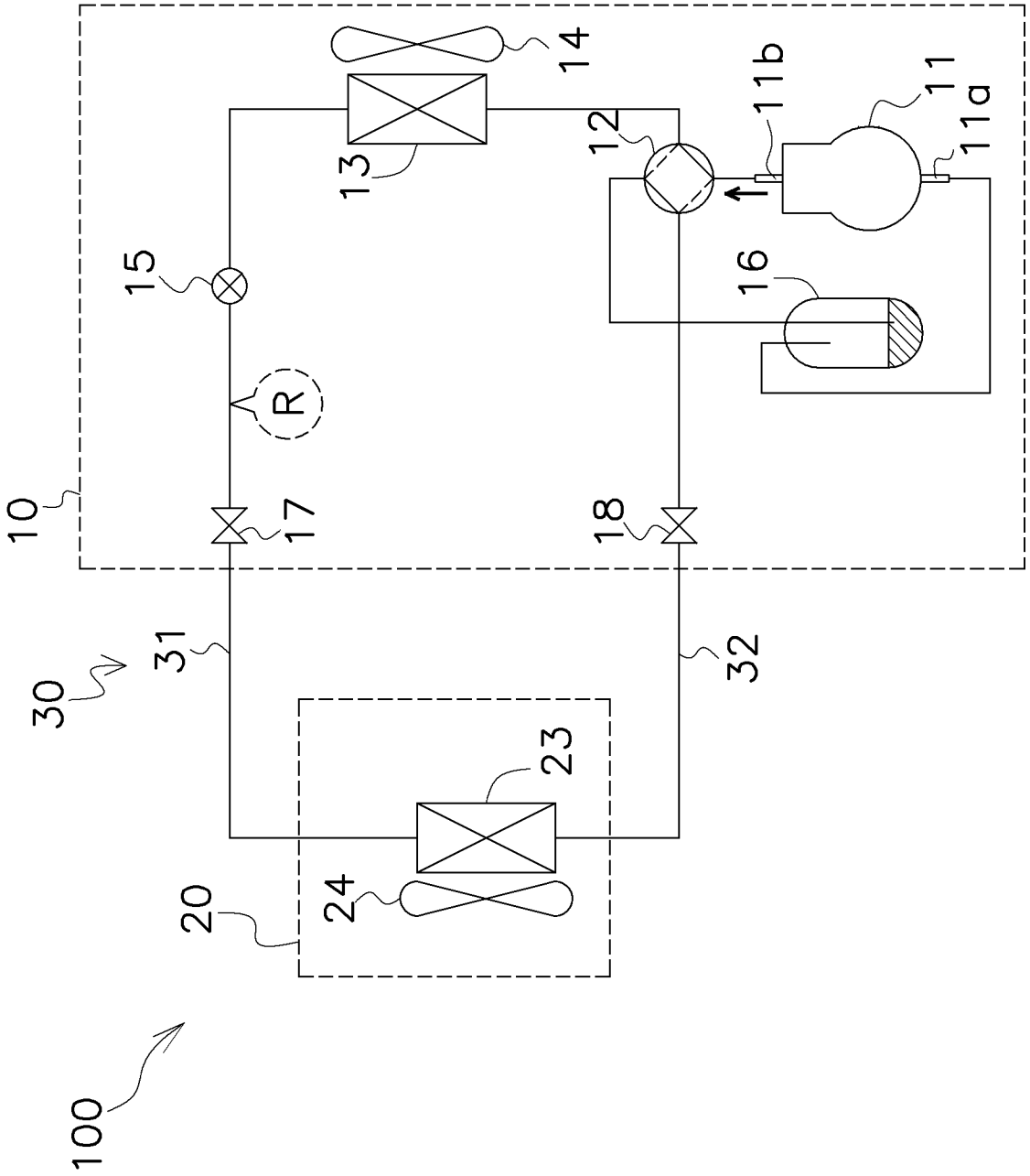

FIG. 1

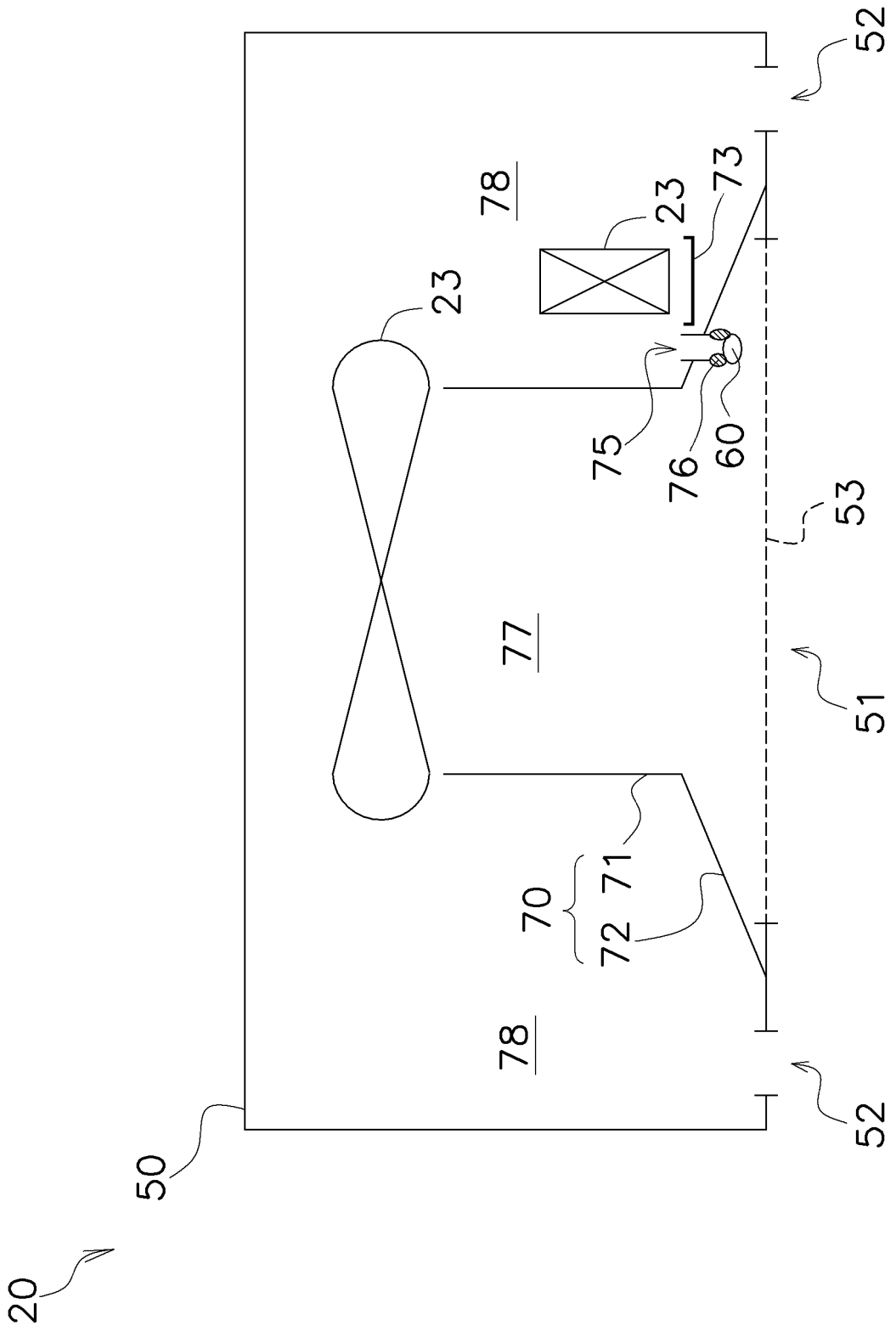

FIG. 2

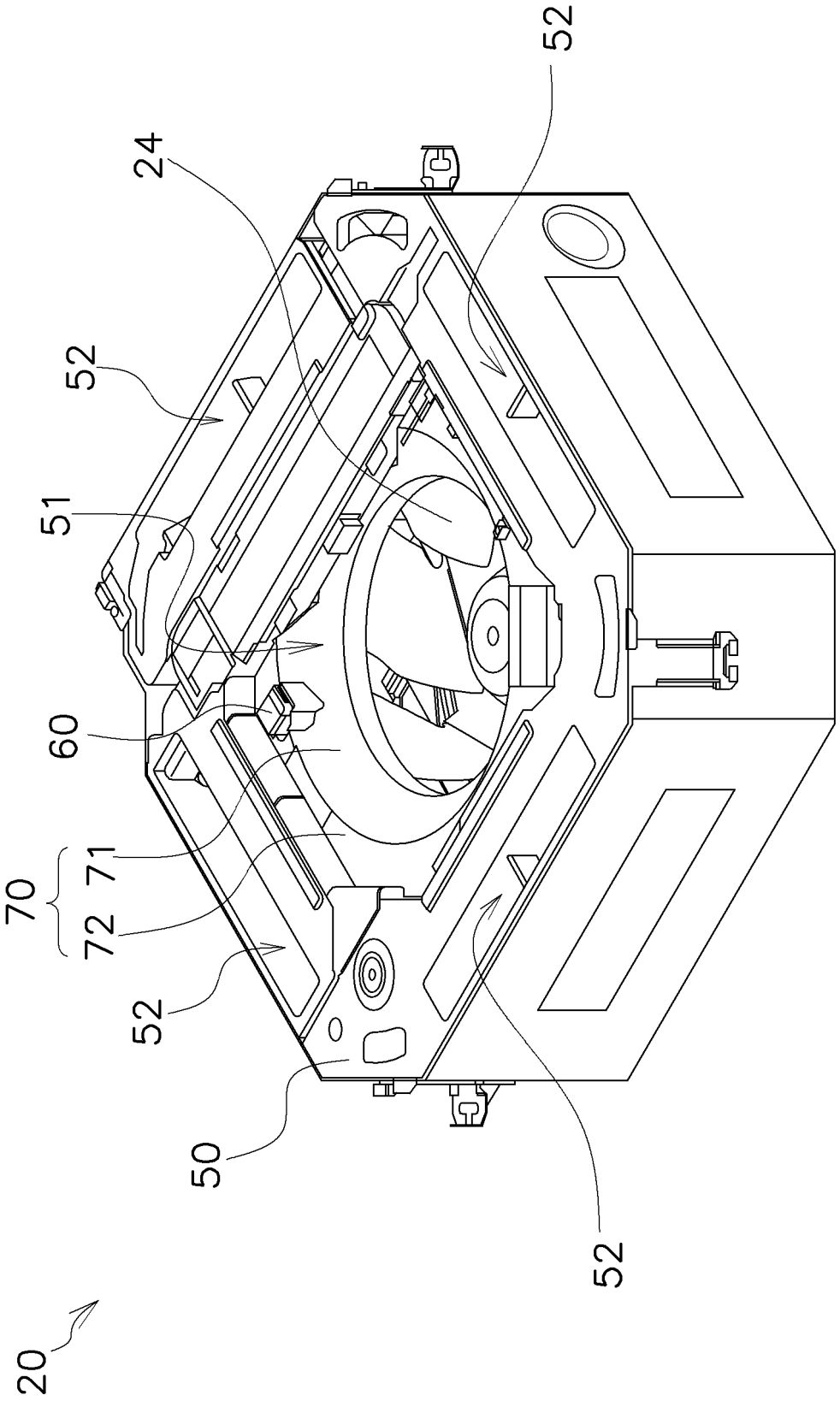

FIG. 3

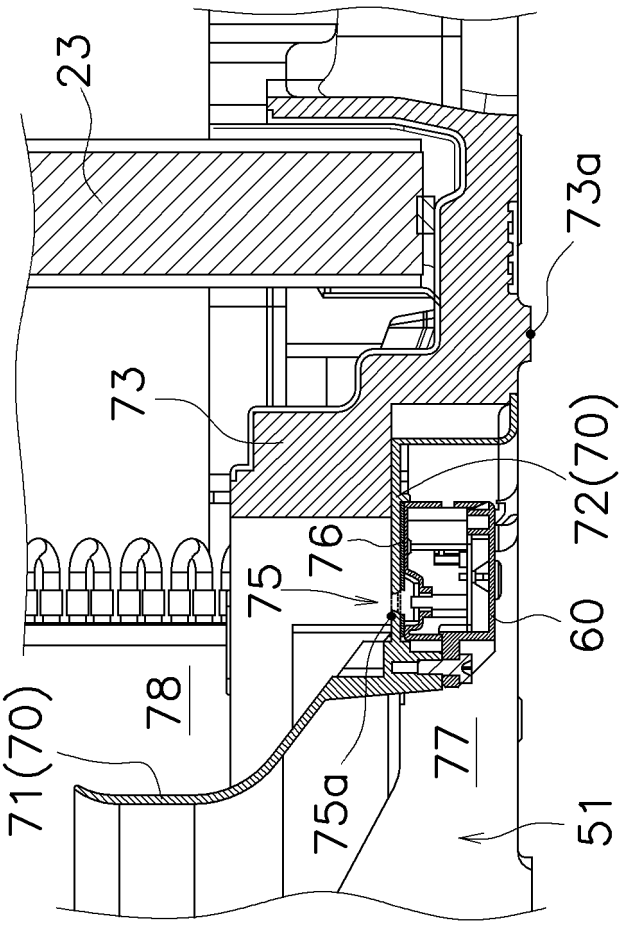

FIG. 4

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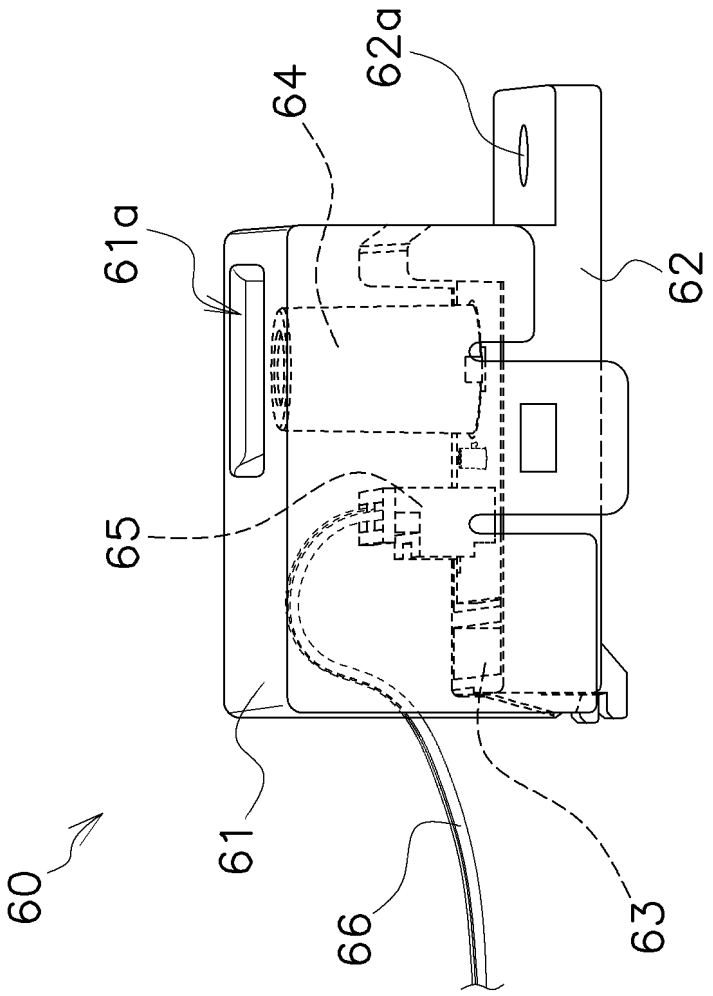

FIG. 5

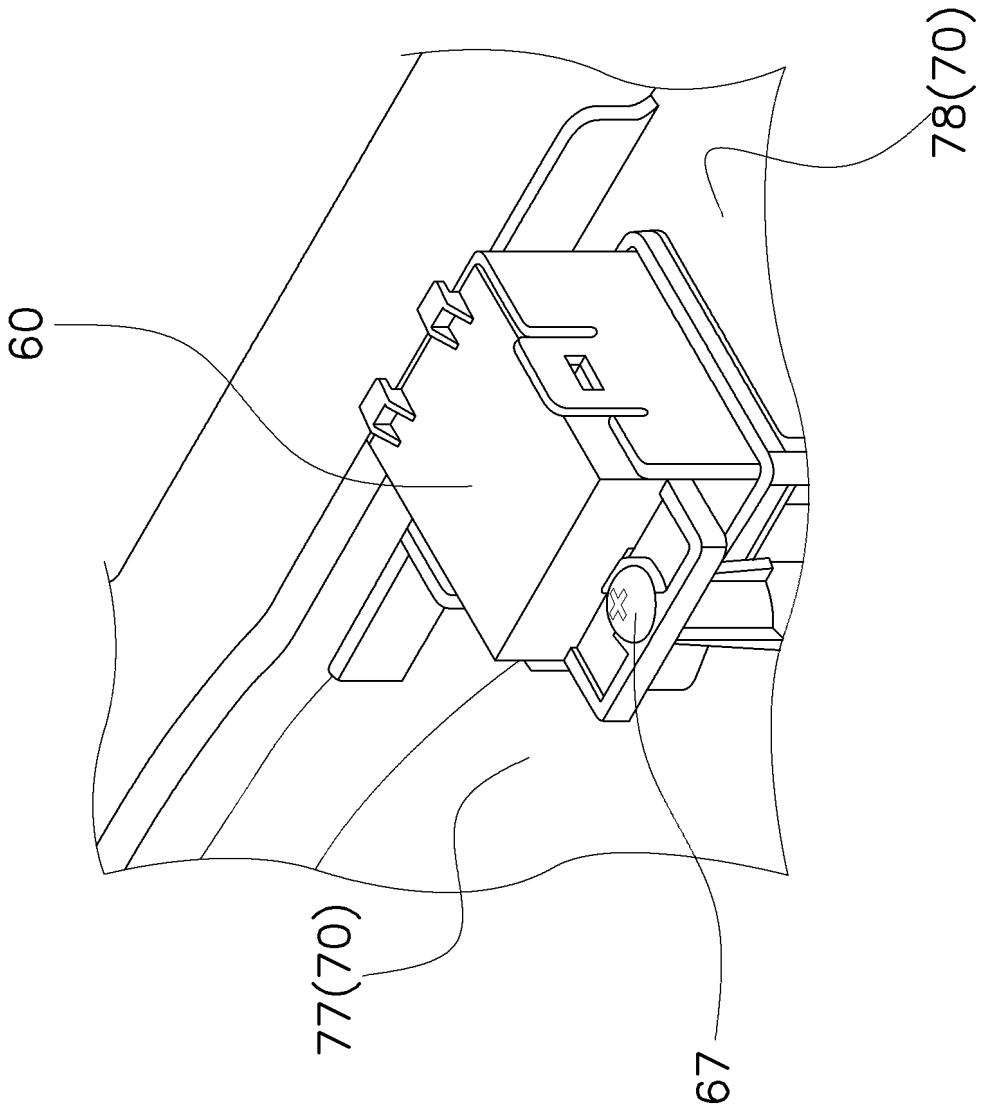

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/014783

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/36(2018.01)i; ***F24F 1/035***(2019.01)i; ***F24F 1/0073***(2019.01)i; ***F24F 13/20***(2006.01)i; ***F24F 13/22***(2006.01)i; ***F25B 49/02***(2006.01)i

FI: F24F11/36; F25B49/02 520M; F24F1/0007 401E; F24F1/02 411E; F24F1/0007 361D; F24F1/02 371D; F24F1/0073; F24F1/035

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F11/36; F24F1/035; F24F1/0073; F24F13/20; F24F13/22; F25B49/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2022-19215 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 27 January 2022 (2022-01-27) paragraphs [0009]-[0057]	1-2, 5-6
A		3-4
Y	WO 2015/29094 A1 (MASUDA, Keiji) 05 March 2015 (2015-03-05) paragraphs [0035]-[0075]	1-2, 5-6

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 April 2024	**18 June 2024**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/014783

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2022-19215 A	27 January 2022	(Family: none)	
WO 2015/29094 A1	05 March 2015	(Family: none)	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2019234902 A **[0002] [0048]**