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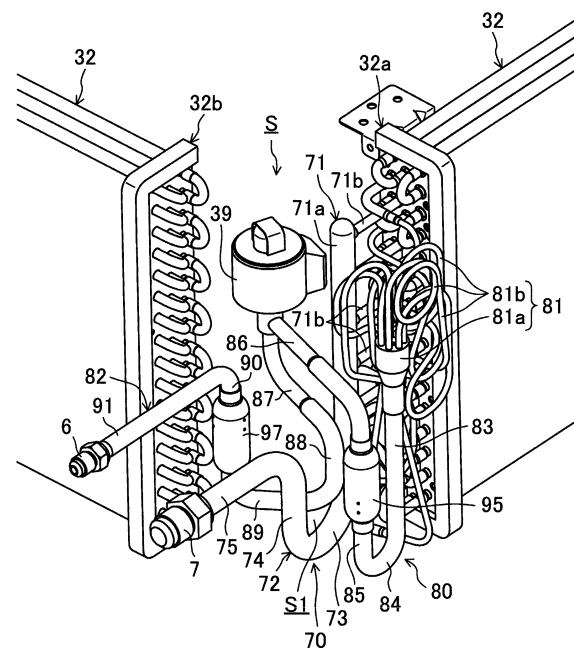
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(54) **INDOOR UNIT FOR AIR CONDITIONING DEVICES**

(57) A gas-side pipe (70) is provided with a header body (71 a) extending vertically along a side end portion (32a) of an indoor heat exchanger (32), a vertical tube portion (74) facing the header body (71a), and a bent tube portion (73) connecting a lower end portion of the header body (71 a) and a lower end portion of the vertical tube portion (74) together. Part of a liquid-side pipe (80) is provided in a space (S1) between the header body (71 a), the vertical tube portion (74), and the bent tube portion (73).

FIG.5



Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor unit for an air conditioning device, and more particularly relates to a measure to save spaces for pipes around an indoor heat exchanger.

BACKGROUND ART

[0002] Air conditioning devices for cooling or heating an indoor space have been known. For example, an air conditioning device disclosed in Patent Document 1 includes a casing, an indoor fan housed in the casing, an indoor heat exchanger provided to surround the indoor fan, a gas-side connection port connected to a gas-side communication pipe, and a liquid-side connection port connected to a liquid communication pipe. In other words, its indoor unit is connected with its outdoor unit through the liquid communication pipe and the gas communication pipe.

[0003] The gas-side pipe is provided with a header, and the liquid-side pipe is provided with a flow divider. The header includes a header body and a plurality of branch pipes branching from the header body and connected to a gas-side end portion of the indoor heat exchanger. Also, the flow divider includes a flow divider body and a plurality of dividing pipes (capillary tubes) branching from the flow divider body and connected to a liquid-side end portion of the indoor heat exchanger.

[0004] During a cooling operation of the air conditioning device, a refrigerant condensed in an outdoor heat exchanger flows into the liquid-side pipe of the indoor unit through the liquid communication pipe. This refrigerant flows from the flow divider into the indoor heat exchanger, and exchanges heat with air carried by the indoor fan. As a result, in the indoor heat exchanger, the refrigerant absorbs heat from the indoor air, and consequently evaporates. The refrigerant thus evaporated flows from the header into the gas-side pipe, and then flows out to the gas communication pipe.

[0005] On the other hand, during a heating operation of the air conditioning device, a refrigerant compressed by a compressor flows into the gas-side pipe of the indoor unit through the gas communication pipe. This refrigerant flows from the header into the indoor heat exchanger, and exchanges heat with air carried by the indoor fan. As a result, in the indoor heat exchanger, the refrigerant dissipates heat to the indoor air, and consequently condenses. The refrigerant thus condensed flows from the flow divider into the liquid-side pipe, and then flows out to the liquid communication pipe.

CITATION LIST

PATENT DOCUMENT

- 5 **[0006]** Patent Document 1: Japanese Unexamined Patent Publication No. 2011-163741

SUMMARY OF THE INVENTION

10 TECHNICAL PROBLEM

[0007] As can be seen from the foregoing, in the indoor unit for the air conditioning device, it is necessary to provide, in the casing, pipes (the liquid-side pipe and the gas-side pipe) for connecting the indoor heat exchanger with the respective communication pipes. Accordingly, to provide the liquid-side pipe and the gas-side pipe so as not to interfere with other devices, spaces for installing the pipes need to be widened in the vertical or horizontal direction. This causes an increase in the overall size of the indoor unit.

[0008] In view of the foregoing background, it is therefore an object of the present invention to provide an air conditioning device with an indoor unit which can cut down such spaces for installing a liquid-side pipe and a gas-side pipe.

SOLUTION TO THE PROBLEM

30 **[0009]** A first aspect of the present invention is directed to an indoor unit for an air conditioning device. The indoor unit includes an indoor fan (27), an indoor heat exchanger (32) arranged to surround the indoor fan (27), a gas-side pipe (70) connecting the indoor heat exchanger (32) and a gas communication pipe (3) together, and a liquid-side pipe (80) connecting the indoor heat exchanger (32) and a liquid communication pipe (2) together, and is provided on a ceiling. The gas-side pipe (70) includes a header body (71a) extending vertically along a side end portion (32a) of the indoor heat exchanger (32), a vertical tube portion (74) facing the header body (71 a), and a bent tube portion (73) connecting a lower end portion of the header body (71 a) and a lower end portion of the vertical tube portion (74) together. Part of the liquid-side pipe (80) is provided in a space (S1) between the header body (71 a), the vertical tube portion (74), and the bent tube portion (73).

[0010] In the gas-side pipe (70) according to the first aspect of the present invention, the lower end portion of the header body (71 a) and the lower end portion of the vertical tube portion (74) facing the header body (71 a) are connected together by the bent tube portion (73). Accordingly, in the gas-side pipe (70), a space (S1) is formed between the header body (71a), the vertical tube portion (74), and the bent tube portion (73). In the present invention, part of the liquid-side pipe (80) is provided in this space (S1). As a result, a space for installing the liquid-side pipe (80) is cut down.

[0011] A second aspect of the present invention is an embodiment of the first aspect of the present invention. In the second aspect, the liquid-side pipe (80) is connected with an expansion valve (39) disposed inside the indoor heat exchanger (32).

[0012] According to the second aspect of the present invention, the expansion valve (39) is disposed inside the indoor heat exchanger (32). Accordingly, it is easy to carry out maintenance of the expansion valve (39) from the indoor fan (27) side (e.g., through the suction port).

[0013] A third aspect of the present invention is an embodiment of the second aspect of the present invention. In the third aspect, the liquid-side pipe (80) is connected with a flow divider body (81a) disposed outside the indoor heat exchanger (32), and a liquid relay pipe (82) coupling the flow divider body (81a) to the expansion valve (39). The liquid relay pipe (82) is disposed above the bent tube portion (73) so as to intersect with the bent tube portion (73) of the gas-side pipe (70).

[0014] According to the third aspect of the present invention, the expansion valve (39) is disposed inside the indoor heat exchanger (32), whereas the flow divider body (81a) is disposed outside the indoor heat exchanger (32). Accordingly, well-balanced spaces may be left inside and outside the indoor heat exchanger (32) without allowing the expansion valve (39) and the flow divider body (81a) to interfere with each other. Also, if the flow divider body (81a) is disposed outside the indoor heat exchanger (32) and if the expansion valve (39) is disposed inside the indoor heat exchanger (32) as described above, it is necessary to provide an installation space for the liquid relay pipe (82) connecting these elements with each other. However, according to the present invention, the liquid relay pipe (82) is provided above the bent tube portion (73) of the gas-side pipe (70). This thus prevents the pipe space from widening in the horizontal direction.

ADVANTAGES OF THE INVENTION

[0015] According to the present invention, part of the liquid-side pipe (80) is provided in the space between the header body (71a), vertical tube portion (74), and bent tube portion (73) of the gas-side pipe (70). This thus allows for cutting down the installation space for the liquid-side pipe (80), and eventually, the overall size of the indoor unit.

[0016] Also, according to the second aspect of the present invention, the expansion valve (39) connected to the liquid-side pipe (80) is disposed inside the indoor heat exchanger (32). Accordingly, it is easy to carry out maintenance of the expansion valve (39) from the indoor fan (27) (i.e., the suction grill) side.

[0017] In particular, according to the third aspect of the present invention, the expansion valve (39) is disposed inside the indoor heat exchanger (32), and the flow divider body (81a) is disposed outside the indoor heat exchanger (32). Thus, according to the third aspect of the present invention, the space inside the indoor heat ex-

changer (32) widens compared with, e.g., a situation where the expansion valve (39) and the flow divider body (81a) are disposed inside the indoor heat exchanger (32). Therefore, a sufficient installation space is ensured for the indoor fan (27) inside the indoor heat exchanger (32). Also, according to the third aspect of the present invention, the space outside the indoor heat exchanger (32) widens compared with, e.g., a situation where the expansion valve (39) and the flow divider body (81a) are disposed outside the indoor heat exchanger (32). This thus allows for cutting down horizontally the size of the casing that houses the indoor heat exchanger (32), and eventually, the overall size of the indoor unit.

[0018] Furthermore, according to the third aspect of the present invention, the liquid relay pipe (82) which forms part of the liquid-side pipe (80) and which couples the expansion valve (39) to the flow divider body (81a), is disposed over the bent tube portion (73). Consequently, the installation space for the liquid relay pipe (82) is cut down horizontally, and therefore, the indoor unit is further downsized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

[FIG. 1] FIG. 1 is a piping diagram showing a general configuration of a refrigerant circuit for an air conditioning device according to an embodiment.

[FIG. 2] FIG. 2 is a perspective view showing the appearance of an indoor unit according to an embodiment.

[FIG. 3] FIG. 3 is a vertical cross-sectional view showing the internal structure of an indoor unit according to an embodiment.

[FIG. 4] FIG. 4 is a plan view of the inside of an indoor unit according to an embodiment as viewed from over its top panel.

[FIG. 5] FIG. 5 is a first perspective view showing a gas-side pipe, a liquid-side pipe and surrounding structures thereof according to an embodiment.

[FIG. 6] FIG. 6 is a plan view showing a gas-side pipe, a liquid-side pipe, and surrounding structures thereof according to an embodiment.

[FIG. 7] FIG. 7 is a second perspective view showing a gas-side pipe, a liquid-side pipe, and surrounding structures thereof according to an embodiment.

DESCRIPTION OF EMBODIMENTS

[0020] Embodiments of the present invention will be described in detail below with reference to the drawings. The following description of embodiments is merely an illustrative one in nature, and does not intend to limit the scope of the present invention or applications or uses thereof.

[0021] An embodiment of the present invention is an air conditioning device (10) configured to cool and heat

indoor air. As illustrated in FIG. 1, the air conditioning device (10) includes an outdoor unit (11) installed outdoors and an indoor unit (20) installed indoors. The outdoor unit (11) and the indoor unit (20) are connected with each other through two communication pipes (2, 3), which thus forms a refrigerant circuit (C) in this air conditioning device (10). In the refrigerant circuit (C), a refrigerant injected therein is circulated to perform a vapor compression refrigeration cycle.

<Configuration of Refrigerant Circuit>

[0022] The outdoor unit (11) is provided with a compressor (12), an outdoor heat exchanger (13), an outdoor expansion valve (14), and a four-way switching valve (15). The compressor (12) compresses a low-pressure refrigerant, and discharges a high-pressure refrigerant thus compressed. In the compressor (12), a compression mechanism such as a scroll or rotary compression mechanism is driven by a compressor motor (12a). The compressor motor (12a) is configured so that the number of rotation (i.e., the operation frequency) thereof can be changed by an inverter.

[0023] The outdoor heat exchanger (13) is a fin and tube heat exchanger. An outdoor fan (16) is installed near the outdoor heat exchanger (13). In the outdoor heat exchanger (13), the air carried by the outdoor fan (16) exchanges heat with a refrigerant. The outdoor fan (16) is configured as a propeller fan driven by an outdoor fan motor (16a). The outdoor fan motor (16a) is configured so that the number of rotation thereof can be changed by an inverter.

[0024] The outdoor expansion valve (14) is configured as an electronic expansion valve, of which the degree of opening is variable. The four-way switching valve (15) includes first to fourth ports. In the four-way switching valve (15), the first port is connected to a discharge side of the compressor (12), the second port is connected to a suction side of the compressor (12), the third port is connected to a gas-side end portion of the outdoor heat exchanger (13), and the fourth port is connected to a gas-side shut-off valve (5). The four-way switching valve (15) is switchable between a first state (a state indicated by the solid curves in FIG. 1) and a second state (a state indicated by the broken curves in FIG. 1). In the four-way switching valve (15) in the first state, the first port communicates with the third port, and the second port communicates with the fourth port. In the four-way switching valve (15) in the second state, the first port communicates with the fourth port, and the second port communicates with the third port.

[0025] The two communication pipes are embodied as a liquid communication pipe (2) and a gas communication pipe (3), respectively. One end of the liquid communication pipe (2) is connected to a liquid-side shut-off valve (4), and the other end thereof is connected to a liquid-side end portion of the indoor heat exchanger (32). One end of the gas communication pipe (3) is connected to a

gas-side shut-off valve (5), and the other end thereof is connected to a gas-side end portion of the indoor heat exchanger (32).

[0026] The indoor unit (20) is provided with the indoor heat exchanger (32) and an indoor expansion valve (39). The indoor heat exchanger (32) is a fin and tube heat exchanger. An indoor fan (27) is installed near the indoor heat exchanger (32). The indoor fan (27) is a centrifugal blower driven by an indoor fan motor (27a). The indoor fan motor (27a) is configured so that the number of rotation thereof can be changed by an inverter. In the refrigerant circuit (C), the indoor expansion valve (39) is connected to the liquid-side end portion of the indoor heat exchanger (32). The indoor expansion valve (39) is configured as an electronic expansion valve, of which the degree of opening is variable.

<Detailed Structure of Indoor Unit>

[0027] A detailed structure of the indoor unit (20) of the air conditioning device (10) will be described with reference to FIGS. 2-4. The indoor unit (20) of this embodiment is configured as a ceiling mounted indoor unit. Specifically, as illustrated in FIG. 3, the indoor unit (20) is fitted and attached into an opening (O) of a ceiling (U) facing the room space (R). The indoor unit (20) includes an indoor unit body (21) and a decorative panel (40) attached to the bottom of the indoor unit body (21).

-Indoor Unit Body-

[0028] As illustrated in FIGS. 2 and 3, the indoor unit body (21) includes a box-shaped casing (22) having a generally rectangular parallelepiped shape. The casing (22) includes a top panel (23) which is generally square in a plan view and four generally rectangular side panels (24) extending downward from a peripheral portion of the top panel (23). The lower surface of the casing (22) has an opening. As illustrated in FIG. 2, an elongate, box-shaped electric component box (25) is attached to a side panel (24a), which is one of the four side panels (24). Also, a liquid-side connecting pipe (6) and a gas-side connecting pipe (7), which are connected to the indoor heat exchanger (32), run through this side panel (24a). The liquid-side connecting pipe (6) is connected to the liquid communication pipe (2), and the gas-side connecting pipe (7) is connected to the gas communication pipe (3).

[0029] The casing (22) houses the indoor fan (27), a bell mouth (31), the indoor heat exchanger (32), and a drain pan (36).

[0030] As illustrated in FIGS. 3 and 4, the indoor fan (27) is arranged at the center inside the casing (22). The indoor fan (27) includes the indoor fan motor (27a), a hub (28), a shroud (29), and an impeller (30). The indoor fan motor (27a) is supported on the top panel (23) of the casing (22). The hub (28) is fixed to a lower end of the indoor fan motor's (27a) drive shaft (27b) to be driven in

rotation. The hub (28) includes a ringlike base (28a) provided radially outside the indoor fan motor (27a), and a central swelling portion (28b) expanding downward from an inner peripheral portion of the base (28a).

[0031] The shroud (29) is arranged under the base (28a) of the hub (28) so as to face the base (28a). A lower portion of the shroud (29) is provided with a circular central suction port (29a) communicating with the inside of the bell mouth (31). The impeller (30) is housed in an impeller housing space (29b) between the hub (28) and the shroud (29). The impeller (30) is comprised of a plurality of turbo blades (30a) arranged along the rotation direction of the drive shaft (27b).

[0032] The bell mouth (31) is arranged under the indoor fan (27). The bell mouth (31) has a circular opening at each of its upper and lower ends, and is formed in a tubular shape so that the area of the opening increases toward the decorative panel (40). The inner space (31a) of the bell mouth (31) communicates with the impeller housing space (29b) of the indoor fan (27).

[0033] As illustrated in FIG. 4, the indoor heat exchanger (32) is provided so as to surround the indoor fan (27) by bending a refrigerant pipe (a heat transfer tube). The indoor heat exchanger (32) is installed on the upper surface of the drain pan (36) so as to stand up vertically. Air blowing laterally from the indoor fan (27) passes through the indoor heat exchanger (32). The indoor heat exchanger (32) serves as an evaporator that cools the air during a cooling operation, and also serves as a condenser (a radiator) that heats the air during a heating operation.

[0034] As illustrated in FIGS. 3 and 4, the drain pan (36) is arranged under the indoor heat exchanger (32). The drain pan (36) includes an inner wall portion (36a), an outer wall portion (36b), and a water receiving portion (36c). The inner wall portion (36a) is formed along an inner peripheral portion of the indoor heat exchanger (32), and is configured as a ringlike vertical wall that stands up vertically. The outer wall portion (36b) is formed along the four side panels (24) of the casing (22), and is also configured as a ringlike vertical wall that stands up vertically. The water receiving portion (36c) is provided between the inner wall portion (36a) and the outer wall portion (36b), and is configured as a groove for collecting condensed water produced by the indoor heat exchanger (32). In addition, four body-side blowout flow channels (37) extending along the four associated side panels (24) are provided to vertically run through the outer wall portion (36b) of the drain pan (36). Each of the body-side blowout flow channels (37) allows a downstream space of the indoor heat exchanger (32) to communicate with an associated one of four panel-side blowout flow channels (43) of the decorative panel (40).

[0035] Also, a body-side heat insulator (38) is further provided for the indoor unit body (21). The body-side heat insulator (38) is generally in the shape of a box with an opened bottom. The body-side heat insulator (38) includes a top panel-side heat insulating portion (38a)

formed along the top panel (23) of the casing (22) and a side panel-side heat insulating portion (38b) formed along the side panels (24) of the casing (22). A central portion of the top panel-side heat insulating portion (38a) has a circular through hole (38c) that an upper end portion of the indoor fan motor (27a) penetrates. The side panel-side heat insulating portion (38b) is arranged outside the body-side blowout flow channels (37) in the outer wall portion (36b) of the drain pan (36).

-Decorative Panel-

[0036] The decorative panel (40) is attached to the lower surface of the casing (22). The decorative panel (40) includes a panel body (41) and a suction grill (60).

[0037] The panel body (41) has a rectangular frame shape in a plan view. The panel body (41) has one panel-side suction flow channel (42) and four panel-side blowout flow channels (43).

[0038] As illustrated in FIG. 3, the panel-side suction flow channel (42) is formed in a central portion of the panel body (41). A suction port (42a) facing the room space (R) is provided at the lower end of the panel-side suction flow channel (42). The panel-side suction flow channel (42) allows the suction port (42a) to communicate with the inner space (31a) of the bell mouth (31). An inside panel member (44) having a frame shape is fitted into the panel-side suction flow channel (42). Also, in the panel-side suction flow channel (42), provided is a dust collection filter (45) that catches dust in the air sucked through the suction port (42a).

[0039] The respective panel-side blowout flow channels (43) are arranged outside the panel-side suction flow channel (42) so as to surround the panel-side suction flow channel (42). Each of the panel-side blowout flow channels (43) extends along an associated one of four sides of the panel-side suction flow channel (42). An outlet port (43a) facing the room space (R) is provided at the lower end of each of the panel-side blowout flow channels (43). Each of the panel-side blowout flow channels (43) allows an associated one of the outlet ports (43a) to communicate with an associated one of the body-side blowout flow channels (37).

[0040] As illustrated in FIG. 3, an inside heat insulating portion (46) is provided inside of the panel-side blowout flow channels (43) (i.e., is provided closer to the center of the panel body (41)). Also, an outside heat insulating portion (47) is provided outside of the panel-side blowout flow channels (43) (i.e., is provided closer to the outer periphery of the panel body (41)). An inside seal member (48) is provided on the upper surface of the inside heat insulating portion (46) and outside heat insulating portion (47) so as to be interposed between the panel body (41) and the drain pan (36).

[0041] An outside panel member (49) is fitted into an inner peripheral portion of the outside heat insulating portion (47). The outside panel member (49) includes an inner wall portion (50) defining an inner wall surface of

the body-side blowout flow channel (37) and an extending portion (51) extending from a lower end portion of the inner wall portion (50) toward an outer peripheral portion of the panel body (41). The extending portion (51) is formed in the shape of a rectangular frame along the lower surface of the ceiling (U). An outside seal member (52) is provided on the upper surface of the extending portion (51) so as to be interposed between the extending portion (51) and the ceiling (U).

[0042] Also, each of the body-side blowout flow channels (37) is provided with an air blowing direction adjusting blade (53) for adjusting the blowing direction of the air (blown out air) flowing through the body-side blowout flow channels (37). The air blowing direction adjusting blades (53) are provided at both ends of the body-side blowout flow channels (37) in the longitudinal direction thereof so as to be arranged along the side panels (24) of the casing (22). The air blowing direction adjusting blades (53) are each configured to be rotatable on a rotation shaft (53a) extending in the longitudinal direction thereof.

[0043] The suction grill (60) is attached to the lower end of the panel-side suction flow channel (42) (i.e., the suction port (42a)). The suction grill (60) includes a grill body (61) facing the suction port (42a), and a rectangular extension (65) extending outward from the grill body (61) toward the respective outlet ports (43a). The grill body (61) is generally square in a plan view. In a central region of the grill body (61), a large number of suction holes (63) are arranged in a grid pattern. These suction holes (63) are configured as through holes that run through the grill body (61) in the thickness direction (or vertical direction) thereof. Each suction hole (63) is an opening with a square cross section.

[0044] The extension (65) of the suction grill (60) has a rectangular frame shape so as to extend outward from the grill body (61) toward the outlet ports (43a). The extension (65) overlaps with the panel body (41) vertically so as to be in contact with the lower surface of the inside heat insulating portion (46). Also, a lateral end portion of the extension (65) is shifted closer to the suction port (42a) than an inside edge portion of the outlet ports (43a) is.

-Operation-

[0045] Next, it will be described how the air conditioning device (10) of this embodiment operates. This air conditioning device (10) performs a cooling operation and a heating operation selectively.

<Cooling Operation>

[0046] During a cooling operation, the four-way switching valve (15) is turned to the state indicated by the solid curves in FIG. 1 to make the compressor (12), the indoor fan (27), and the outdoor fan (16) operate. Thus, the refrigerant circuit (C) performs a refrigeration cycle in which

the outdoor heat exchanger (13) serves as a condenser and the indoor heat exchanger (32) serves as an evaporator.

[0047] Specifically, a high-pressure refrigerant compressed by the compressor (12) flows through the outdoor heat exchanger (13) and exchanges heat with outdoor air. In the outdoor heat exchanger (13), the high-pressure refrigerant dissipates heat to the outdoor air and consequently condenses. The refrigerant thus condensed in the outdoor heat exchanger (13) is passed to the indoor unit (20). In the indoor unit (20), the refrigerant has its pressure reduced by the indoor expansion valve (39), and subsequently flows through the indoor heat exchanger (32).

[0048] In the indoor unit (20), indoor air flows upward through the suction port (42a), the panel-side suction flow channel (42), and the inner space (31a) of the bell mouth (31) in this order, and then is sucked into the impeller housing space (29b) of the indoor fan (27). The air in the impeller housing space (29b) is carried by the impeller (30) and is blown out radially outward from between the hub (28) and the shroud (29). This air passes through the indoor heat exchanger (32) and exchanges heat with a refrigerant. In the indoor heat exchanger (32), the refrigerant absorbs heat from the indoor air, and evaporates. Consequently, the air is cooled by the refrigerant.

[0049] The air cooled by the indoor heat exchanger (32) is divided into the body-side blowout flow channels (37), then flows downward through the panel-side blowout flow channels (43), and is subsequently supplied through the outlet ports (43a) into the room space (R). Also, the refrigerant evaporated in the indoor heat exchanger (32) is sucked into the compressor (12), and is compressed there again.

<Heating Operation>

[0050] During a heating operation, the four-way switching valve (15) is turned to the state indicated by the broken curves in FIG. 1 to make the compressor (12), the indoor fan (27), and the outdoor fan (16) operate. Thus, this refrigerant circuit (C) performs a refrigeration cycle in which the indoor heat exchanger (32) serves as a condenser and the outdoor heat exchanger (13) serves as an evaporator.

[0051] Specifically, a high-pressure refrigerant compressed by the compressor (12) flows through the indoor heat exchanger (32) of the indoor unit (20). In the indoor unit (20), indoor air flows upward through the suction port (42a), the panel-side suction flow channel (42), and the inner space (31 a) of the bell mouth (31) in this order, and then is sucked into the impeller housing space (29b) of the indoor fan (27). The air in the impeller housing space (29b) is carried by the impeller (30) and is blown out radially outward from between the hub (28) and the shroud (29). This air passes through the indoor heat exchanger (32) and exchanges heat with a refrigerant. In the indoor heat exchanger (32), the refrigerant dissipates

heat to indoor air, and condenses. Consequently, the air is heated by the refrigerant.

[0052] The air heated by the indoor heat exchanger (32) is divided into the body-side blowout flow channels (37), then flows downward through the panel-side blowout flow channels (43), and is subsequently supplied through the outlet ports (43a) into the room space (R). Also, the refrigerant condensed in the indoor heat exchanger (32) has its pressure reduced by the outdoor expansion valve (14), and subsequently flows through the outdoor heat exchanger (13). In the outdoor heat exchanger (13), the refrigerant absorbs heat from outdoor air, and evaporates. The refrigerant evaporated from the outdoor heat exchanger (13) is sucked into the compressor (12), and is compressed there again.

<Gas-side Pipe, Liquid-side Pipe, and Their Surrounding Structures>

[0053] Next, a gas-side pipe (70) and a liquid-side pipe (80) housed in the indoor unit (20), and their surrounding structures will be described in detail with reference to FIGS. 5-7.

[0054] For the indoor heat exchanger (32), formed are a first side end portion (32a) and a second side end portion (32b). The first side end portion (32a) is formed on one of the side ends of the indoor heat exchanger (32) in the longitudinal direction of the heat transfer tubes thereof. The second side end portion (32b) is formed on the other side end of the indoor heat exchanger (32) in the longitudinal direction of the heat transfer tubes thereof. The gas-side pipe (70) and the liquid-side pipe (80) are installed in a pipe housing space (S) between the first and second side end portions (32a, 32b) of the indoor heat exchanger (32).

[0055] The gas-side pipe (70) is provided so as to extend from the gas-side end portion of the indoor heat exchanger (32) to the gas-side connecting pipe (7) described above. The gas-side pipe (70) includes a header (71) connected to the indoor heat exchanger (32), and a gas relay pipe (72) connected between the header (71) and the gas-side connecting pipe (7).

[0056] The header (71) is disposed near the first side end portion (32a) of the indoor heat exchanger (32). The header (71) includes a header body (71a) and a plurality of branch pipes (71b) branching from the header body (71a). The header body (71a) extends vertically along the first side end portion (32a) of the indoor heat exchanger (32). In other words, the header body (71a) is parallel to the first side end portion (32a) so as to be located at a predetermined distance from the first side end portion (32a) of the indoor heat exchanger (32). During a cooling operation, the header body (71a) allows refrigerants flowed out of the respective branch pipes (71b) to join together. On the other hand, during a heating operation, the header body (71a) allows a refrigerant flowed out of the gas relay pipe (72) to divide into the respective branch pipes (71b).

[0057] The plurality of branch pipes (71b) are provided between the header body (71a) and the first side end portion (32a) of the indoor heat exchanger (32). The branch pipes (71b) are arranged along the side surface of the header body (71a) (i.e., arranged in the vertical direction) so as to be parallel to one another. One end of each of the branch pipes (71b) is connected to an associated one of the heat transfer tubes of the first side end portion (32a) of the indoor heat exchanger (32). In other words, the header (71) is connected to the heat transfer tubes of the first side end portion (32a), which is one of the two side end portions provided on both sides of the indoor heat exchanger (32). The other end of each of the branch pipes (71b) is connected to the header body (71a), and communicates with the inside of the header body (71a).

[0058] The gas relay pipe (72) is comprised of a first bent tube portion (73) (a bent tube portion), a first vertical tube portion (74) (a vertical tube portion), and a first horizontal tube portion (75), which are arranged in this order to form respective portions of a single continuous tube extending from the header body (71a) toward the gas-side connecting pipe (7). In a side view, the first bent tube portion (73) has a generally U shape with an open upper end. The first bent tube portion (73) couples a lower end portion of the header body (71a) with a lower end portion of the first vertical tube portion (74). The first vertical tube portion (74) extends in the vertical direction so as to face a lower side surface of the header body (71a). The first vertical tube portion (74) couples the first bent tube portion (73) with the first horizontal tube portion (75). The first horizontal tube portion (75) is bent in the horizontal direction from an upper end portion of the first vertical tube portion (74), and connected to the gas-side connecting pipe (7). The gas relay pipe (72) defines a vertically elongate space (S1) between the header body (71a), the first bent tube portion (73), and the first vertical tube portion (74).

[0059] The liquid-side pipe (80) is formed so as to extend from the liquid-side end portion of the indoor heat exchanger (32) to the liquid-side connecting pipe (6) described above. The liquid-side pipe (80) includes a flow divider (81) and a liquid relay pipe (82) connected between the flow divider (81) and the liquid-side connecting pipe (6). The flow divider (81) is disposed near the first side end portion (32a) of the indoor heat exchanger (32). The flow divider (81) includes a flow divider body (81a) and a plurality of diverging pipes (81b) diverging from the flow divider body (81a).

[0060] The flow divider body (81a) is disposed outside the indoor heat exchanger (32). Specifically, supposing a virtual plane P1 is defined along a downstream surface of the indoor heat exchanger (32), which is adjacent to the first side end portion (32a) (see FIG. 6), the flow divider body (81a) is disposed between the virtual plane P1 and a side panel (24) of the casing (22). The flow divider body (81a) is formed to have a tubular shape with a bottom and a vertically extending axis. Also, the plurality

of diverging pipes (81b) are connected to an upper end surface of the flow divider body (81 a). During a cooling operation, the flow divider body (81a) allows a refrigerant flowed out of the liquid relay pipe (82) to diverge into the respective diverging pipes (81b). On the other hand, during a heating operation, the flow divider body (81a) allows refrigerants flowed out of the respective diverging pipes (81b) to join together. The plurality of diverging pipes (81b) are provided between the flow divider body (81a) and the first side end portion (32a) of the indoor heat exchanger (32). Each of the diverging pipes (81b) is configured as a capillary tube, of which the flow channel is smaller in diameter than that of the flow divider body (81 a).

[0061] The liquid relay pipe (82) is comprised of a second vertical tube portion (83), a second bent tube portion (84), a third vertical tube portion (85), a second horizontal tube portion (86), a third horizontal tube portion (87), a fourth vertical tube portion (88), a fourth horizontal tube portion (89), a fifth vertical tube portion (90), and a fifth horizontal tube portion (91), which are arranged in the order to form respective portions of a single continuously tube extending from the flow divider body (81a) toward the liquid-side connecting pipe (6).

[0062] The second vertical tube portion (83) extends downward from a lower end portion of the flow divider body (81a). The second bent tube portion (84) has a generally U shape with an open upper end. The second bent tube portion (84) connects a lower end portion of the second vertical tube portion (83) with a lower end portion of the third vertical tube portion (85). The third vertical tube portion (85) is connected with a first filter (95) that catches foreign substances in the refrigerant flowing inside. Just like the flow divider body (81 a), the first filter (95) is also disposed outside the indoor heat exchanger (32). The second horizontal tube portion (86) extends in the horizontal direction from an upper end portion of the third vertical tube portion (85) toward the indoor fan (27). In other words, the second horizontal tube portion (86) is formed so as to extend from outside of the indoor heat exchanger (32) to inside of the indoor heat exchanger (32). The second horizontal tube portion (86) is provided above the first bent tube portion (73) so as to intersect with the first bent tube portion (73) of the gas-side pipe (70).

[0063] The second horizontal tube portion (86) has an inside end portion connected to the indoor expansion valve (39) described above. The indoor expansion valve (39) is disposed inside the indoor heat exchanger (32). Specifically, supposing a virtual plane P2 is defined along an upstream surface of the indoor heat exchanger (32), which is adjacent to the first side end portion (32a) (see FIG. 6), the indoor expansion valve (39) is disposed closer to the axis of the indoor fan (27) than the virtual plane P2 is.

[0064] The third horizontal tube portion (87) extends in the horizontal direction from a lower end portion of the indoor expansion valve (39) toward the casing (22). The

fourth vertical tube portion (88) extends vertically along the header (71) and the first vertical tube portion (74). The fourth vertical tube portion (88) is provided in the space (S) between the header (71), first bent tube portion (73), and first vertical tube portion (74) of the gas-side pipe (70). The fourth horizontal tube portion (89) is bent from a lower end portion of the fourth vertical tube portion (88) and extends in the horizontal direction. The fifth vertical tube portion (90) is bent upward from an inside end portion of the fourth vertical tube portion (88) and extends in the vertical direction. The fifth vertical tube portion (90) is connected with a second filter (97) that catches foreign substances in a refrigerant flowing inside. Just like the indoor expansion valve (39), the second filter (97) is disposed inside the indoor heat exchanger (32). The fifth horizontal tube portion (91) is bent in the horizontal direction from an upper end portion of the fourth vertical tube portion (88) and connected to the liquid-side connecting pipe (6).

[0065] In this embodiment, part of the liquid relay pipe (82) is provided in the vertically elongate space (S1) between the header (71), first bent tube portion (73), and first vertical tube portion (74) of the gas-side pipe (70). Specifically, in this embodiment, an outside end portion of the third horizontal tube portion (87), the fourth vertical tube portion (88), and the inside end portion of the fourth horizontal tube portion (89) of the liquid relay pipe (82) are provided in the space (S1). This allows for cutting down an installation space for the liquid relay pipe (82) without letting the gas-side pipe (70) and the liquid-side pipe (80) interfere with each other.

[0066] Also, in this embodiment, the indoor expansion valve (39) is disposed inside the indoor heat exchanger (32). This allows the user or any other person to carry out maintenance or replacement of the indoor expansion valve (39) from the suction flow channel (42) side. On the other hand, the flow divider (81) is disposed outside the indoor heat exchanger (32). If the flow divider (81) is arranged, along with the indoor expansion valve (39), inside the indoor heat exchanger (32), the space inside the indoor heat exchanger (32) could narrow so much that sufficient installation space could not be ensured for the indoor fan (27). In contrast, sufficient installation space is ensured for the indoor fan (27) by disposing the flow divider body (81a) outside the indoor heat exchanger (32).

[0067] Here, in this embodiment, part of the liquid relay pipe (82) connecting the indoor expansion valve (39) with the flow divider body (81 a) (namely, the second horizontal tube portion (86)) is provided above the U-shaped first bent tube portion (73). Accordingly, the installation space for the second horizontal tube portion (86) is also reduced horizontally.

-Advantages of Embodiments-

[0068] According to the embodiments described above, part of the liquid-side pipe (80) is provided in the

space (S1) between the header body (71 a), first vertical tube portion (74), and first bent tube portion (73) of the gas-side pipe (70). This thus allows for cutting down the installation space for the liquid-side pipe (80), and eventually, the overall size of the indoor unit (20).

[0069] Also, the indoor expansion valve (39) is disposed inside the indoor heat exchanger (32). Accordingly, it is easy to carry out maintenance of the indoor expansion valve (39) from the indoor fan (27) (the suction grill (60)) side. Also, the indoor expansion valve (39) is disposed inside the indoor heat exchanger (32), and the flow divider body (81a) is disposed outside the indoor heat exchanger (32). Accordingly, well-balanced installation spaces are ensured inside and outside of the indoor heat exchanger (32). In addition, according to this embodiment, the pipe connecting the indoor expansion valve (39) with the flow divider body (81 a) (the second horizontal tube portion (86)) is disposed above the first bent tube portion (73). Accordingly, the installation space for the liquid relay pipe (82) is reduced in the horizontal direction, and the indoor unit (20) is further downsized.

[0070] Furthermore, in the embodiment described above, the indoor unit (20) for the air conditioning device (1) is configured as a ceiling mounted one fitted into an opening (O) of a ceiling (U). However, the indoor unit (20) may also be configured as a ceiling suspended one suspended from a ceiling and arranged in the room space (R).

INDUSTRIAL APPLICABILITY

[0071] As can be seen from the forgoing description, the present invention is useful for saving spaces for pipes to be arranged around an indoor heat exchanger of an indoor unit for an air conditioning device.

DESCRIPTION OF REFERENCE CHARACTERS

[0072]

2	Liquid Communication Pipe	
3	Gas Communication Pipe	
10	Air Conditioning Device	
20	Indoor Unit	
27	Indoor Fan	
32	Indoor Heat Exchanger	
32a	First Side End Portion (Side End Portion)	
39	Indoor Expansion Valve (Expansion Valve)	
70	Gas-Side Pipe	
71a	Header Body	50
73	First Bent Tube Portion (Bent Tube Portion)	
74	First Vertical Tube Portion (Vertical Tube Portion)	
80	Liquid-Side Pipe	
81a	Flow Divider Body	
82	Liquid Relay Pipe	55

Claims

1. An indoor unit for an air conditioning device, the indoor unit comprising:

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an indoor fan (27); an indoor heat exchanger (32) arranged to surround the indoor fan (27); a gas-side pipe (70) coupling the indoor heat exchanger (32) and a gas communication pipe (3) together; and a liquid-side pipe (80) coupling the indoor heat exchanger (32) and a liquid communication pipe (2) together, the indoor unit being provided on a ceiling, wherein the gas-side pipe (70) includes

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a header body (71 a) extending vertically along a side end portion (32a) of the indoor heat exchanger (32),

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a vertical tube portion (74) facing the header body (71 a), and

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a bent tube portion (73) connecting a lower end portion of the header body (71 a) and a lower end portion of the vertical tube portion (74) together, and

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part of the liquid-side pipe (80) is provided in a space (S1) between the header body (71a), the vertical tube portion (74), and the bent tube portion (73).

2. The indoor unit for an air conditioning device of claim 1, wherein

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the liquid-side pipe (80) is connected with an expansion valve (39) disposed inside the indoor heat exchanger (32).

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3. The indoor unit for an air conditioning device of claim 2, wherein

the liquid-side pipe (80) is connected with a flow divider body (81a) disposed outside the indoor heat exchanger (32)

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and

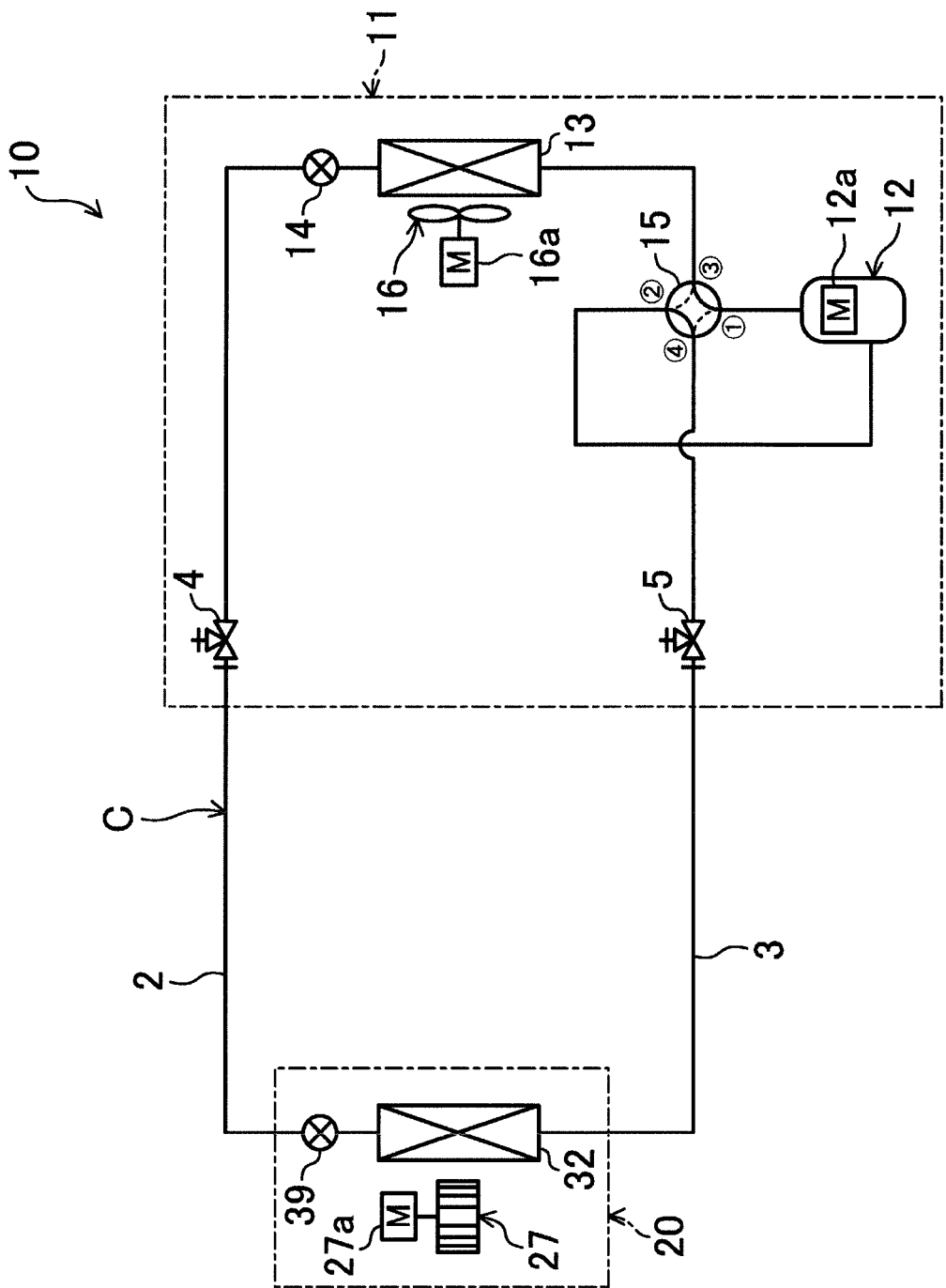
a liquid relay pipe (82) coupling the flow divider body (81 a) to the expansion valve (39), and the liquid relay pipe (82) is disposed above the bent tube portion (73) so as to intersect with the bent tube portion (73) of the gas-side pipe (70).

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FIG.1



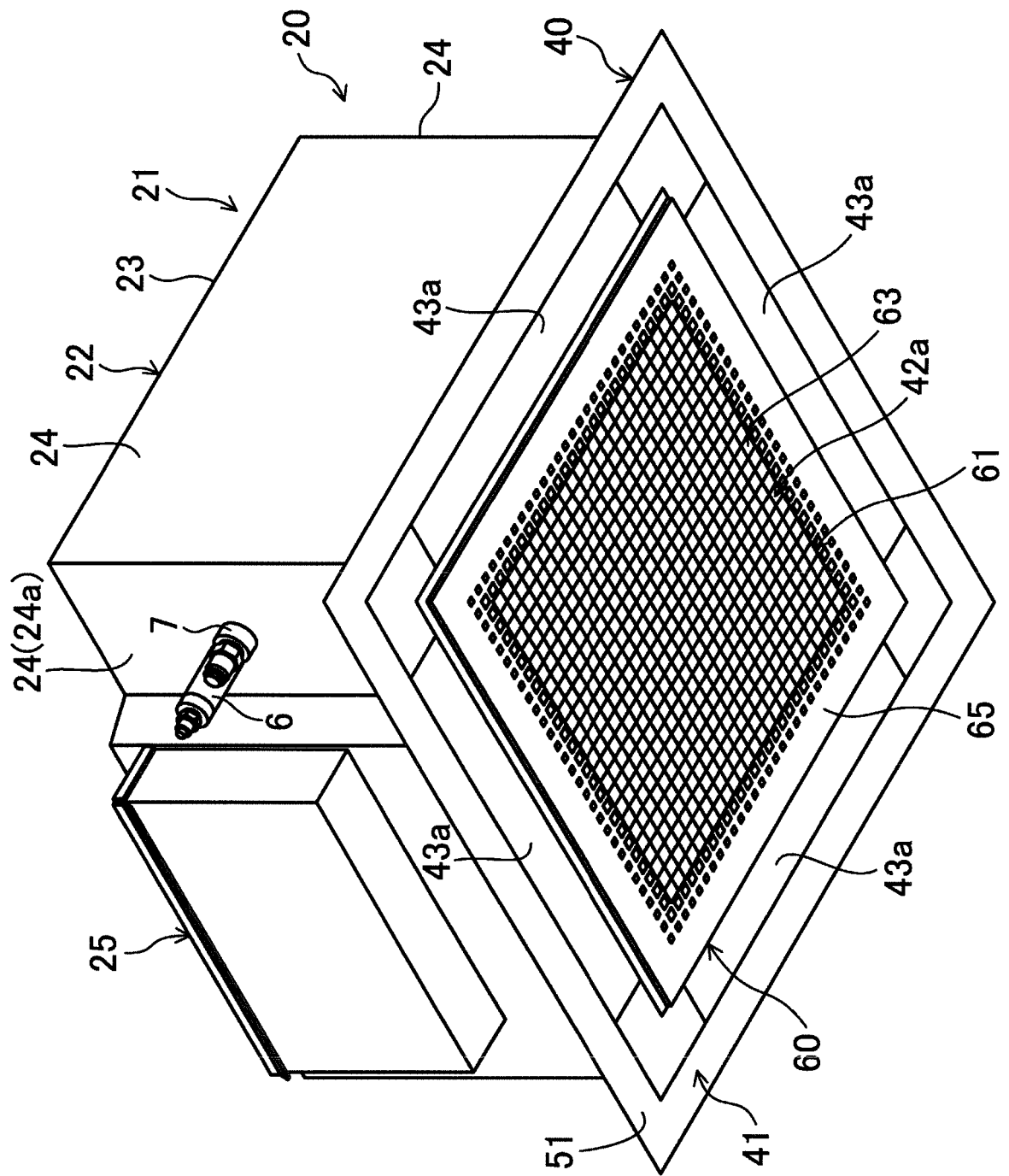


FIG. 2

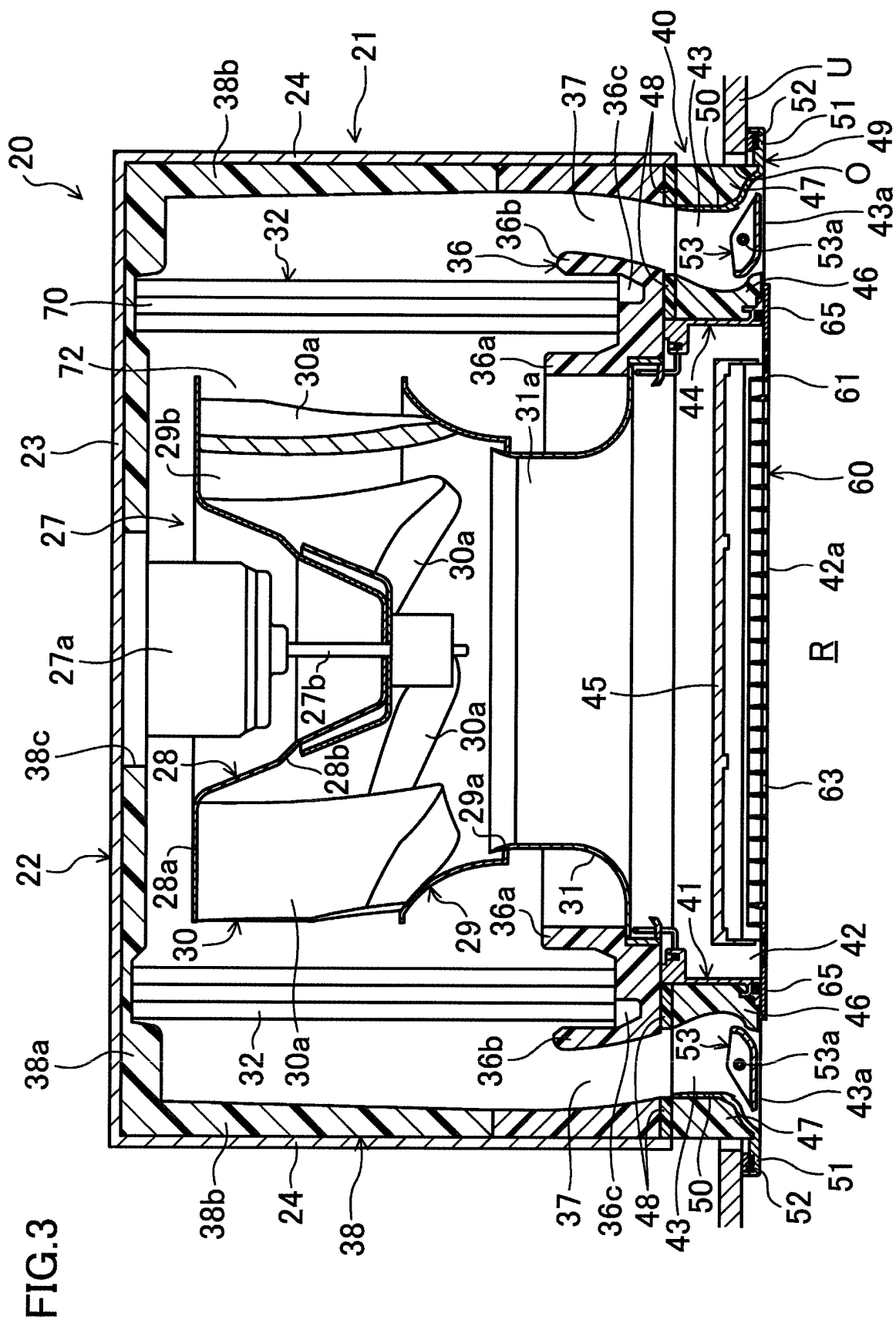


FIG.4

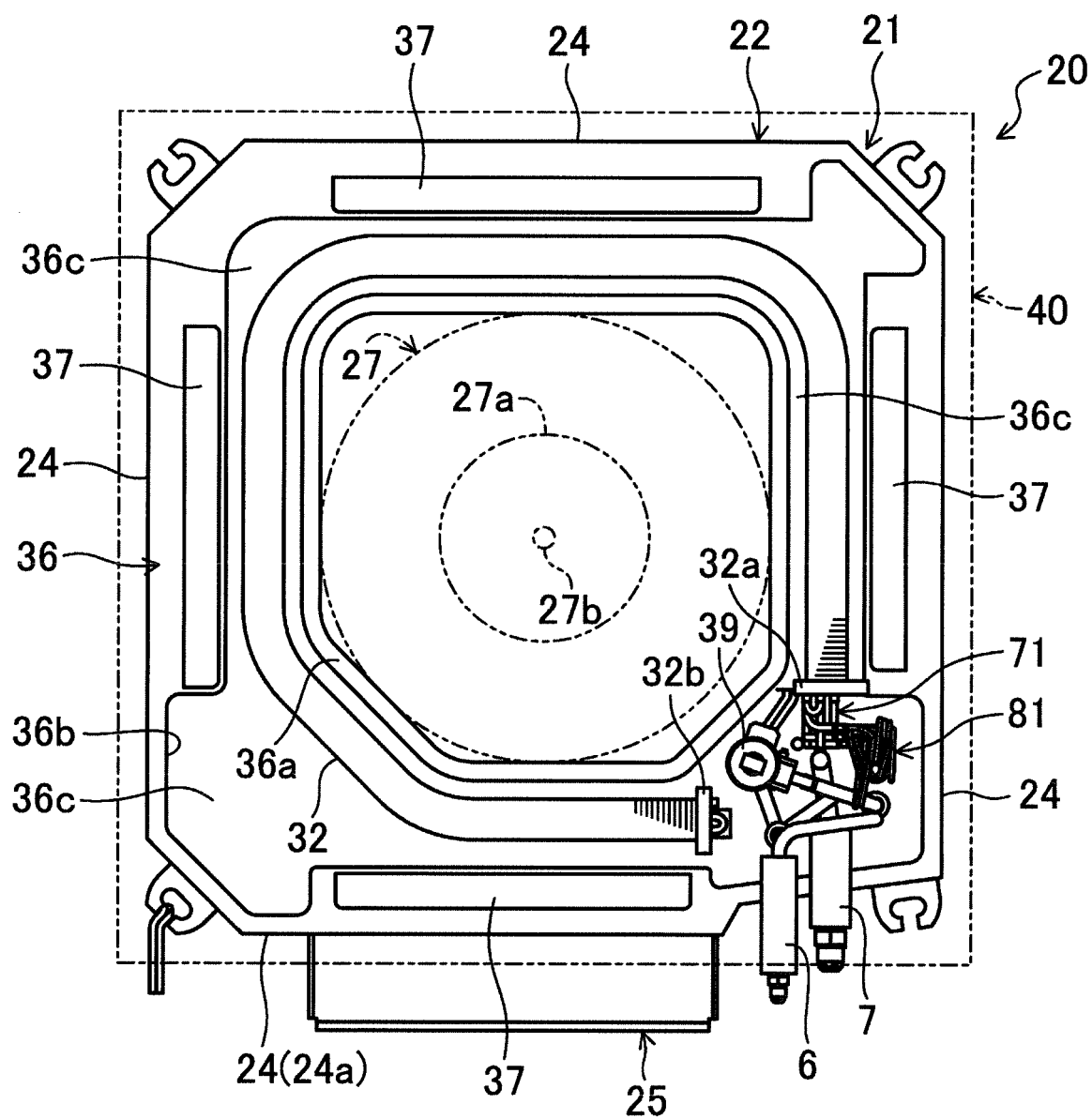


FIG.5

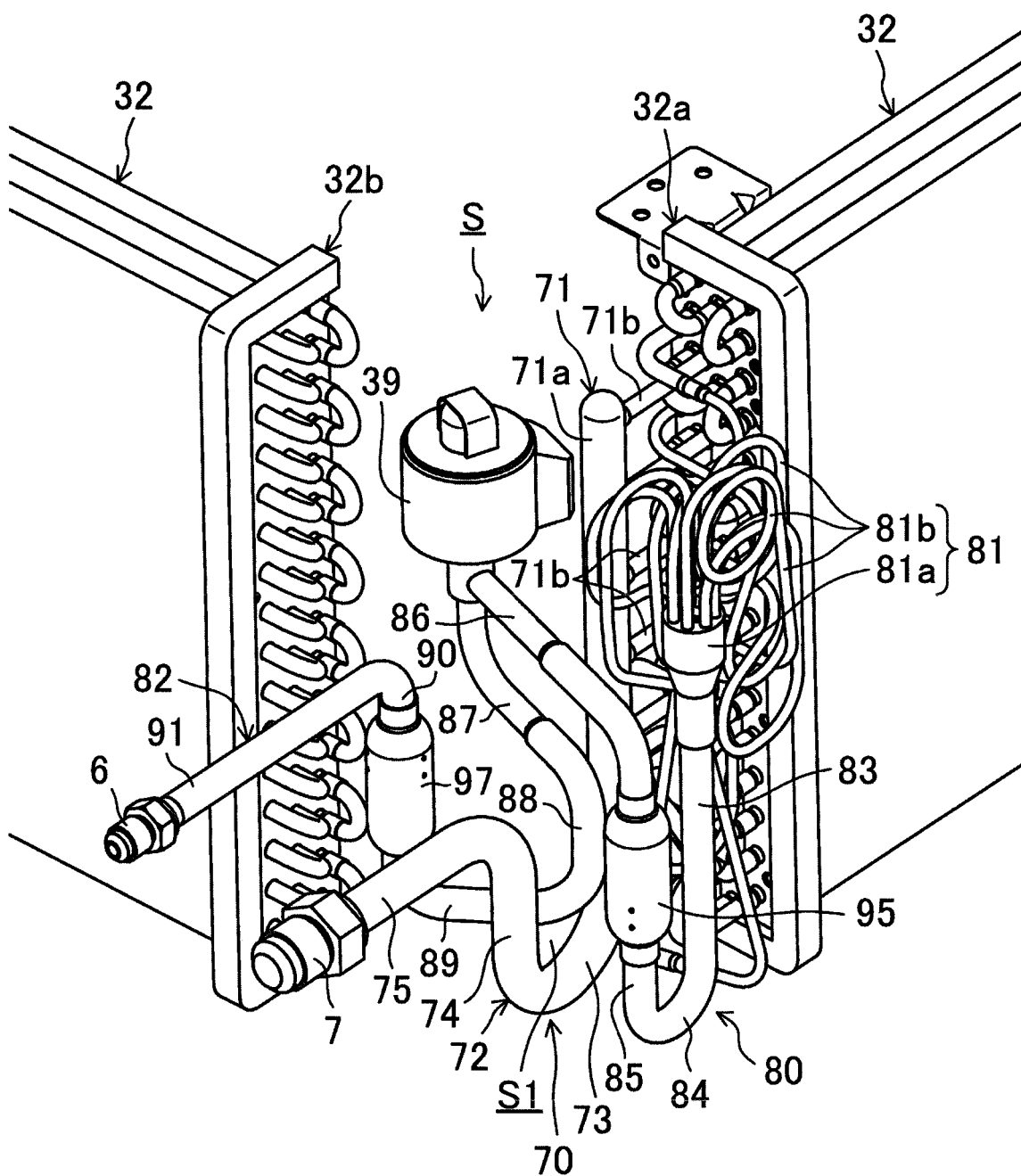


FIG.6

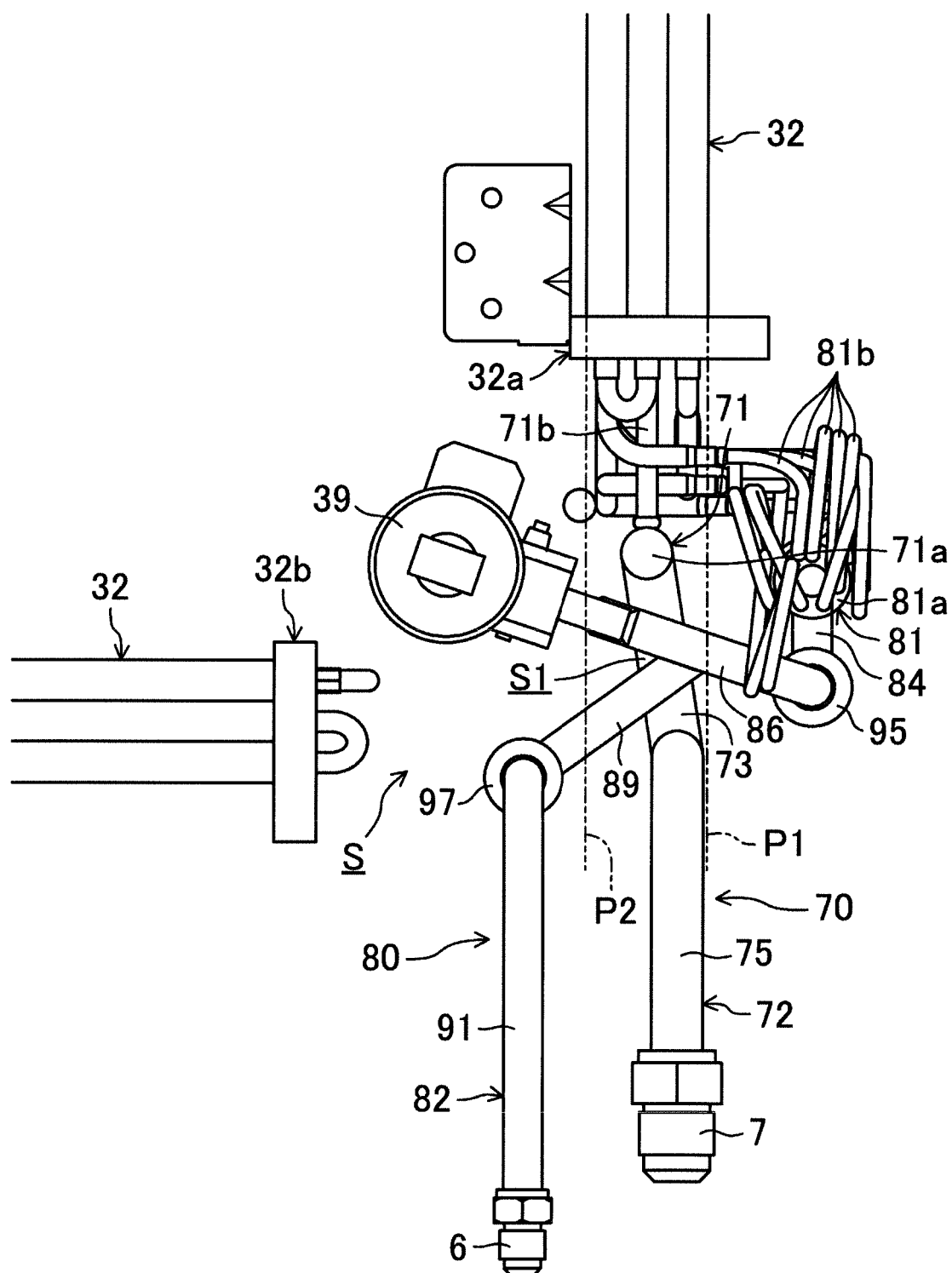
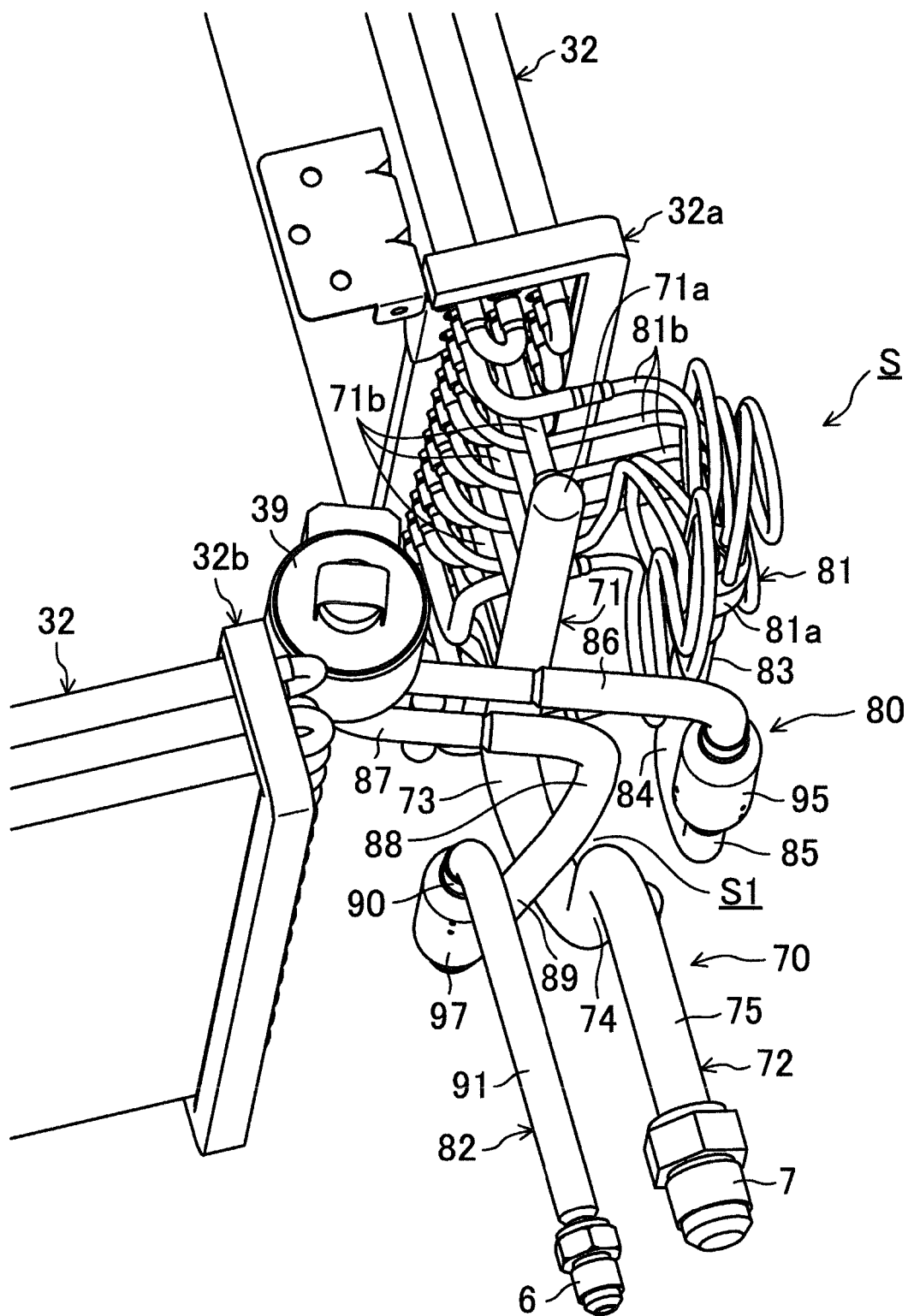


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/002305

A. CLASSIFICATION OF SUBJECT MATTER

F24F1/00(2011.01)i, F25B39/00(2006.01)i, F25B41/00(2006.01)i

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)

F24F1/00, F25B39/00, F25B41/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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 2001-263702 A (Sanyo Electric Co., Ltd.), 26 September 2001 (26.09.2001), paragraphs [0024] to [0030]; fig. 1 to 4 (Family: none)	1-3
Y	JP 2006-226586 A (Sanyo Electric Co., Ltd.), 31 August 2006 (31.08.2006), paragraph [0013]; fig. 4 to 5 (Family: none)	1-3
Y	JP 2003-254555 A (Toshiba Carrier Corp.), 10 September 2003 (10.09.2003), paragraphs [0036] to [0037]; fig. 4 & CN 1441203 A	1-3

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

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search
22 July, 2014 (22.07.14)Date of mailing of the international search report
29 July, 2014 (29.07.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/002305

5	C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
10	A	JP 2000-179992 A (Sanyo Electric Co., Ltd.), 30 June 2000 (30.06.2000), paragraphs [0002] to [0006]; fig. 2 to 3 (Family: none)	1-3
15			
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Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011163741 A [0006]