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

(11) **EP 2 667 109 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
27.11.2013 Bulletin 2013/48

(21) Application number: **12736171.5**

(22) Date of filing: **17.01.2012**

(51) Int Cl.:
F24F 11/02 *(2006.01)* ***F24F 1/00*** *(2011.01)*
F25B 13/00 *(2006.01)* ***F25B 49/02*** *(2006.01)*

(86) International application number:
PCT/JP2012/050871

(87) International publication number:
WO 2012/099128 (26.07.2012 Gazette 2012/30)

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

(30) Priority: **17.01.2011 JP 2011006806**

(71) Applicant: **DAIKIN INDUSTRIES, LTD.**
Osaka-shi, Osaka 530-8323 (JP)

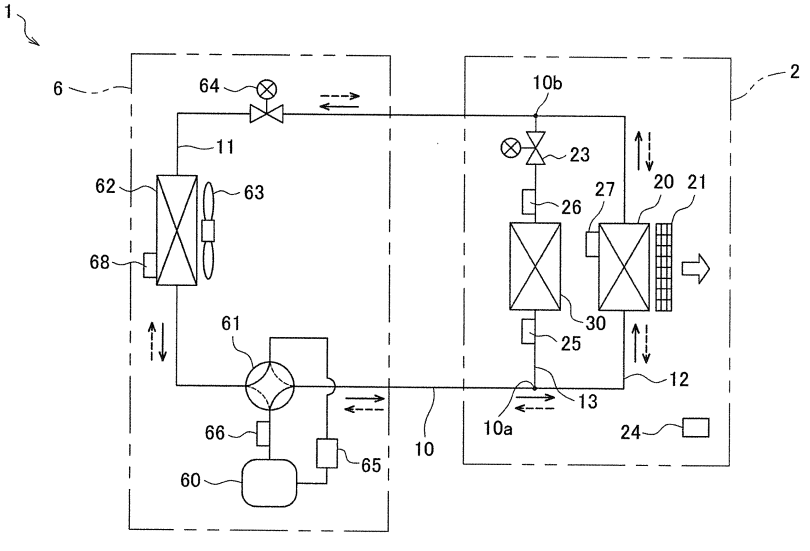
(72) Inventor: **FUJIOKA, Yuuki**
Osaka-shi,
Osaka 530-8323 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **AIR CONDITIONER**

(57) In order to detect abnormalities in a valve mechanism, this indoor unit has an indoor heat exchanger disposed inside the indoor unit, and a radiation panel disposed on the outer surface of the indoor unit. A refrigerant circuit connecting the indoor unit and an outdoor unit has: a principal channel on which an outdoor motor-operated valve (64), an outdoor heat exchanger, and a compressor (60) are disposed in that order; a first channel on which the indoor heat exchanger is disposed; and a second channel on which the radiation panel is disposed. The first channel, during heating operation, connects a branching section disposed downstream side of the compressor (60) on the principal channel, and a merging section disposed upstream side of the outdoor motor-operated valve (64). The second channel connects the branching section and the merging section to the first channel in parallel. An indoor motor-operated valve (23) is disposed on the second channel between the radiation panel and the merging section. In addition, an abnormality detector (73) for detecting abnormalities that occur in the indoor motor-operated valve (23) is provided.

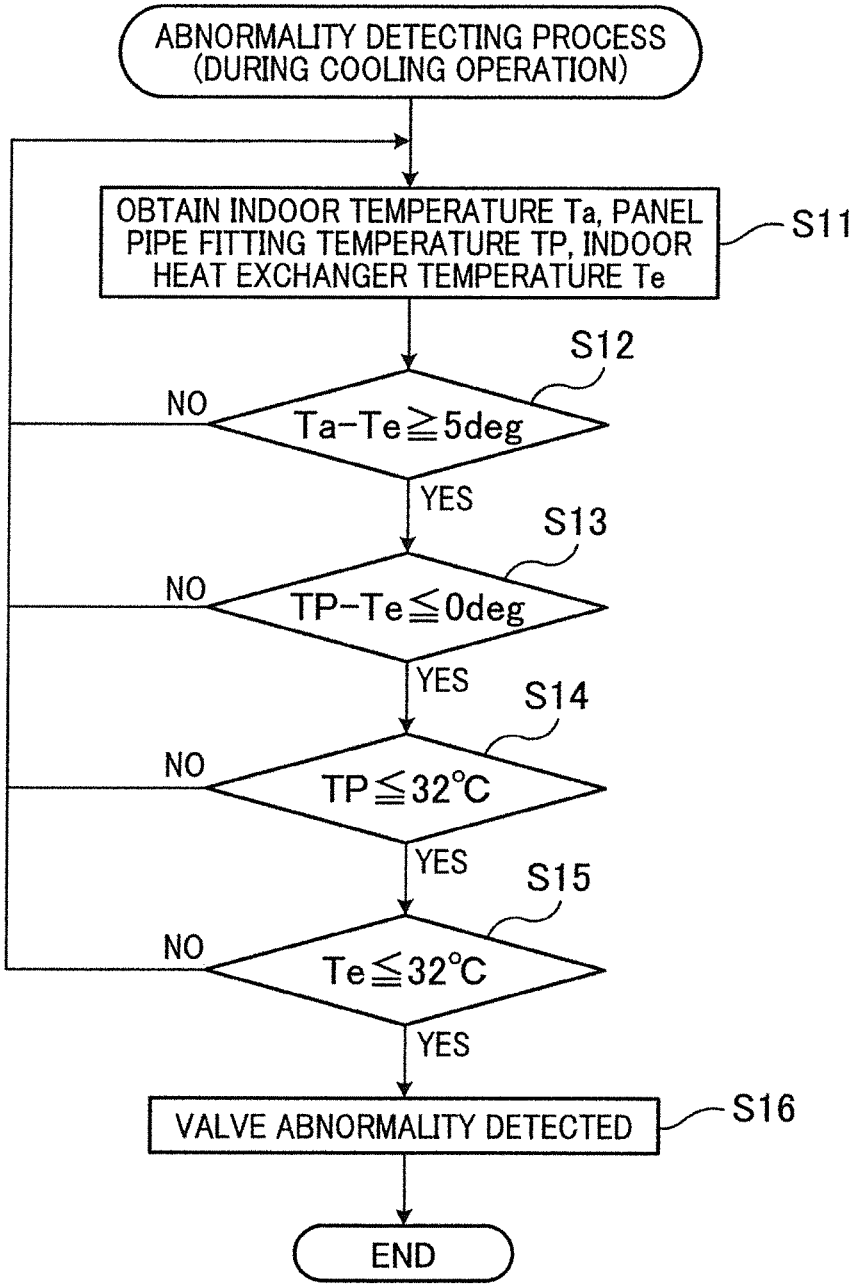
FIG.1



EP 2 667 109 A1

(Cont. next page)

FIG.9


ABNORMALITY DETECTING PROCESS (DURING COOLING OPERATION)
OBTAIN INDOOR TEMPERATURE Ta, PANEL PIPE FITTING TEMPERATURE TP, INDOOR HEAT EXCHANGER TEMPERATURE Te
S11
S12
NO
Ta-Te≧5deg
YES
S13
NO
TP-Te≦0deg
YES
S14
NO
TP≦32°C
YES
S15
NO
Te≦32°C
YES
VALVE ABNORMALITY DETECTED
S16
END

Description

Technical Field

[0001] The present invention relates to an air conditioner including an indoor unit having an indoor heat exchanger and a radiation panel.

Background Art

[0002] As an air conditioner, there has been known one which is connected to an outdoor unit through a refrigerant circuit, and which includes an indoor unit having therein an indoor heat exchanger, and a radiation panel provided to a surface of the indoor unit (e.g., see PTL 1). In the refrigerant circuit of the air conditioner disclosed in PTL 1, the indoor heat exchanger and the radiation panel are connected in parallel with each other.

Citation List

Patent Literature

[0003] [PTL 1] Japanese Unexamined Patent Publication No. 280762/1993 (Tokukaihei 5-280762)

Summary of Invention

Technical Problems

[0004] In the above described air conditioner, it is possible to provide a valve structure for adjusting the flow rate of a refrigerant supplied to the radiation panel, on a downstream side of the radiation panel, during a heating operation. In this air conditioner, the valve structure is closed during a cooling operation, so that the refrigerant does not flow in the radiation panel, but flows only in the indoor heat exchanger. During a warm-air heating operation, the valve structure is closed so that the refrigerant does not flow in the radiation panel and flows only in the indoor heat exchanger. During a radiation heating operation, the valve structure is opened and the refrigerant flows both in the radiation panel and the indoor heat exchanger.

[0005] In the above described refrigerant circuit, various problems may take place when there is an abnormality in the valve structure. For example, during the cooling operation, if the refrigerant flows out of the valve structure which is supposed to be closed, a low-temperature refrigerant flows into the pipe fitting of the radiation panel and causes dew condensation on the radiation panel. Further, during the warm-air heating operation, if the refrigerant leaks from the valve structure which is supposed to be closed, a high-temperature refrigerant passes the pipe fitting of the radiation panel causing an increase in the temperature of the radiation panel which is not supposed to increase. Further, during the radiation heating operation, if the valve structure is closed, or if the opening degree falls short of a required opening degree, the temperature of the radiation panel which is supposed to increase does not increase. These problems attributed to an abnormality in the valve structure may also take place in a similar manner, in a circuit where the indoor heat exchanger and the radiation panel are serially connected.

[0006] In view of the above problems, an objective of the present invention is to provide an air conditioner capable of detecting occurrence of an abnormality in the valve structure.

Solution to the Problems

[0007] A first aspect of the present invention is an air conditioner, comprising a refrigerant circuit connecting an indoor unit with an outdoor unit, wherein the indoor unit has therein an indoor heat exchanger provided to oppose to a fan and a radiation panel provided on a surface of the indoor unit, and wherein the refrigerant circuit includes: a valve structure configured to perform switching over between a state where a refrigerant flows in the radiation panel and a state where the refrigerant does not flow in the radiation panel; and an abnormality detector configured to detect occurrence of an abnormality in the valve structure based on a temperature of the radiation panel.

[0008] In this air conditioner, occurrence of an abnormality in the valve structure is detectable by the abnormality detector based on the temperature of the radiation panel. This restrains dew condensation on the radiation panel during the cooling operation and inappropriate radiation panel temperatures during the warm-air heating operation and the radiation heating operation, which are attributed to an abnormality in the valve structure.

[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 in which a decompression structure, an outdoor heat exchanger, and a compressor

are provided in this order; a first channel provided with the indoor heat exchanger, which connects a branching section provided to the downstream side of the compressor in the principal channel with a merging section provided to the upstream side of the decompression structure during the heating operation; and a second channel provided with the radiation panel, which connects the branching section and the merging section with the first channel in parallel; and wherein the valve structure is provided between the radiation panel and the merging section in the refrigerant circuit.

[0010] Note that the "the valve structure is provided between the radiation panel and the merging section in the refrigerant circuit" encompasses cases where the valve structure is provided to the merging section.

[0011] In this air conditioner in which the first channel having the indoor heat exchanger and the second channel having the radiation panel are connected in parallel with each other, occurrence of an abnormality in the valve structure is detectable.

[0012] A third aspect of the present invention is the air conditioner of the first or the second invention, adapted so that the abnormality detector detects occurrence of an abnormality in the valve structure, if the refrigerant flows in the radiation panel while the valve structure is in a state in which the refrigerant does not flow in the radiation panel.

[0013] In this air conditioner, occurrence of an abnormality in the valve structure is detectable by the abnormality detector, if the refrigerant flows in the radiation panel while the valve structure is in the state where the refrigerant does not flow in the radiation panel.

[0014] A fourth aspect of the present invention is the air conditioner of the first to the third invention, further including: an indoor heat exchanger temperature sensor provided to the indoor heat exchanger; and a panel temperature sensor provided between a radiator of the radiation panel and the valve structure, wherein the abnormality detector detects occurrence of an abnormality in the valve structure, based on a temperature detected by the panel temperature sensor and a temperature detected by the indoor heat exchanger temperature sensor.

[0015] In this air conditioner, the open/close state of the valve structure is detectable by comparing the temperature detected by the panel temperature sensor with the temperature detected by the indoor heat exchanger temperature sensor. Thus, occurrence of an abnormality in the valve structure is detectable, if the valve structure is opened and the refrigerant flows in the radiation panel while the valve structure is supposed to be in the state where the refrigerant does not flow in the radiation panel, or if the valve structure is closed and the refrigerant does not flow in the radiation panel while the valve structure is supposed to be in the state where the refrigerant flows in the radiation panel.

[0016] A fifth aspect of the present invention is the air conditioner of the fourth aspect, adapted so that wherein, during the cooling operation, the abnormality detector detects occurrence of an abnormality in the valve structure, when a pressure in the indoor heat exchanger is at or lower than a predetermined value.

[0017] This air conditioner brings about the following effect. Namely, when the pressure (low pressure) in the indoor heat exchanger is not sufficiently lowered during the cooling operation, the difference between the indoor temperature and the temperature detected by the indoor heat exchanger temperature sensor is small. In such a case, the temperature detected by the panel temperature sensor and the temperature detected by the indoor heat exchanger temperature sensor are close to each other, even when the valve structure is properly closed and the refrigerant does not flow in the radiation panel. Therefore, even though there is no abnormality in the valve structure, there is a possibility of misdetection that the refrigerant is flowing in the radiation panel due to an abnormality in the valve structure. In view of this, misdetection of abnormality in the valve structure is restrained by excluding such a case.

[0018] A sixth aspect of the present invention is the air conditioner of the fourth or the fifth invention, further including an indoor temperature sensor configured to detect an indoor temperature, wherein the abnormality detector detects occurrence of an abnormality in the valve structure, when a difference between a temperature detected by the indoor temperature sensor and a temperature detected by the indoor heat exchanger temperature sensor is a predetermined value or greater.

[0019] In this air conditioner, misdetection of an abnormality in the valve structure is restrained by excluding cases where the difference between the temperature detected by the indoor temperature sensor and the temperature detected by the indoor heat exchanger temperature sensor is small.

Advantageous Effects

[0020] As hereinabove described, the present invention brings about the following effects.

[0021] In the first aspect of the present invention, occurrence of an abnormality in the valve structure is detectable by the abnormality detector based on the temperature of the radiation panel. This restrains problems such as dew condensation on the radiation panel during the cooling operation and inappropriate radiation panel temperatures during the warm-air heating operation and the radiation heating operation, which are attributed to an abnormality in the valve structure.

[0022] With the second aspect of the present invention, occurrence of an abnormality in the valve structure is detectable in an air conditioner in which the first channel having the indoor heat exchanger and the second channel having the radiation panel are connected in parallel with each other.

[0023] In the third aspect of the present invention, occurrence of an abnormality in the valve structure is detectable by the abnormality detector, if the refrigerant flows in the radiation panel while the valve structure is in the state where the refrigerant does not flow in the radiation panel.

[0024] In the fourth aspect of the present invention, the open/close state of the valve structure is detectable by comparing the temperature detected by the panel temperature sensor with the temperature detected by the indoor heat exchanger temperature sensor. Thus, occurrence of an abnormality in the valve structure is detectable, if the valve structure is opened and the refrigerant flows in the radiation panel while the valve structure is supposed to be in the state where the refrigerant does not flow in the radiation panel, or if the valve structure is closed and the refrigerant does not flow in the radiation panel while the valve structure is supposed to be in the state where the refrigerant flows in the radiation panel.

[0025] The fifth aspect of the present invention brings about the following effect. Namely, when the pressure (low pressure) in the indoor heat exchanger is not sufficiently lowered during the cooling operation, the difference between the indoor temperature and the temperature detected by the indoor heat exchanger temperature sensor is small. In such a case, the temperature detected by the panel temperature sensor and the temperature detected by the indoor heat exchanger temperature sensor are close to each other, even when the valve structure is properly closed and the refrigerant does not flow in the radiation panel. Therefore, even though there is no abnormality in the valve structure, there is a possibility of misdetection that the refrigerant is flowing in the radiation panel due to an abnormality in the valve structure. In view of this, misdetection of abnormality in the valve structure is restrained by excluding such a case.

[0026] In the sixth aspect of the present invention, misdetection of an abnormality in the valve structure is restrained by excluding cases where the difference between the temperature detected by the indoor temperature sensor and the temperature detected by the indoor heat exchanger temperature sensor is small.

Brief Description of Drawings

[0027]

[FIG. 1] FIG. 1 is a circuit diagram illustrating a schematic configuration of an air conditioner related to an embodiment of the present invention, and shows a flow of a refrigerant during a cooling operation and a warm-air heating operation.
[FIG. 2] FIG. 2 is a circuit diagram illustrating a schematic configuration of the air conditioner related to the embodiment of the present invention, and shows a flow of the refrigerant during the radiation heating operation.
[FIG. 3] FIG. 3 is a perspective view of an indoor unit illustrated 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 in FIG. 3.
[FIG. 5] FIG. 5 is a block diagram illustrating a schematic configuration of a controller controlling the air conditioner.
[FIG. 6] FIG. 6 is a graph explaining a condition for detecting an abnormality by an abnormality detector illustrated in FIG. 5, during the cooling operation, taking into account prevention of misdetection.
[FIG. 7] FIG. 7 is a graph explaining a condition for detecting an abnormality by the abnormality detector illustrated in FIG. 5, during the warm-air heating operation.
[FIG. 8] FIG. 8 is a graph explaining a condition for detecting an abnormality by the abnormality detector illustrated in FIG. 5, during the radiation heating operation.
[FIG. 9] FIG. 9 is a flowchart showing steps of an abnormality detecting process executed by the abnormality detector illustrated in FIG. 5 during the cooling operation.
[FIG. 10] FIG. 10 is a flowchart showing steps of an abnormality detecting process executed by the abnormality detector illustrated in FIG. 5 during the warm-air heating operation.
[FIG. 11] FIG. 11 is a flowchart showing steps of an abnormality detecting process executed by the abnormality detector illustrated in FIG. 5 during the radiation heating operation.
[FIG. 12] FIG. 12 is a circuit diagram illustrating a schematic configuration of an air conditioner related to a modification of the embodiment.

Description of Embodiments

[0028] Hereinafter, an air conditioner 1 according to an embodiment of the present invention will be described.

<Entire Configuration of Air Conditioner 1>

[0029] As illustrated in Figs. 1 and 2, the air conditioner 1 of the embodiment includes an indoor unit 2 that is installed in a room, an outdoor unit 6 that is installed out of the room, and a remote controller 9 (see FIG. 5). The indoor unit 2 includes an indoor heat exchanger 20 disposed to oppose to an indoor fan 21, 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 that is disposed near the outdoor

heat exchanger 62, and an outdoor motor-operated valve 64 (a decompression structure).

[0030] 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 provided in this order. An intake-side pipe fitting and a discharge-side pipe fitting 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 FIG. 1 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 merging section 10b 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.

[0031] 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. 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 pipe fitting and is on the upstream side of a radiator 35, which will be described later, (see FIG. 4) of the radiation panel 30 during the heating operation. The panel outgoing temperature sensor 26 is provided in the pipe fitting and is on the downstream side of the radiator 35 of the radiation panel 30 and upstream side of the indoor motor-operated valve 23, during the heating operation.

[0032] 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.

[0033] The indoor heat exchanger 20 includes the pipe fitting, 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.

[0034] The radiation panel 30 is disposed on a surface side of the indoor unit 2, and includes a panel pipe fitting 36 which is a pipe fitting constituting a part of the refrigerant circuit 10. Heat of the refrigerant flowing in the panel pipe fitting 36 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. Controlling opening and closing of the indoor motor-operated valve 23 enables switching over between a state where the refrigerant flows in the panel pipe fitting 36 of the radiation panel 30 and a state where the refrigerant does not flow in the panel pipe fitting 36 of the radiation panel 30.

[0035] The air conditioner 1 of the embodiment is capable of performing a cooling operation, a warm-air heating operation, and a radiation heating operation. The cooling operation is an operation which performs cooling by causing the refrigerant to flow not in the radiation panel 30, but in the indoor heat exchanger 20, whereas the warm-air heating operation is an operation which performs 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 which performs radiation heating by causing the refrigerant to flow in the radiation panel 30, while performing warm-air heating by causing the refrigerant to flow in the indoor heat exchanger 20.

[0036] A flow of the refrigerant in the refrigerant circuit 10 during each operation will be described with reference to Figs. 1 and 2.

During the cooling operation, 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. Note that, with the indoor motor-operated valve 23 being closed, the refrigerant decompressed by the outdoor motor-operated valve 64 is kept from flowing towards the radiation panel 30 beyond the indoor motor-operated valve 23 in the second channel 13.

[0037] During the warm-air heating operation, the indoor motor-operated valve 23 is closed, and the four-way valve 61 is switched to the 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 in the indoor heat exchanger 20 through the four-way valve 61. The refrigerant condensed by the indoor heat exchanger 20 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. With the indoor motor-operated valve 23 being closed, the refrigerant discharged from the compressor 60 does not flow onto the

side of the merging section 10b beyond the indoor motor-operated valve 23 in the second channel 13. That is, in the second channel 13, the refrigerant is accumulated on the upstream side of the indoor motor-operated valve 23.

[0038] During the radiation 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>

[0039] 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". A right-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".

[0040] 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 that is 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 also 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.

[0041] 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.

[0042] The body frame 41 is one that is 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 of 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.

[0043] Each internal device accommodated in the casing 4 will be described below.

The indoor fan 21 is disposed slightly above a central 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.

[0044] 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 that is opposed to the rear surface of the front panel 5 and a rear heat exchanger 20b that is upwardly inclined toward the rear surface from a vicinity of the lower end portion of the front heat exchanger 20a. The front heat exchanger 20a is disposed in front of the indoor fan 21, and its upper half is opposed to the indoor fan 21. The rear heat exchanger 20b is disposed below the indoor fan 21 and is opposed to 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 oppose to the front and lower side of the indoor fan 21.

[0045] A horizontally extending drain pan 22 is disposed below the indoor heat exchanger 20. Further, below the drain pan 22 is arranged an electric component unit 47.

[0046] 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 has a horizontal flap 46a disposed nearby the outlet 4d. The horizontal flap 46a changes the direction of an air flow from the outlet 4d relative to the vertical direction, and

open or closes the outlet 4d.

[0047] 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 central 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.

[0048] To the filter retaining section 42a are attached a lower filter 43 and an upper filter 44. As shown in FIG. 4, the lower filter 43 held by the filter retaining section 42a extends downward from substantially the central portion of the front heat exchanger 20a relative to the vertical direction, and its lower end portion is tilted in a direction obliquely backside. The lower end of the lower filter 43 is positioned nearby the rear end of the principal inlet 4a. Further, the upper filter 44 extends upwards from the substantially central portion of the front heat exchanger 20a relative to the vertical direction. With the lower filter 43 and the upper filter 44, the space between the front heat exchanger 20a and the front panel 5 is divided relative to the front-rear direction.

[0049] 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.

[0050] The radiation panel 30 has the horizontally long, substantially rectangular shape. 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 radiation plate 31 is positioned below the front panel section 51a of the outlet cover 51. As illustrated in FIG. 4, the panel pipe fitting 36 that is of the part of the pipe fitting constituting the refrigerant circuit 10 is attached to the rear surface of the radiation plate 31. The portion of the radiation panel 30 where the radiation plate 31 and the panel pipe fitting 36 are in contact with each other, are the portions serving as the radiator 35.

[0051] 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 the horizontally long rectangular shape. 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.

<Remote Controller 9>

[0052] 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.

<Controller 7>

[0053] Next, the controller 7 for controlling the air conditioner 1 is described with reference to FIG. 5.
As shown in FIG. 5, the controller 7 has a storage 70, an indoor motor-operated valve controller 72, an abnormality detector 73, an indoor fan controller 74, a compressor controller 75, and an outdoor motor-operated valve controller 76.

[0054] 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 embodiment, the target temperature range 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.

[0055] The indoor motor-operated valve controller 72 controls 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, 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, a surface temperature (predicted value) of the radiation panel 30 is calculated based on a calculated value of temperatures detected by the panel incoming temperature sensor 25 and the panel outgoing temperature sensor 26. The opening degree of the indoor motor-operated valve 23 is controlled so that this surface temperature of the radiation panel 30 (hereinafter, simply referred to as radiation panel temperature) is within a panel target temperature range (e.g. 50 to 55°C). Note that when the value detected by the panel incoming temperature sensor 25 is a predetermined value (e.g. , 80°C) or more, the indoor motor-operated valve 23 is closed.

[0056] The abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23, based on the temperature of the radiation panel 30. That is, during the cooling operation and during the warm-air heating

operation, the abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23, if the refrigerant flows out of the indoor motor-operated valve 23 which is supposed to be closed and flows in the panel pipe fitting 36 of the radiation panel 30. Further, during the radiation heating operation, occurrence of an abnormality in the indoor motor-operated valve 23 is detected when the indoor motor-operated valve 23 is completely closed, and the refrigerant does not flow in the panel pipe fitting 36 of the radiation panel 30. Specifically, during the cooling operation, the abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23, based on a temperature (hereinafter, simply referred to as indoor temperature Ta) detected by the indoor temperature sensor 24, a temperature (hereinafter, simply referred to as panel pipe fitting temperature TP) detected by the panel outgoing temperature sensor 26, and a temperature (hereinafter, simply referred to as indoor heat exchanger temperature Te) detected by the indoor heat exchanger temperature sensor 27. Further, during the warm-air heating operation and during the radiation heating operation, occurrence of an abnormality in the indoor motor-operated valve 23 is detected based on the panel pipe fitting temperature TP and the indoor heat exchanger temperature Te.

[0057] When an abnormality occurs in the indoor motor-operated valve 23 during the cooling operation, and the refrigerant flows out of the indoor motor-operated valve 23 which is supposed to be closed, the low-temperature refrigerant having flown from the merging section 10b into the second channel 13 flows into the pipe fitting on the downstream side (the side of radiation panel 30) of the indoor motor-operated valve 23. Therefore, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 drops to a temperature at or below the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 provided in the indoor heat exchanger 20 where heat exchanging takes place. In other words, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 1) is satisfied.

$$TP - Te \leq 0 \text{ deg.} \quad \text{(Formula 1)}$$

[0058] In the embodiment, the abnormality in the indoor motor-operated valve 23 is detected only in cases where the temperature of the refrigerant flowing out of the outdoor motor-operated valve 64 is sufficiently low and where such a refrigerant, when flowing into the pipe fitting of the radiation panel 30, may cause dew condensation on the radiation panel 30. Therefore, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 2) and (Formula 3) are satisfied, in addition to (Formula 1).

$$TP \leq 32°C \quad \text{(Formula 2)}$$

$$Te \leq 32°C \quad \text{(Formula 3)}$$

[0059] Additionally, for example, when the outdoor unit 6 is a multi-connectable outdoor unit which is connectable with a plurality of indoor units, and when the indoor units connected with the outdoor unit 6 are operated at the same time, the pressure (low pressure) in the indoor heat exchanger 20 may not sufficiently drop. Since the indoor temperature Ta, the panel pipe fitting temperature TP, and the indoor heat exchanger temperature Te are substantially the same temperature in such a case, the above (Formula 1) may be satisfied even though no abnormality takes place in the indoor motor-operated valve 23. To prevent such a misdetection, the following (Formula 4) is added to the above (Formula 1) to (Formula 3) as a condition for the abnormality detector 73 to detect that the indoor motor-operated valve 23 is abnormal.

$$Ta - Te \geq 5 \text{ deg.} \quad \text{(Formula 4)}$$

[0060] Note that, when the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is less than 5 deg., dew condensation will not take place on the radiation panel 30 as long as the relative humidity is not more than 80%, even if the refrigerant is flowing out due to an abnormality in the indoor motor-operated valve 23.

[0061] Based on the above (Formula 4), an abnormality detectable area of the indoor motor-operated valve 23 is only an area (I) shown in FIG. 6. That is, an abnormality in the indoor motor-operated valve 23 is not detected in an area (an area indicated by (II) in the figure) where the indoor heat exchanger temperature Te is higher than the indoor temperature Ta (i.e., Ta-Te < 0 deg.) and where detection of abnormality in the indoor motor-operated valve 23 is not necessary,

and in an area (area indicated by (III) in the figure) where the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is relatively small (i.e., 0 deg. ≤ Ta-Te < 5 deg.) and misdetection of an abnormality in the indoor motor-operated valve 23 may take place.

[0062] Thus, when the indoor temperature Ta detected by the indoor temperature sensor 24, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26, and the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 satisfy all of the (Formula 1) to (Formula 4) during the cooling operation, the abnormality detector 73 detects that the indoor motor-operated valve 23 is abnormal.

[0063] During the warm-air heating operation, if the abnormality occurs in the indoor motor-operated valve 23 and the refrigerant flows out of the indoor motor-operated valve 23 which is supposed to be closed, the high-temperature refrigerant having flown from the branching section 10a into the second channel 13 flows out of the second channel 13 via the pipe fitting of the radiation panel 30 and the indoor motor-operated valve 23. Therefore, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 increases and becomes equal to or higher than the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 provided in the indoor heat exchanger 20. That is, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 5) is satisfied.

$$Te - TP \leq 0 \text{ deg.} \quad \text{(Formula 5)}$$

[0064] Further, in the embodiment, an abnormality in the indoor motor-operated valve 23 is detected only in cases where the temperature of the refrigerant discharged from the compressor 60 is relatively high and where the radiation panel 30 has a high temperature of a certain extent as the refrigerant passes through the pipe fitting in the radiation panel 30. Therefore, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 6) and (Formula 7) are satisfied, in addition to (Formula 5).

$$TP \geq 43°C \quad \text{(Formula 6)}$$

$$Te \geq 43°C \quad \text{(Formula 7)}$$

[0065] Considering the relation between the surface temperature of the radiation panel 30 (hereinafter, simply referred to as panel temperature TPO) and the indoor heat exchanger temperature Te, an abnormality detectable area of the indoor motor-operated valve 23 is only an area (an area indicated by (I) in the figure) shown in FIG. 7, where the panel temperature TPO is 40°C or higher and where the indoor heat exchanger temperature Te is 43°C or higher. In other words, an abnormality in the indoor motor-operated valve 23 is not detected in an area (an area indicated by (II) in the figure) which does not possibly occur in an actual operation, in which area the panel temperature TPO is 40°C or higher and the indoor heat exchanger temperature Te is lower than 43°C, or in an area (an area indicated by (III) in the figure) where the panel temperature TPO is lower than 40°C, in which case if an abnormality is to be detected, there would be a chance of misdetection of an abnormality in the indoor motor-operated valve 23.

[0066] In other words, when the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 and the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 satisfy all the above (Formula 5) to (Formula 7) during the warm-air heating operation, the abnormality detector 73 detects that the indoor motor-operated valve 23 is abnormal.

[0067] When the indoor motor-operated valve 23 is closed, and there is an abnormality in the indoor motor-operated valve 23 during the radiation heating operation, the high-temperature refrigerant having flowing from the branching section 10a into the second channel 13 is accumulated in the pipe fitting on the upstream side (the side of the radiation panel 30) of the indoor motor-operated valve 23. Therefore, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 does not increase and the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is increased. That is, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 8) is satisfied.

$$Te - TP \geq 35 \text{ deg.} \quad \text{(Formula 8)}$$

[0068] Note that, when the indoor motor-operated valve 23 is completely closed, the indoor temperature is 10°C, and the indoor heat exchanger temperature is 55°C, the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is 35 deg.

[0069] Further, in the embodiment, an abnormality in the indoor motor-operated valve 23 is not detected if the temperature of the radiation panel 30 shows a certain increase even though the indoor motor-operated valve 23 is closed. An abnormality in the indoor motor-operated valve 23 is detected only if there seems to be no increase in the temperature of the radiation panel 30. Therefore, an abnormality in the indoor motor-operated valve 23 is detected by the abnormality detector 73 on condition that the following (Formula 9) and (Formula 10) are satisfied, in addition to (Formula 8).

$$TP \leq 60°C \quad \text{(Formula 9)}$$

$$Te \leq 60°C \quad \text{(Formula 10)}$$

[0070] Considering the relation between the panel temperature TPO and the indoor heat exchanger temperature Te, an abnormality detectable area of the indoor motor-operated valve 23 is only an area (I) shown in FIG. 8. In other words, an abnormality in the indoor motor-operated valve 23 is not detected in an area (an area indicated by (II) in the figure) which does not possibly occur in an actual operation, in which area the panel temperature TP0 is higher than the indoor heat exchanger temperature Te (i.e., Te - TPO < 0 deg.), or in an area (an area indicated by (III) in the figure) where the difference between the indoor heat exchanger temperature Te and the panel temperature TPO is relatively small (i.e., 0 deg. ≤ Te - TPO < 35 deg.) and where an abnormality in the indoor motor-operated valve 23 is not detectable.

[0071] In other words, when the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 and the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 satisfy all the above (Formula 8) to (Formula 10) during the radiation heating operation, the abnormality detector 73 detects that the indoor motor-operated valve 23 is abnormal.

[0072] The indoor fan controller 74 controls the rotational frequency of the indoor fan 21 according to the operation mode, the indoor setting temperature, the blowing air quantity set by the remote controller 9, and the indoor temperature detected by the indoor temperature sensor 24.

[0073] The compressor controller 75 controls the operation frequency of the compressor 60, based on the indoor temperature, the indoor setting temperature, the heat exchanger temperature detected by the indoor heat exchanger temperature sensor 27, and the like.

[0074] The outdoor motor-operated valve controller 76 controls the opening degree of the outdoor motor-operated valve 64. More specifically, the outdoor motor-operated valve controller 76 controls the opening degree of the outdoor motor-operated valve 64 so that the temperature detected by the discharge temperature sensor 66 becomes an optimal temperature in the operation status. The optimal temperature is determined based on a calculated value using the indoor heat exchanger temperature and an outdoor heat exchanger temperature.

<Abnormality Detecting Process by Abnormality Detector 73>

[0075] The following describes the steps of an abnormality detecting process executed by the abnormality detector 73 for detecting an abnormality in the indoor motor-operated valve 23.

[0076] During the cooling operation, as shown in FIG. 9, the indoor temperature Ta detected by the indoor temperature sensor 24, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26, and the Te detected by the indoor heat exchanger temperature sensor 27 are first obtained (step S11). Next, there is determined whether or not the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is 5 deg. or more (step S12). When the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is smaller than 5 deg. (step S12: NO), there is a possibility of misdetection of an abnormality in the indoor motor-operated valve 23. Therefore, the process does not proceed to the next step and returns to step S11.

[0077] On the other hand, when the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is at least 5 deg. (step S12: YES), there is determined whether or not the difference between the panel pipe fitting temperature TP and the indoor heat exchanger temperature Te is at most 0 deg. (step S13). When the difference between the panel pipe fitting temperature TP and the indoor heat exchanger temperature Te is higher than 0 deg. (step S13: NO), it is considered that the indoor motor-operated valve 23 is properly closed, and there is no refrigerant flowing out. Therefore, the process does not proceed to the next step, and returns to step S11.

[0078] Further, when the difference between the panel pipe fitting temperature TP and the indoor heat exchanger

temperature Te is 0 deg. or smaller (step S13: YES), it is considered that the refrigerant is flowing out of the indoor motor-operated valve 23 which is supposed to be closed. Next, in step S14, there is determined whether the panel pipe fitting temperature TP is at most 32°C, and there is determined in step S15 whether the indoor heat exchanger temperature Te is at most 32°C. When the panel pipe fitting temperature TP is determined as to be higher than the 32°C in step S14 (step S14: NO), or when the indoor heat exchanger temperature Te is determined as to be higher than 32°C in step S15 (step S15: NO), it is considered that dew condensation will not take place on the radiation panel 30. Therefore, the process does not proceed to the next step and returns to step S11.

[0079] On the other hand, when the panel pipe fitting temperature TP is determined as to be 32°C or lower in step S14 (step S14: YES), or when the indoor heat exchanger temperature Te is determined as to be 32°C or lower in step S15 (step S15: YES), occurrence of an abnormality in the indoor motor-operated valve 23 is detected (step S16).

[0080] During the warm-air heating operation, as shown in FIG. 10, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26, the Te detected by the indoor heat exchanger temperature sensor 27 are first obtained (step S21). Next, there is determined whether the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is at most 0 deg. (step S22). Here, when the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is greater than 0 deg. (step S22: NO), it is considered that the indoor motor-operated valve 23 is properly closed, and there is no refrigerant flowing out. Therefore, the process does not proceed to the next step and returns to step S21.

[0081] Further, when the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is at most 0 deg. (step S22: YES), it is considered that the refrigerant is flowing out of the indoor motor-operated valve 23 which is supposed to be closed. Next, there is determined whether the panel pipe fitting temperature TP is 43°C or higher in step S23, and there is determined whether the indoor heat exchanger temperature Te is 43°C or higher in step S24. When the panel pipe fitting temperature TP is determined as to be lower than 43°C in step S23 (step S23: NO), or when the indoor heat exchanger temperature Te is determined as to be lower than 43°C in step S24 (step S24: NO), it is considered that the temperature of the radiation panel 30 will not increase so much (that detection of an abnormality in the indoor motor-operated valve 23 is necessary). Therefore, the process does not proceed to the next step and returns to step S21.

[0082] On the other hand, when the panel pipe fitting temperature TP is determined as to be 43°C or higher in step S23 (step S23: YES), or when the indoor heat exchanger temperature Te is determined as to be 43°C or higher in step S24 (step S24: YES), occurrence of an abnormality in the indoor motor-operated valve 23 is detected (step S25).

[0083] During the radiation heating operation, as shown in FIG. 11, the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26, the Te detected by the indoor heat exchanger temperature sensor 27 are first obtained (step S31). Next, there is determined whether the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is 35 deg. or greater (step S32). When the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is determined as to be smaller than 35 deg. (step S22: NO), it is considered that the indoor motor-operated valve 23 is opened. Therefore, the process does not proceed to the next step and returns to step S31.

[0084] Further, when the difference between the indoor heat exchanger temperature Te and the panel pipe fitting temperature TP is 35 deg. or greater (step S32: YES), it is considered that the indoor motor-operated valve 23 which is supposed to be opened is closed. Next, there is determined whether the panel pipe fitting temperature TP is at most 60°C in step S33, and there is determined whether the indoor heat exchanger temperature Te is at most 60°C or lower in step S34. When the panel pipe fitting temperature TP is determined as to be higher than 60°C in step S33 (step S33 : NO), or when the indoor heat exchanger temperature Te is determined as to be higher than 60°C in step S34 (step S34: NO), the process does not proceed to the next step and returns to step S31.

[0085] On the other hand, when the panel pipe fitting temperature TP is determined as to be 60°C or lower in step S33 (step S33: YES), or when the indoor heat exchanger temperature Te is determined as to be 60°C or lower in step S34 (step S34: YES), occurrence of an abnormality in the indoor motor-operated valve 23 is detected (step S35).

[0086] When occurrence of an abnormality in the indoor motor-operated valve 23 is detected in the abnormality detecting process, for example, the occurrence of an abnormality is reported to the user by means of indication on the emission display section 49 or the like.

<Features of Air Conditioner 1 of the Embodiment>

[0087] In the air conditioner 1 of the embodiment, the controller 7 has the abnormality detector 73 which detects occurrence of an abnormality in the indoor motor-operated valve 23 which is configured to switch over between a state where the refrigerant flows in the panel pipe fitting 36 of the radiation panel 30 and a state where the refrigerant does not flow in the panel pipe fitting 36 of the radiation panel 30. Therefore, it is possible to detect occurrence of an abnormality in the indoor motor-operated valve 23 by the abnormality detector 73. This restrains dew condensation on the radiation panel 30 during the cooling operation, and an abnormality in the surface temperature of the radiation panel 30 during

the indoor motor-operated valve 23 during the warm-air heating operation and radiation heating operation, which are attributed to the abnormality in the indoor motor-operated valve 23.

[0088] Further, in the air conditioner 1 of the embodiment, the refrigerant circuit 10 has: the principal channel 11 in which the outdoor motor-operated valve 64, the outdoor heat exchanger 62, and the compressor 60 are provided in this order; the first channel 12 having the indoor heat exchanger 20, which, during the heating operation, connects the branching section 10a provided on the downstream side of the compressor 60 in the principal channel 11 with the merging section 10b provided on the upstream side of the outdoor motor-operated valve 64; and a second channel 13 having the radiation panel 30, which connects the branching section 10a and the merging section 10b in parallel with the first channel 12. The indoor motor-operated valve 23 is provided between the radiation panel 30 and the merging section 10b in the refrigerant circuit 10. Therefore, it is possible to detect occurrence of an abnormality in the indoor motor-operated valve 23 in the air conditioner 1 in which the first channel 12 having the indoor heat exchanger 20 and the second channel 13 having the radiation panel 30 are connected in parallel with each other.

[0089] Further, in the air conditioner 1 of the embodiment, the abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23, based on the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 between the radiator 35 of the radiation panel 30 and the indoor motor-operated valve 23, and the indoor heat exchanger temperature Te detected by the indoor heat exchanger temperature sensor 27 provided to the indoor heat exchanger 20. Therefore, it is possible to detect the open/close state of the indoor motor-operated valve 23 by comparing the panel pipe fitting temperature TP with the indoor heat exchanger temperature Te. Thus, it is possible to detect occurrence of an abnormality in the valve structure, if the refrigerant flows out of the indoor motor-operated valve 23 although the indoor motor-operated valve 23 is supposed to be closed, or if the indoor motor-operated valve 23 is closed although it is supposed to be opened.

[0090] Further, in an air conditioner 1 of the embodiment during the cooling operation, the abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23 only when the difference between the indoor temperature Ta detected by the indoor temperature sensor 24 and the indoor heat exchanger temperature Te is 5 deg. or greater. Excluding the cases where the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is small, misdetection of an abnormality in the indoor motor-operated valve 23 is restrained.

[0091] The embodiment of the present invention is described above with reference to the drawings. However, it should be understood that the specific configuration is not limited to the embodiment. It is noted that the scope of the present invention is determined by not the description of the embodiment but claims of the present invention, and that all meanings equivalent to the claims and all modifications within the scope are included in the present invention.

[0092] The above described embodiment deals with a case in which the refrigerant circuit 10 that connects the indoor unit 2 and the outdoor unit 6 to each other includes the second channel 13 that is connected in parallel with the first channel 12 in which the indoor heat exchanger 20 is provided, and the radiation panel 30 is provided in the second channel 13. Alternatively, the indoor heat exchanger 20 and the radiation panel 30 may be connected in series with each other.

[0093] As illustrated in FIG. 12, a refrigerant circuit 110 of an air conditioner 101 according to a modification of the embodiment includes a circular principal channel 111 in which the outdoor motor-operated valve 64, the outdoor heat exchanger 62, the compressor 60, the radiation panel 30, and the indoor heat exchanger 20 are connected in this order. The discharge-side pipe fitting and intake-side pipe fitting of the compressor 60 are connected to the four-way valve 61. Branching sections 101a and 101b are respectively provided on both sides of the radiation panel 30, and both ends of a branching channel 112 are connected to the branching sections 101a and 101b. The branching section 101a is located between the indoor heat exchanger 20 and the radiation panel 30, and the branching section 101b is located on the opposite side to the branching section 101a with respect to the radiation panel 30. Further, the branching section 101a is provided with a three-way valve 123.

[0094] Between the branching section 101b and the radiator 35 of the radiation panel 30 is a panel incoming temperature sensor 25. Between the branching section 101a and the radiator 35 of the radiation panel 30 is a panel outgoing temperature sensor 26.

[0095] In the refrigerant circuit 110, the four-way valve 61 is switched to a state indicated by a broken line in FIG. 12 during the cooling operation. Further, the three-way valve 123 is switched to a state in which the refrigerant from the indoor heat exchanger 20 flows in the branching channel 112 but not in the radiation panel 30. Therefore, as indicated by a broken-line arrow in FIG. 12, 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 branching channel 112, four-way valve 61, and accumulator 65.

[0096] During the warm-air heating operation, the four-way valve 61 is switched to a state indicated by a solid line in FIG. 12. Further, the three-way valve 123 is switched to a state in which the refrigerant ejected from the compressor 60 flows in the branching channel 112 but not in the radiation panel 30. Therefore, the high-temperature, high-pressure

refrigerant discharged from the compressor 60 flows into the indoor heat exchanger 20, through the four-way valve 61 and the branching channel 112, as shown by the solid-line arrow in FIG. 12. The refrigerant condensed by the indoor heat exchanger 20 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.

[0097] During the radiation heating operation, the four-way valve 61 is switched to the state indicated by a solid line in FIG. 12. Further, the three-way valve 123 is switched to a state in which the refrigerant discharged from the compressor 60 flows in the radiation panel 30 and in the branching channel 112. Therefore, the high-temperature, high-pressure refrigerant discharged 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-line arrow in FIG. 12. The refrigerant condensed by the radiation panel 30 and indoor heat exchanger 20 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.

[0098] In the air conditioner 101 of the modification too, the abnormality detector 73 of the controller 7 detects occurrence of an abnormality in the three-way valve 123 configured to switch over between a state where the refrigerant flows in the panel pipe fitting 36 of the radiation panel 30 and a state where the refrigerant does not flow in the panel pipe fitting 36 of the radiation panel 30, as in the case of the embodiment described above.

[0099] In the above modification, the outdoor motor-operated valve 64, the outdoor heat exchanger 62, the compressor 60, the radiation panel 30, and the indoor heat exchanger 20 are connected in this order in the annular principal channel 111 of the refrigerant circuit 110; however, the present invention is not limited to this. That is, the positions of the radiation panel 30 and the indoor heat exchanger 20 may be other way around; i.e., the outdoor motor-operated valve 64, the outdoor heat exchanger 62, the compressor 60, the indoor heat exchanger 20, and the radiation panel 30 may be connected in this order. In this case too, the both ends of the branching channel 112 are connected to the branching sections provided to both ends of the radiation panel 30.0 Further, the three-way valve 123 configured to switch over between a state where the refrigerant flows in the panel pipe fitting 36 of the radiation panel 30 and a state where the refrigerant does not flow in the panel pipe fitting 36 of the radiation panel 30 may be provided to the branching section positioned on the opposite side of the indoor heat exchanger 20 over the radiation panel 30.

[0100] Further, in the embodiment described above, the indoor motor-operated valve 23 is provided between the radiation panel 30 and the merging section 10b in the refrigerant circuit 10; however, the present invention is not limited to this. For example, the three-way valve may be provided to the merging section 10b, and this three-way valve may be used as the indoor motor-operated valve 23.

[0101] Further, in the embodiment described above, the abnormality detector 73 detects occurrence of an abnormality in the indoor motor-operated valve 23 based on the panel pipe fitting temperature TP detected by the panel outgoing temperature sensor 26 provided between the radiator 35 of the radiation panel 30 and the indoor motor-operated valve 23 and the indoor heat exchanger temperature Te; however, the present invention is not limited to this. That is, for example, it is possible to configure the abnormality detector 73 so as to detect occurrence of an abnormality in the indoor motor-operated valve 23 based on the temperature detected by the panel incoming temperature sensor 25 provided on the opposite side to the indoor motor-operated valve 23 over the radiator 35 of the radiation panel 30 and the indoor heat exchanger temperature Te.

[0102] Additionally, in the embodiment described above, the abnormality detector 73 during the cooling operation detects occurrence of an abnormality in the indoor motor-operated valve 23, when the difference between the indoor temperature Ta and the indoor heat exchanger temperature Te is a predetermined value or greater; however, the present invention is not limited to this. Misdetection is prevented by having the abnormality detector 73 detect an abnormality in the indoor motor-operated valve 23 when the pressure (low pressure) in the indoor heat exchanger 20 is at a predetermined value or lower. Therefore, it is possible to configure the abnormality detector 73 so as to detect occurrence of an abnormality in the indoor motor-operated valve 23, when the difference between the indoor temperature Ta and the panel pipe fitting temperature TP is a predetermined difference or greater.

[0103] Further, in the embodiment described above, the abnormality detector 73 during the radiation heating operation detects occurrence of an abnormality in the indoor motor-operated valve 23 when the indoor motor-operated valve 23 is completely closed; however, the present invention is not limited to this. That is, occurrence of an abnormality in the indoor motor-operated valve 23 may be detected, not only in cases where the indoor motor-operated valve 23 is completely closed, but also in cases where the opening degree of the indoor motor-operated valve 23 falls short of a required opening degree (an opening degree to cause the surface temperature of the radiation panel 30 to fall within a panel target temperature range).

[0104] Further, in the embodiment described above, occurrence of an abnormality in the indoor motor-operated valve 23 is detected when (Formula 1) to (Formula 4) are all satisfied during the cooling operation, when (Formula 5) to (Formula 7) are all satisfied during the warm-air heating operation, and when (Formula 8) to (Formula 10) are all satisfied during the radiation heating operation; however, the present invention is not limited to this. That is, occurrence of an

abnormality in the indoor motor-operated valve 23 may be detected when at least (Formula 1) is satisfied during the cooling operation, when at least (Formula 5) is satisfied during the warm-air heating operation, and when at least (Formula 8) is satisfied during the radiation heating operation. Further, numerical values given in (Formula 1) to (Formula 8) are no more than examples, and are variable as needed.

Industrial Applicability

[0105] The present invention allows detection of an abnormality in a valve structure.

Reference Signs List

[0106]

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
21	Indoor Fan
23	Indoor Motor-Operated Valve (Valve Structure)
24	Indoor Temperature Sensor
26	Panel Outgoing Temperature Sensor (Panel Temperature Sensor)
27	Indoor Heat Exchanger Temperature Sensor
30	Radiation Panel
35	Radiator
60	Compressor
62	Outdoor Heat Exchanger
64	Outdoor Motor-Operated Valve (Decompression Structure)
73	Abnormality Detector (Abnormality Detector)
123	Three-Way Valve (Valve Structure)

Claims

1. An air conditioner, comprising a refrigerant circuit connecting an indoor unit with an outdoor unit, wherein
the indoor unit has therein an indoor heat exchanger provided to oppose to a fan and a radiation panel provided on a surface of the indoor unit, and
the refrigerant circuit includes:

a valve structure configured to perform switching over between a state where a refrigerant flows in the radiation panel and a state where the refrigerant does not flow in the radiation panel; and
an abnormality detector configured to detect occurrence of an abnormality in the valve structure based on a temperature of the radiation panel.

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

a principal channel in which a decompression structure, an outdoor heat exchanger, and a compressor are provided in this order;
a first channel provided with the indoor heat exchanger, which connects a branching section provided to the downstream side of the compressor in the principal channel with a merging section provided to the upstream side of the decompression structure during the heating operation; and
a second channel provided with the radiation panel, which connects the branching section and the merging

section with the first channel in parallel, and
wherein the valve structure is provided between the radiation panel and the merging section in the refrigerant circuit.

3. The air conditioner according to claim 1 or 2, wherein
the abnormality detector detects occurrence of an abnormality in the valve structure, if the refrigerant flows in the radiation panel while the valve structure is in a state in which the refrigerant does not flow in the radiation panel.

4. The air conditioner according to claim 1 or 3, further comprising:

an indoor heat exchanger temperature sensor provided to the indoor heat exchanger; and
a panel temperature sensor provided between a radiator of the radiation panel and the valve structure,
wherein the abnormality detector detects occurrence of an abnormality in the valve structure, based on a temperature detected by the panel temperature sensor and a temperature detected by the indoor heat exchanger temperature sensor.

5. The air conditioner according to claim 4, wherein
during the cooling operation, the abnormality detector detects occurrence of an abnormality in the valve structure, when a pressure in the indoor heat exchanger is at or lower than a predetermined value.

6. The air conditioner according to claim 4 or 5, further comprising:

an indoor temperature sensor configured to detect an indoor temperature, wherein
the abnormality detector detects occurrence of an abnormality in the valve structure, when a difference between a temperature detected by the indoor temperature sensor and a temperature detected by the indoor heat exchanger temperature sensor is a predetermined value or greater.

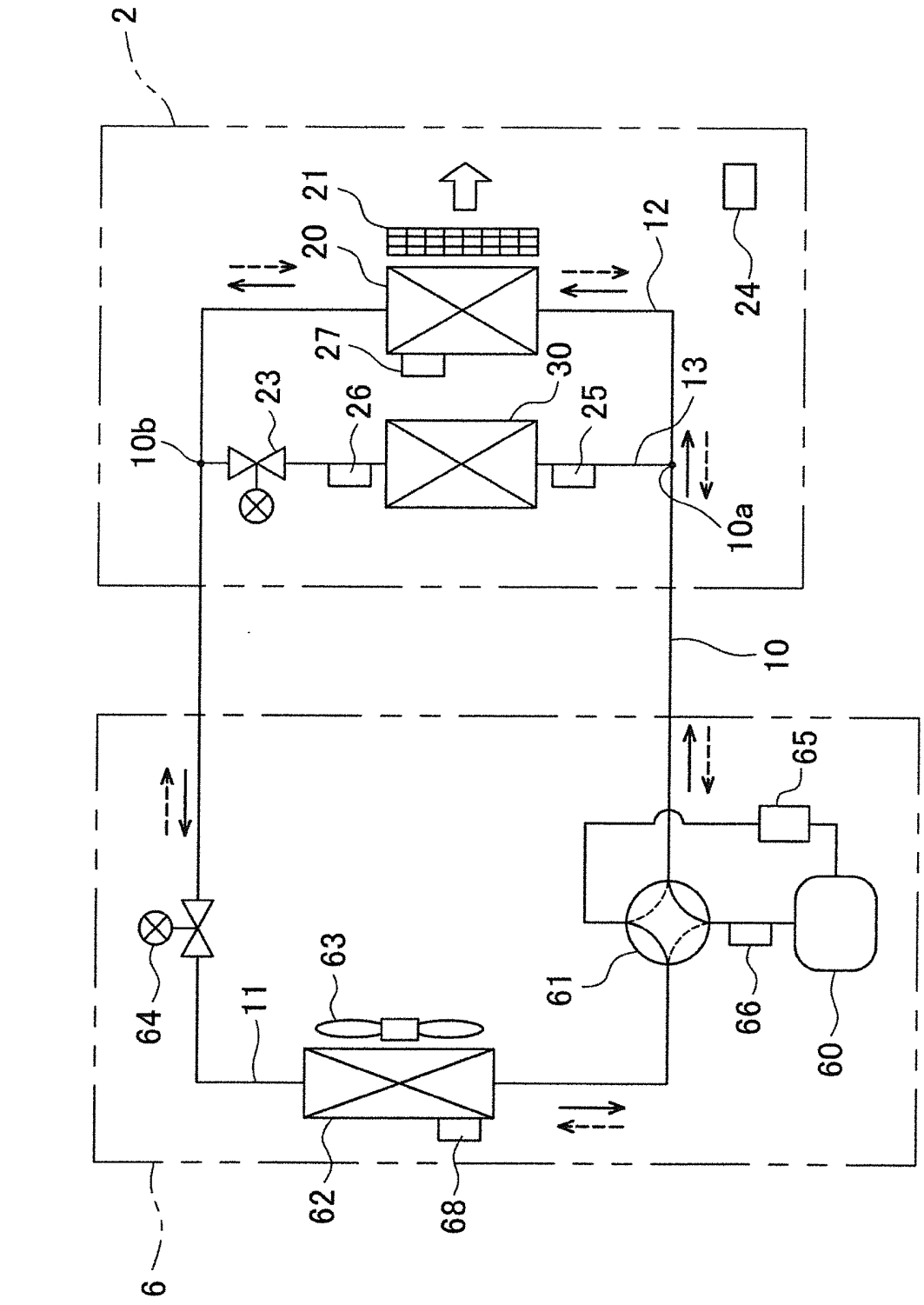
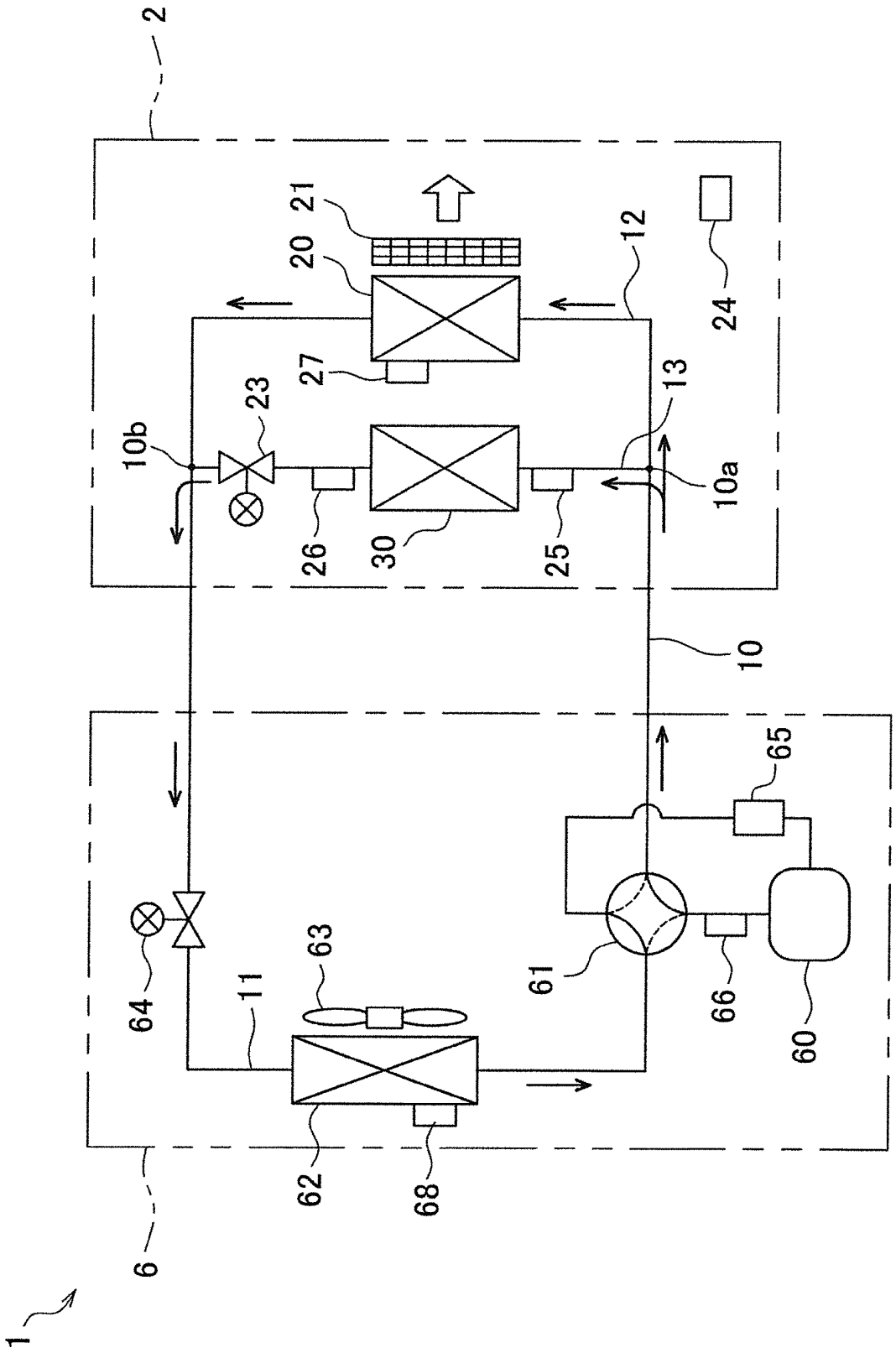


FIG.1

FIG.2



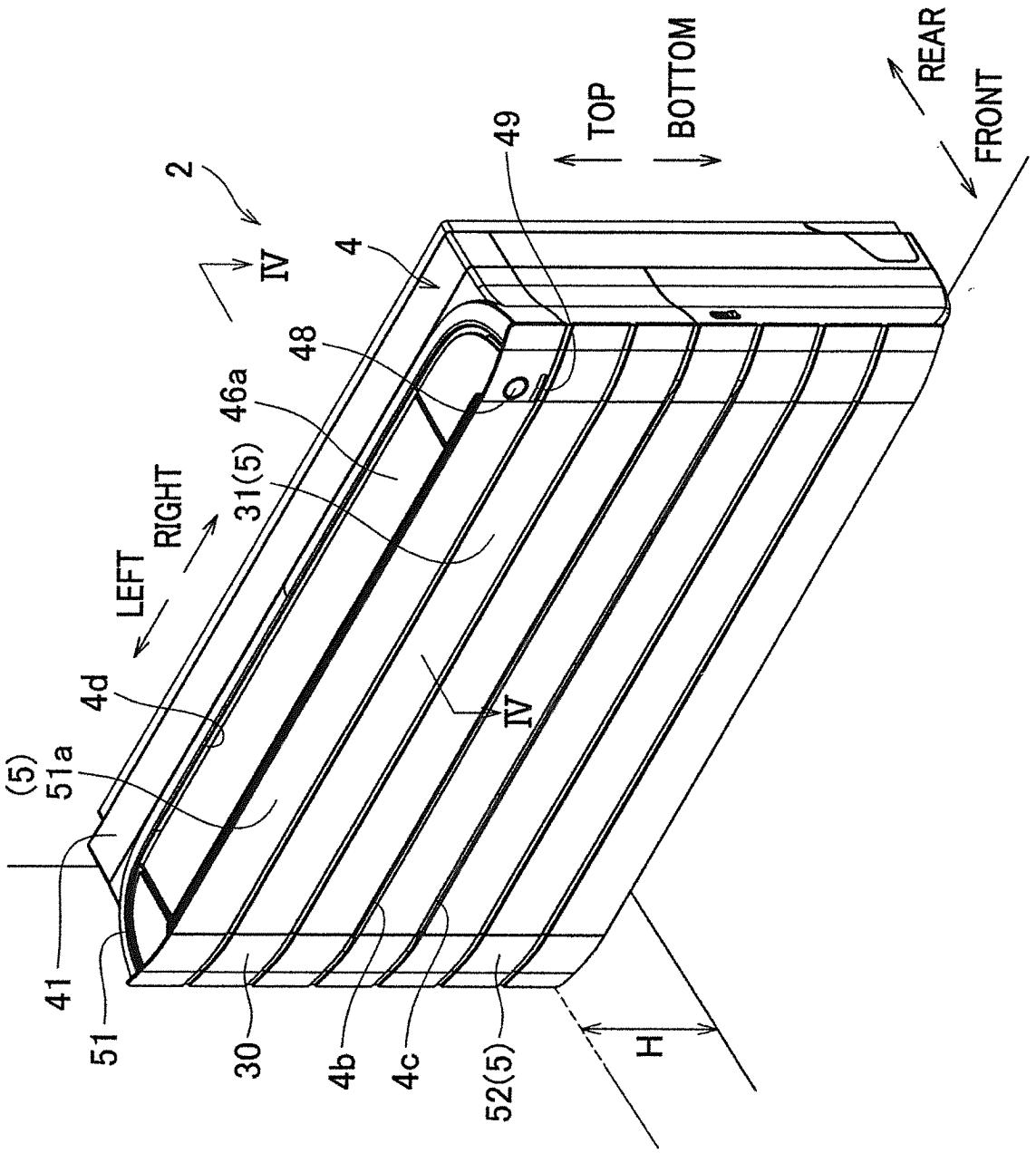

2
IV
4
49
TOP
BOTTOM
REAR
FRONT
48
46a
31(5)
RIGHT
LEFT
4d
(5)
51a
IV
41
51
30
4b
4c
52(5)
H

FIG.3

FIG.4

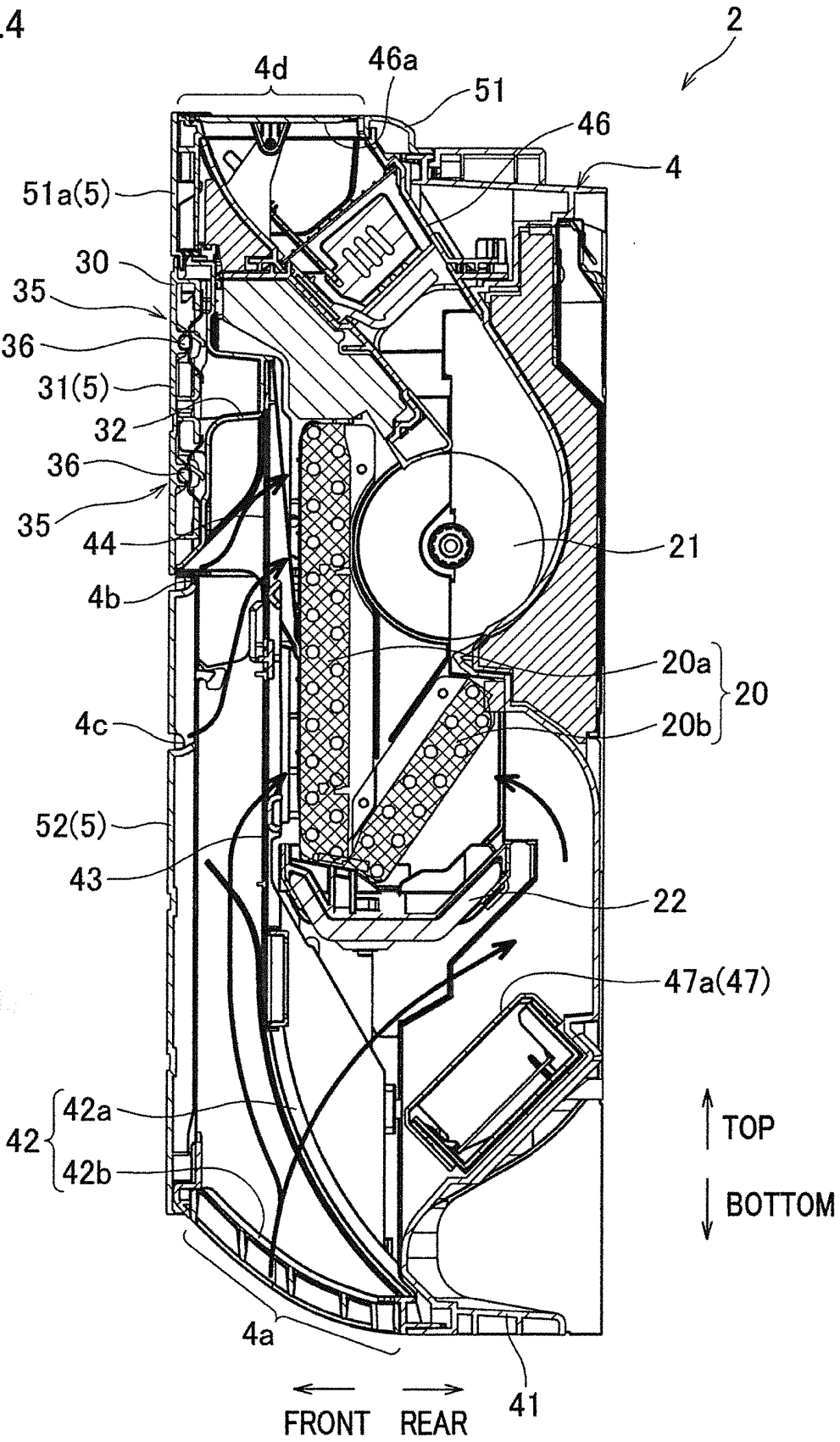

2
4d
46a
51
46
4
51a(5)
30
35
36
31(5)
32
36
35
44
4b
21
20a
20
20b
4c
52(5)
43
22
47a(47)
42
42a
42b
TOP
BOTTOM
4a
41
FRONT
REAR

FIG.5

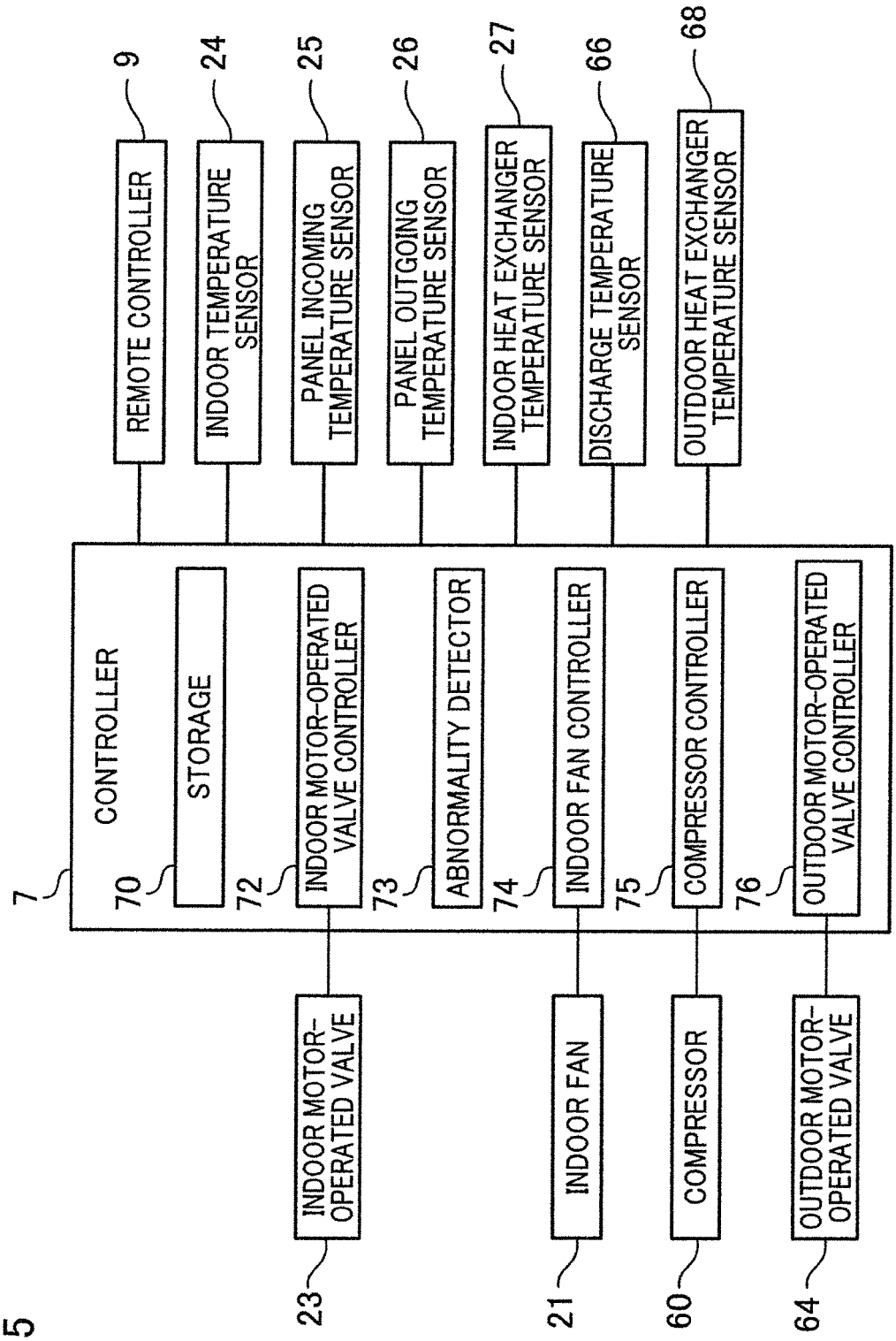

9
REMOTE CONTROLLER
24
INDOOR TEMPERATURE SENSOR
25
PANEL INCOMING TEMPERATURE SENSOR
26
PANEL OUTGOING TEMPERATURE SENSOR
27
INDOOR HEAT EXCHANGER TEMPERATURE SENSOR
66
DISCHARGE TEMPERATURE SENSOR
68
OUTDOOR HEAT EXCHANGER TEMPERATURE SENSOR
7
CONTROLLER
70
STORAGE
72
INDOOR MOTOR-OPERATED VALVE CONTROLLER
73
ABNORMALITY DETECTOR
74
INDOOR FAN CONTROLLER
75
COMPRESSOR CONTROLLER
76
OUTDOOR MOTOR-OPERATED VALVE CONTROLLER
23
INDOOR MOTOR-OPERATED VALVE
21
INDOOR FAN
60
COMPRESSOR
64
OUTDOOR MOTOR-OPERATED VALVE

FIG.6

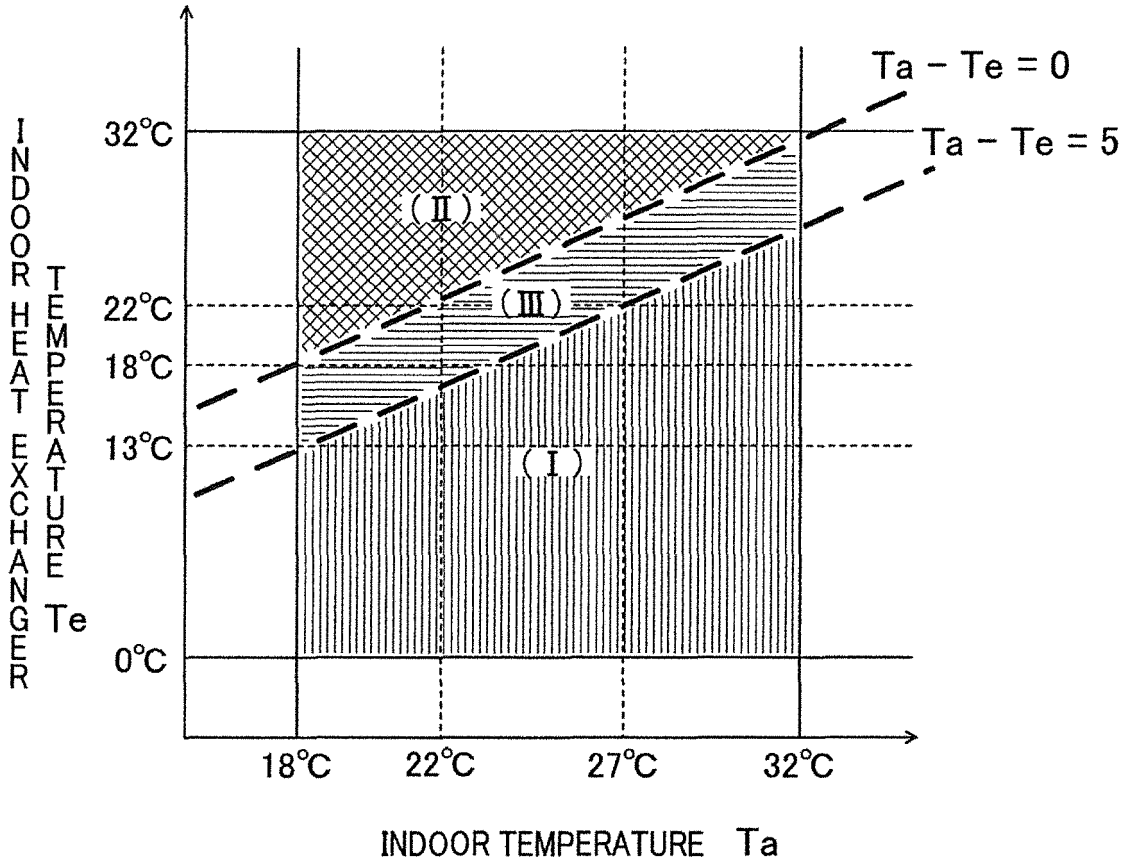

Ta − Te = 0
Ta − Te = 5
32°C
22°C
18°C
13°C
0°C
(Ⅱ)
(Ⅲ)
(Ⅰ)
INDOOR HEAT EXCHANGER TEMPERATURE Te
18°C
22°C
27°C
32°C
INDOOR TEMPERATURE Ta

FIG.7

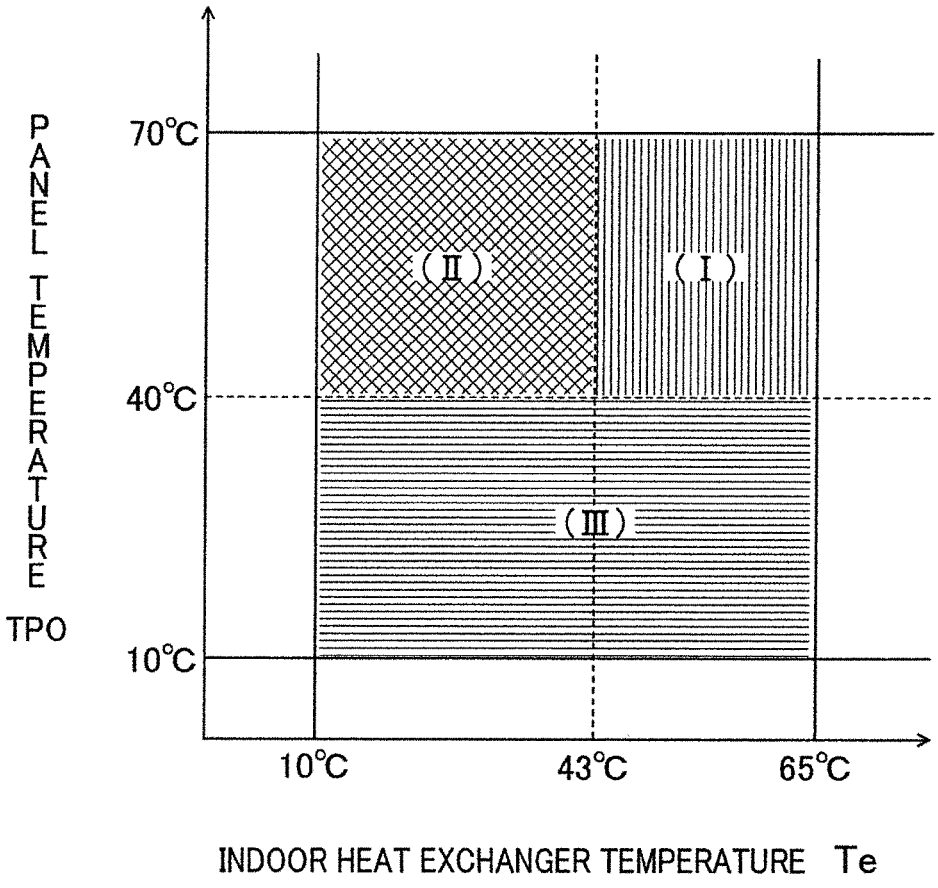

PANEL TEMPERATURE TPO
70℃
40℃
10℃
(Ⅱ)
(Ⅰ)
(Ⅲ)
10℃
43℃
65℃
INDOOR HEAT EXCHANGER TEMPERATURE Te

FIG.8

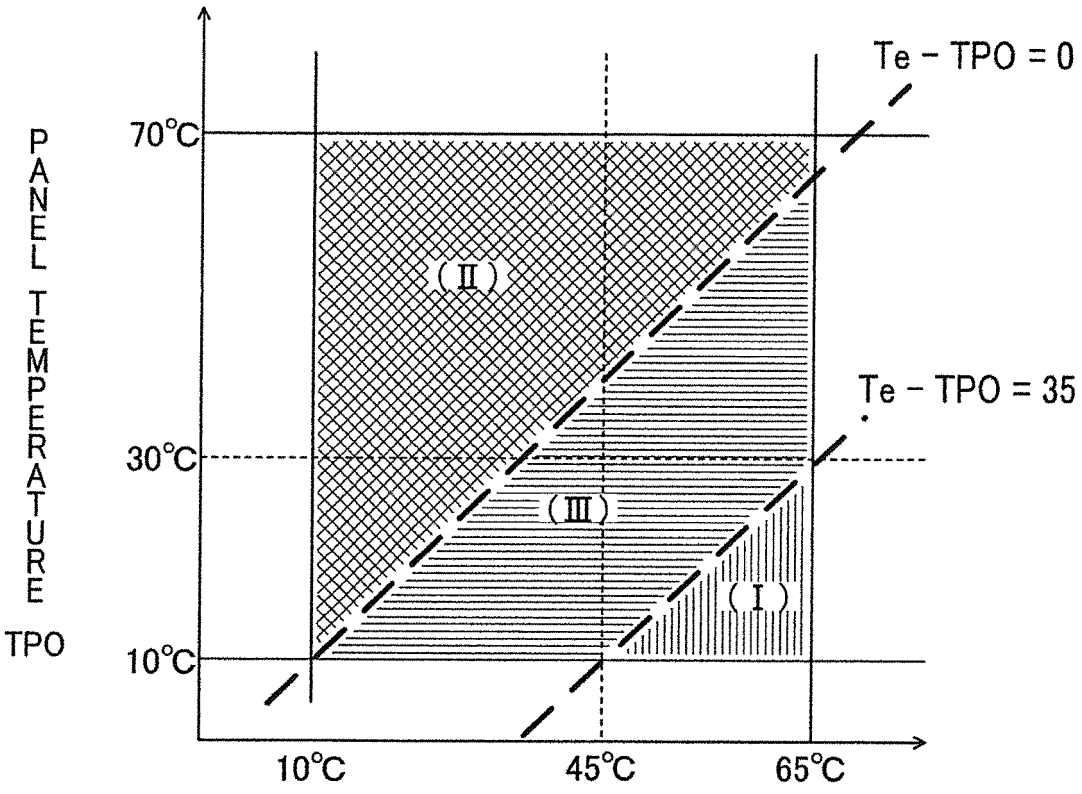

Te − TPO = 0
Te − TPO = 35
70°C
30°C
10°C
(Ⅱ)
(Ⅲ)
(Ⅰ)
PANEL TEMPERATURE TPO
10°C
45°C
65°C
INDOOR HEAT EXCHANGER TEMPERATURE Te

FIG.9

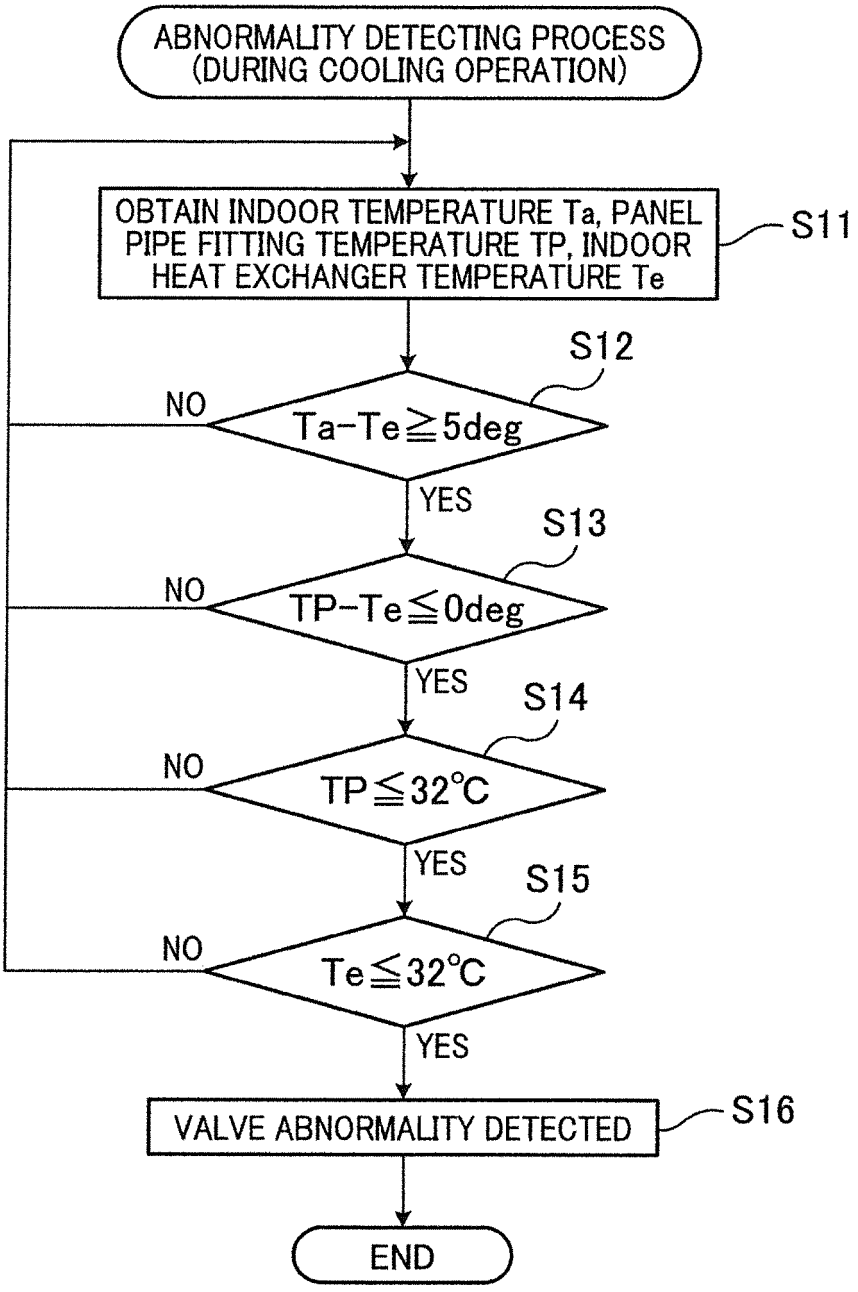

ABNORMALITY DETECTING PROCESS (DURING COOLING OPERATION)
OBTAIN INDOOR TEMPERATURE Ta, PANEL PIPE FITTING TEMPERATURE TP, INDOOR HEAT EXCHANGER TEMPERATURE Te
S11
S12
Ta-Te≧5deg
NO
YES
S13
TP-Te≦0deg
NO
YES
S14
TP≦32°C
NO
YES
S15
Te≦32°C
NO
YES
VALVE ABNORMALITY DETECTED
S16
END

FIG.10

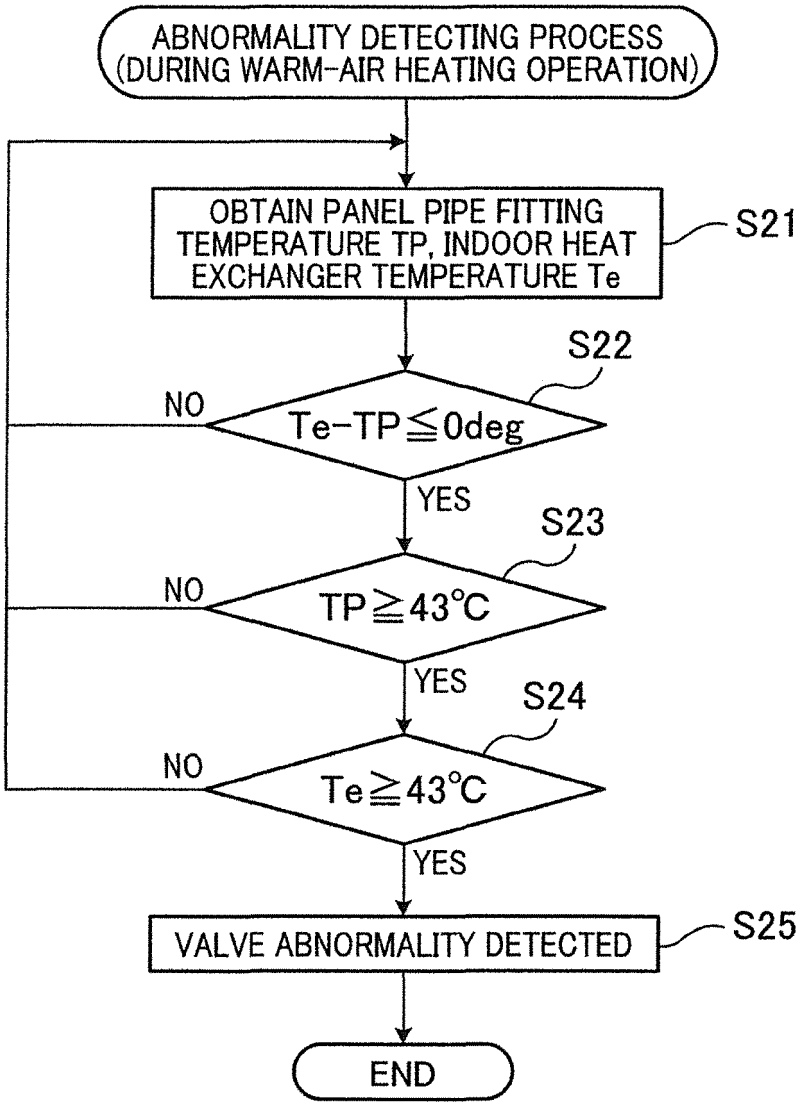

ABNORMALITY DETECTING PROCESS (DURING WARM-AIR HEATING OPERATION)
OBTAIN PANEL PIPE FITTING TEMPERATURE TP, INDOOR HEAT EXCHANGER TEMPERATURE Te
S21
S22
NO
Te-TP≦0deg
YES
S23
NO
TP≧43°C
YES
S24
NO
Te≧43°C
YES
VALVE ABNORMALITY DETECTED
S25
END

FIG.11

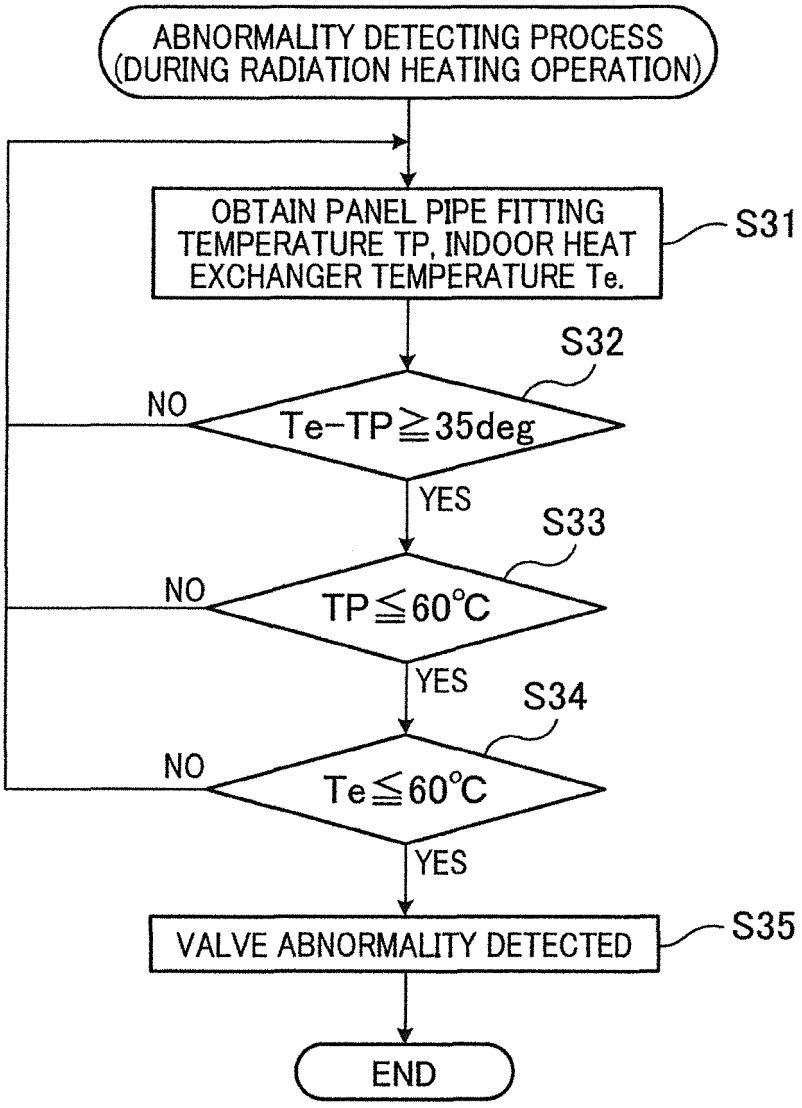
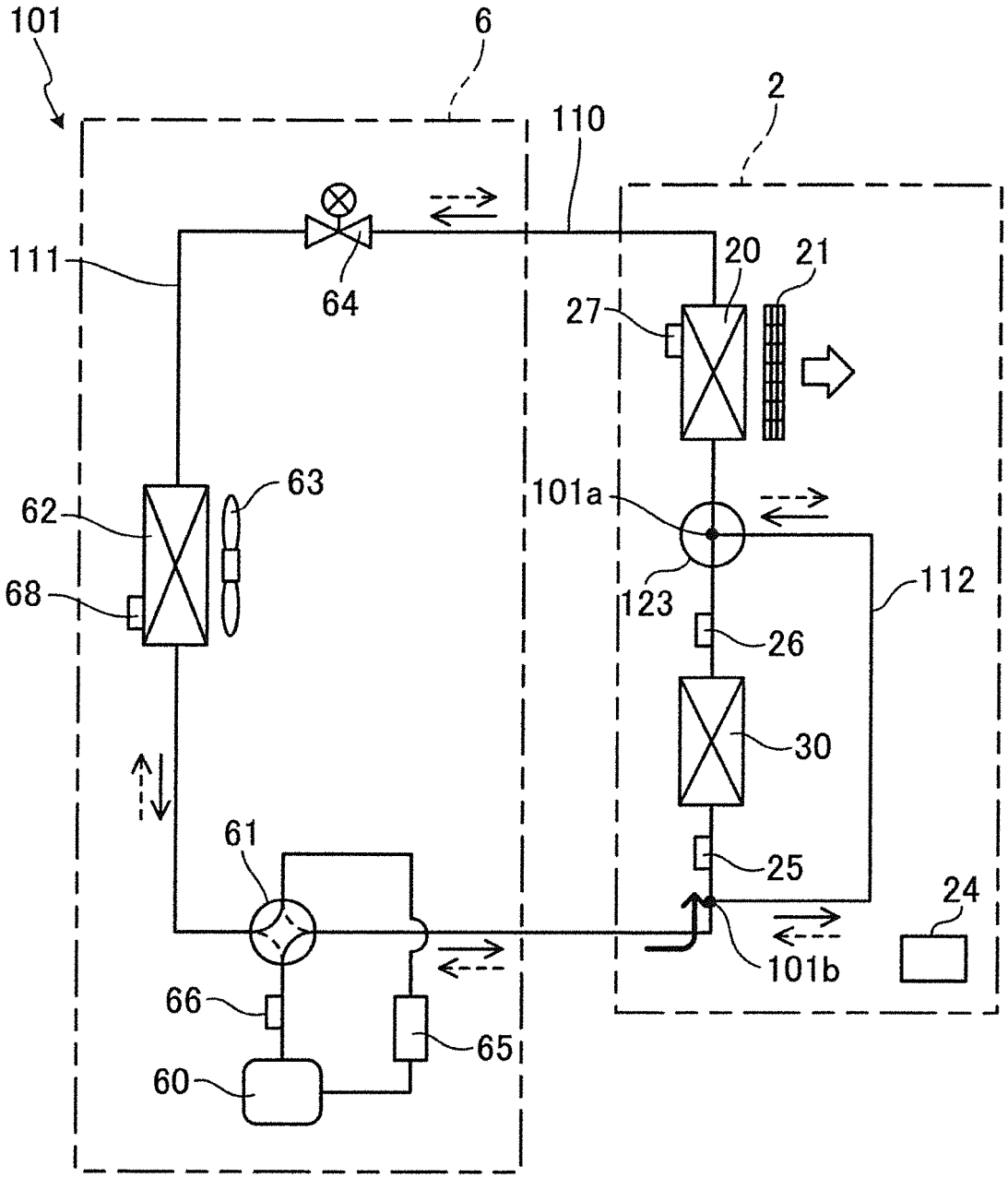

ABNORMALITY DETECTING PROCESS (DURING RADIATION HEATING OPERATION)
OBTAIN PANEL PIPE FITTING TEMPERATURE TP, INDOOR HEAT EXCHANGER TEMPERATURE Te.
S31
S32
NO
Te-TP≧35deg
YES
S33
NO
TP≦60°C
YES
S34
NO
Te≦60°C
YES
VALVE ABNORMALITY DETECTED
S35
END

FIG.12


101
6
110
2
111
64
20
21
27
63
62
101a
68
123
112
26
30
61
25
24
101b
66
65
60

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/050871

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/02(2006.01)i, *F24F1/00*(2011.01)i, *F25B13/00*(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)
F24F11/02, F24F1/00, F25B13/00, 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.
Y A	JP 2010-216767 A (Daikin Industries, Ltd.), 30 September 2010 (30.09.2010), paragraphs [0017] to [0024]; fig. 1 & WO 2010/106771 A1	1-4 5,6
Y	JP 2001-90977 A (Mitsubishi Electric Corp.), 03 April 2001 (03.04.2001), paragraphs [0031], [0059], [0060]; fig. 1 (Family: none)	1-4
Y	JP 2003-322388 A (Toshiba Carrier Corp.), 14 November 2003 (14.11.2003), paragraphs [0010], [0025], [0029]; fig. 1 (Family: none)	2

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 03 April, 2012 (03.04.12)	Date of mailing of the international search report 17 April, 2012 (17.04.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/050871

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-71188 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 08 March 2002 (08.03.2002), paragraphs [0015] to [0029]; fig. 1, 2 (Family: none)	5,6
A	JP 2007-333219 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 27 December 2007 (27.12.2007), paragraphs [0013] to [0026] (Family: none)	1-6

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

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 5280762 A **[0003]**