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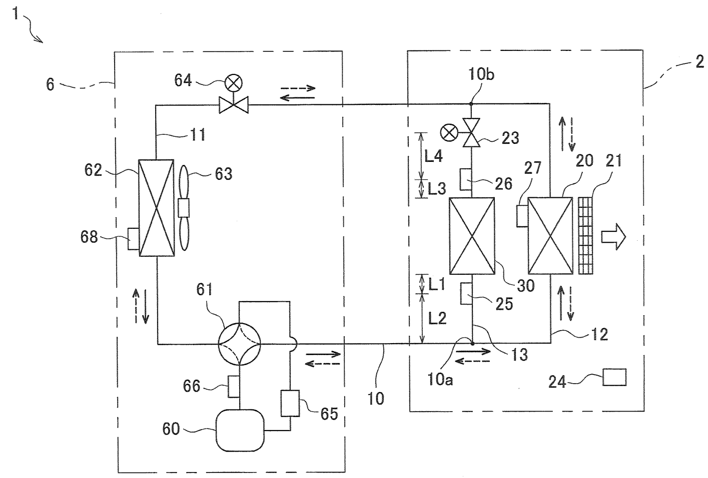
(54) AIR CONDITIONER

(57) This air conditioner appropriately controls the temperature of a radiant panel (radiant heat exchanger). The air conditioner has a compressor (60), an outdoor motor-operated valve (64), an outdoor heat exchanger (62), an indoor heat exchanger (20), and a radiant panel (30), and is provided with a refrigerant circuit (10) that is configured in a manner so that high-temperature refrigerant flows to the radiant panel (30) during a radiant heating operation. During the radiant heating operation, a panel incoming temperature sensor (25) is provided to the conduit upstream from the radiant conduit of the radiant panel (30), and a panel outgoing temperature sensor (26) is provided to the conduit downstream from the radiant conduit of the radiant panel (30). An indoor motor-operated valve control unit controls an indoor motor-operated valve (23) provided upstream from the radiant conduit of the radiant panel (30) on the basis of the temperatures detected by the panel incoming temperature sensor (25) and the panel outgoing temperature sensor (26).

FIG.1



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Description

Technical Field

[0001] The present invention relates to an air conditioner including a refrigerant circuit having an outdoor heat exchanger and a radiation heat exchanger.

Background Art

[0002] There have been an air conditioner having an indoor unit and an outdoor unit connected to each other, and including a refrigerant circuit having a compressor, an indoor heat exchanger, a radiation panel, a decompression structure, and an outdoor heat exchanger (e.g., see Patent Literature 1). The air conditioner disclosed in Patent Literature 1 has a panel temperature sensor provided to the radiation panel, the sensor configured to detect the temperature on the side of the refrigerant inlet port. Then, based on the temperature detected by the panel temperature sensor, the temperature of the radiation panel is controlled.

Prior Art Documents

Patent Literature

[0003] [Patent Literature 1] Japanese Examined Utility Model Publication No. 18935/1995 (Jitsukouhei 7- 18935)

Summary of the Invention

Technical Problem

[0004] The temperature of refrigerant having flown into the radiation panel rapidly drops due to radiation from the radiation panel and influences from natural convection. Therefore, the temperature detected by the panel temperature sensor is not the temperature of the refrigerant having flown into the radiation panel, but the temperature of the refrigerant having flown into the radiation panel, which is lowered due to the radiation or the influences by the natural convection. This leads to a problem that the temperature of the radiation panel is not suitably controlled.

[0005] In view of the present invention, it is an object of the present invention to provide an air conditioner capable of suitably controlling the temperature of the radiation panel (radiation heat exchanger).

Technical Solution

[0006] A first aspect of the present invention is an air conditioner, including a refrigerant circuit including a compressor, a decompression structure, an outdoor heat exchanger, an indoor heat exchanger, and a radiation heat exchanger, wherein the refrigerant circuit is configured to cause a high temperature refrigerant to flow in the radiation heat exchanger during a radiation heating operation, and wherein a temperature sensor is provided in at least one of a conduit which, during the radiation heating operation, is on the upstream side of the radiation heat exchanger in the refrigerant circuit and a conduit which, during the radiation heating operation, is on the downstream side of the radiation heat exchanger in the refrigerant circuit.

[0007] Note that the expression "conduit which (during the radiation heating operation) is on the upstream side of the radiation heat exchanger" means that the conduit on the upstream side of the most upstream end portion of the conduits constituting the radiation heat exchanger, and the expression "conduit which (during the radiation heating operation) is on the downstream side of the radiation heat exchanger" means the conduit on the downstream side of the most downstream end portion of the conduits constituting the radiation heat exchanger.

[0008] The temperature sensor in this air conditioner is provided at least one of the conduit on the downstream side of the radiation heat exchanger and the conduit on the upstream side of the radiation heat exchanger. Therefore, the temperature detected by the temperature sensor is hardly influenced by the radiation from the radiation heat exchanger or by the natural convection. This allows suitable temperature control of the radiation heat exchanger.

[0009] A second aspect of the present invention is the air conditioner of the first aspect adapted so that the refrigerant circuit includes: a principal channel having the decompression structure, the outdoor heat exchanger, and the compressor in this order; a first channel provided with the indoor heat exchanger, which connects a branching section and a merging section, the branching section being provided in a position which, during the heating operation, is on the downstream side of the compressor in the principal channel, and the merging section being provided in a position which, during the heating operation, is on the upstream side of the decompression structure; and a second channel provided with the radiation heat exchanger, which connects the branching section and the merging section with the first channel in parallel during the heating operation, the temperature sensor is provided in at least one of the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel and the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel.

[0010] The air conditioner having the indoor heat exchanger and the radiation heat exchanger provided in parallel with each other allows suitable temperature control of the radiation heat exchanger.

[0011] A third aspect of the present invention is the air conditioner of the first or second aspect adapted so that the temperature sensor is provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger and at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger.

[0012] With the temperature sensor provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger, the air conditioner is able to detect the temperature of the refrigerant before it flows into the radiation heat exchanger, in the circuit during the heating operation. In other words, it is possible to detect the temperature of the refrigerant before the temperature drops due to the radiation from the radiation heat exchanger. Thus, excessively high surface temperature of the radiation heat exchanger (radiation panel) is promptly and reliably restrained. It is possible to provide a functional part such as a valve in the conduit which is on the downstream side of the radiation heat exchanger in the circuit during the heating operation. Closing this valve or the like prevents the refrigerant from flowing into the radiation heat exchanger, during the cooling operation. In this case, when the refrigerant leaks out from the functional part such as a valve during the cooling operation, that leakage is detected before the refrigerant flows into the radiation heat exchanger by providing a temperature sensor at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger and which is closer to the radiation heat exchanger than it is to the functional part such as a valve. Thus, it is possible to promptly and reliably detect the leakage of the refrigerant, and detect dew condensation on the radiation heat exchanger. Further, a predicted surface temperature value of the radiation heat exchanger (radiation panel) is highly accurately calculated based on the temperatures detected by the temperature sensors on the both sides.

[0013] A fourth aspect of the present invention is the air conditioner of the third aspect adapted so that the refrigerant circuit has a valve structure provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel or the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel; and the valve structure is controlled based on a first temperature detected by the temperature sensor provided at the conduit which is on the upstream side of the radiation heat exchanger, and a second temperature detected by the temperature sensor provided at the conduit which is on the downstream side of the radiation heat exchanger.

[0014] In the air conditioner, the valve structure is controlled to adjust the surface temperature of the radiation heat exchanger (radiation panel) derived from the first temperature and the second temperature to the target temperature. Thus, the performance of the indoor heat exchanger is not influenced, unlike the cases where the decompression structure is controlled to control the surface temperature of the radiation heat exchanger.

[0015] A fifth aspect of the present invention is the air conditioner of the first or second aspect adapted so that the temperature sensor is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger.

[0016] Further, with the air conditioner, it is possible to provide a functional part such as a valve in the conduit which is on the downstream side of the radiation heat exchanger in the circuit during the heating operation. Closing this valve or the like prevents the refrigerant from flowing into the radiation heat exchanger, during the cooling operation. In this case, when the refrigerant leaks out from the functional part such as a valve during the cooling operation, that leakage is detected before the refrigerant flows into the radiation heat exchanger by providing a temperature sensor at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger and which is closer to the radiation heat exchanger than it is to the functional part such as a valve. Thus, it is possible to promptly and reliably detect the leakage of the refrigerant, and detect dew condensation on the radiation heat exchanger.

[0017] A sixth aspect of the present invention is the air conditioner of the first or second aspect adapted so that the temperature sensor is provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger.

[0018] With the temperature sensor provided at the conduit which is on the upstream side of the radiation heat exchanger in the circuit during the heating operation, the air conditioner is able to detect the temperature of the refrigerant before it flows into the radiation heat exchanger, during the heating operation. In other words, it is possible to detect the temperature of the refrigerant before the temperature drops due to the radiation from the radiation heat exchanger. Thus, excessively high surface temperature of the radiation heat exchanger (radiation panel) is promptly and reliably restrained.

[0019] A seventh aspect of the present invention is the air conditioner of the second aspect adapted so that the temperature sensor is provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel, and the temperature sensor is positioned closer to the radiation heat exchanger than it is to the branching section.

[0020] The air conditioner is capable of detecting the temperature of the refrigerant immediately before it flows into the radiation heat exchanger, during the heating operation. Thus, the surface temperature of the radiation heat exchanger (radiation panel) is highly accurately controlled.

[0021] A eighth aspect of the present invention is the air conditioner of the second or seventh aspect adapted so that the valve structure is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel, and the temperature sensor is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel, and is positioned closer to the radiation heat exchanger than it is to the valve structure.

[0022] The air conditioner is capable of detecting the temperature of the refrigerant immediately after it flows out of the radiation heat exchanger, during the heating operation. Thus, the surface temperature of the radiation heat exchanger (radiation panel) is highly accurately controlled.

Advantageous Effects

[0023] As hereinabove described, the present invention brings about the following effects.

[0024] The first aspect of the present invention is provided at least one of the conduit on the downstream side of the radiation heat exchanger and the conduit on the upstream side of the radiation heat exchanger. Therefore, the temperature detected by the temperature sensor is hardly influenced by the radiation from the radiation heat exchanger or by the natural convection. This allows suitable temperature control of the radiation heat exchanger.

[0025] A second aspect of the present invention having the indoor heat exchanger and the radiation heat exchanger provided in parallel with each other allows suitable control of the radiation heat exchanger.

[0026] The third aspect of the present invention, with the temperature sensor provided at the conduit which is on the upstream side of the radiation heat exchanger in the circuit during the heating operation, is able to detect the temperature of the refrigerant before it flows into the radiation heat exchanger, during the heating operation. In other words, it is possible to detect the temperature of the refrigerant before the temperature drops due to the radiation from the radiation heat exchanger. Thus, excessively high surface temperature of the radiation heat exchanger (radiation panel) is promptly and reliably restrained. It is possible to provide a functional part such as a valve in the conduit which is on the downstream side of the radiation heat exchanger in the circuit during the heating operation. Closing this valve or the like prevents the refrigerant from flowing into the radiation heat exchanger, during the cooling operation. In this case, when the refrigerant leaks out from the functional part such as a valve during the cooling operation, that leakage is detected before the refrigerant flows into the radiation heat exchanger by providing a temperature sensor at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger and which is closer to the radiation heat exchanger than it is to the functional part such as a valve. Thus, it is possible to promptly and reliably detect the leakage of the refrigerant, and detect dew condensation on the radiation heat exchanger. Further, a predicted surface temperature value of the radiation heat exchanger (radiation panel) is highly accurately calculated based on the temperatures detected by the temperature sensors on the both sides.

[0027] With the fourth aspect of the present invention, the valve structure is controlled to adjust the surface temperature of the radiation heat exchanger (radiation panel) derived from the first temperature and the second temperature to the target temperature. Thus, the performance of the indoor heat exchanger is not influenced, unlike the cases where the decompression structure is controlled to control the surface temperature of the radiation heat exchanger.

[0028] With the fifth aspect of the present invention, it is possible to provide a functional part such as a valve in the conduit which is on the downstream side of the radiation heat exchanger in the circuit during the heating operation. Closing this valve or the like prevents the refrigerant from flowing into the radiation heat exchanger, during the cooling operation. In this case, when the refrigerant leaks out from the functional part such as a valve during the cooling operation, that leakage is detected before the refrigerant flows into the radiation heat exchanger by providing a temperature sensor at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger and which is closer to the radiation heat exchanger than it is to the functional part such as a valve. Thus, it is possible to promptly and reliably detect the leakage of the refrigerant, and detect dew condensation on the radiation heat exchanger.

[0029] The sixth aspect of the present invention, with the temperature sensor provided at the conduit which is on the upstream side of the radiation heat exchanger in the circuit during the heating operation, is able to detect the temperature of the refrigerant before it flows into the radiation heat exchanger, during the heating operation. In other words, it is possible to detect the temperature of the refrigerant before the temperature drops due to the radiation from the radiation heat exchanger. Thus, excessively high surface temperature of the radiation heat exchanger (radiation panel) is promptly and reliably restrained.

[0030] The seventh aspect of the present invention is capable of detecting the temperature of the refrigerant immediately before it flows into the radiation heat exchanger, during the heating operation. Thus, the surface temperature of the radiation heat exchanger (radiation panel) is highly accurately controlled.

[0031] The eighth aspect of the present invention is capable of detecting the temperature of the refrigerant immediately after it flows out of the radiation heat exchanger, during the heating operation. Thus, the surface temperature of the radiation heat exchanger (radiation panel) is highly accurately controlled.

Brief Description of Drawings

[0032]

[Fig. 1] FIG. 1 is a circuit diagram showing a schematic configuration of an air conditioner related to an embodiment, in accordance with the present invention, and shows a flow of the refrigerant during a cooling operation and a warm air heating operation.
[Fig. 2] FIG. 2 is a circuit diagram showing a schematic configuration of the air conditioner related to the embodiment, in accordance with the present invention, and shows a flow of the refrigerant during a radiation heating operation and a radiation breeze heating operation.
[Fig. 3] FIG. 3 is a perspective diagram of an indoor unit shown in Fig. 1 and Fig. 2.
[Fig. 4] FIG. 4 is a cross sectional view of the indoor unit taken along the line IV-IV shown in Fig. 3.
[Fig. 5] FIG. 5 is a front view of a front grill and an open/close panel of the indoor unit shown in Fig. 3.
[Fig. 6] FIG. 6 (a) is a front view of conduits arranged on the right side of the indoor heat exchanger shown in Fig. 5, and FIG. 6 (b) is a right side view of the same shown in FIG. 6(a).
[Fig. 7] FIG. 7 (a) is a front view of the radiation panel shown in Fig. 3, FIG. 7(b) is a top view of the same shown in FIG. 7(a), and FIG. 7(c) is a rear view of the same shown in FIG. 7(a).
[Fig. 8] FIG. 8(a) is a rear view of a front panel unit shown in Fig. 7, and FIG. 8 (b) is a cross sectional view taken along the line b-b in FIG. 8(a).
[Fig. 9] FIG. 9 is a cross sectional view taken along the line IX-IX in Fig. 7.
[Fig. 10] FIG. 10 is a block diagram showing a schematic configuration of a controller controlling the air conditioner.
[Fig. 11] FIG. 11 is an explanatory diagram of a control performed by an indoor motor-operated valve controller shown in Fig. 10.
[Fig. 12] FIG. 12 is a diagram showing an example control performed by the controller showing in Fig. 10.
[Fig. 13] FIG. 13 is a circuit diagram showing a schematic configuration of an air conditioner related to a first modification of the embodiment.
[Fig. 14] FIG. 14 is a circuit diagram showing a schematic configuration of an air conditioner related to a second modification of the embodiment.

Description of Embodiments

[0033] Hereinafter, an air conditioner 1 according to an embodiment of the present invention will be described.

<Entire Configuration of Air Conditioner 1>

[0034] As illustrated in Figs. 1 and 2, the air conditioner 1 of the embodiment includes an indoor unit 2 installed in a room, an outdoor unit 6 installed out of the room, and a remote controller 9 (see FIG. 10). The indoor unit 2 includes an indoor heat exchanger 20, an indoor fan 21 disposed near the indoor heat exchanger 20, a radiation panel 30, an indoor motor-operated valve 23, and an indoor temperature sensor 24 that detects an indoor temperature. The outdoor unit 6 includes a compressor 60, a four-way valve 61, an outdoor heat exchanger 62, an outdoor fan 63 disposed near the outdoor heat exchanger 62, and an outdoor motor-operated valve 64 (a decompression structure).
[0035] The air conditioner 1 includes a refrigerant circuit 10 that connects the indoor unit 2 and the outdoor unit 6 to each other. The refrigerant circuit 10 includes a principal channel 11 in which the outdoor motor-operated valve 64, the outdoor heat exchanger 62, and the compressor 60 are sequentially provided. An intake-side conduit and a discharge-side conduit of the compressor 60 are connected to the four-way valve 61. A branching section 10a is provided in a portion that becomes a downstream side of the compressor 60 in the principal channel 11 during a heating operation (as described later, when a refrigerant is flowing in a direction indicated by a solid-line arrow in Figs. 1 and 2 in the refrigerant circuit 10), and a merging section 10b is provided in a portion that becomes an upstream side of the outdoor motor-operated valve 64. The refrigerant circuit 10 also includes a first channel 12 and a second channel 13. The first channel 12 connects the branching section 10a and the refrigerant circuit 10 to each other, and the indoor heat exchanger 20 is provided in the first channel 12. The second channel 13 is connected in parallel with the first channel 12 between the branching section 10a and merging section 10b, and the radiation panel 30 is provided in the second channel 13.
[0036] An indoor motor-operated valve (valve structure) 23 is provided between the radiation panel 30 and the merging section 10b in the second channel 13; i.e., to the conduit downstream of the radiation conduit 36c (see Fig. 8 or the like)

of the radiation heat exchanger 34 in the radiation panel 30. A panel incoming temperature sensor 25 and a panel outgoing temperature sensor 26 are attached to both sides of the radiation panel 30 in the second channel 13. More specifically, the panel incoming temperature sensor 25 is provided in a conduit and is on the upstream side of a radiation conduit 36c of the radiation panel 30 during the heating operation. The panel outgoing temperature sensor 26 is provided at the conduit and is on the downstream side of the radiation conduit 36c of the radiation panel 30 during the heating operation.

[0037] As shown in Fig. 1, a length L1 from the panel incoming temperature sensor 25 to the radiation conduit 36c of the radiation panel 30 is shorter than a length L2 from the branching section 10a to the panel incoming temperature sensor 25. That is, the panel incoming temperature sensor 25 is positioned closer to the radiation conduit 36c than it is to the branching section 10a. Further, a length L3 from the panel outgoing temperature sensor 26 to the radiation conduit 36c of the radiation panel 30 is shorter than a length L4 from the indoor motor-operated valve 23 to the panel outgoing temperature sensor 26. That is, the panel outgoing temperature sensor 26 is positioned closer to the radiation conduit 36c than it is to the indoor motor-operated valve 23.

[0038] In the refrigerant circuit 10, an accumulator 65 is interposed between an intake side of the compressor 60 and the four-way valve 61, and a discharge temperature sensor 66 is attached between a discharge side of the compressor 60 and the four-way valve 61. An outdoor heat exchanger temperature sensor 68 is attached to the outdoor heat exchanger 62.

[0039] The indoor heat exchanger 20 includes the conduit, which constitutes a part of the refrigerant circuit 10, and an indoor heat exchanger temperature sensor 27 is attached to the indoor heat exchanger 20. The indoor heat exchanger 20 is disposed on a windward side of the indoor fan 21. Air heated or cooled by heat exchange with the indoor heat exchanger 20 is blown as warm wind or cool wind into the room by the indoor fan 21, thereby performing warm-air heating or cooling.

[0040] As described in detail later, the radiation panel 30 is disposed on a surface side of the indoor unit 2, and includes a panel conduit 36 (see Fig. 8 and the like), which constitutes a part of the refrigerant circuit 10. Heat of the refrigerant flowing at the conduit is radiated into the room to perform radiation heating. The indoor motor-operated valve 23 is provided in order to adjust a flow rate of the refrigerant supplied to the radiation panel 30.

[0041] The air conditioner 1 of the present embodiment is capable of performing a cooling operation, a warm air heating operation, a radiation heating operation, and a radiation breeze heating operation. The cooling operation is an operation for performing cooling by causing the refrigerant to flow not in the radiation panel 30 but in the indoor heat exchanger 20, and the warm air heating operation is an operation for performing warm-air heating by causing the refrigerant to flow not in the radiation panel 30 but in the indoor heat exchanger 20. The radiation heating operation is an operation for performing radiation heating which causes the refrigerant to flow in the radiation panel 30, while causing the refrigerant to also flow in the indoor heat exchanger 20 to perform warm-air heating. The radiation breeze heating operation is an operation which performs warm-air heating with a fixed air-flow lower than that of the warm air heating operation and the radiation heating operation, while causing the refrigerant to flow in the radiation panel 30 to perform radiation heating operation.

[0042] The indoor motor-operated valve 23 is provided in order to adjust a flow rate of the refrigerant supplied to the radiation panel 30. During the cooling operation mode, the indoor motor-operated valve 23 is closed, and the four-way valve 61 is switched to a state indicated by a broken line in Fig. 1. Therefore, as indicated by a broken-line arrow in Fig. 1, the high-temperature, high-pressure refrigerant discharged from the compressor 60 flows in the outdoor heat exchanger 62 through the four-way valve 61. The refrigerant condensed by the outdoor heat exchanger 62 flows in the indoor heat exchanger 20 after being decompressed by the outdoor motor-operated valve 64. The refrigerant vaporized by the indoor heat exchanger 20 flows in the compressor 60 through the four-way valve 61 and accumulator 65.

[0043] During the warm air heating operation, the indoor motor-operated valve 23 is opened and the four-way valve 61 is switched to a state indicated by the solid line in Fig. 1. Therefore, as indicated by the solid-line arrow in Fig. 1, the high-temperature, high-pressure refrigerant discharged from the compressor 60 flows into the indoor heat exchanger 20 through the four-way valve 61. The refrigerant condensed in the indoor heat exchanger 20 flows into the outdoor heat exchanger 62 after being depressurized by the outdoor motor-operated valve 64. The refrigerant vaporized by the outdoor heat exchanger 62 flows in the compressor 60 through the four-way valve 61 and the accumulator 65.

[0044] During the radiation heating operation mode and the radiation breeze heating operation, the indoor motor-operated valve 23 is opened, and the four-way valve 61 is switched to a state indicated by a solid line in Fig. 2. Therefore, as indicated by a solid-line arrow in Fig. 2, the high-temperature, high-pressure refrigerant discharged from the compressor 60 flows in the indoor heat exchanger 20 and radiation panel 30 through the four-way valve 61. The refrigerant condensed by the indoor heat exchanger 20 and radiation panel 30 flows in the outdoor heat exchanger 62 after being decompressed by the outdoor motor-operated valve 64. The refrigerant vaporized by the outdoor heat exchanger 62 flows in the compressor 60 through the four-way valve 61 and accumulator 65.

<Configuration of Indoor Unit 2>

[0045] A configuration of the indoor unit 2 will be described below. As illustrated in Fig. 3, the indoor unit 2 of the embodiment has a rectangular solid shape as a whole, and is installed near a floor surface in the room. In the embodiment, the indoor unit 2 is attached to a wall surface while floating from the floor surface by about 10 cm. Hereinafter, a direction in which the indoor unit 2 projects from the attached wall is referred to as a '"front", and the opposite direction is referred to as a "rear". Aright-left direction in Fig. 3 is simply referred to as a "horizontal direction", and an up-down direction is simply referred to as a "vertical direction".

[0046] As illustrated in Fig. 4, the indoor unit 2 mainly includes a casing 4, internal devices, such as the indoor fan 21, the indoor heat exchanger 20, an outlet unit 46, and an electric component unit 47, which are accommodated in the casing 4, and a front grill 42. As described in detail later, the casing 4 includes a principal inlet 4a formed in a lower wall of the casing 4 and auxiliary inlets 4b and 4c that are formed in a front wall of the casing 4. An outlet 4d is formed in an upper wall of the casing 4. In the indoor unit 2, by driving the indoor fan 21, while the air near the floor surface is drawn through the principal inlet 4a, the air is drawn through the auxiliary inlets 4b and 4c. The indoor heat exchanger 20 heats or cools the drawn air to perform conditioning. Then the post-conditioning air is blown from the outlet 4d and returned to the room.

[0047] The casing 4 includes a body frame 41, an outlet cover 51, the radiation panel 30, and an opening-closing panel 52. As described in detail later, the outlet cover 51 includes a front panel section 51a, and the radiation panel 30 includes a radiation plate 31. The front panel section 51a of the outlet cover 51, the radiation plate 31 of the radiation panel 30, and the opening-closing panel 52 are disposed so as to be flush with one another in a front surface of the casing 4, and the front panel section 51a, the radiation plate 31, and the opening-closing panel 52 constitute a front panel 5. As illustrated in Fig. 3, a power button 48 and an emission display section 49 that indicates an operation status are provided in an upper right end portion of the front panel 5, namely, a right end portion of the front panel section 51a of the outlet cover 51.

[0048] The body frame 41 is one attached to a wall surface, and the body frame 41 supports various internal devices described above. The front grill 42, the outlet cover 51, the radiation panel 30, and the opening-closing panel 52 are attached to the front surface of the body frame 41 while the body frame 41 supports the internal devices. The outlet cover 51 is attached to an upper end portion of the body frame 41, and the outlet 4d that is a horizontally long rectangular opening is formed on the upper wall of the outlet cover 51. The radiation panel 30 is attached below the outlet cover 51, and the opening-closing panel 52 is attached below the radiation panel 30. The principal inlet 4a that is the horizontally long opening is formed between a lower front end of the body frame 41 and a lower end of the opening-closing panel 52.

[0049] Each internal device accommodated in the casing 4 will be described below.

The indoor fan 21 is disposed slightly above a middle portion in a height direction of the casing 4 such that an axial direction of the indoor fan 21 is aligned with the horizontal direction. The indoor fan 21 draws the air from the lower front and flows the air to the upper rear.

[0050] The indoor heat exchanger 20 is disposed in substantially parallel with the front panel 5. The indoor heat exchanger 20 includes a front heat exchanger 20a facing the rear surface of the front panel 5 and a rear heat exchanger 20b upwardly inclined toward the rear surface from a vicinity of the lower end portion of the front heat exchanger 20a. The front-surface heat exchanger 20a is disposed at the front side of the indoor fan 21, and the upper half thereof faces the indoor fan 21. As shown in Fig. 4, the upper end of the front-surface heat exchanger 20a is positioned higher than the position of the upper end of the indoor fan 21. The back-surface heat exchanger 20b is disposed below the indoor fan 21. That is, the indoor heat exchanger 20 as a whole has a substantially V-shape, and is disposed in such a manner as to face the front and lower side of the indoor fan 21.

[0051] As illustrated in Fig. 6, when viewed from the front, conduits are provided integral with the indoor heat exchanger 20 on the right side of the indoor heat exchanger 20 in order to supply the refrigerant sent from the outdoor unit 6 to the indoor heat exchanger 20 and radiation panel 30. As illustrated in Fig. 5, a drip-resistant cover 45 is attached in front of the conduits.

[0052] As illustrated in Fig. 6(a), a first connection section 15 and a second connection section 16 are disposed in the right end portion of the indoor unit 2. During the heating operation, the first connection section 15 is connected to the conduit constituting the channel on the downstream side of the compressor 60 in the principal channel 11, and the second connection section 16 is connected to the conduit constituting the channel on the upstream side of the outdoor motor-operated valve 64 in the principal channel 11. As shown in Fig. 6 (b), the second connection section 16 is positioned obliquely above the first connection section 15.

[0053] A third connection section 17 and a fourth connection section 18 are disposed on the left sides of the first connection section 15 and second connection section 16. As described later, the third connection section 17 and the fourth connection section 18 are connected to both ends of the panel conduit 36 (see Fig. 8 and the like) provided integral with the radiation panel 30, respectively. The fourth connection section 18 is positioned obliquely below the third connection section 17.

[0054] The conduit that extends from the first connection section 15 is connected to a branching conduit that serves as the branching section 10a. The conduits, which constitute the first channel 12 having the indoor heat exchanger 20 and the second channel 13 having the radiation panel 30, extend from the branching conduit. The indoor heat exchanger 20 of the embodiment is configured such that the refrigerant flows in the merging section 10b from the indoor heat exchanger 20 through the plurality of conduits while the refrigerant flows in the indoor heat exchanger 20 from the branching conduit through the plurality of conduits. The first channel 12 is constructed by the plurality of conduits that connect the branching section 10a and the merging section 10b to each other through the indoor heat exchanger 20. The conduit, which extends from the branching conduit and constitutes the second channel 13, is connected to the third connection section 17. The conduit is curved into a substantial U-shape in the vicinity of the third connection section 17, and the panel incoming temperature sensor 25 is attached to the curved portion. That is, the panel incoming temperature sensor 25 is disposed nearby the third connection section 17.

[0055] The conduit that constitutes the second channel 13 extending from the fourth connection section 18 is connected to a merging conduit that serves as the merging section 10b. The conduit is curved into the substantial U-shape in the vicinity of the fourth connection section 18, and the panel outgoing temperature sensor 26 is attached to the curved portion. That is, the panel outgoing temperature sensor 26 is disposed nearby the fourth connection section 18. The indoor motor-operated valve 23 is interposed between the fourth connection section 18 and the merging conduit 75. The first channel 12 and the second channel 13 merge with each other in the merging section 10b. The conduit from the merging conduit is connected to the second connection section 16.

[0056] As indicated by an arrow in Fig. 6, during the operation in the radiation heating operation or the radiation breeze heating operation, the refrigerant sent from the outdoor unit 6 flows from the first connection section 15, and flows in the first channel 12 and second channel 13 through the merging section 10b. The refrigerant, which flows in the second channel 13, flows in the panel conduit 36 of the radiation panel 30 through the third connection section 17. The refrigerant, which flows out from the panel conduit 36, flows from the fourth connection section 18, and flows out from the second connection section 16 through the indoor motor-operated valve 23 and merging section 10b.

[0057] As illustrated in Fig. 5, a horizontally extending drain pan 22 is disposed below the indoor heat exchanger 20. When viewed from the front, the end portion on the left side of the drain pan 22 is located so as to be substantially opposed to the end portion of the indoor heat exchanger 20, and the end portion on the right side is located so as to be opposed to the conduit disposed on the right side of the indoor heat exchanger 20. As illustrated in Fig. 4, the end portions in a front-back direction of the drain pan 22 are located so as to be substantially opposed to the end portions in a front-back direction of the indoor heat exchanger 20.

[0058] The outlet unit 46 is disposed above the indoor fan 21, and guides the air blown from the indoor fan 21 to the outlet 4d formed in the upper wall of the casing 4. The outlet unit 46 includes a horizontal flap 46a disposed near the outlet 4d. The horizontal flap 46a opens and closes the outlet 4d while changing a vertical direction of wind of the air blown from the outlet 4d.

[0059] As illustrated in Fig. 5, the electric component unit 47 is disposed below the drain pan 22, and includes an electric component box 47a in which a circuit board (not illustrated) and the like are accommodated and a terminal stage 47b that are electrically connected to the board accommodated in the electric component box 47a. The electric component box 47a is disposed in the position that is substantially opposed to a right half of the indoor heat exchanger 20, and the terminal stage 47b is disposed in the position that is opposed to the conduit disposed on the right side of the indoor heat exchanger 20. A lead from the electric component unit 47 is routed straight up from the right side of the terminal stage 47b, and connected to the power button 48 and an LED luminous body of the emission display section 49, which are provided in the upper right end portion of the front panel 5.

[0060] As described above, the front grill 42 is attached to the body frame 41 so as to cover the body frame 41 to which such internal devices as the indoor heat exchanger 20, the indoor fan 21, the outlet unit 46, and the electric component unit 47 are attached. More specifically, the front grill 42 is attached to the body frame 41 so as to cover a range from the substantially middle portion in the vertical direction of the front heat exchanger 20a to the lower end of the body frame 41. The front grill 42 includes a filter retaining section 42a and an inlet grill 42b disposed in the principal inlet 4a.

[0061] A lower filter 43 and an upper filter 44 are attached to the filter retaining section 42a. As shown in Fig. 4, the lower filter 43 retained by the filter retaining section 42a extends downward from the substantially middle portion in the vertical direction of the front-surface heat exchanger 20a, and the lower end portion is tilted towards back. The lower end of the lower filter 43 is positioned nearby the rear end of the main inlet port 4a. Further, the upper filter 44 extends upward from the substantially middle portion in the vertical direction of the front-surface heat exchanger 20a. This lower filter 43 and the upper filter 44 divide the space between the front-surface heat exchanger 20a and the front panel 5, relative to the front-back direction.

[0062] The outlet cover 51 covers the outlet unit 46. As described above, the outlet 4d is formed in the upper wall of the outlet cover 51. The front panel section 51a is provided in the front surface of the outlet cover 51. The front panel section 51a has the horizontally long rectangular shape. Here, the length of the front panel unit 51a relative to the vertical direction is defined as to be L.

[0063] The radiation panel 30 has the horizontally long, substantially rectangular shape. As shown in Fig. 7, Fig. 8, and Fig. 9, the radiation panel 30 mainly includes an aluminum radiation plate 31 and a resin heat-insulating cover 32 attached to the rear surface of the radiation plate 31. The length of the radiation plate 31 relative to the vertical direction is substantially twice the length of the front panel unit 51a of the outlet port cover 51. In other words, the length of the radiation plate 31 relative to the vertical direction is approximately 1L, as shown in FIG. 3. The radiation plate 31 is positioned below the front-surface panel section 41a of the outlet port cover 41. As shown in FIG. 4, the substantially middle part of the radiation panel 30 relative to the vertical direction faces the upper end portion of the front-surface heat exchanger 20a. Further, the panel conduit 36 that is the part of the conduit constituting the refrigerant circuit 10 is attached to the rear surface of the radiation plate 31.

[0064] As illustrated in Fig. 7(a), when viewed from the front, both end portions of the panel conduit 36 are located below the right end portion of the radiation plate 31. As described above, the connection sections 36a and 36b are provided at both ends of the panel conduit 36, and connected respectively to the third connection section 17 and fourth connection section 18 of the conduit disposed on the right side of the indoor heat exchanger 20. The refrigerant sent from the outdoor unit 6 flows in the panel conduit 36 through the connection section 36a, and flows out from the connection section 36b to the outside of the panel conduit 36.

[0065] As indicated by the broken line in Fig. 7(a), a substantial U-shape radiation conduit 36c opened onto the right side is provided in a portion opposed to the rear surface of the radiation plate 31 in the panel conduit 36. More particularly, the radiation conduit 36c vertically includes two horizontally extending linear portions, and the left end portions of the linear portions are connected to form the substantial U-shape. Out of the linear portions, the right end portion of the linear portion located on the upper side is connected to the connection section 36a, and the right end portion of the linear portion located on the lower side is connected to the connection section 36b. Therefore, when viewed from the front, the refrigerant, which flows in the panel conduit 36 through the connection section 36a, flows from the right side toward the left side in the linear portion located on the upper side of the radiation conduit 36c, then, flows from the left side toward the right side in the linear portion located on the lower side, and flows out from the connection section 36b.

[0066] As illustrated in Figs. 8(a) and 9, two horizontally extending projections 31a are vertically formed in the rear surface of the radiation plate 31. The linear portions of the radiation conduit 36c described above is buried in the projections 31a. More particularly, in each of the linear portions of the radiation conduit 36c, at least a half surface is covered with the projection 31a and the portion being opposite side to the radiation plate 31 is exposed. Thus, most of the surface of the linear portions of the radiation conduit 36c is substantially covered with the projection 31a formed in the radiation plate 31, so that the heat of the refrigerant flowing in the radiation conduit 36c can efficiently be transferred to the radiation plate 31. As illustrated in Fig. 8(b), in the panel conduit 36, the linear portions of the radiation conduit 36c are in contact with the rear surface of the radiation plate 31, and the portion except the linear portions of the radiation conduit 36c is separated from the rear surface of the radiation plate 31.

[0067] In the radiation panel 30, the portion constructed by the whole radiation plate 31 and radiation conduit 36c constitutes the radiation heat exchanger 34. The portion of the radiation panel 30, where the sub-protrusions 31a to which the linear portions of the radiation conduit 36c are buried, i.e., the portion where the radiation plate 31 and the panel conduit 36 are in contact with each other, are the portions serving as the radiation unit. That is, in the present embodiment, there are two radiation units; in the upper portion and the lower portion.

[0068] A fixation section 31b is formed above the projection 31a located in the upper portion of the rear surface of the radiation plate 31, and the fixation section 31b is also formed below the projection 31a located in the lower portion of the rear surface of the radiation plate 31 for screwing the heat-insulating cover 32 to the rear surface of the radiation plate 31. The fixation section 31b extends along the horizontal direction, projecting from the rear surface of the radiation plate 31, and a leading end of the fixation section 31b is bent toward the side of the projection 31a. The bent portion is substantially parallel to the rear surface of the radiation plate 31, and a plurality of screw holes 31c are formed in the fixation section 31b in order to screw the heat-insulating cover 32.

[0069] The heat-insulating cover 32 is attached to the fixation sections 31b of the radiation plate 31 by the screws. As illustrated in Fig. 9, the sub-protrusion 31a of the radiation plate 31 is disposed in a space formed between the rear surface of the radiation plate 31 and the front surface of the heat-insulating cover 32. A heat-insulating effect caused by the air in the space can suppress the transfer of the heat from the radiation conduit 36c to a space outside the heat-insulating cover 32. As illustrated in Fig. 7, a side panel 37 constituting the side surface of the casing 4 and an attaching member 38 used to attach the radiation panel 30 to the body frame 41 are attached to each of both the end portions in the horizontal direction of the rear surface of the radiation plate 31 from the end part in turn.

[0070] The opening-closing panel 52 is detachably attached to the lower portion of the radiation plate 31 of the radiation panel 30. The opening-closing panel 52 has a rectangular shape which is long in the horizontal direction, and its length relative to the vertical direction is approximately four times the length of the front-surface panel section 51a of the outlet port cover 51. In other words, the length of the opening-closing panel 52 relative to the vertical direction is approximately 4L, as shown in FIG. 3. As illustrated in Fig. 4, the vertical position at the upper end of the opening-closing panel 52 has the substantially same level as the upper end of the front grill 42. As described above, the lower end of the opening-closing panel 52 constitutes the part of the principal inlet 4a. Accordingly, the front grill 42 is exposed by detaching the opening-closing panel 52, so that the lower filter 43 and upper filter 44, which are attached to the filter retaining section 42a of the front grill 42, can be detached.

[0071] As described above, the front panel 5 includes the front panel section 51a provided in the outlet cover 51, the radiation plate 31 provided in the radiation panel 30, and the opening-closing panel 52. The auxiliary inlet 4b that is the slit-like opening extending in the horizontal direction is formed between the radiation plate 31 of the radiation panel 30 and the opening-closing panel 52. The auxiliary inlet 4c that is the slit-like opening extending in the horizontal direction is formed near the upper end of the opening-closing panel 52. As shown in FIG. 3, the distance from the upper end of the opening-closing panel 52 to the auxiliary inlet port 4c, relative to the vertical direction is L.

[0072] Thus, the length of the front- surface panel 5 relative to the vertical direction is 7L, and the auxiliary inlet port 4b is in a position 3L from the upper end of the front- surface panel 5, and the auxiliary inlet port 4c is in a position 3L from the lower end of the front- surface panel 5. In other words, the auxiliary inlet ports 4b, 4c are provided in the middle portion of the front- surface panel 5 relative to the vertical direction. Further, as shown in Fig. 4, the auxiliary inlets 4b and 4c are opposed to the front heat exchanger 20a.

<Assembling Indoor Unit 2>

[0073] The following describes the steps of assembling the indoor unit 2 having the above described structure. First, to the body frame 41, the indoor fan 21, the indoor heat exchanger 20, the outlet port unit 46, and the internal devices such as the electrical component unit 47 are attached. At this time, on the right side of the indoor heat exchanger 20, when viewed from the front, attached to the body frame 41, the conduit integrally provided with the indoor heat exchanger 20 is disposed. To this conduit is attached the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 at the leading end of the line (not shown) extended from the electrical component unit 47.

[0074] Next, the radiation panel 30 is attached to the body frame 41. Then, the connecting sections 36a, 36b of the panel conduit 36 integrally provided with the radiation panel 30 are connected to the third connection section 17 and the fourth connection section 18 of the conduit integrally provided with the indoor heat exchanger 20. After that, the outlet port cover 51 is attached above the radiation panel 30, and the front grill 42 and the open/ close panel 52 are sequentially attached below the radiation panel 30.

[0075] To disassemble the indoor unit 2 for the purpose of maintenance or repairing, the above describe steps are reversed. That is, for example, to detach the radiation panel 30, the outlet port cover 51, the open/close panel 52, and the front grill 42 are first detached, and then the radiation panel 30 is detached.

[0076] As described hereinabove, the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are disposed at the conduit integrally provided with the indoor heat exchanger 20. Therefore, when the radiation panel 30 is detached, the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are not moved unless the indoor heat exchanger 20 is detached from the body frame 41. In cases where the panel conduit 36 of the radiation panel 30 has a sensor, the wiring of the sensor needs to be detached every time the radiation panel 30 is detached. However, such a process is not necessary in the present embodiment.

<Remote Controller 9>

[0077] With the remote controller 9, a user is able to start or stop the operation of the air conditioner 1, set the operation mode, set the target indoor temperature (indoor setting temperature), or set the blowing air quantity, or the like. During the warm air heating operation and the cooling operation, the air quantity setting may be selected from "air quantity automatic", and "strong" to "weak". In the present embodiment, the air quantity is automatically controlled during the radiation heating operation and the radiation breeze heating operation.

<Controller 7>

[0078] Next, the controller 7 for controlling the air conditioner 1 is described with reference to Fig. 10. As shown in Fig. 10, the controller 7 includes a storage 70, an indoor motor- operated valve controller 72, an indoor fan controller 73, a compressor controller 74, and an outdoor motor- operated valve controller 75.

[0079] The storage 70 stores various operation settings related to the air conditioner 1, a control program, a data table necessary for running the control program, or the like. The operation settings include user-setting set by a user operating the remote controller 9, such as target indoor temperature (indoor setting temperature), and a presetting which is set in advance in the air conditioner 1. In the air conditioner 1 of the present embodiment, the range of target temperature of the radiation panel 30 is set to a predetermined temperature range (e.g., 50 to 55°C). The target temperature range of the radiation panel 30 however may be set by operating the remote controller 9.

[0080] The indoor motor-operated valve controller 72 controls the number of pulses input to the stepping motor (not shown) for controlling the indoor motor-operated valve 23 so as to control the opening degree of the indoor motor-operated valve 23. During the cooling operation or the warm air heating operation, the indoor motor-operated valve controller 72 closes the indoor motor-operated valve 23. Further, during the radiation heating operation or the radiation breeze heating operation, the indoor motor-operated valve controller 72 controls the opening degree of the indoor motor-operated valve 23 based on the temperature of the radiation panel 30. Specifically, as shown in the following (equation 1), a predicted value (hereinafter, simply referred to as radiation panel temperature) Tp of the surface temperature of the radiation panel 30 is calculated based on the a temperature Tp1 (first temperature) detected by the panel incoming temperature sensor 25 and a temperature Tp2 (second temperature) detected by the panel outgoing temperature sensor 26. The opening degree of the indoor motor-operated valve 23 is controlled so that this radiation panel temperature Tp is within a panel target temperature range (e.g. 50 to 55°C).

$$Tp = (Tp1+Tp2) \times A+B \quad \text{(equation 1)}$$

Note that the above A and B in (equation 1) are both a constant in the present embodiment, and A = 0.5 and B = 0.

[0081] The following details the control of the indoor motor-operated valve 23, during the radiation heating operation or the radiation breeze heating operation.

The indoor motor-operated valve controller 72 controls the indoor motor-operated valve 23 differently for each of five different zones set for the radiation panel temperatures Tp, as shown in Fig. 11. The five different zones are: an up zone, a no-change zone, a suspended zone, a stop zone, and a recovery zone. When the radiation panel temperature Tp is in the up zone, the number of pulses input to the stepping motor is increased at a ratio of DEV1 (pulse)/TEV1 (Sec.) so as to increase the opening degree of the indoor motor-operated valve 23. When the radiation panel temperature Tp is in the no-change zone, the number of pulses input to the stepping motor is not changed so as not to cause a change in the opening degree of the indoor motor-operated valve 23. When the radiation panel temperature Tp is in the suspended zone, the number of pulses input to the stepping motor is reduced at a ratio of DEV2 (pulse) /TEV2 (Sec.), so as to reduce the opening degree of the indoor motor-operated valve 23. When the radiation panel temperature Tp is in the stop zone, the number of pulses input to the stepping motor is made zero to close the indoor motor-operated valve 23. When the radiation panel temperature Tp enters the stop zone, a control at the beginning of operation is executed after the radiation panel temperature Tp drops to the recovery zone. The control at the beginning of operation is a control to fix the opening degree of the indoor motor-operated valve 23 to an initial opening degree, for a predetermined period t1.

[0082] Note that in the present embodiment, the ratio DEV1 (pulse) /TEV1 (Sec.) at which the opening degree of the indoor motor- operated valve 23 is increased in the up zone and the ratio DEV2 (pulse) /TEV2 (Sec.) at which the opening degree of the indoor motor- operated valve 23 is reduced in the suspended zone are the same. However, these ratios may be different from each other.

[0083] As shown in Fig. 11 and Table 1, while the radiation panel temperature Tp is rising, the radiation panel temperature Tp of less than 53 °C is the up zone, the radiation panel temperature Tp of 53°C or higher but lower than 55°C is the no-change zone, the radiation panel temperature Tp of 55°C or higher but lower than 70°C is the suspended zone, the radiation panel temperature Tp of 70°C or higher is the stop zone. That is, when the radiation panel temperature Tp is relatively low, the indoor motor-operated valve controller 72 performs a control to increase the opening degree of the indoor motor-operated valve 23, and when the radiation panel temperature Tp reaches or exceeds a certain level, performs control to cause no change in the opening degree of the indoor motor-operated valve 23. When the radiation panel temperature Tp is relatively high, the indoor motor-operated valve controller 72 performs a control to reduce the opening degree of the indoor motor-operated valve 23. When the radiation panel temperature Tp is excessively high (70°C or higher), the indoor motor-operated valve controller 72 performs a control performs a control to close the indoor motor-operated valve 23.

[Table 1]

Zone Name	While Radiation Panel Temp. (Tp) is rising.	Whiel Radiation Panel Temp. (Tp) is falling.
Stop	70°C ≤ Tp	70°C ≤ Tp
Suspended	55°C ≤ Tp < 70°C	53°C ≤ Tp < 70°C
No-change	53°C ≤ Tp < 55°C	51°C ≤ Tp < 53°C
Up	Tp < 53°C	Tp < 51°C
Recovery	-	Tp < 45°C

[0084] After the radiation panel temperature Tp rises up to 70°C or higher, the indoor motor-operated valve 23 is kept closed until the temperature drops to the recovery zone which is lower than 45°C. On the other hand, when the radiation panel temperature Tp rises and then starts to fall from a temperature of less than 70°C, the radiation panel temperature Tp of less than 70°C but not less than 53°C is the suspended zone, the radiation panel temperature Tp of less than 53°C but not less than 51°C is the no-change zone, the radiation panel temperature Tp of less than 51°C is the up zone.

[0085] The indoor fan controller 73 controls the rotational frequency of the indoor fan 21.
During the warm air heating operation, the air-quantity automatic operation of the cooling operation, or the radiation heating operation, the indoor fan controller 73 controls the rotational frequency of the indoor fan 21 based on the indoor temperature detected by the indoor temperature sensor 24, the indoor setting temperature, or the like. Further, when the air quantity setting is set to any of "strong" to "weak" during the warm air heating operation or the cooling operation, or during the radiation breeze heating operation, the rotational frequency of the indoor fan 21 is controlled to the rotational frequency corresponding to a corresponding one of pre-set fan taps.

[0086] The compressor controller 74 controls the operation frequency of the compressor 60, based on the indoor temperature, the indoor setting temperature, the heat exchanger temperature detected by the temperature sensor 27, or the like.

[0087] The outdoor motor-operated valve controller 75 controls the opening degree of the outdoor motor-operated valve 64. Specifically, the motor-operated valve controller 75 controls the opening degree of the outdoor motor-operated valve 64 so that the temperature detected by the discharge temperature sensor 66 is the optimum temperature of the operation state. The optimum temperature is determined based on a calculated value involving an indoor heat exchanger temperature and/or an outdoor heat exchanger temperature.

<Example Control by Controller 7>

[0088] With reference to Fig. 12, the following describes an exemplary changes in the room temperature, the rotational frequency of the indoor fan 21, the radiation panel temperature Tp, the opening degree of the indoor motor-operated valve 23, the operation frequency of the compressor 60, when the air conditioner 1 is controlled by the controller 7. Note that the example of Fig. 12 shows a case where the radiation heating operation and the radiation breeze heating operation are switched to one another depending on the room temperatures.

[0089] First, after the operation is started, the operation frequency of the compressor 60 is raised in stages until the time point t1. At this time, the opening degree of the indoor motor- operated valve 23 is fixed to a predetermined initial opening degree. Thus, the room temperature and the radiation panel temperature Tp rises. When the radiation panel temperature Tp is 55°C or higher, the opening degree of the indoor motor- operated valve 23 is controlled to decrease. Further, at the time point t2 and thereafter, the rotational frequency of the indoor fan 21 is lowered in stages, and becomes c1 at the time point t3. At the time point t3 and thereafter, the rotational frequency of the indoor fan 21 is fixed to c1. The period from the beginning of the operation to the time point t3 is the radiation heating operation and the operation is switched to the radiation breeze heating operation at the time point t3 and thereafter.

[0090] At the time point t4 and thereafter, the operation frequency of the compressor 60 is lowered in stages so as to approximate the room temperature higher than the indoor setting temperature down to the setting temperature. This way, the radiation panel temperature Tp is lowered. Thus, after the time point t5, the opening degree of the indoor motor-operated valve 23 is controlled to open so as to raise the radiation panel temperature Tp to a temperature within the target temperature range.

<Characteristics of Air Conditioner 1 of the Present Embodiment>

[0091] In the air conditioner 1 of the present embodiment, a refrigerant circuit 10 connecting the indoor unit 2 and the outdoor unit 6 with each other includes: a first channel 12 provided with an indoor heat exchanger 20, and a second channel 13 connected in parallel with the first channel 12, which is provided with a radiation panel 30. The circuit includes a panel incoming temperature sensor 25 and a panel outgoing temperature sensor 26. The panel incoming temperature sensor 25 is disposed in a conduit at a position which is upstream side of the radiation conduit 36c of the radiation heat exchanger 34 in the radiation panel 30 in the second channel 13, during the heating operation. The panel outgoing temperature sensor 26 is provided to the conduit at a position which is the downstream side of the radiation conduit 36c, during the heating operation. In other words, the panel incoming temperature sensor 25 is provided in a conduit which, during the heating operation, is at the upstream side of the most upstream one of the two radiation units in the radiation heat exchanger 34 (i.e., where the radiation plate 31 and the linear portion above the radiation conduit 36c are in contact) . Further, the panel outgoing temperature sensor 26 is provided at the conduit which, during the heating operation, is at the downstream side of the most downstream one of the two radiation units (i.e., where the radiation plate 31 and the linear portion below the radiation conduit 36c are in contact). Therefore, the temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are hardly influenced by radiation from the radiation heat exchanger 34 or radiation due to the natural convection. This allows suitable temperature control of the radiation panel 30. Further, during the heating operation, the panel incoming temperature sensor 25 is able to detect the temperature of the refrigerant before it flows into the radiation conduit 36c of the radiation heat exchanger 34 in the radiation panel 30. In other words, it is possible to detect the temperature of the refrigerant before the temperature drops due to the radiation from the radiation heat exchanger 34. Thus, excessive heat generation of the radiation panel 30 is promptly and accurately restrained.

Further, during the cooling operation, the indoor motor-operated valve 23 to prevent the refrigerant from flowing into the radiation conduit 36c of the radiation panel 30. However, even if the refrigerant leaks out from the indoor motor-operated valve 23, the panel outgoing temperature sensor 26 provided between the indoor motor-operated valve 23 and the radiation conduit 36c in the radiation panel 30 is able to detect the leakage before the refrigerant flows into the radiation conduit 36c in the radiation panel 30. Therefore, it is possible to promptly and accurately detect the leakage of the refrigerant and detect condensation on the radiation panel 30. Additionally, the predicted temperature value of the radiation panel 30 is accurately calculated based on the temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26.

[0092] Further, the air conditioner 1 of the present embodiment includes an indoor motor- operated valve 23 provided in a conduit at a position which, during the heating operation, is the downstream side of the radiation conduit 36c of the radiation panel 30. This indoor motor- operated valve 23 is controlled based on the temperature Tp1 detected by the panel incoming temperature sensor 25 provided at the conduit on the upstream side of the radiation conduit 36c, and the temperature Tp2 detected by the panel outgoing temperature sensor 26 provided at the conduit on the downstream side of the radiation conduit 36c. Thus, by controlling the indoor motor- operated valve 23, it is possible to adjust, to the target temperature, the radiation panel temperature Tp derived from the temperature Tp1 detected by the panel incoming temperature sensor 25 and the temperature Tp2 detected by the panel outgoing temperature sensor 26. Therefore, the performance of the indoor heat exchanger 20 is not influenced, unlike the case where the radiation panel temperature Tp is controlled by controlling the outdoor motor- operated valve 64 which is the main decompression structure.

[0093] Further, in the air conditioner 1 of the present embodiment, the panel incoming temperature sensor 25 is positioned closer to the radiation conduit 36c than it is to the branching section 10a. This allows detection of the temperature of the refrigerant immediately before it flows into the radiation conduit 36c. Thus, highly accurate calculation of the predicted temperature value of the radiation panel 30 is possible.

[0094] Further, in the air conditioner 1 of the present embodiment, the panel outgoing temperature sensor 26 is provided closer to the radiation conduit 36c than it is to the indoor motor- operated valve 23. This allows detection of the temperature of the refrigerant immediately after it flows out of the radiation conduit 36c. Thus, highly accurate calculation of the predicted temperature value of the radiation panel 30 is possible.

[0095] Embodiment of the present invention is thus described hereinabove. It should be however noticed that the specific structures of the present invention is not limited to the above embodiment. The above embodiment shall not be interpreted as the definition of the scope of present invention which is defined by claims set forth hereinbelow. Any modification within the scope of claims and those equivalent to claims in terms of meaning shall be encompassed by the present invention.

[0096] The above embodiment deals with a case where the refrigerant circuit 10 connecting the indoor unit 2 and the outdoor unit 6 with each other include the first channel 12 having the indoor heat exchanger 20 and the second channel 13 connected in parallel to the first channel 12, and the radiation panel 30 is provided in the second channel 13. However, the present invention is not limited to this, and the indoor heat exchanger 20 and the radiation panel 30 may be serially connected.

[0097] That is, as shown in Fig. 13, a refrigerant circuit 110 of the air conditioner 101 related to the first modification of the present embodiment includes an annular principal channel 111 in which an outdoor motor-operated valve 64, an outdoor heat exchanger 62, a compressor 60, a radiation panel 30, and an indoor heat exchanger 20 are sequentially connected. The discharge side conduit and the intake side conduit of the compressor 60 are connected to a four-way valve 61. On both sides of the radiation panel 30 are branching sections 101a and 101b, and the branching sections 101a and 101b are connected to the both ends of the branching passage 112, respectively. Note that the branching section 101a is positioned between the indoor heat exchanger 20 and the radiation panel 30, and the branching section 101b is on the opposite side to the branching section 101a, over the radiation panel 30. The branching passage 112 has a first indoor motor-operated valve 128.

[0098] Between the radiation panel 30 and the branching section 101a is a second indoor motor-operated valve 123. A panel incoming temperature sensor 25 is provided between the branching section 101b and a radiation conduit 36c of the radiation panel 30, and a panel outgoing temperature sensor 26 is provided between the second indoor motor-operated valve 123 and the radiation conduit 36c of the radiation panel 30.

[0099] In the refrigerant circuit 110, during the cooling operation, the first indoor motor-operated valve 128 is opened and the second indoor motor-operated valve 123 is opened, and the four-way valve 61 is switched to a state shown by the broken line in Fig. 13. Therefore, the high-temperature, high-pressure refrigerant from the compressor 60 flows into the outdoor heat exchanger 62, through the four-way valve 61, as shown by the broken-line arrow in Fig. 13. Then, the refrigerant condensed by the outdoor heat exchanger 62 flows into the indoor heat exchanger 20, after being depressurized by the outdoor motor-operated valve 64. Further, the refrigerant vaporized by the indoor heat exchanger 20 flows into the compressor 60, through the branching passage 112, the four-way valve 61, and the accumulator 65.

[0100] During the warm air heating operation, the first indoor motor-operated valve 128 is opened and the second indoor motor-operated valve 123 is closed, and the four-way valve 61 is switched to a state shown by the solid line in Fig. 13. Therefore, the high-temperature, high-pressure refrigerant from the compressor 60 flows into the indoor heat exchanger 20, through the four-way valve 61 and the branching passage 112, as shown by the solid-line arrow in Fig. 13. Then, the refrigerant condensed by the indoor heat exchanger 20 flows into the outdoor heat exchanger 62, after being depressurized by the outdoor motor-operated valve 64. Further, the refrigerant vaporized by the outdoor heat exchanger 62 flows into the compressor 60 through the four-way valve 61 and the accumulator 65.

[0101] During the radiation heating operation and the radiation breeze heating operation, the first indoor motor-operated valve 128 is closed and the second indoor motor-operated valve 123 is opened, and the four-way valve 61 is switched to a state shown by the solid line in Fig. 13. Therefore, the high-temperature, high-pressure refrigerant from the compressor 60 flows into the radiation panel 30 through the four-way valve 61, and then flows into the indoor heat exchanger 20, as shown by the bold arrow in Fig. 13. Then, the refrigerant condensed by the radiation panel 30 and the indoor heat exchanger 20 flows in to the outdoor heat exchanger 62, after being depressurized by the outdoor motor-operated valve 64. The refrigerant vaporized by the outdoor heat exchanger 62 flows into the compressor 60, through the four-way valve 61 and the accumulator 65.

[0102] In the air conditioner 101 of this modification too, the temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are not influenced by the radiation from the radiation heat exchanger 34 of the radiation panel 30, as in the case with the above described embodiment. Thus, the radiation panel 30 is suitably controlled.

In this modification, the panel incoming temperature sensor 25 is provided at the conduit extending from the four-way valve 61 to the radiation conduit 36c of the radiation panel 30, i. e. , at the conduit on the upstream side of the radiation conduit 36c of the radiation panel 30 in the circuit during the heating operation. Further, the panel outgoing temperature sensor 26 is provided at the conduit extending from the indoor heat exchanger 20 to the radiation conduit 36c of the radiation panel 30, i.e., at the conduit on the downstream side of the radiation conduit 36c of the radiation panel 30 in the circuit during the heating operation.

[0103] A refrigerant circuit 210 of an air conditioner 201 related to a second modification of the present embodiment includes an annular principal channel 211 in which an outdoor motor-operated valve 64, an outdoor heat exchanger 62, a compressor 60, an indoor heat exchanger 20 and a radiation panel 30 are sequentially connected, as shown in Fig. 14. In other words, this modification differs from the refrigerant circuit 110 of the first modification in that the indoor heat exchanger 20 and the radiation panel 30 are positioned other way around. As in the case of the refrigerant circuit 110 of the first modification, branching sections 201a, 201b are provided on both sides of the radiation panel 30, respectively, and the branching sections 201a, 201b are connected to the both ends of the branching passage 212, respectively. To the branching passage 212 is provided a first indoor motor-operated valve 228.

[0104] Between the radiation panel 30 and the branching section 201a is provided a second indoor motor-operated valve 223. Further, a panel incoming temperature sensor 25 is provided between the branching section 201b and a radiation conduit 36c of the radiation panel 30, and a panel outgoing temperature sensor 26 is provided between the second indoor motor-operated valve 223 and the radiation conduit 36c of the radiation panel 30.

[0105] In the air conditioner 201 of this modification too, the temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are hardly influenced by the radiation from the radiation heat exchanger 34 of the radiation panel 30, as in the case of the above described embodiment. Thus, the radiation panel 30 is suitably controlled. In this modification, the panel incoming temperature sensor 25 is provided at the conduit extending from the indoor heat exchanger 20 to the radiation conduit 36c of the radiation panel 30, i.e., at the conduit on the upstream side of the radiation conduit 36c of the radiation panel 30 in the circuit during the heating operation. Further, the panel outgoing temperature sensor 26 is provided at the conduit extending from the outdoor motor-operated valve 64 to the radiation conduit 36c of the radiation panel 30, i.e., at the conduit on the downstream side of the radiation conduit 36c of the radiation panel 30 in the circuit during the heating operation.

[0106] Further, the above embodiment deals with a case where the panel incoming temperature sensor 25 is provided at the conduit which, during the heating operation, is on the upstream side of the radiation conduit 36c of the radiation panel 30 in the second channel 13, and the panel outgoing temperature sensor 26 is provided at the conduit which, during the heating operation, is on the downstream side of the radiation conduit 36c of the radiation panel 30. However, the present invention is not limited to this. That is, the temperature may be provided in at least one of the conduits which, during the heating operation, are on the upstream side or on the downstream side of the radiation conduit 36c of the radiation panel 30 in the second channel 13. The above embodiment deals with a case where the indoor motor- operated valve controller 72 calculates the predicted temperature value of the radiation panel 30, based on the temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26, respectively. When there is only one temperature sensor, the predicted temperature value of the radiation panel 30 is calculated based on the temperature detected by that single temperature sensor.

[0107] Further, the above embodiment deals with a case where the indoor motor- operated valve controller 72 controls the indoor motor- operated valve 23, based on the temperature Tp1 detected by the panel incoming temperature sensor 25 and the temperature Tp2 detected by the panel outgoing temperature sensor 26, the indoor motor- operated valve 23 provided at the conduit which, during the heating operation, is on the downstream side of the radiation conduit 36c of the radiation panel 30. The indoor motor- operated valve 23 controlled by the indoor motor- operated valve controller 72 may be provided at the conduit which, during the heating operation, is on the upstream side of the radiation conduit 36c of the radiation panel 30.

[0108] Further, the above embodiment deals with a case where the radiation panel temperature Tp is calculated by the following (equation 1) .

$$Tp = (Tp1+Tp2) \times A+B \quad \text{(equation 1)}$$

Note that the Tp1 is a temperature detected by the panel incoming temperature sensor 25, the Tp2 is the temperature detected by the panel outgoing temperature sensor 26, and the constants A = 0.5, B = 0.

The above values of the constants are not limited to those. The values of the constants A and B are derived by experiments.

[0109] Further, the above embodiment deals with a case where the panel incoming temperature sensor 25 is provided closer to the radiation conduit 36c than it is to the branching section 10a. However, the panel incoming temperature sensor 25 may be provided closer to the branching section 10a than it is to the radiation conduit 36c.

[0110] Additionally, the above embodiment deals with a case where the panel outgoing temperature sensor 26 is provided closer to the radiation conduit 36c than it is to the indoor motor- operated valve 23. However, the panel outgoing temperature sensor 26 is provided closer to the indoor motor- operated valve 23 than it is to the radiation conduit 36c.

[0111] Further, the above embodiment deals with a case where the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26 are provided at the conduits integrally provided with the indoor heat exchanger 20; however, the present invention is not limited to this. That is, the panel incoming temperature sensor 25 may be provided between the radiation conduit 36c and the upper one of the two linear portions in the connecting sections 36a, as shown in Fig. 8 (a) . The panel outgoing temperature sensor 26 may be provided between the connecting sections 36b and the lower one of the two linear portions in the radiation conduit 36c.

[0112] Further, in the above embodiment, the radiation conduit 36c constituting the radiation heat exchanger 34 includes two linear portions fixed to the radiation plate 31, and the conduit between the two linear portions; however, the present invention is not limited to this. That is, the entire radiation conduit 36c may be fixed to the radiation plate 31. The radiation conduit 36c, when there are a plurality of portions fixed to the radiation plate 31, include a plurality of portions to be fixed to the radiation plate 31 and the conduit for connecting those portions. That is, the both end portions of the radiation conduit 36c are fixed to the radiation plate 31.

Industrial Applicability

[0113] The present invention allows suitable control of the temperature of the radiation panel (radiation heat exchanger).

Reference Signs List

[0114]

1. Air Conditioner
2. Indoor Unit
6. Outdoor Unit
10. Refrigerant Circuit
10a. Branching Section
10b. Merging Section
11. Principal Channel
12. First Channel
13. Second Channel
20. Indoor Heat Exchanger
23. Indoor Motor-Operated Valve (Valve Structure)

25. Panel Incoming Temperature Sensor (Temperature Sensor)
26. Panel Outgoing Temperature Sensor (Temperature Sensor)
30. Radiation Panel
31. Radiation Plate
34. Radiation Heat Exchanger
36c. Radiation Conduit
60. Compressor
62. Outdoor Heat Exchanger
64. Outdoor Motor-Operated Valve (Decompression Structure)

Claims

1. An air conditioner, comprising a refrigerant circuit including a compressor, a decompression structure, an outdoor heat exchanger, an indoor heat exchanger, and a radiation heat exchanger,
wherein the refrigerant circuit is configured to cause a high temperature refrigerant to flow in the radiation heat exchanger during a radiation heating operation,
and wherein a temperature sensor is provided in at least one of a conduit which, during the radiation heating operation, is on the upstream side of the radiation heat exchanger in the refrigerant circuit and a conduit which, during the radiation heating operation, is on the downstream side of the radiation heat exchanger in the refrigerant circuit.

2. The air conditioner according to claim 1, wherein the refrigerant circuit includes:

   a principal channel having the decompression structure, the outdoor heat exchanger, and the compressor in this order;
   a first channel provided with the indoor heat exchanger, which connects a branching section and a merging section, the branching section being provided in a position which, during the heating operation, is on the downstream side of the compressor in the principal channel, and the merging section being provided in a position which, during the heating operation, is on the upstream side of the decompression structure; and
   a second channel provided with the radiation heat exchanger, which connects the branching section and the merging section with the first channel in parallel during the heating operation,
   the temperature sensor is provided in at least one of the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel and the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel.

3. The air conditioner according to claim 1 or 2, wherein the temperature sensor is provided in the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger and at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger.

4. The air conditioner according to claim 3, wherein: the refrigerant circuit has a valve structure provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel or the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel; and
the valve structure is controlled based on a first temperature detected by the temperature sensor provided at the conduit which is on the upstream side of the radiation heat exchanger, and a second temperature detected by the temperature sensor provided at the conduit which is on the downstream side of the radiation heat exchanger.

5. The air conditioner according to claim 1 or 2, wherein the temperature sensor is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger.

6. The air conditioner according to claim 1 or 2, wherein the temperature sensor is provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger.

7. The air conditioner according to claim 2, wherein the temperature sensor is provided at the conduit which, during the heating operation, is on the upstream side of the radiation heat exchanger in the second channel, and the temperature sensor is positioned closer to the radiation heat exchanger than it is to the branching section.

8. The air conditioner according to claim 2 or 7, wherein the valve structure is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel, and
the temperature sensor is provided at the conduit which, during the heating operation, is on the downstream side of the radiation heat exchanger in the second channel, and is positioned closer to the radiation heat exchanger than it is to the valve structure.

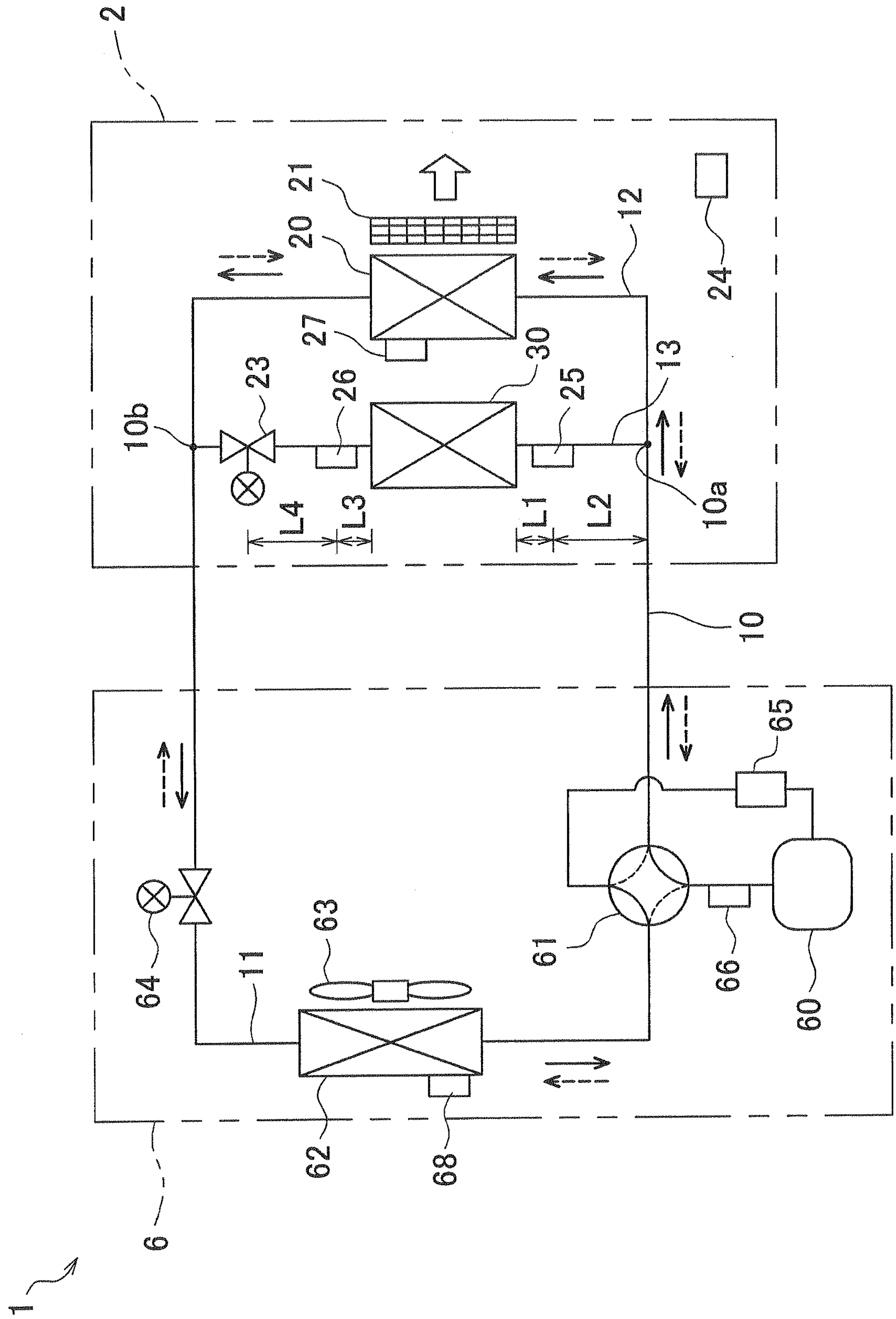
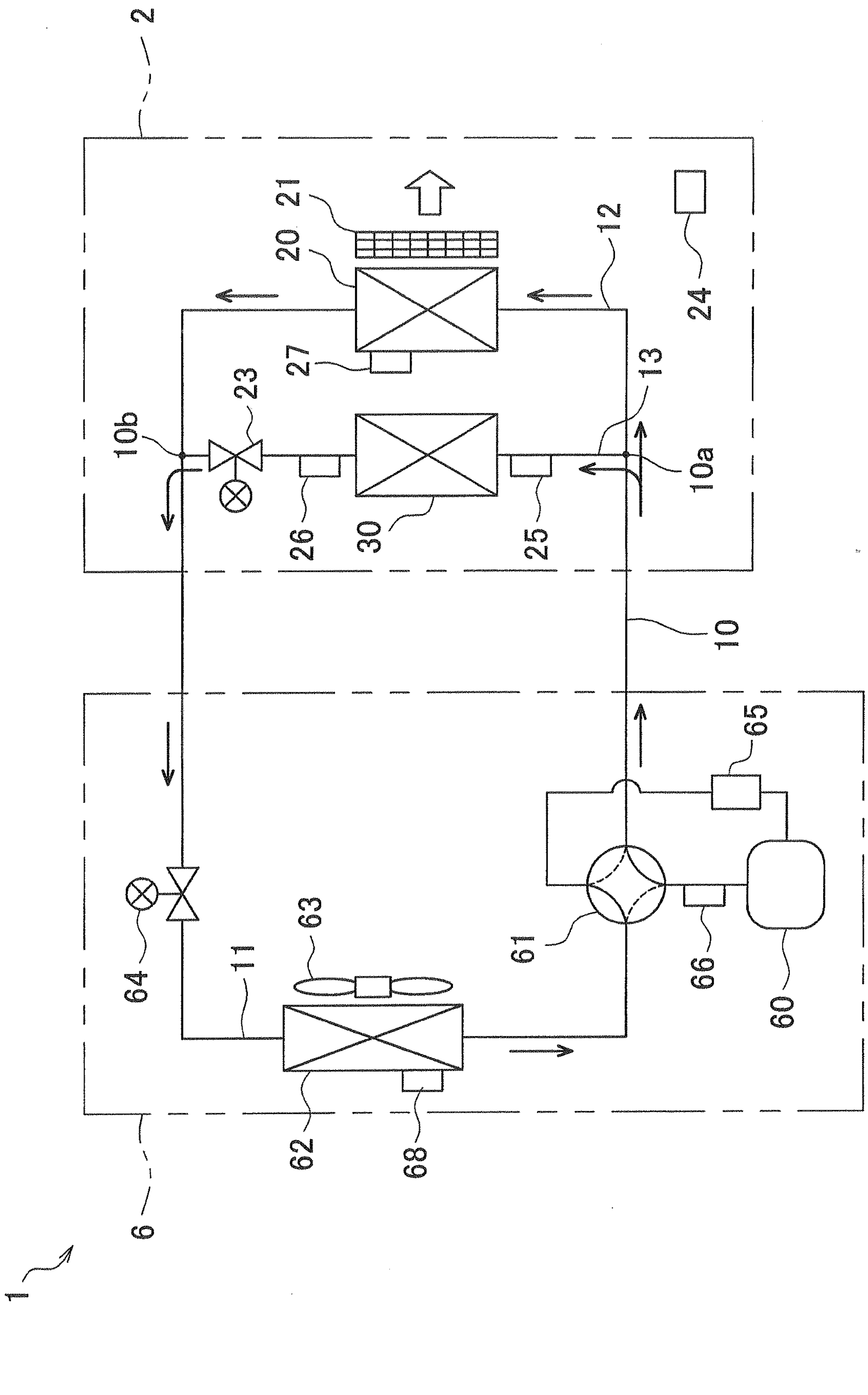

1
2
6
10
10a
10b
11
12
13
20
21
23
24
25
26
27
30
60
61
62
63
64
65
66
68
L1
L2
L3
L4

FIG.1

FIG.2



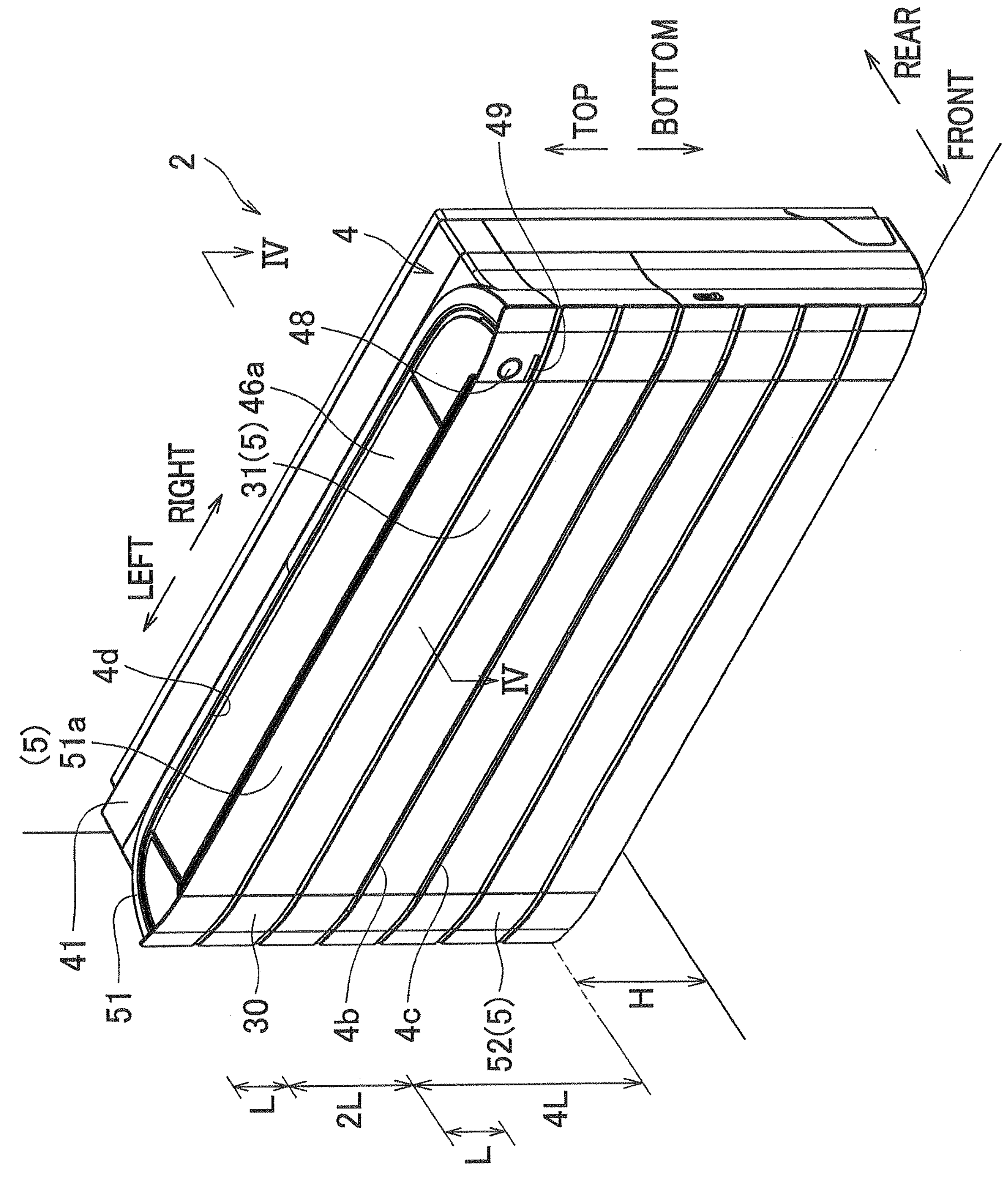

2
IV
4
49
TOP
BOTTOM
REAR
FRONT
48
31(5) 46a
RIGHT
LEFT
4d
IV
(5)
51a
41
51
30
4b
4c
52(5)
H
L
2L
4L
L

FIG.3

FIG.4

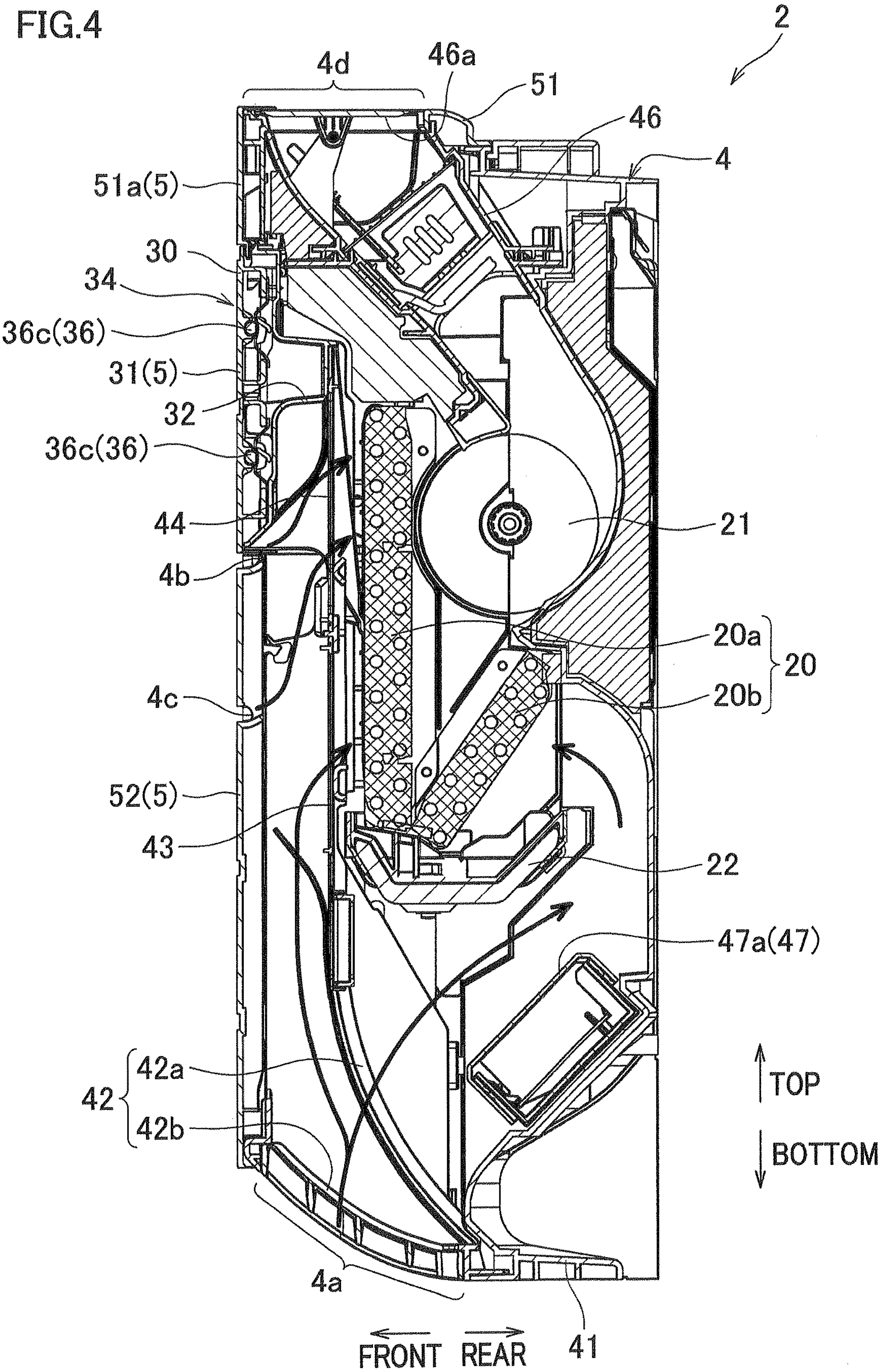

2
4d
46a
51
46
4
51a(5)
30
34
36c(36)
31(5)
32
36c(36)
44
4b
21
20a
20
20b
4c
52(5)
43
22
47a(47)
42
42a
42b
TOP
BOTTOM
4a
FRONT
REAR
41

FIG.5

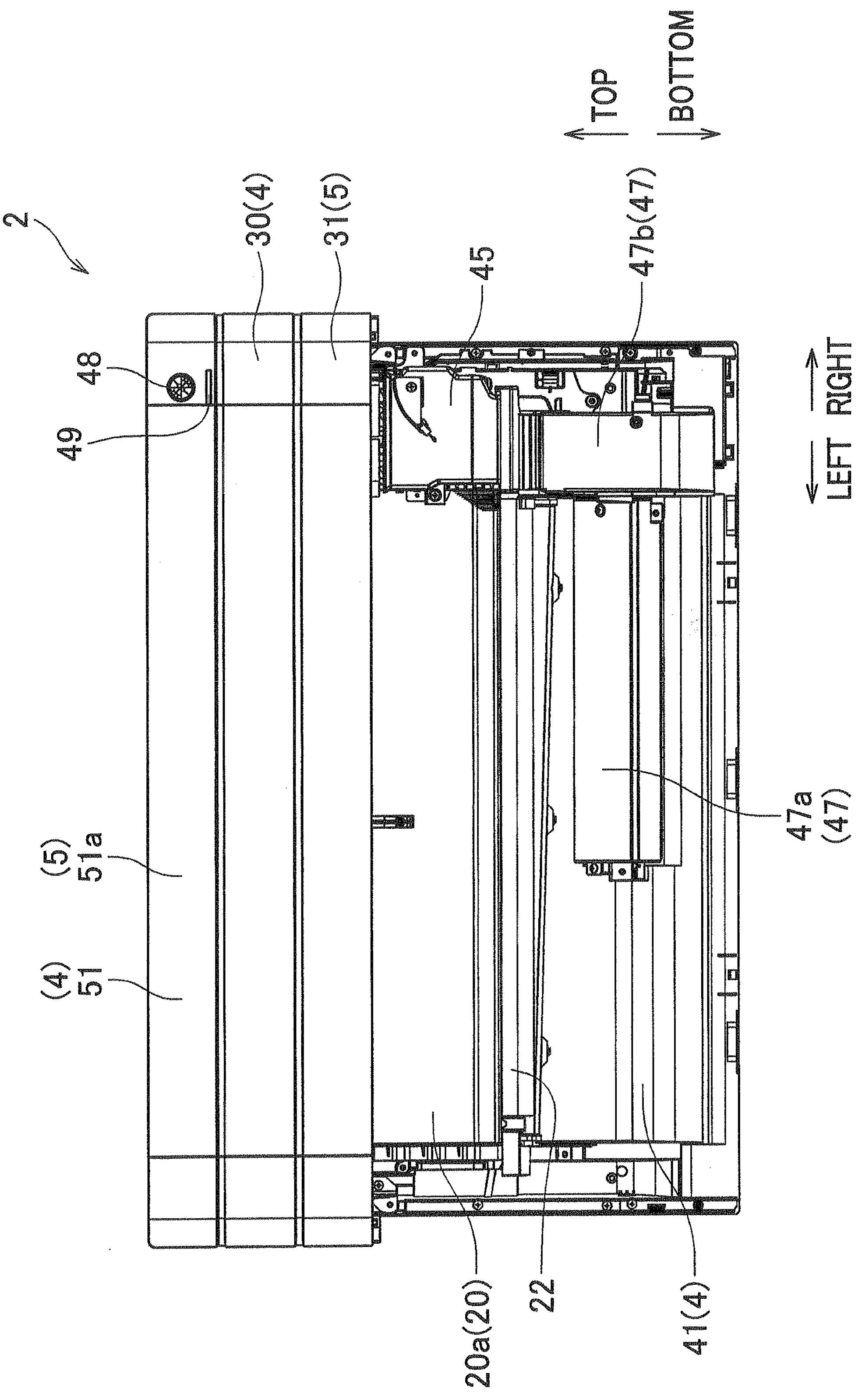

2
30(4)
31(5)
45
47b(47)
48
49
(5)
51a
(4)
51
47a
(47)
20a(20)
22
41(4)
TOP
BOTTOM
LEFT
RIGHT

FIG.6(a)

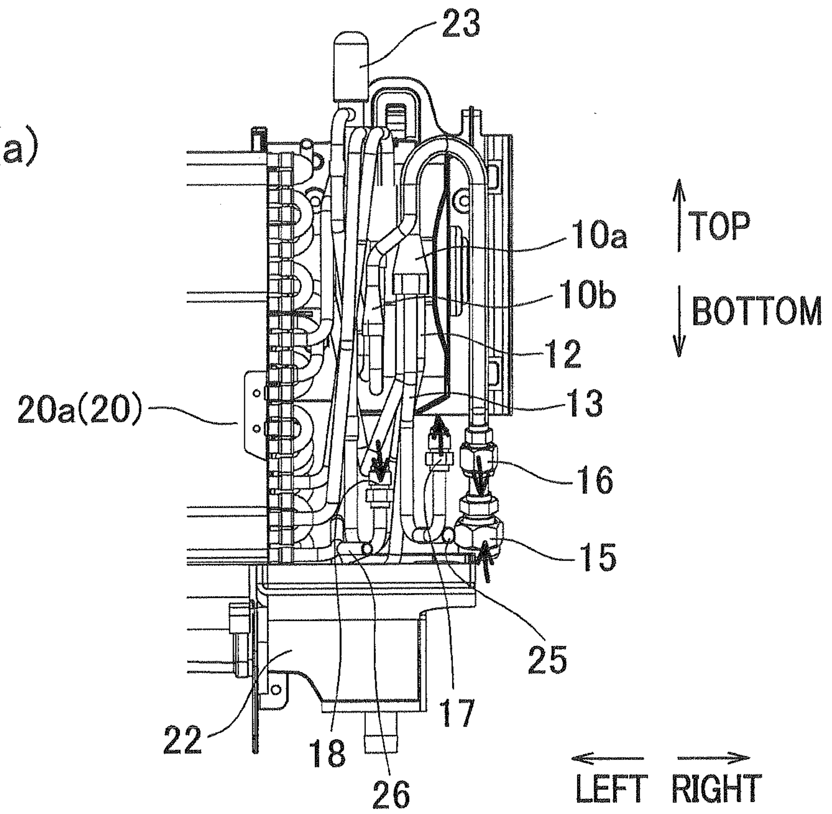

23
10a
10b
12
13
16
15
25
17
26
18
22
20a(20)
TOP
BOTTOM
LEFT
RIGHT

FIG.6(b)

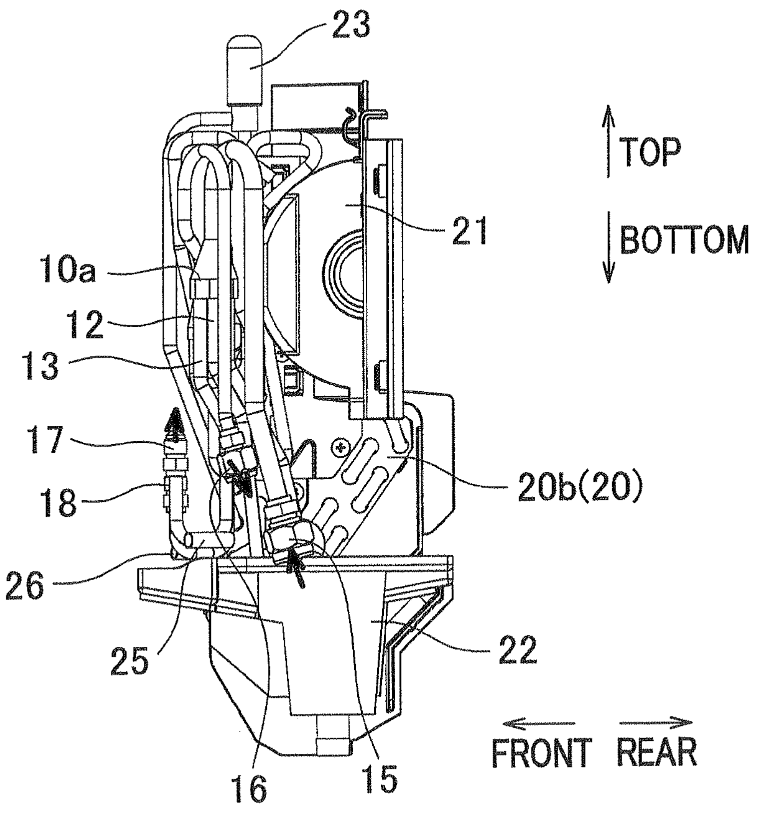

23
21
10a
12
13
17
18
26
25
16
15
22
20b(20)
TOP
BOTTOM
FRONT
REAR

FIG.7(a)

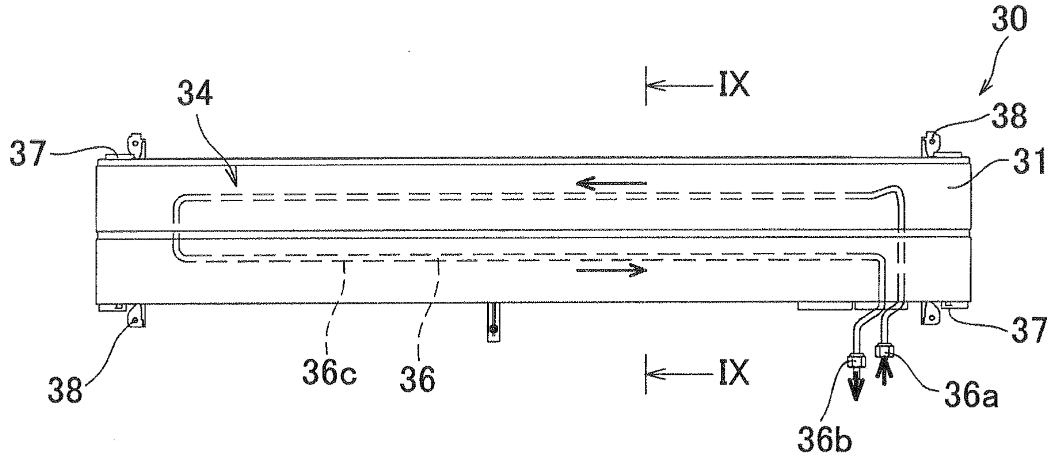


FIG.7(b)

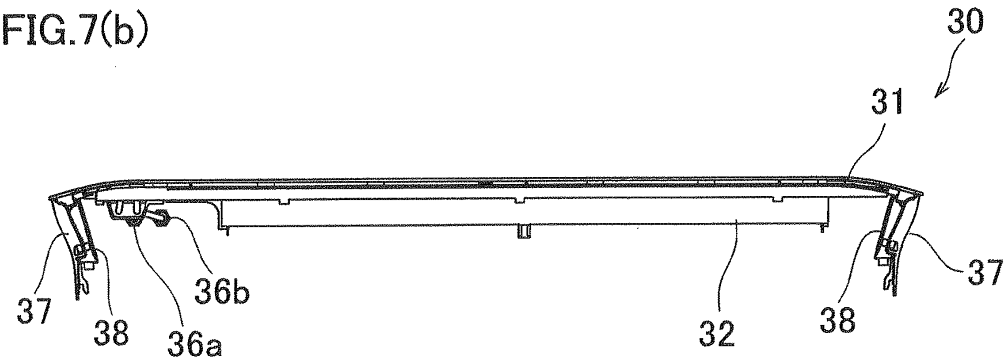
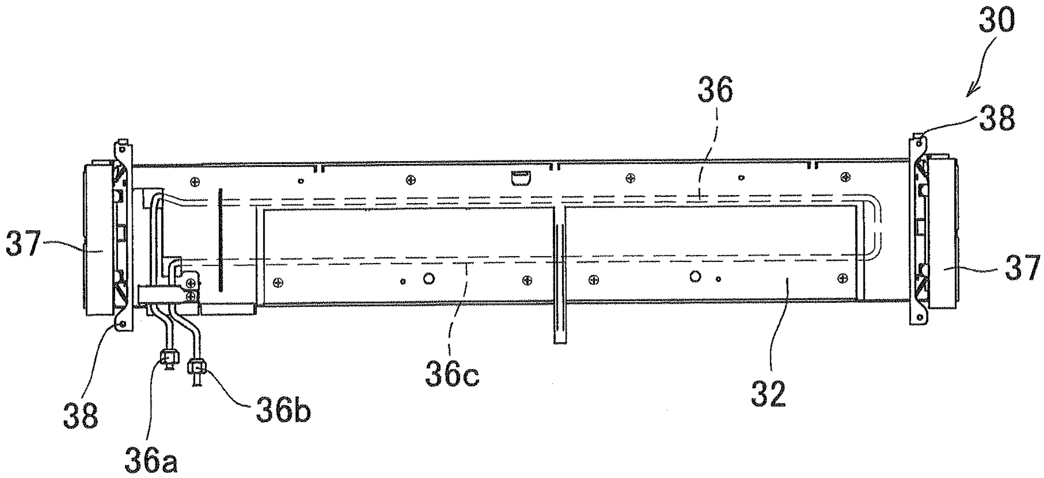


FIG.7(c)



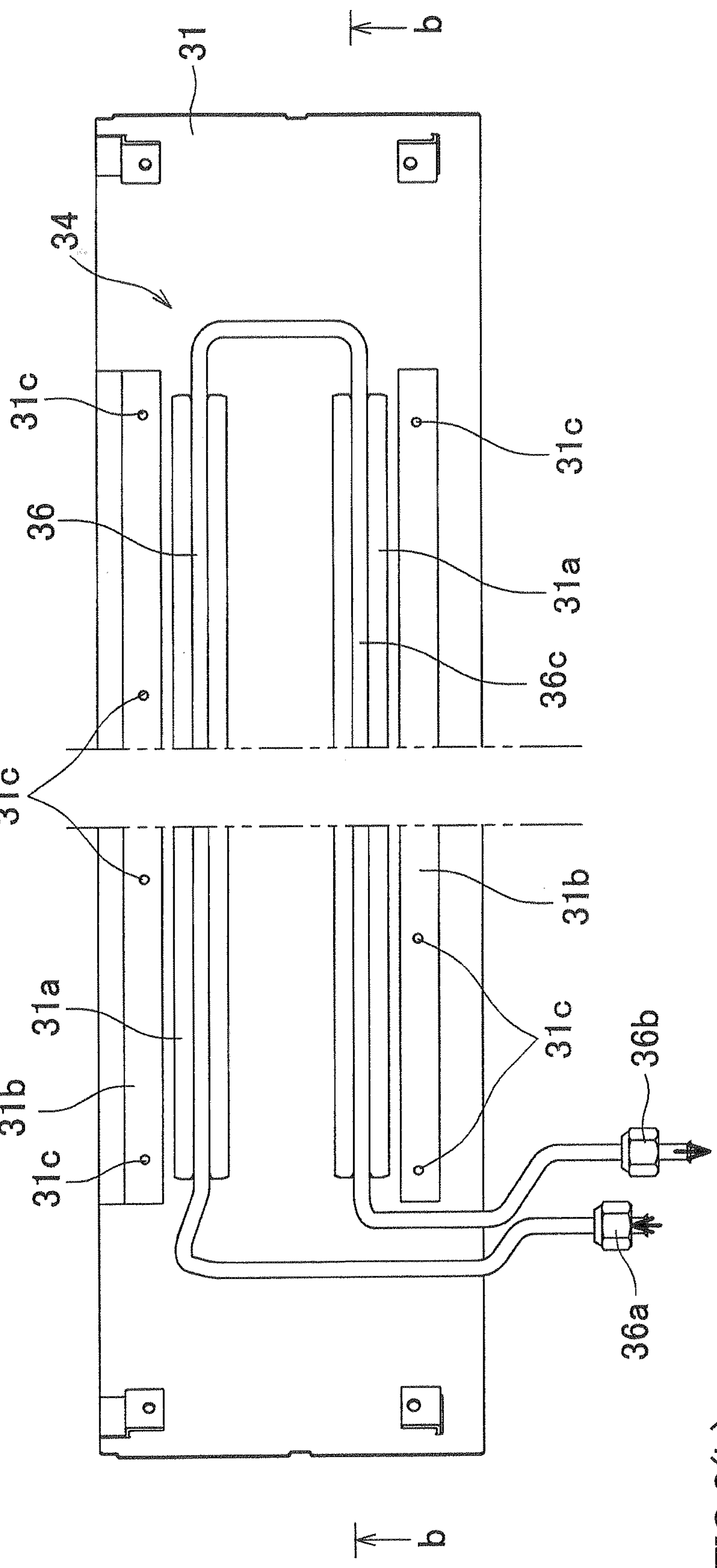

b
31
34
31c
31c
36
31a
36c
31c
31b
31a
31b
31c
31c
36b
36a
b

FIG.8(a)

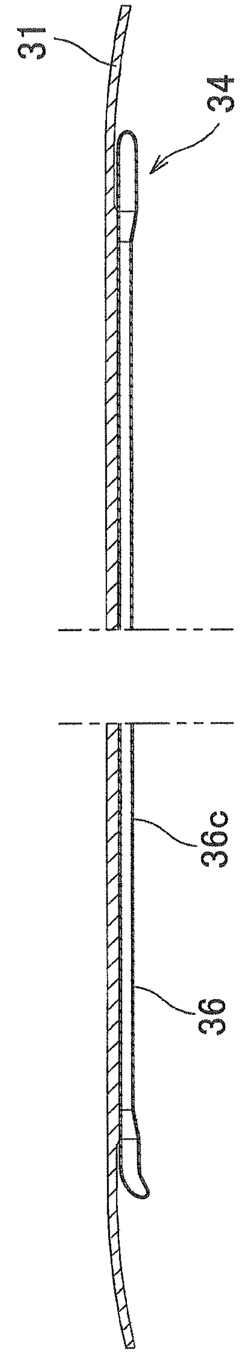
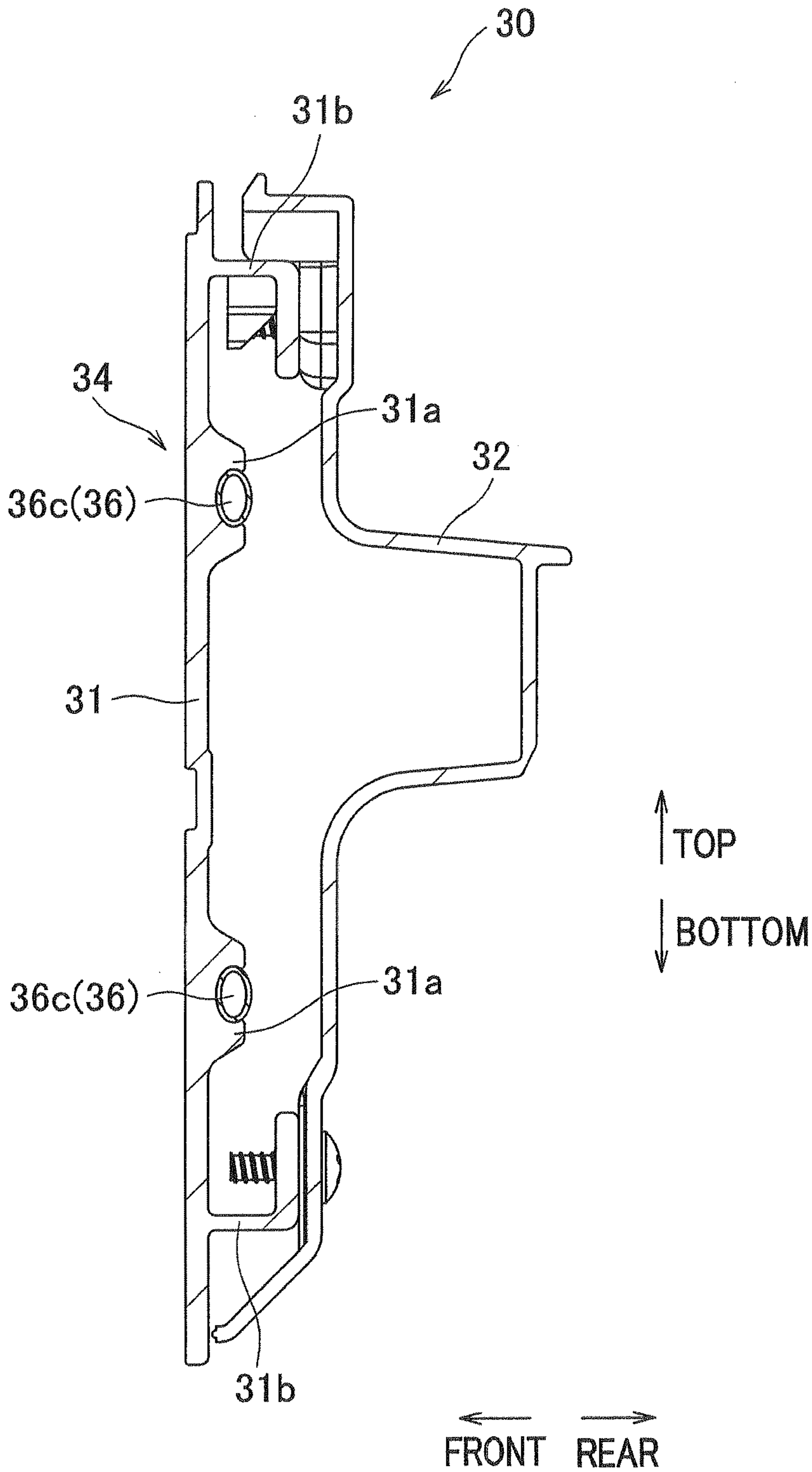

31
34
36c
36

FIG.8(b)

FIG.9



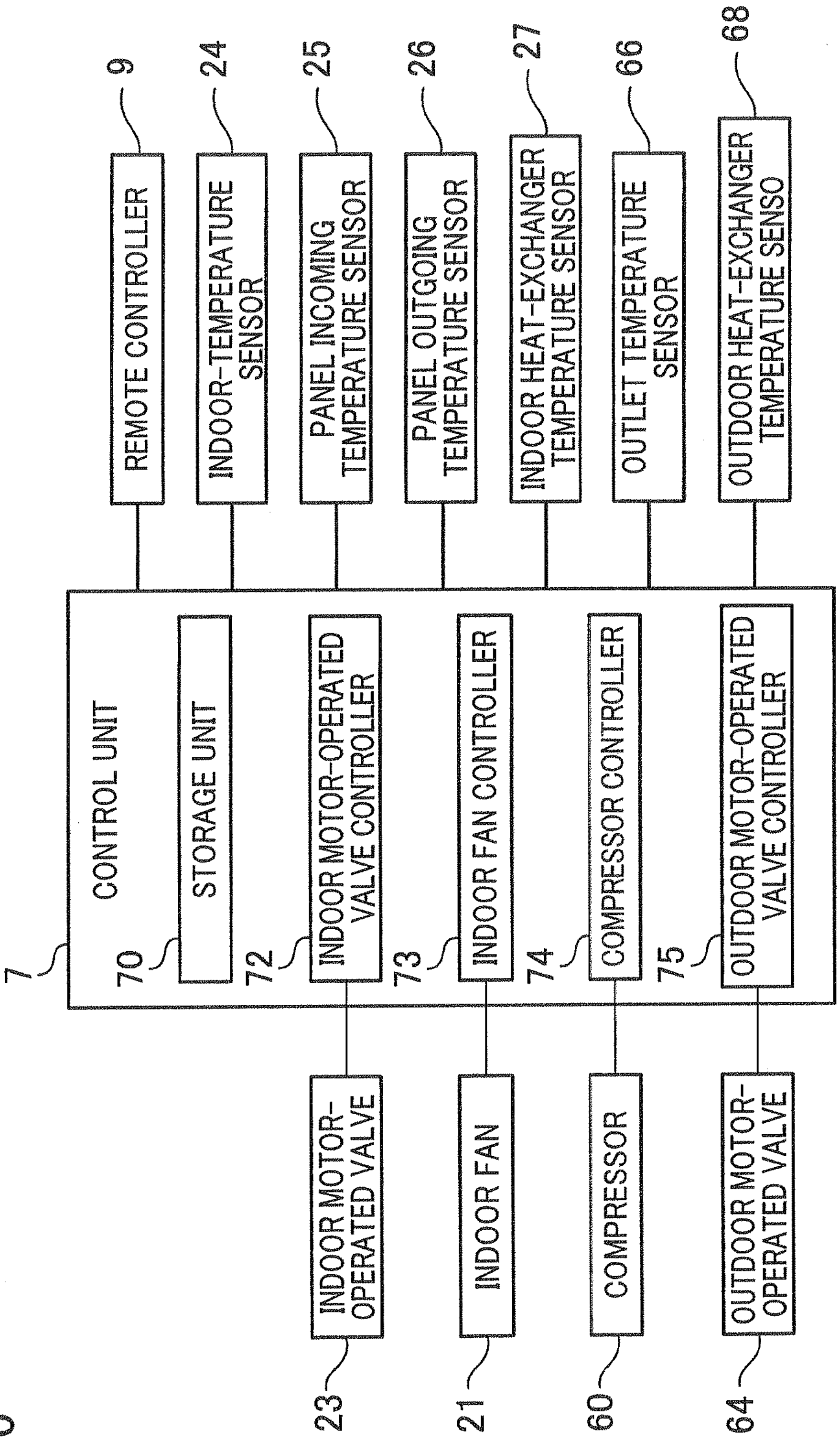

REMOTE CONTROLLER
INDOOR-TEMPERATURE SENSOR
PANEL INCOMING TEMPERATURE SENSOR
PANEL OUTGOING TEMPERATURE SENSOR
INDOOR HEAT-EXCHANGER TEMPERATURE SENSOR
OUTLET TEMPERATURE SENSOR
OUTDOOR HEAT-EXCHANGER TEMPERATURE SENSO
9
24
25
26
27
66
68
CONTROL UNIT
STORAGE UNIT
INDOOR MOTOR-OPERATED VALVE CONTROLLER
INDOOR FAN CONTROLLER
COMPRESSOR CONTROLLER
OUTDOOR MOTOR-OPERATED VALVE CONTROLLER
7
70
72
73
74
75
INDOOR MOTOR-OPERATED VALVE
INDOOR FAN
COMPRESSOR
OUTDOOR MOTOR-OPERATED VALVE
23
21
60
64

FIG.10

FIG.11

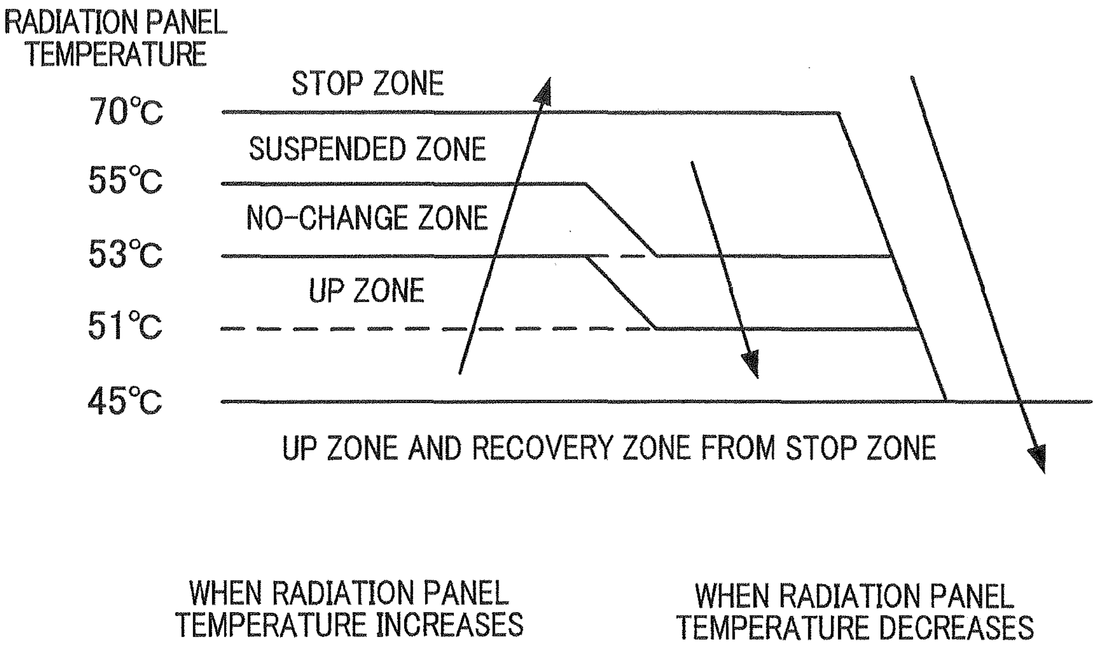

RADIATION PANEL TEMPERATURE
STOP ZONE
70°C
SUSPENDED ZONE
55°C
NO-CHANGE ZONE
53°C
UP ZONE
51°C
45°C
UP ZONE AND RECOVERY ZONE FROM STOP ZONE
WHEN RADIATION PANEL TEMPERATURE INCREASES
WHEN RADIATION PANEL TEMPERATURE DECREASES

FIG.12

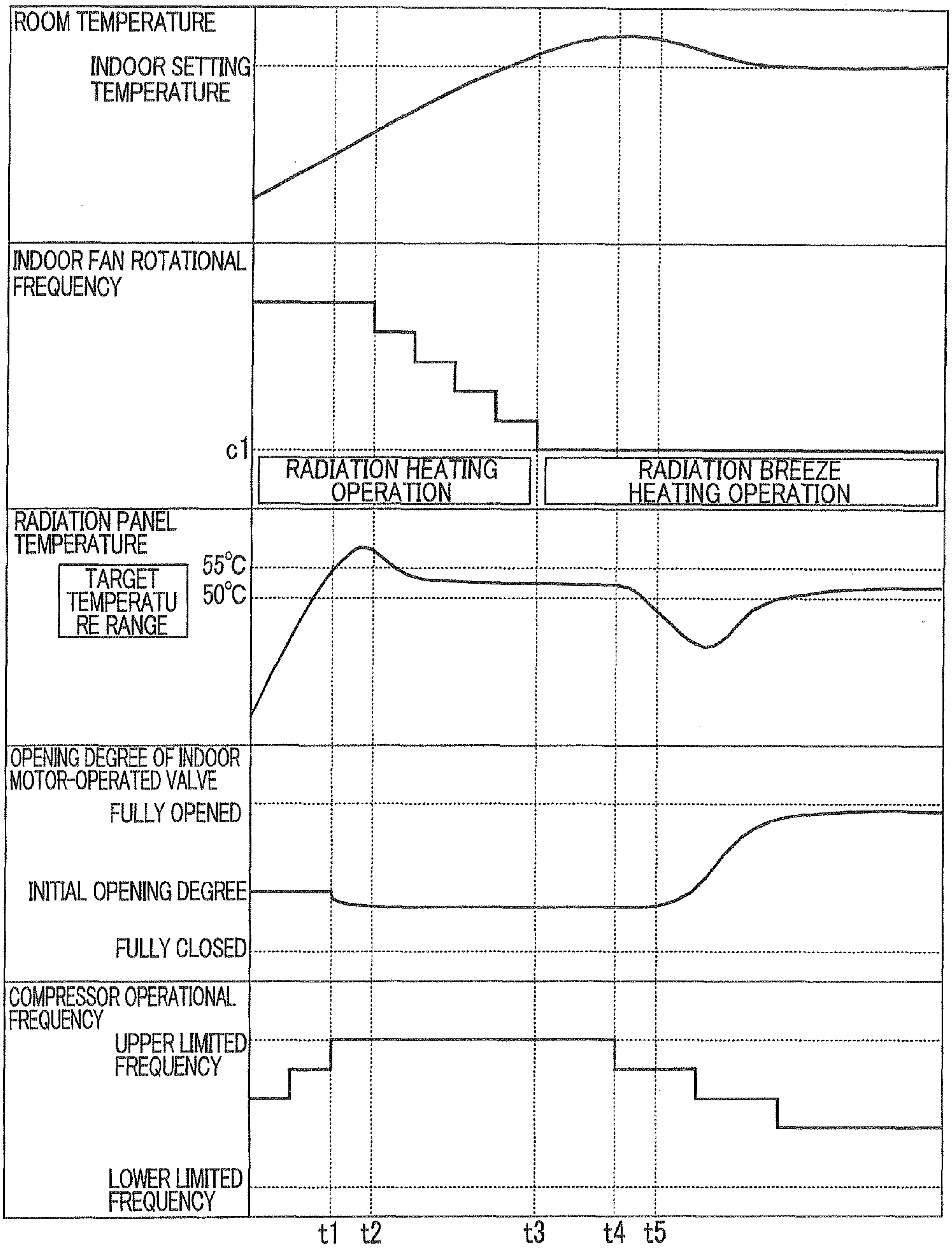
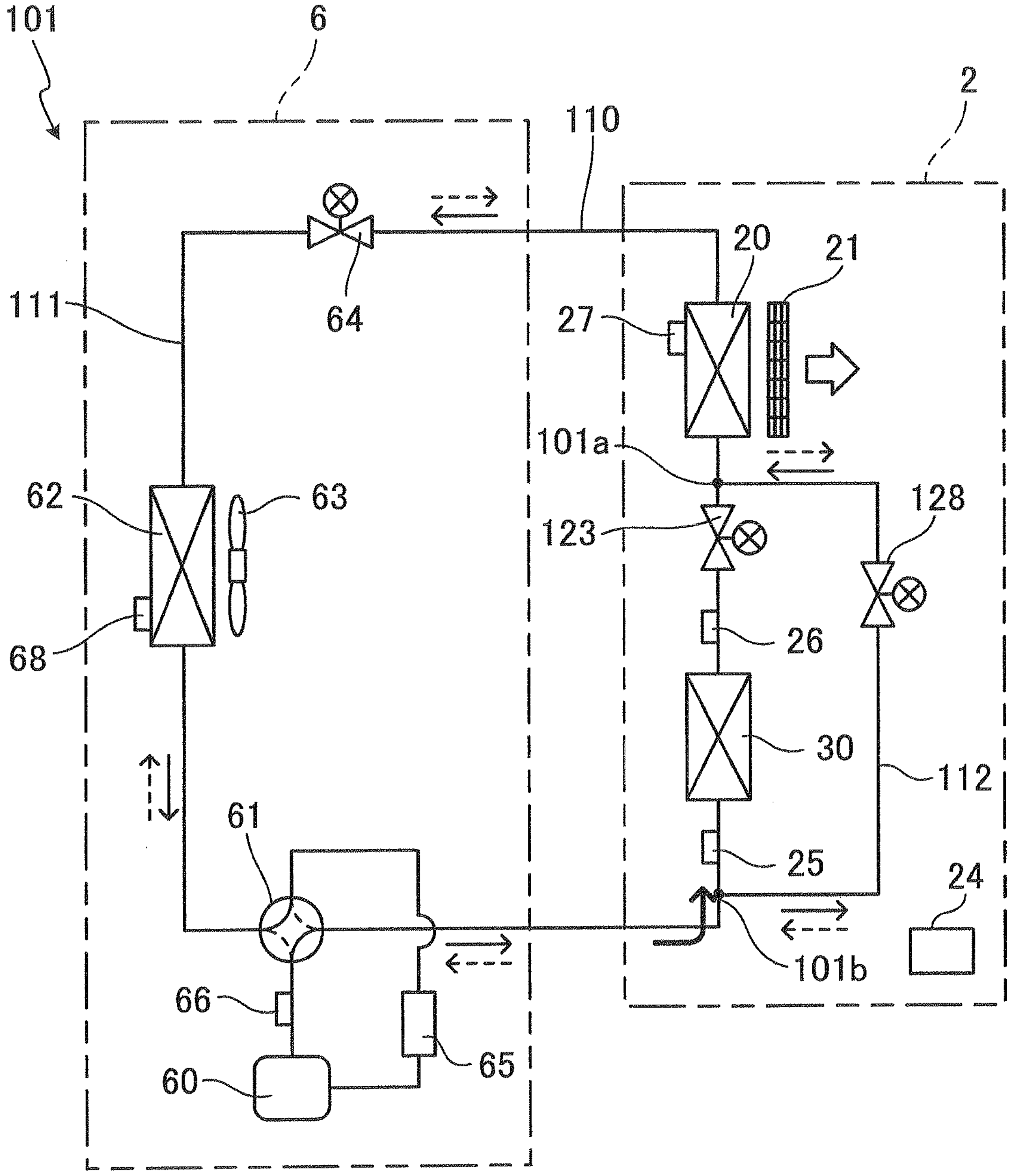

ROOM TEMPERATURE
INDOOR SETTING TEMPERATURE
INDOOR FAN ROTATIONAL FREQUENCY
c1
RADIATION HEATING OPERATION
RADIATION BREEZE HEATING OPERATION
RADIATION PANEL TEMPERATURE
TARGET TEMPERATU RE RANGE
55°C
50°C
OPENING DEGREE OF INDOOR MOTOR-OPERATED VALVE
FULLY OPENED
INITIAL OPENING DEGREE
FULLY CLOSED
COMPRESSOR OPERATIONAL FREQUENCY
UPPER LIMITED FREQUENCY
LOWER LIMITED FREQUENCY
t1
t2
t3
t4
t5

FIG.13


101
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101b
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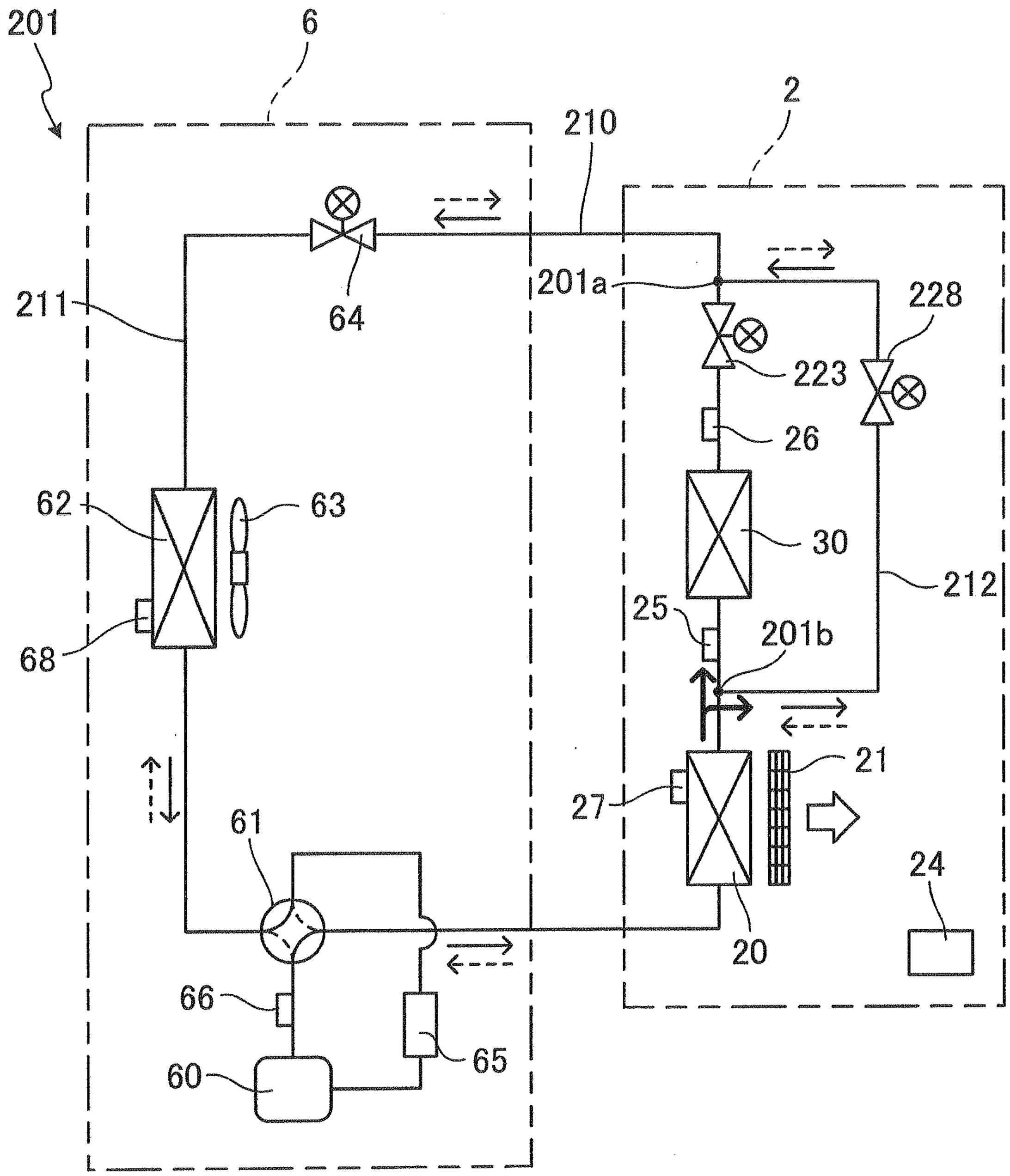
65
60

FIG.14


201
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210
211
64
201a
228
223
26
62
63
30
212
68
25
201b
21
27
61
24
20
66
65
60

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/074245

A. CLASSIFICATION OF SUBJECT MATTER
F24F1/00(2011.01)i, *F24F11/02*(2006.01)i, *F25B49/02*(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, F24F11/02, F25B49/02

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
X Y	WO 2010/106771 A1 (Daikin Industries, Ltd.), 23 September 2010 (23.09.2010), paragraphs [0010] to [0012]; fig. 1 & JP 2010-216767 A	1,2,6,7 3-5,8
X Y	JP 4-369327 A (Sharp Corp.), 22 December 1992 (22.12.1992), paragraph [0011]; fig. 1 (Family: none)	1,3,5,6 2,4,7,8
Y	JP 4-48140 A (Toshiba Corp.), 18 February 1992 (18.02.1992), page 4, upper left column, lines 13 to 17; fig. 1 (Family: none)	4

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

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Date of the actual completion of the international search	Date of mailing of the international search report
17 January, 2012 (17.01.12)	24 January, 2012 (24.01.12)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/074245

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 74386/1990 (Laid-open No. 32434/1992) (Mitsubishi Heavy Industries, Ltd.), 17 March 1992 (17.03.1992), entire text; all drawings (Family: none)	1-8
A	JP 4-236062 A (Sharp Corp.), 25 August 1992 (25.08.1992), entire text; all drawings (Family: none)	1-8
A	JP 5-79713 A (Sharp Corp.), 30 March 1993 (30.03.1993), entire text; all drawings (Family: none)	1-8

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Patent documents cited in the description

- JP 7018935 A **[0003]**