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(71) Applicant: **Daikin Industries, Ltd.**
Osaka 530-8323 (JP)

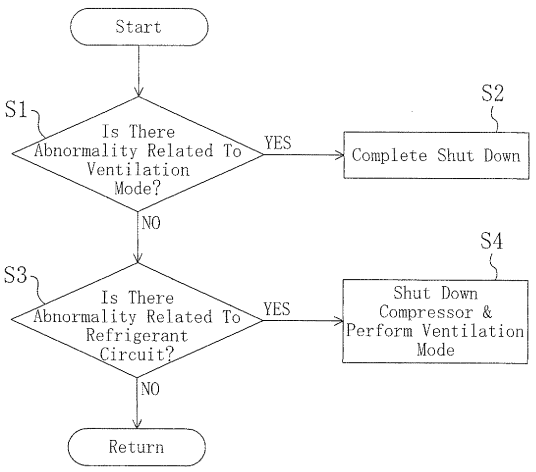
(72) Inventors:
- **MATSUI, Nobuki**
  Sakai-shi
  Osaka 591-8511 (JP)
- **HORI, Kikuji**
  Sakai-shi
  Osaka 591-8511 (JP)

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

(54) **HUMIDITY CONTROL DEVICE**

(57) A humidity control apparatus (10) includes: a casing (11); exhaust and air-supplying fans (25, 26) and dampers (41-48, 83, 84) for exchanging the outside air and the room air with each other via air passageways (31-34, 37, 38, 81, 82) of the casing (11); and a refrigerant, circuit (50) for controlling the humidity of the air passing through the air passageways. The humidity control apparatus (10) further includes a controller (60) for monitoring an abnormality inside the apparatus and determining the type of the detected abnormality. When the detected abnormality is an abnormality related to the refrigerant circuit (50) and is not an abnormality related to the exhaust and air-supplying fans (25, 26) and the dampers (41-48, 83, 84), the controller (60) stops the refrigeration cycle of the refrigerant circuit (50) to shut down the humidity-controlling mode, and keeps the ventilation mode available.

FIG. 9



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Description

TECHNICAL FIELD

[0001] The present invention relates to a humidity control apparatus for supplying the outside air, of which the humidity is controlled, into the room.

BACKGROUND ART

[0002] A humidity control apparatus has been known in the art, which dehumidifies or humidifies the received outside air and supplies the air into the room (see, for example, Patent Document 1). The humidity control apparatus of this patent document controls the humidity of the air by performing an adsorbing operation of adsorbing the moisture in the air onto the adsorption member, and a recovery operation of desorbing the moisture from the adsorption member.

[0003] The humidity control apparatus of Patent Document 1 includes: two adsorption member accommodating spaces respectively accommodating two adsorption members; a plurality of air passageways respectively carrying the outside air and the room air passing therethrough which communicate with the adsorption member accommodating spaces; and open/close mechanisms for selectively connecting or disconnecting the adsorption member accommodating spaces and the air passageways.

[0004] With the humidity control apparatus having such a configuration, the open/close mechanisms are individually opened/closed so as to switch the mode of passage (channel) of the room air and the outside air from one to another, thereby controlling the humidity of the outside air with the adsorption member and then supplying the air into the room, or controlling the humidity of the room air with the adsorption member and then supplying the air into the room.

[0005] Such a humidity control apparatus can also perform a simple ventilation mode in which the passage of the refrigerant through the refrigerant circuit is blocked, and the outside air and the room air are passed through the air passageways in such a state, thereby only performing ventilation.

CITATION LIST

[0006]

PATENT DOCUMENT

PATENT DOCUMENT 1: Japanese Patent Publication No. 2005-283053

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007] Now, such a humidity control apparatus as described above is monitoring the status of the refrigerant in the refrigerant circuit or an abnormality in a component such as the compressor. If an abnormality is detected, the operation of the humidity control apparatus is shut down.

[0008] Here, there are various apparatus abnormalities, including, for example, an abnormality in the compressor of the refrigerant circuit and an abnormality in the fan for performing the ventilation mode. It is not the best option to indiscriminately shut down the operation of the humidity control apparatus irrespective of the type of the abnormality. That is, with such a humidity control apparatus as described above that is also capable of performing the ventilation mode, it may be possible to perform the ventilation mode even when an abnormality has occurred in the refrigerant circuit, etc. If there is any operation that can be performed with no problems even when an abnormality has occurred in some part of the apparatus, it is preferred that such an operation is allowed to be performed.

[0009] The present invention has been made in view of such problems and has an object to provide a humidity control apparatus that allows for a ventilation mode as long as the ventilation mode can be performed even when an abnormality has occurred regarding the refrigerant circuit.

SOLUTION TO THE PROBLEM

[0010] The first aspect is directed to a humidity control apparatus including: a casing (11) including an air passageway (31-34, 37, 38, 81, 82) formed therein; a ventilation mechanism (25, 26, 41-48, 83, 84) for exchanging an outside air and a room air with each other via the air passageway (31-34, 37, 38, 81, 82) of the casing (11); and a refrigerant circuit (50) for controlling a humidity of the air passageway (31-34, 37, 38, 81, 82), wherein a humidity-controlling mode is performed in which an air, of which a humidity is controlled by actuating the ventilation mechanism (25, 26, 41-48, 83, 84) and causing the refrigerant circuit (50) to perform a refrigeration cycle, is supplied into a room. The humidity control apparatus further includes an abnormality determination means (60) for monitoring an abnormality inside the apparatus and determining a type of the detected abnormality, and when the detected abnormality is an abnormality related to the refrigerant circuit (50) and is not an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality, determination means (60) stops the refrigeration cycle of the refrigerant circuit (50) to shut down the humidity-controlling mode and keeps available a ventilation mode in which the ventilation mechanism (25, 26, 41-48, 83, 84) is actuated to exchange the outside air and the room air with each other.

[0011] With such a configuration, the abnormality determination means (60) can detect an abnormality in the humidity control apparatus, and determine the abnormality. When the abnormality detected by the abnormality

determination means (60) is an abnormality related to the refrigerant circuit (50) and is not an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the refrigeration cycle of the refrigerant circuit (50) is stopped to shut down the humidity-controlling mode, and the ventilation mode is kept available. Therefore, when an abnormality is detected, the ventilation mode is available as long as it is possible to perform the ventilation mode, instead of entirely shutting down the operation of the humidity control apparatus.

[0012] Here, the ventilation mode being available means that the ventilation mode can be performed, whether or not the ventilation mode is performed immediately. When the humidity-controlling mode is shut down, the ventilation mode may be performed or continued. Alternatively, when the humidity-controlling mode is shut down, the entire operation may once be shut down, entering a stand-by state where the process waists for an instruction from the user, or the like, to perform the ventilation mode.

[0013] The second aspect is directed to the first aspect, wherein when the detected abnormality is an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality determination means (60) shuts down the ventilation mechanism (25, 26, 41-48, 83, 84) and stops the refrigeration cycle of the refrigerant circuit (50) to shut down the humidity-controlling mode.

[0014] With such a configuration, the ventilation mechanism (25, 26, 41-48, 83, 84) performs the ventilation mode, and also performs the humidity-controlling mode in cooperation with the refrigerant circuit (50). That is, when the ventilation mechanism (25, 26, 41-48, 83, 84) is not operating normally, both the ventilation mode and the humidity-controlling mode cannot be performed normally. Therefore, when the detected abnormality is an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the operation of the ventilation mechanism (25, 26, 41-48, 83, 84) is shut down so as not to perform the ventilation mode, and the refrigeration cycle of the refrigerant circuit (50) is also stopped so as to shut down the humidity-controlling mode. Thus, the ventilation mode and the humidity-controlling mode can be prevented from being performed with an abnormality.

[0015] The third aspect is directed to the first and second aspects, wherein the ventilation mechanism (25, 26, 41-48, 83, 84) includes an exhaust fan (25) provided in the casing (11) for discharging an air to an outside, and an air-supplying fan (26) provided in the casing (11) for supplying an air into the room, and the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the exhaust fan (25) and the air-supplying fan (26).

[0016] With such a configuration, the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) is specifically identified. That is, when the humidity control apparatus includes the exhaust fan (25) or the air-supplying fan (26) as the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the exhaust fan (25) and the air-supplying fan (26).

[0017] The fourth aspect is directed to one of the first to third aspects, wherein the ventilation mechanism (25, 26, 41-48, 83, 84) includes an open/close mechanism (41-48, 83, 84) provided in the casing (11) for connecting/disconnecting the air passageway (31-34, 37, 38, 81, 82), and the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the open/close mechanism (41-48, 83, 84).

[0018] With such a configuration, the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) is further identified. That is, when the humidity control apparatus includes the open/close mechanism (41-48, 83, 84) for connecting/disconnecting the air passageway (31-34, 37, 38, 81, 82) as the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the open/close mechanism (41-48, 83, 84).

[0019] The fifth aspect is directed to one of the first to fourth aspects, wherein a compressor (53), a four-way switching valve (54) and an expansion valve (55) are connected to the refrigerant circuit (50), and the abnormality related to the refrigerant circuit (50) includes an abnormality of the compressor (53), the four-way switching valve (54) and the expansion valve (55).

[0020] With such a configuration, the abnormality related to the refrigerant circuit (50) is identified. That is, when the compressor (53), the four-way switching valve (54) and the expansion valve (55) are connected to the refrigerant circuit (50), the abnormality related to the refrigerant circuit (50) includes an abnormality of the compressor (53), the four-way switching valve (54) and the expansion valve (55).

ADVANTAGES OF THE INVENTION

[0021] According to the first aspect, the abnormality determination means (60) determines the abnormality of the humidity control apparatus, and when the detected abnormality is an abnormality related to the refrigerant circuit (50) and is not an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the humidity-controlling mode is shut down, and the ventilation mode is kept available. Therefore, even if an abnormality is detected, the ventilation mode can be performed as long as it is possible to perform the ventilation mode, thereby preventing the humidity control apparatus from being shut down unnecessarily.

[0022] According to the second aspect, with a configuration where the ventilation mechanism (25, 26, 41-48, 83, 84) is used both in the ventilation mode and in the humidity-controlling mode, when an abnormality related to the refrigerant circuit (50) is detected and an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) is detected, the humidity-controlling mode is shut down and the ventilation mode is kept available,

whereas when an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) is detected, both the humidity-controlling mode and the ventilation mode are shut down, whether or not an abnormality related to the refrigerant circuit (50) is detected, thereby preventing the ventilation mode and the humidity-controlling mode from being performed with an abnormality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

[FIG. 1] FIG. 1 is a perspective view showing a humidity control apparatus as viewed from the front surface side, omitting a part of the casing and the electrical component box.

[FIG. 2] FIG. 2 shows a schematic plan view, a right side view and a left side view showing the humidity control apparatus, omitting a part thereof.

[FIG. 3] FIG. 3 is a piping diagram showing a configuration of the refrigerant circuit, where (A) shows an operation during the first operation and (B) shows an operation during the second operation.

[FIG. 4] FIG. 4 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the first operation of the dehumidifying ventilation mode.

[FIG. 5] FIG. 5 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the second operation of the dehumidifying ventilation mode.

[FIG. 6] FIG. 6 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the first operation of the humidifying ventilation mode.

[FIG. 7] FIG. 7 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the second operation of the humidifying ventilation mode.

[FIG. 8] FIG. 8 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the simple ventilation mode.

[FIG. 9] FIG. 9 shows a schematic plan view, a right side view and a left side view of the humidity control apparatus showing the flow of the air in the purge operation.

[FIG. 10] FIG. 10 is a schematic configuration diagram showing a humidity control apparatus of Variation 3 of the embodiment, where (A) shows an operation during the first operation and (B) shows an operation during the second operation.

[FIG. 11] FIG. 11 is a schematic configuration diagram showing a humidity control apparatus of Variation 4 of the embodiment.

DESCRIPTION OF REFERENCE CHARACTERS

[0024]

10	Humidity control apparatus
11	Casing
25	Exhaust fan (ventilation mechanism)
26	Air-supplying fan (ventilation mechanism)
31	Air-supplying-side passageway (air passageway)
32	Inside air-side passageway (air passageway)
33	Exhaust-side passageway (air passageway)
34	Outside air-side passageway (air passageway)
37	First heat exchanger chamber (air passageway)
38	Second heat exchanger chamber (air passageway)
41	First inside air-side damper (ventilation mechanism, open/close mechanism)
42	Second inside air-side damper (ventilation mechanism, open/close mechanism)
43	First outside air-side damper (ventilation mechanism, open/close mechanism)
44	Second outside air-side damper (ventilation mechanism, open/close mechanism)
45	First air-supplying-side damper (ventilation mechanism, open/close mechanism)
46	Second air-supplying-side damper (ventilation mechanism, open/close mechanism)
47	First exhaust-side damper (ventilation mechanism, open/close mechanism)
48	Second exhaust-side damper (ventilation mechanism, open/close mechanism)
50	Refrigerant circuit (humidity controlling means)
60	Controller (abnormality determination means)
53	Compressor
54	Four-way switching valve
55	Electric expansion valve (expansion valve)
81	First bypass passageway (air passageway)
82	Second bypass passageway (air passageway)
83	First bypass damper (ventilation mechanism, open/close mechanism)
84	Second bypass damper (ventilation mechanism, open/close mechanism)

DESCRIPTION OF EMBODIMENTS

[0025] An embodiment of the present invention will now be described with reference to the drawings.

[0026] A humidity control apparatus (10) of the present embodiment is for controlling the humidity of the room while also ventilating the room, and the humidity control apparatus (10) controls the humidity of the received outside air (OA) to supply the outside air into the room while simultaneously discharging the received room air (RA) to the outside.

<Generation Configuration Of Humidity Control Apparatus>

[0027] The humidity control apparatus (10) will be described with reference to FIGS. 1 and 2 as necessary. Note that the terms "upper," "lower," "left," "right," "front," "rear," "near" and "far" as used herein refer to the respective directions as the humidity control apparatus (10) is viewed from the front surface side.

[0028] The humidity control apparatus (10) includes a casing (11). A refrigerant circuit (50) is accommodated in the casing (11). A first adsorption heat exchanger (51), a second adsorption heat exchanger (52), a compressor (53), a four-way switching valve (54) and an electric expansion valve (55) are connected to the refrigerant circuit (50). The details of the refrigerant circuit (50) will be described later.

[0029] The casing (11) is formed in a rectangular parallelepiped shape that is slightly flattened and has a relatively low height. The near left side surface (i.e., the front surface) of the casing (11) shown in FIG. 1 forms a front surface panel portion (12), the far right side surface (i.e., the rear surface) forms a rear surface panel portion (13), the near right side surface forms a first side surface panel portion (14), and the far left side surface forms a second side surface panel portion (15).

[0030] The casing (11) is provided with an outside air inlet port (24), an inside air inlet port (23), an air-supplying port (22) and an exhaust port (21). The outside air inlet port (24) and the inside air inlet port (23) are opened in the rear surface panel portion (13). The outside air inlet port (24) is placed in a lower portion of the rear surface panel portion (13). The inside air inlet port (23) is placed in an upper portion of the rear surface panel portion (13). The air-supplying port (22) is placed near an end portion of the first side surface panel portion (14) toward the front surface panel portion (12). The exhaust port (21) is placed near an end portion of the second side surface panel portion (15) toward the front surface panel portion (12).

[0031] In the internal space of the casing (11), an upstream-side partition (71), a downstream-side partition (72), a center partition (73), a first partition (74), and a second partition (75) are provided. These partitions (71-75) are each provided upright on the bottom plate of the casing (11), partitioning the internal space of the casing (11) from the bottom plate to the top plate of the casing (11).

[0032] The upstream-side partition (71) and the downstream-side partition (72) are placed at a predetermined interval in the front-rear direction of the casing (11) in orientations parallel to the front surface panel portion (12) and the rear surface panel portion (13). The upstream-side partition (71) is placed closer to the rear surface panel portion (13). The downstream-side partition (72) is placed closer to the front surface panel portion (12).

[0033] The first partition (74) and the second partition (75) are placed in orientations parallel to the first side surface panel portion (14) and the second side surface panel portion (15). The first partition (74) is placed at a predetermined interval from the first side surface panel portion (14) so as to cover the space between the upstream-side partition (71) and the downstream-side partition (72) from the right side. The second partition (75) is placed at a predetermined interval from the second side surface panel portion (15) so as to cover the space between the upstream-side partition (71) and the downstream-side partition (72) from the left side.

[0034] The center partition (73) is placed between the upstream-side partition (71) and the downstream-side partition (72) in an orientation perpendicular to the upstream-side partition (71) and the downstream-side partition (72). The center partition (73) is provided extending from the upstream-side partition (71) to the downstream-side partition (72), partitioning the space between the upstream-side partition (71) and the downstream-side partition (72) into left and right portions.

[0035] In the casing (11), the space between the upstream-side partition (71) and the rear surface panel portion (13) is partitioned into two, upper and lower, spaces, where the upper space forms an inside air-side passageway (32), and the lower space forms an outside air-side passageway (34). The inside air-side passageway (32) communicates with the room via a duct connected to the inside air inlet port (23). An inside air-side filter (27) and an inside air humidity sensor (96) are placed along the inside air-side passageway (32). The outside air-side passageway (34) communicates with the outside space via a duct connected to the outside air inlet port (24). An outside air-side filter (28) and an outside air humidity sensor (97) are placed in the outside air-side passageway (34).

[0036] The space between the upstream-side partition (71) and the downstream-side partition (72) in the casing (11) is partitioned by the center partition (73) into left and right portions, where the space on the right side of the center partition (73) forms a first heat exchanger chamber (37), and the space on the left side of the center partition (73) forms a second heat exchanger chamber (38). The first adsorption heat exchanger (51) is accommodated in the first heat exchanger chamber (37). The second adsorption heat exchanger (52) is accommodated in the second heat exchanger chamber (38). Although not shown in the figures, the electric expansion valve (55) of the refrigerant circuit (50) is accommodated in the first heat exchanger chamber (37). These first and second heat exchanger chambers (37, 38) form the air passageways.

[0037] Each of the adsorption heat exchangers (51, 52) is a so-called "cross-fin-type fin-and-tube heat exchanger" with an adsorbent carried on the surface thereof, and as a whole is formed in a rectangular thick plate shape or a flattened rectangular parallelepiped shape. Each adsorption heat exchanger (51, 52) is provided upright in the heat exchanger chambers (37, 38) in an orientation such that the front surface and the rear surface

are parallel to the upstream-side partition (71) and the downstream-side partition (72).

[0038] In the internal space of the casing (11), a space along the front surface of the downstream-side partition (72) is partitioned into upper and lower portions, where the upper one of the upper and lower partitioned spaces forms an air-supplying-side passageway (31), and the lower one forms an exhaust-side passageway (33).

[0039] The upstream-side partition (71) is provided with four open/close dampers (41-44). Each of the dampers (41-44) is generally formed in a horizontally-oriented rectangular shape. Specifically, in a portion (upper portion) of the upstream-side partition (71) that is facing the inside air-side passageway (32), the first inside air-side damper (41) is attached on the right of the center partition (73), and the second inside air-side damper (42) is attached on the left of the center partition (73). In a portion (lower portion) of the upstream-side partition (71) that is facing the outside air-side passageway (34), the first outside air-side damper (43) is attached on the right of the center partition (73), and the second outside air-side damper (44) is attached on the left of the center partition (73).

[0040] The downstream-side partition (72) is provided with four open/close dampers (45-48). Each of the dampers (45-48) is generally formed in a horizontally-oriented rectangular shape. Specifically, in a portion (upper portion) of the downstream-side partition (72) that is facing the air-supplying-side passageway (31), the first air-supplying-side damper (45) is attached on the right of the center partition (73), and the second air-supplying-side damper (46) is attached on the left of the center partition (73). In a portion (lower portion) of the dawnstream-side partition (72) that is facing the exhaust-side passageway (33), the first exhaust-side damper (47) is attached on the right of the center partition (73), and the second exhaust-side damper (48) is attached on the left of the center partition (73).

[0041] In the casing (11), the space between the air-supplying-side passageway (31) and the exhaust-side passageway (33) and the front surface panel portion (12) is partitioned by a partition (77) into left and right portions, where the space on the right side of the partition (77) forms an air-supplying fan chamber (36), and the space on the left side of the partition (77) forms an exhaust fan chamber (35).

[0042] An air-supplying fan (26) is accommodated in the air-supplying fan chamber (36). An exhaust fan (25) is accommodated in the exhaust fan chamber (35). The air-supplying fan (26) and the exhaust fan (25) are each a centrifugal-type multi-blade fan (so-called a "sirocco fan"). The air-supplying fan (26) sucks in the air from the side of the downstream-side partition (72), and blows the air out to the air-supplying port (22). The exhaust fan (25) sucks in the air from the side of the downstream-side partition (72), and blows the air out to the exhaust port (21).

[0043] The compressor (53) and the four-way switching valve (54) of the refrigerant circuit (50) are accommodated in the air-supplying fan chamber (36). The compressor (53) and the four-way switching valve (54) are placed between the air-supplying fan (26) in the air-supplying fan chamber (36) and the partition (77).

[0044] In the casing (11), the space between the first partition (74) and the first side surface panel portion (14) forms a first bypass passageway (81). The starting end of the first bypass passageway (81) communicates only with the outside air-side passageway (34) and is blocked from the inside air-side passageway (32). The terminal end of the first bypass passageway (81) is separated by a partition (78) from the air-supplying-side passageway (31), the exhaust-side passageway (33) and the air-supplying fan chamber (36). A fist bypass damper (83) is provided on a portion of the partition (78) that faces the air-supplying fan chamber (36).

[0045] In the casing (11), the space between the second partition (75) and the second side surface panel portion (15) forms a second bypass passageway (82). The starting end of the second bypass passageway (82) communicates only with the inside air-side passageway (32), and is blocked from the outside air-side passageway (34). The terminal end of the second bypass passageway (82) is separated by the partition (79) from the air-supplying-side passageway (31), the exhaust-side passageway (33) and the exhaust fan chamber (35). A second bypass damper (84) is provided on a portion of the partition (79) that faces the exhaust fan chamber (35).

[0046] The air-supplying-side passageway (31), the inside air-side passageway (32), the exhaust-side passageway (33), the outside air-side passageway (34), the first bypass passageway (81) and the second bypass passageway (82) form the air passageways. The first inside air-side damper (41), the second inside air-side damper (42), the first outside air-side damper (43), the second outside air-side damper (44), the first air-supplying-side damper (45), the second air-supplying-side damper (46), the first exhaust-side damper (47), the second exhaust-side damper (48), the first bypass damper (83) and the second bypass damper (84) form the open/close mechanisms.

[0047] Note that the first bypass passageway (81), the second bypass passageway (82), the first bypass damper (83) and the second bypass damper (84) are not shown in the right side view and the left side view of FIG. 2.

<Configuration Of Refrigerant Circuit>

[0048] As shown in FIG. 3, the refrigerant circuit (50) is a closed circuit including the first adsorption heat exchanger (51), the second adsorption heat exchanger (52), the compressor (53), the four-way switching valve (54) and the electric expansion valve (55). The refrigerant circuit (50) allows refrigerant, filling the refrigerant circuit (50), to circulate therethrough to perform a vapor-compression refrigeration cycle. The refrigerant circuit (50) forms the humidity controlling means.

[0049] In the refrigerant circuit (50), the compressor (53) has its discharge side connected to the first port of the four-way switching valve (54), and its intake side connected to the second port of the four-way switching valve (54). In the refrigerant circuit (50), the first adsorption heat exchanger (51), the electric expansion valve (55) and the second adsorption heat exchanger (52) are connected in this order from the third port to the fourth port of the four-way switching valve (54).

[0050] The four-way switching valve (54) can be switched between a first state (the state shown in FIG. 3 (A)) in which the first port and the third port communicate with each other and the second port and the fourth port communicate with each other, and a second state (the state shown in FIG. 3(B)) in which the first port and the fourth port communicate with each other and the second port and the third port communicate with each other.

[0051] The compressor (53) is a totally closed type compressor, in which a compression mechanism for compressing the refrigerant and a motor for driving the compression mechanism are accommodated in a single casing. As the frequency of the alternating current supplied to the motor of the compressor (53) (i.e., the operation frequency of the compressor (53)) is varied, the rotational speed of the compression mechanism driven by the motor is varied, thereby changing the amount of the refrigerant discharged from the compressor (53) per unit time. That is, the compressor (53) is capacity-variable.

[0052] In the refrigerant circuit (50), a high-pressure pressure sensor (91) and a discharge pipe temperature sensor (93) are attached to a pipe that connects between the discharge side of the compressor (53) and the first port of the four-way switching valve (54). The high-pressure pressure sensor (91) measures the pressure of the refrigerant discharged from the compressor (53). The discharge pipe temperature sensor (93) measures the temperature of the refrigerant discharged from the compressor (53).

[0053] In the refrigerant circuit (50), a low-pressure pressure sensor (92) and an intake pipe temperature sensor (94) are attached to a pipe that connects between the intake side of the compressor (53) and the second port of the four-way switching valve (54). The low-pressure pressure sensor (92) measures the pressure of the refrigerant to be taken into the compressor (53). The intake pipe temperature sensor (94) measures the temperature of the refrigerant to be taken into the compressor (53).

[0054] In the refrigerant circuit (50), a pipe temperature sensor (95) is attached to a pipe that connects between the third port of the four-way switching valve (54) and the first adsorption heat exchanger (51). The pipe temperature sensor (95) is placed near the four-way switching valve (54) along the pipe, and measures the temperature of the refrigerant flowing through the pipe.

<Configuration Of Controller>

[0055] The humidity control apparatus (10) is provided with a controller (60) as a control unit. Although not shown in FIGS. 1 and 2, an electrical component box is attached to the front surface panel portion (12) of the casing (11), and the control substrate accommodated in the electrical component box forms the controller (60).

[0056] The controller (60) receives measured values from the inside air humidity sensor (96), the inside air temperature sensor, the outside air humidity sensor (97), the outside air temperature sensor and the sensors (91, 92,...) provided in the refrigerant circuit (50). The controller (60) is connected directly or indirectly with the inverter of the compressor (53), the inverter of the exhaust fan (25), the inverter of the air-supplying fan (26), the motors of the dampers (41-48, 83, 94), the actuator of the four-way switching valve (54), the motor of the electric expansion valve (55), etc., so that signals can be exchanged therebetween. Based on these measured values received, the controller (60) controls the operations of the dampers (41-48, 83, 84), the fans (25, 26), the compressor (53), the four-way switching valve (54) and the electric expansion valve (55) so as to control the operation of the humidity control apparatus (10). With the control operation by the controller (60), the operation of the humidity control apparatus (10) is switched between a dehumidifying ventilation mode, a humidifying ventilation mode, and a simple ventilation mode.

-Operating Modes-

[0057] The humidity control apparatus (10) of the present embodiment selectively performs one of a dehumidifying ventilation mode, a humidifying ventilation mode and a simple ventilation mode. The humidity control apparatus (10) performs the dehumidifying ventilation mode and the humidifying ventilation mode as humidity-controlling modes.

<Dehumidifying Ventilation Mode>

[0058] The humidity control apparatus (10) in the dehumidifying ventilation mode performs a first operation and a second operation, which will be described later, alternately with each other at intervals of a predetermined period (e.g., at intervals of 3-4 min). In the dehumidifying ventilation mode, the first bypass damper (83) and the second bypass damper (84) are always closed.

[0059] In the humidity control apparatus (10) in the dehumidifying ventilation mode, the outside air is taken into the casing (11) through the outside air inlet port (24) as the first air, and the room air is taken into the casing (11) through the inside air inlet point (23) as the second air.

[0060] First, the first operation of the dehumidifying ventilation mode will be described. As shown in FIG. 4, in the first operation, the first inside air-side damper (41), the second outside air-side damper (44), the second air-

supplying-side damper (46) and the first exhaust-side damper (47) are open, and the second inside air-side damper (42), the first outside air-side damper (43), the first air-supplying-side damper (45) and the second exhaust-side damper (48) are closed. In the refrigerant circuit (50) in the first operation, the four-way switching valve (54) is set in the first state (the state shown in FIG. 3(A)), where the first adsorption heat exchanger (51) serves as the condenser and the second adsorption heat exchanger (52) serves as the evaporator.

[0061] The first air, which has passed through the outside air-side filter (28) flowing into the outside air-side passageway (34), flows into the second heat exchanger chamber (38) through the second outside air-side damper (44), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), the moisture of the first air is adsorbed by the adsorbent, with the resulting heat of adsorption being absorbed by the refrigerant. The first air, which has been dehumidified through the second adsorption heat exchanger (52), flows into the air-supplying-side passageway (31) through the second air-supplying-side damper (46), and is supplied into the room through the air-supplying port (22) after passing through the air-supplying fan chamber (36).

[0062] On the other hand, the second air, which has passed through the inside air-side filter (27) flowing into the inside air-side passageway (32), flows into the first heat exchanger chamber (37) through the first inside air-side damper (41), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), the moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air, which has been given the moisture through the first adsorption heat exchanger (51), flows into the exhaust-side passageway (33) through the first exhaust-side damper (47), and is discharged to the outside through the exhaust port (21) after passing through the exhaust fan chamber (35).

[0063] Next, the second operation in the dehumidifying ventilation mode will be described. As shown in FIG. 5, in the second operation, the second inside air-side damper (42), the first outside air-side damper (43), the first air-supplying-side damper (45) and the second exhaust-side damper (48) are open, and the first inside air-side damper (41), the second outside air-side damper (44), the second air-supplying-side damper (46) and the first exhaust-side damper (47) are closed. In the refrigerant circuit (50) in the second operation, the four-way switching valve (54) is set in the second state (the state shown in FIG. 3(B)), where the first adsorption heat exchanger (51) serves as the evaporator and the second adsorption heat exchanger (52) serves as the condenser.

[0064] The first air, which has passed through the outside air-side filter (28) flowing into the outside air-side passageway (34), flows into the first heat exchanger chamber (37) through the first outside air-side damper (43), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), the moisture of the first air is adsorbed by the adsorbent, with the resulting heat of adsorption being absorbed by the refrigerant. The first air, which has been dehumidified through the first adsorption heat exchanger (51), flows into the air-supplying-side passageway (31) through the first air-supplying-side damper (45), and is supplied into the room through the air-supplying port (22) after passing through the air-supplying fan chamber (36).

[0065] On the other hand, the second air, which has passed through the inside air-side filter (27) flowing into the inside air-side passageway (32), flows into the second heat exchanger chamber (38) through the second inside air-side damper (42), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), the moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air, which has been given the moisture through the second adsorption heat exchanger (52), flows into the exhaust-side passageway (33) through the second exhaust-side damper (48), and is discharged to the outside through the exhaust port (21) after passing through the exhaust fan chamber (35).

<Humidifying Ventilation Mode>

[0066] The humidity control apparatus (10) in the humidifying ventilation mode performs a first operation and a second operation, which will be described later, alternately with each other at intervals of a predetermined period (e.g., at intervals of 3-4 min). In the humidifying ventilation mode, the first bypass damper (83) and the second bypass damper (84) are always closed.

[0067] In the humidity control apparatus (10) in the humidifying ventilation mode, the outside air is taken into the casing (11) from the outside air inlet port (24) as the second air, and the room air is taken into the casing (11) from the inside air inlet port (23) as the first air.

[0068] First, the first operation of the humidifying ventilation mode will be described. As shown in FIG. 6, in the first operation, the second inside air-side damper (42), the first outside air-side damper (43), the first air-supplying-side damper (45) and the second exhaust-side damper (48) are open, and the first inside air-side damper (41), the second outside air-side damper (44), the second air-supplying-side damper (46) and the first exhaust-side damper (47) are closed. In the refrigerant circuit (50) in the first operation, the four-way switching valve (54) is set in the first state (the state shown in FIG. 3(A)), where the first adsorption heat exchanger (51) serves as the condenser and the second adsorption heat exchanger (52) serves as the evaporator.

[0069] The first air, which has passed through the inside air-side filter (27) flowing into the inside air-side passageway (32), flows into the second heat exchanger chamber (38) through the second inside air-side damper (42), and then passes through the second adsorption

heat exchanger (52). In the second adsorption heat exchanger (52), the moisture of the first air is adsorbed by the adsorbent, with the resulting heat of adsorption being absorbed by the refrigerant. The first air, which has been deprived of the moisture through the second adsorption heat exchanger (52), flows into the exhaust-side passageway (33) through the second exhaust-side damper (48), and is discharged to the outside through the exhaust port (21) after passing through the exhaust fan chamber (35).

[0070] On the other hand, the second air, which has passed through the outside air-side filter (28) flowing into the outside air-side passageway (34), flows into the first heat exchanger chamber (37) through the first outside air-side damper (43), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), the moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air, which has been humidified through the first adsorption heat exchanger (51), flows into the air-supplying-side passageway (31) through the first air-supplying-side damper (45), and is supplied into the room through the air-supplying port (22) after passing through the air-supplying fan chamber (36).

[0071] Next, the second operation in the humidifying ventilation mode will be described. As shown in FIG. 7, in the second operation, the first inside air-side damper (41), the second outside air-side damper (44), the second air-supplying-side damper (46) and the first exhaust-side damper (47) are open, and the second inside air-side damper (42), the first outside air-side damper (43), the first air-supplying-side damper (45) and the second exhaust-side damper (48) are closed. In the refrigerant circuit (50) in the second operation, the four-way switching valve (54) is set in the second state (the state shown in FIG. 3(B)), where the first adsorption heat exchanger (51) serves as the evaporator and the second adsorption heat exchanger (52) serves as the condenser.

[0072] The first air, which has passed through the inside air-side filter (27) flowing into the inside air-side passageway (32), flows into the first heat exchanger chamber (37) through the first inside air-side damper (41), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), the moisture of the first air is adsorbed by the adsorbent, with the resulting heat of adsorption being absorbed by the refrigerant. The first air, which has been deprived of the moisture through the first adsorption heat exchanger (51), flows into the exhaust-side passageway (33) through the first exhaust-side damper (47), and is discharged to the outside through the exhaust port (21) after passing through the exhaust fan chamber (35).

[0073] On the other hand, the second air, which has passed through the outside air-side filter (28) flowing into the outside air-side passageway (34), flows into the second heat exchanger chamber (38) through the second outside air-side damper (44), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), the moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air, which has been humidified through the second adsorption heat exchanger (52), flows into the air-supplying-side passageway (31) through the second air-supplying-side damper (46), and is supplied into the room through the air-supplying port (22) after passing through the air-supplying fan chamber (36).

<Simple Ventilation Mode>

[0074] On the other hand, the humidity control apparatus (10) in the simple ventilation mode supplies the received outside air (OA) as it is into the room as the supply air (SA) while simultaneously discharging the received room air (RA) as it is to the outside as the exhaust air (EA). The operation of the humidity control apparatus (10) in the simple ventilation mode will now be described with reference to FIG. 8.

[0075] In the humidity control apparatus (10) in the simple ventilation mode, the first bypass damper (83) and the second bypass damper (84) are open, and the first inside air-side damper (41), the second inside air-side damper (42), the first outside air-side damper (43), the second outside air-side damper (44), the first air-supplying-side damper (45), the second air-supplying-side damper (46), the first exhaust-side damper (47) and the second exhaust-side damper (48) are closed. In the simple ventilation mode, the compressor (53) of the refrigerant circuit (50) is shut down.

[0076] In the humidity control apparatus (10) in the simple ventilation mode, the outside air is taken into the casing (11) through the outside air inlet port (24). The outside air, which has passed through the outside air inlet port (24) flowing into the outside air-side passageway (34), flows into the air-supplying fan chamber (36) from the first bypass passageway (81) through the first bypass damper (83), and is then supplied into the room through the air-supplying port (22).

[0077] In the humidity control apparatus (10) in the simple ventilation mode, the room air is taken into the casing (11) through the inside air inlet port (23). The room air, which has flown into the inside air-side passageway (32) through the inside air inlet port (23), flows into the exhaust fan chamber (35) from the second bypass passageway (82) through the second bypass damper (84), and is then discharged to the outside through the exhaust port (21).

[0078] The exhaust fan (25), the air-supplying fan (26) and the dampers (41-48, 83, 84) form the ventilation mechanism.

-Abnormality Determination-

[0079] The controller (60), which performs the dehumidifying ventilation mode, the humidifying ventilation mode and the simple ventilation mode as described

above, also performs an abnormality determination control as follows. Specifically, the controller (60) monitors various parts of the humidity control apparatus (10), e.g., abnormalities of the compressor (53), the four-way switching valve (54) and the sensors (91-97), and abnormalities of the exhaust fan (25), the air-supplying fan (26) and the dampers (41-48, 83, 84). When an abnormality is detected, the controller (60) determines what is the abnormality related to, and controls the humidity control apparatus (10) to perform different operations depending on the determination result. The controller (60) serves as the abnormality determination means.

[0080] The abnormality determination control will be described in detail below with reference to the flow chart of FIG. 9.

[0081] The controller (60) determines in step S1 whether a ventilation mode-related abnormality (the details of which will be described later) has been detected. The process proceeds to step S2 when a ventilation mode-related abnormality has been detected, and to step S3 when no ventilation mode-related abnormality has been detected.

[0082] In step S2, the controller (60) shuts down the operation of the compressor (53), the exhaust fan (25), the air-supplying fan (26), etc., to entirely shut down the operation of the humidity control apparatus (10). That is, neither the humidity-controlling mode nor the simple ventilation mode is performed.

[0083] On the other hand, in step S3, the controller (60) determines whether a refrigerant circuit-related abnormality (the details of which will be described later) has been detected. The process proceeds to step S4 when a refrigerant circuit-related abnormality has been detected, and to Return when no refrigerant circuit-related abnormality has been detected.

[0084] Then, in step S3, the controller (60) shuts down the operation of the compressor (53), actuates the exhaust fan (25) and the air-supplying fan (26), opens the first bypass damper (83) and the second bypass damper (84), and closes the first inside air-side damper (41), the second inside air-side damper (42), the first outside air-side damper (43), the second outside air-side damper (44), the first air-supplying-side damper (45), the second air-supplying-side damper (46), the first exhaust-side damper (47) and the second exhaust-side damper (48). That is, the refrigeration cycle in the refrigerant circuit (50) is stopped to shut down the humidity-controlling mode, but the simple ventilation mode is performed.

[0085] Here, the ventilation mode-related abnormality refers to an abnormality with which the ventilation mode cannot be performed normally, e.g., an abnormality of the exhaust fan (25), an abnormality of the air-supplying fan (26), and an abnormality of the damper (41-48, 83, 84).

[0086] The abnormality of the exhaust fan (25) can be detected by comparing the instruction value from the controller (60) to the exhaust fan (25) with the behavior of the exhaust fan (25) in response to the instruction value. That is, it can be determined that the exhaust fan (25) is abnormal when, in response to an instruction value from the controller (60) to the exhaust fan (25), the exhaust fan (25) is not exhibiting a behavior according to the instruction value. The behavior of the exhaust fan (25) can be detected based on a motor current, etc.

[0087] As is the abnormality of the exhaust fan (25), the abnormality of the air-supplying fan (26) can be detected by comparing an instruction value from the controller (60) to the air-supplying fan (26) with the behavior of the air-supplying fan (26) in response to the instruction value.

[0088] The abnormality of the damper (41-48, 83, 84) can be detected by comparing an instruction value from the controller (60) to the damper (41-48, 83, 84) with the behavior of the damper (41-48, 83, 84) in response to the instruction value. That is, it is possible to determine that the damper (41-48, 83, 84) is abnormal when, in response to an instruction value from the controller (60) to the damper (41-48, 83, 84), the damper (41-48, 83, 84) is not exhibiting a behavior according to the instruction value. The behavior of the damper (41-48, 83, 84) can be detected by a limit switch, or the like, provided in the vicinity thereof.

[0089] On the other hand, the refrigerant circuit-related abnormality refers to an abnormality with which the refrigeration cycle cannot be performed normally, including, for example, an abnormality of an overcurrent to the motor of the compressor (53), an abnormality of the inverter printed circuit board of the compressor (53), an operation abnormality of the four-way switching valve (54), an abnormality of the sensor (91-94), an abnormality of the refrigeration cycle, etc.

[0090] The abnormality of an overcurrent to the motor of the compressor (53) can be detected by monitoring the motor current to the compressor (53). An overcurrent to the motor can be detected by detecting the motor current going out of a predetermined range that is considered normal.

[0091] The abnormality of the inverter printed circuit board of the compressor (53) can be detected by monitoring the internal data of the inverter printed circuit board. It is possible to determine that the inverter printed circuit board is abnormal when the internal data read out from the inverter printed circuit board is not an expected value.

[0092] The operation abnormality of the four-way switching valve (54) can be detected by making a comparison between the condensation temperature calculated based on the high-pressure pressure sensor (91) and the temperature of the refrigerant flowing from the four-way switching valve (54) to one of the adsorption heat exchangers (51, 52) that is assumed to be functioning as a condenser if the four-way switching valve (54) is operating as instructed by the controller (60), i.e., the temperature of the refrigerant that is assumed to be the high-pressure refrigerant. Specifically, if the temperature of the refrigerant that is assumed to be the high-pressure refrigerant is less than or equal to the condensation tem-

perature, the four-way switching valve (54) is not operating as instructed by the controller (60), and it is possible to determine that there is an abnormality.

[0093] The abnormality of the sensor (91-94) can be detected by monitoring the output signal from the sensor (91-94). It is possible to determine that the sensor (91-94) is abnormal when the output signal from the sensor (91-94) represents a value outside an expected range.

[0094] The abnormality of the refrigeration cycle is, for example, an abnormal increase in the high pressure of the refrigerant, and can be detected by monitoring the output signal from the sensor (91-34). It is possible to determine that the refrigeration cycle is abnormal when the output signal from the sensor (91-94) represents a value outside a range for which the refrigeration cycle is assumed to be performed normally.

[0095] Thus, the controller (60) monitors an abnormality of the humidity control apparatus (10), and when an abnormality is detected, the controller (60) determines the type of the abnormality, and takes a measure according to the type of the abnormality. That is, when the detected abnormality is a refrigerant circuit-related abnormality and is not a ventilation mode-related abnormality, the controller (60) shuts down the humidity-controlling mode and performs the simple ventilation mode, whereas when the detected abnormality is a ventilation mode-related abnormality, the controller (60) shuts down the humidity-controlling mode and does not perform the simple ventilation mode, irrespective of whether a refrigerant circuit-related abnormality has been detected.

[0096] Note that when the detected abnormality is a refrigerant circuit-related abnormality and is not a ventilation mode-related abnormality, the controller (60) shuts down the humidity-controlling mode, and does not always need to perform the simple ventilation mode. For example, the process may shut down the humidity-controlling mode, and wait for an instruction from the user to perform the simple ventilation mode.

-Advantages Of Embodiment-

[0097] Therefore, according to the present embodiment, the process detects an abnormality in the humidity control apparatus (10), and if the abnormality is a refrigerant circuit-related abnormality and is not a ventilation mode-related abnormality, the process shuts down the operation of the compressor (53) and performs the simple ventilation mode. Thus, even when a humidity-controlling mode such as the dehumidifying ventilation mode or the humidifying ventilation mode cannot be performed normally, the ventilation mode can be performed as long as it is possible to perform the ventilation mode. That is, instead of completely shutting down the humidity control apparatus (10) because of an abnormality in the humidity control apparatus (10), an operation that can be performed normally is kept available, so as to prevent the humidity control apparatus (10) from being shut down unnecessarily, and it is therefore possible to effectively operate the humidity control apparatus (10).

[0098] Particularly, since the humidity control apparatus (10) of the present embodiment performs the humidity-controlling mode and the simple ventilation mode with a single apparatus, many of the components are used both in the humidity-controlling mode and in the simple ventilation mode. Therefore, by determining whether the detected abnormality is an abnormality related to the humidity-controlling mode or an abnormality related to the simple ventilation mode, the simple ventilation mode can be performed as long as it is possible to normally perform the simple ventilation mode even if there is an abnormality in the humidity control apparatus (10).

[0099] In the humidity control apparatus (10) of the present embodiment, the exhaust fan (25), the air-supplying fan (26) and the dampers (41-48, 83, 84) operate not only when performing the simple ventilation mode but also when performing the humidity-controlling mode. That is, if the exhaust fan (25), the air-supplying fan (26) and the dampers (41-48, 83), 84) are not operating normally, neither the simple ventilation mode nor the humidity-controlling mode can be performed normally. Therefore, if the detected abnormality is a ventilation mode-related abnormality, the humidity control apparatus (10) shuts down not only the simple ventilation mode but also the humidity-controlling mode. Then, it is possible to prevent the simple ventilation mode and the humidity-controlling mode from being performed with an abnormality.

-Variation 1 Of Embodiment-

[0100] In the refrigerant circuit (50) of the present embodiment, a supercritical cycle may be performed, in which the high pressure of the refrigeration cycle is set to a value higher than the critical pressure of the refrigerant. In such a case, one of the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) operates as a gas cooler, and the other as an evaporator.

-Variation 2 Of Embodiment-

[0101] In the humidity control apparatus (10) of the present embodiment, the adsorbents carried on the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) are heated or cooled by the refrigerant, but the adsorbents may be heated or cooled by supplying a cold water or hot water to the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52).

-Variation 3 Of Embodiment-

[0102] In the embodiment above, the humidity control apparatus (10) may be configured as follows.

[0103] As shown in FIG. 10, the humidity control apparatus (10) of this variation includes a refrigerant circuit (100) and two adsorption elements (111, 112). The re-

frigerant circuit (100) is a closed circuit in which a compressor (101), a condenser (102), an expansion valve (103) and an evaporator (104) are connected in this order. When the refrigerant is circulated through the refrigerant circuit (100), a vapor-compression refrigeration cycle is performed. The first adsorption element (111) and the second adsorption element (112) each include an adsorbent such as zeolite. Each adsorption element (111, 112) includes many air passageways formed therein, and the air comes into contact with the adsorbent as the air passes through the air passageways.

[0104] The humidity control apparatus (10) of this variation has a normal operation mode in which the dehumidifying ventilation mode and the humidifying ventilation mode are performed, a downtime operation mode in which the simple ventilation mode and the purge operation are performed, and a forced shutdown mode in which the dehumidifying ventilation mode, the humidifying ventilation mode, the simple ventilation mode and the purge operation are all shut down.

[0105] The humidity control apparatus (10) in the dehumidifying ventilation mode or the humidifying ventilation mode performs a first operation and a second operation alternately with each other at intervals of a predetermined period. The humidity control apparatus (10) in the dehumidifying ventilation mode takes in the outside air as the first air and the room air as the second air. On the other hand, the humidity control apparatus (10) in the humidifying ventilation mode takes in the room air as the first air and the outside air as the second air.

[0106] First, the first operation of the dehumidifying ventilation mode and the humidifying ventilation mode will be described with reference to FIG. 10(A). The humidity control apparatus (10) in the first operation supplies the second air, which has been heated through the condenser (102), to the first adsorption element (111). In the first adsorption element (111), the adsorbent is heated by the second air, and the moisture is desorbed from the adsorbent. The humidity control apparatus (10) in the first operation supplies the first air to the second adsorption element (112) so that the moisture in the first air is adsorbed onto the second adsorption element (112). The first air, which has been deprived of the moisture by the second adsorption element (112), is cooled when passing through the evaporator (104).

[0107] Next, the second operation of the dehumidifying ventilation mode and the humidifying ventilation mode will be described with reference to FIG. 10(B). The humidity control apparatus (10) in the second operation supplies the second air, which has been heated through the condenser (102), to the second adsorption element (112). In the second adsorption element (112), the adsorbent is heated by the second air, and the moisture is desorbed from the adsorbent. The humidity control apparatus (10) in the first operation supplies the first air to the first adsorption element (111) so that the moisture in the first air is adsorbed onto the first adsorption element (111). The first air, which has been deprived of the moisture by the first adsorption element (111), is cooled when passing through the evaporator (104).

[0108] The humidity control apparatus (10) in the dehumidifying ventilation mode supplies the first air (outside air), which has been dehumidified, into the room, and discharges the moisture desorbed from the adsorption element (111, 112) to the outside together with the second air (room air). The humidity control apparatus (10) in the humidifying ventilation mode supplies the second air (outside air), which has been humidified, into the room, and discharges the first air (room air), which has been deprived of the moisture by the adsorption element (111, 112), to the outside.

[0109] In the humidity control apparatus (10) in the simple ventilation mode, the compressor (101) of the refrigerant circuit (100) is shut down, and the outside air passes through one of the first adsorption element (111) and the second adsorption element (112) with the room air passing through the other. Then, the outside air is supplied into the room after passing through the adsorption element (111, 112), and the room air is discharged to the outside after passing through the adsorption element (111, 112). In the humidity control apparatus (10) in the simple ventilation mode, the passageways for the outside air and the room air are not switched around.

-Variation 4 Of Embodiment-

[0110] In the embodiment above, the humidity control apparatus (10) may be configured as follows.

[0111] As shown in FIG. 11, the humidity control apparatus (10) of this variation includes a main unit (150) and a heat source unit (165).

[0112] The internal space of the main unit (150) is partitioned into a supplying passageway (151) and an exhaust passageway (152). The starting end of the supplying passageway (151) communicates with an outside air inlet port (153), and the terminal end thereof communicates with an air-supplying port (154). A utilization-side heat exchanger (161), a humidification element (162) and an air-supplying fan (157) are arranged in this order in the supplying passageway (151) from the starting end toward the terminal end thereof. The starting end of the exhaust passageway (152) communicates with an inside air inlet port (155), and the terminal end thereof communicates with an exhaust port (156). An exhaust fan (158) is placed in the exhaust passageway (152).

[0113] The heat source unit (165) is connected to the utilization-side heat exchanger (161) via a pair of connection pipes (166). Although not shown in the figures, the heat source unit (165) includes a compressor, an expansion valve, etc. The heat source unit (165) forms a refrigerant circuit (167) together with the utilization-side heat exchanger (161). The utilization-side heat exchanger (161) is an air heat exchanger for exchanging heat between the air and the refrigerant. The refrigerant circuit (167) selectively performs one of a refrigeration cycle operation in which the utilization-side heat exchanger

(161) serves as the evaporator, and a refrigeration cycle operation in which the utilization-side heat exchanger (161) serves as the condenser.

[0114] Although not shown in the figures, the humidification element (162) includes a water passageway and an air passageway with a moisture permeable membrane interposed therebetween. Externally-supplied tap water passes through the water passageway. The air flowing through the supplying passageway (151) passes through the air passageway. The moisture permeable membrane only allows water vapor to pass but does not allow liquid water to pass.

[0115] The humidity control apparatus (10) of this variation selectively performs one of a dehumidifying ventilation mode, a humidifying ventilation mode, and a simple ventilation mode.

[0116] In the humidity control apparatus (10) in the dehumidifying ventilation mode, the refrigerant circuit (167) performs a refrigeration cycle operation in which the utilization-side heat exchanger (161) serves as the evaporator, and the water supply to the humidification element (162) is shut down. In this operation, the evaporation temperature of the refrigerant in the utilization-side heat exchanger (161) is set to a value lower than the dew point of the outside air. The outside air, which has flown into the supplying passageway (151), is cooled when passing through the utilization-side heat exchanger (161), and the moisture in the outside air is condensed to be drain water. The outside air, which has passed through the utilization-side heat exchanger (161), is supplied into the room through the air-supplying port (154) after passing through the humidification element (162). The drain water generated in the utilization-side heat exchanger (161) is discharged to the outside. The room air, which has flown into the exhaust passageway (152), is discharged to the outside through the exhaust port (156).

[0117] In the humidity control apparatus (10) in the humidifying ventilation mode, the refrigerant circuit (167) performs a refrigeration cycle operation in which the utilization-side heat exchanger (161) serves as the condenser, and the water is supplied to the humidification element (162). The outside air, which has flown into the supplying passageway (151), is sent to the humidification element (162) after being heated when passing through the utilization-side heat exchanger (161). In the humidification element (162), the air is given to the water vapor, which has passed through the moisture permeable membrane. The air, which has been humidified through the humidification element (162), is supplied into the room through the air-supplying port (154). The room air, which has flown into the exhaust passageway (152), is discharged to the outside through the exhaust port (156).

[0118] In the humidity control apparatus (10) in the simple ventilation mode, the operation of the refrigerant circuit (167) and the water supply to the humidification element (162) are both shut down, and only the air-supplying fan (157) and the exhaust fan (158) are operated. The outside air, which has flown into the supplying passageway (151), passes through the utilization-side heat exchanger (161) and the humidification element (162) in this order, and is then supplied into the room through the air-supplying port (154). The room air, which has flown into the exhaust passageway (152), is discharged to the outside through the exhaust port (156).

[0119] Note that the embodiments above are essentially illustrative of preferred embodiments, and are not intended to limit the present invention, applications thereof, or the range of applications thereof.

INDUSTRIAL APPLICABILITY

[0120] As described above, the present invention is useful for a humidity control apparatus for controlling the humidity inside the room.

Claims

1. A humidity control apparatus comprising:

a casing (11) including an air passageway (31-34, 37, 38, 81, 82) formed therein; a ventilation mechanism (25, 26, 41-48, 83, 84) for exchanging an outside air and a room air with each other via the air passageway (31-34, 37, 38, 81, 82) of the casing (11); and

a refrigerant circuit (50) for controlling a humidity of the air passing through the air passageway (31-34, 37, 38, 81, 82), wherein

a humidity-controlling mode is performed in which an air, of which a humidity is controlled by actuating the ventilation mechanism (25, 26, 41-48, 83, 84) and causing the refrigerant circuit (50) to perform a refrigeration cycle, is supplied into a room,

the humidity control apparatus further comprises an abnormality determination means (60) for monitoring an abnormality inside the apparatus and determining a type of the detected abnormality,

when the detected abnormality is an abnormality related to the refrigerant circuit (50) and is not an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality determination means (60) stops the refrigeration cycle of the refrigerant circuit (50) to shut down the humidity-controlling mode and keeps available a ventilation mode in which the ventilation mechanism (25, 26, 41-48, 83, 84) is actuated to exchange the outside air and the room air with each other.

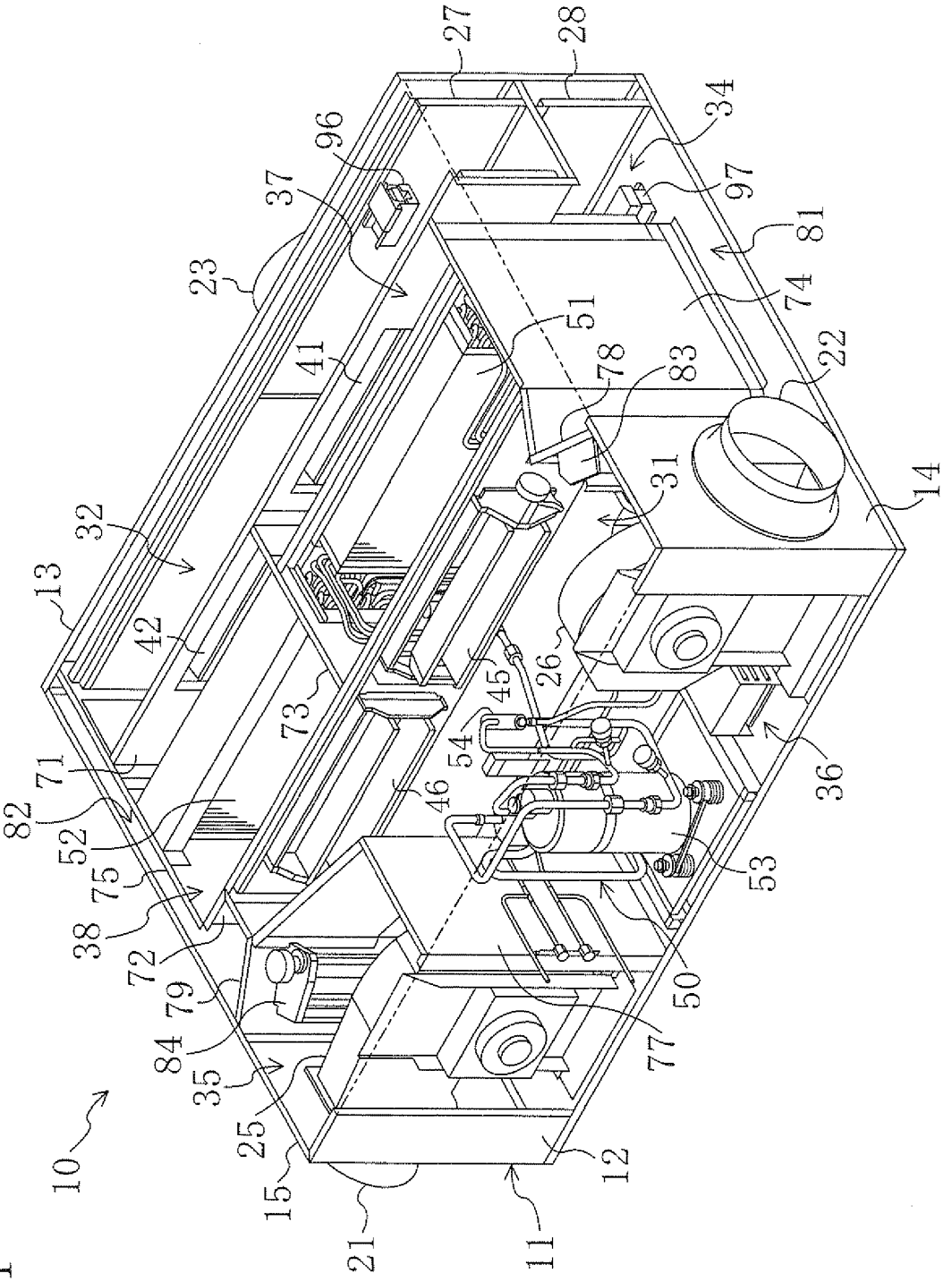
2. The humidity control apparatus of claim 1, wherein when the detected abnormality is an abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84), the abnormality determination means (60)

shuts down the ventilation mechanism (25, 26, 41-48, 83, 84) and stops the refrigeration cycle of the refrigerant circuit (50) to shut down the humidity-controlling mode.

3. The humidity control apparatus of claim 1 or 2, wherein
the ventilation mechanism (25, 26, 41-48, 83, 84) includes an exhaust fan (25) provided in the casing (11) for discharging an air to an outside, and an air-supplying fan (26) provided in the casing (11) for supplying an air into the room, and
the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the exhaust fan (25) and the air-supplying fan (26).

4. The humidity control apparatus of one of claims 1-3, wherein,
the ventilation mechanism (25, 26, 41-48, 83, 84) includes an open/close mechanism (41-48, 83, 84) provided in the casing (11) for connecting/disconnecting the air passageway (31-34, 37, 38, 81, 82), and
the abnormality related to the ventilation mechanism (25, 26, 41-48, 83, 84) includes an abnormality of the open/close mechanism (41-48, 83, 84).

5. The humidity control apparatus of one of claims 1-4, wherein
a compressor (53), a four-way switching valve (54) and an expansion valve (55) are connected to the refrigerant circuit (50), and
the abnormality related to the refrigerant circuit (50) includes an abnormality of the compressor (53), the four-way switching valve (54) and the expansion valve (55).


27
28
34
96
37
97
81
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74
51
41
78
83
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31
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32
13
42
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45
73
54
36
71
46
82
52
53
75
38
72
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79
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84
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11

FIG. 1

FIG. 2

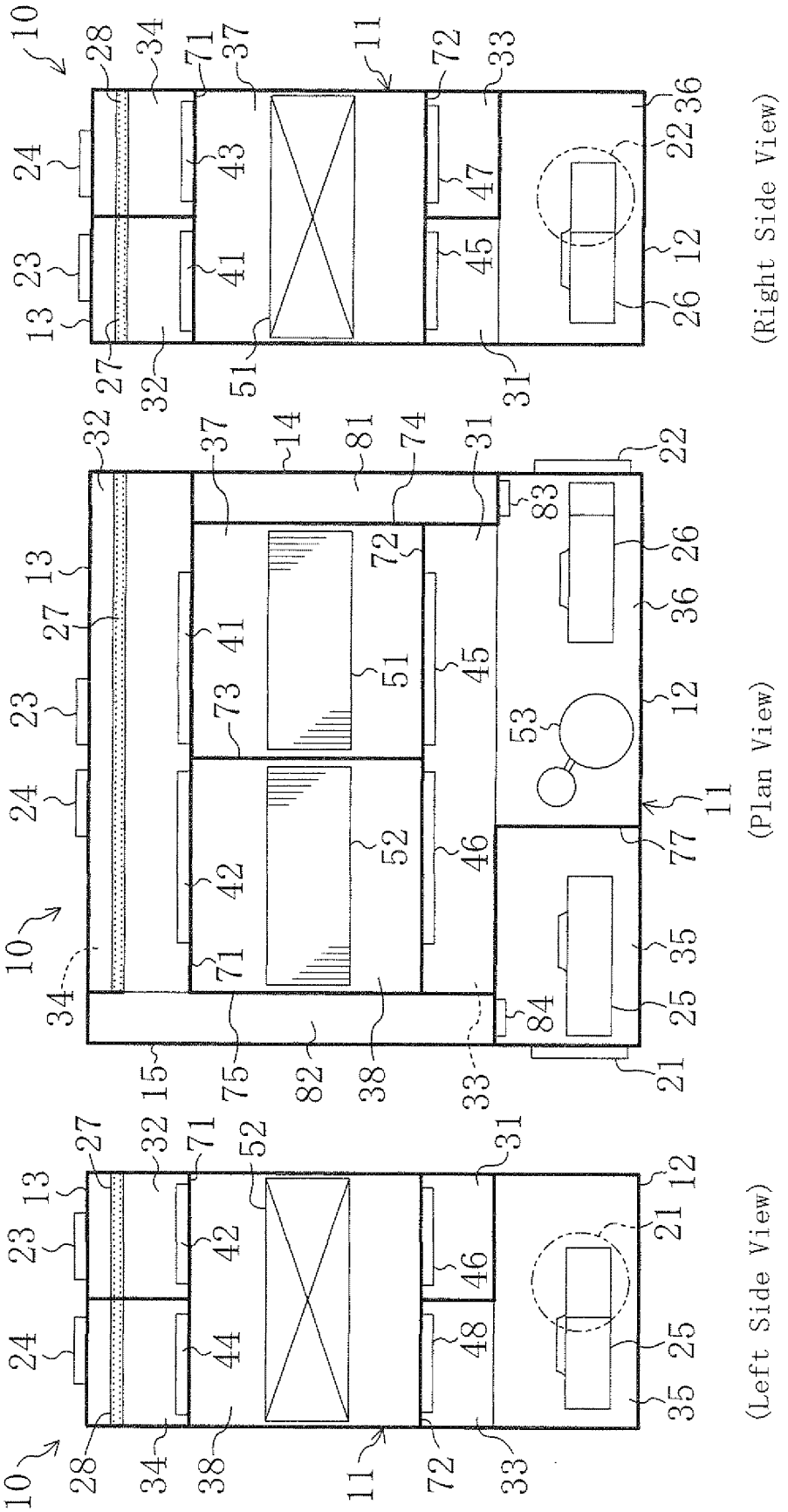


FIG. 3

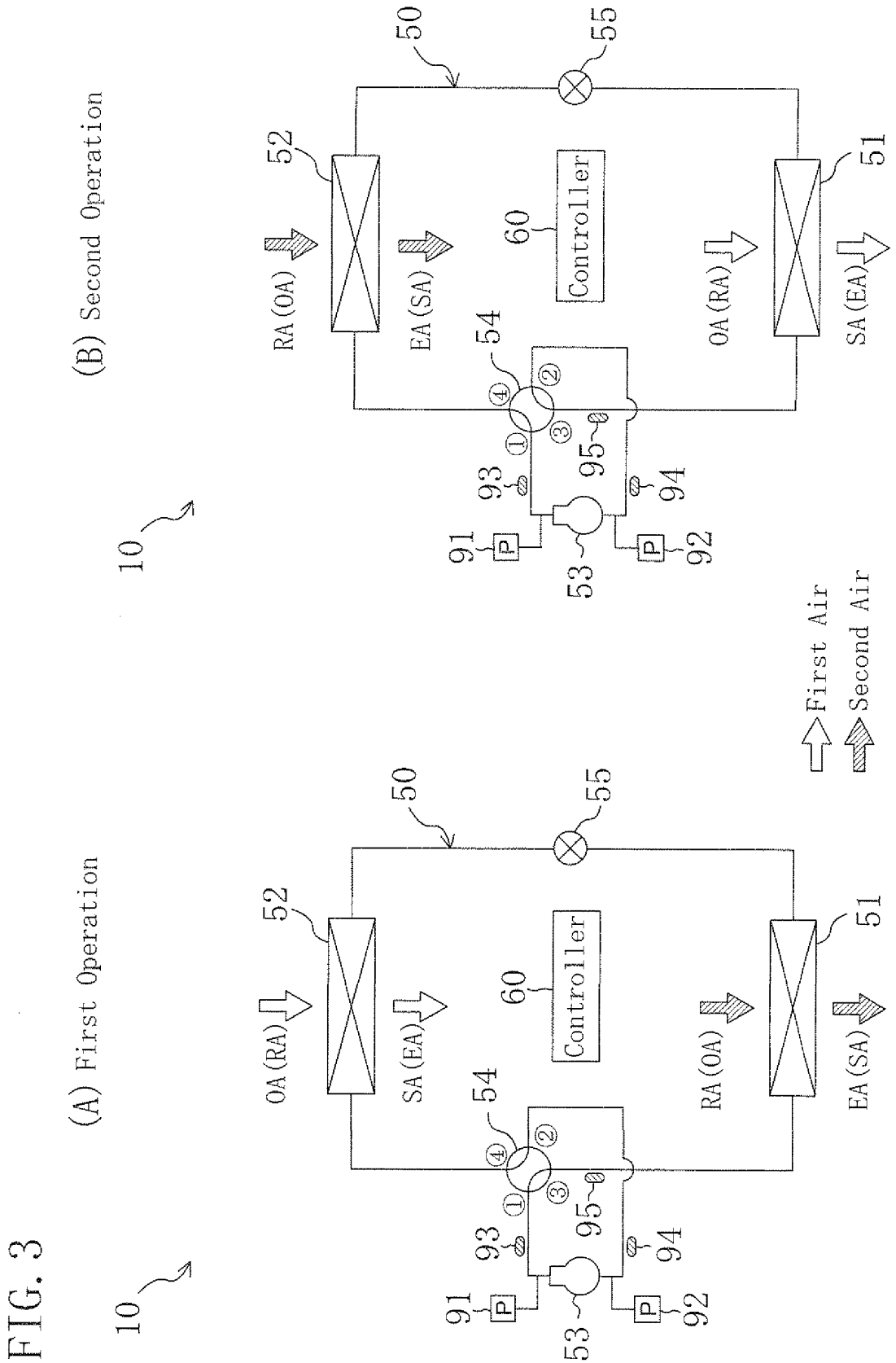

(A) First Operation
(B) Second Operation
10
50
55
52
51
60
Controller
54
53
91
92
93
94
95
P
OA (RA)
SA (EA)
RA (OA)
EA (SA)
First Air
Second Air

FIG. 4

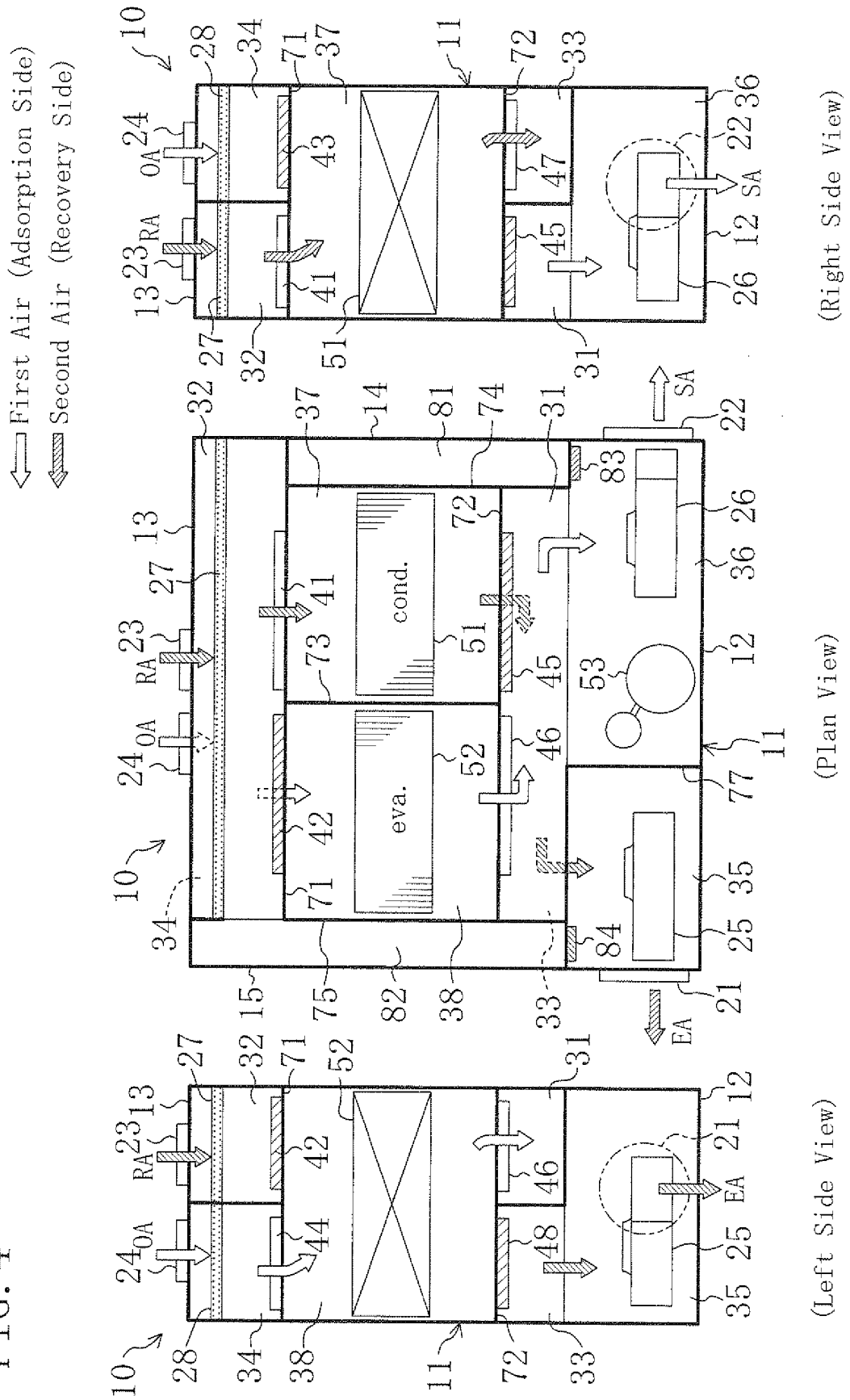

First Air (Adsorption Side)
Second Air (Recovery Side)
(Left Side View)
(Plan View)
(Right Side View)
cond.
eva.
OA
RA
SA
EA

FIG. 5

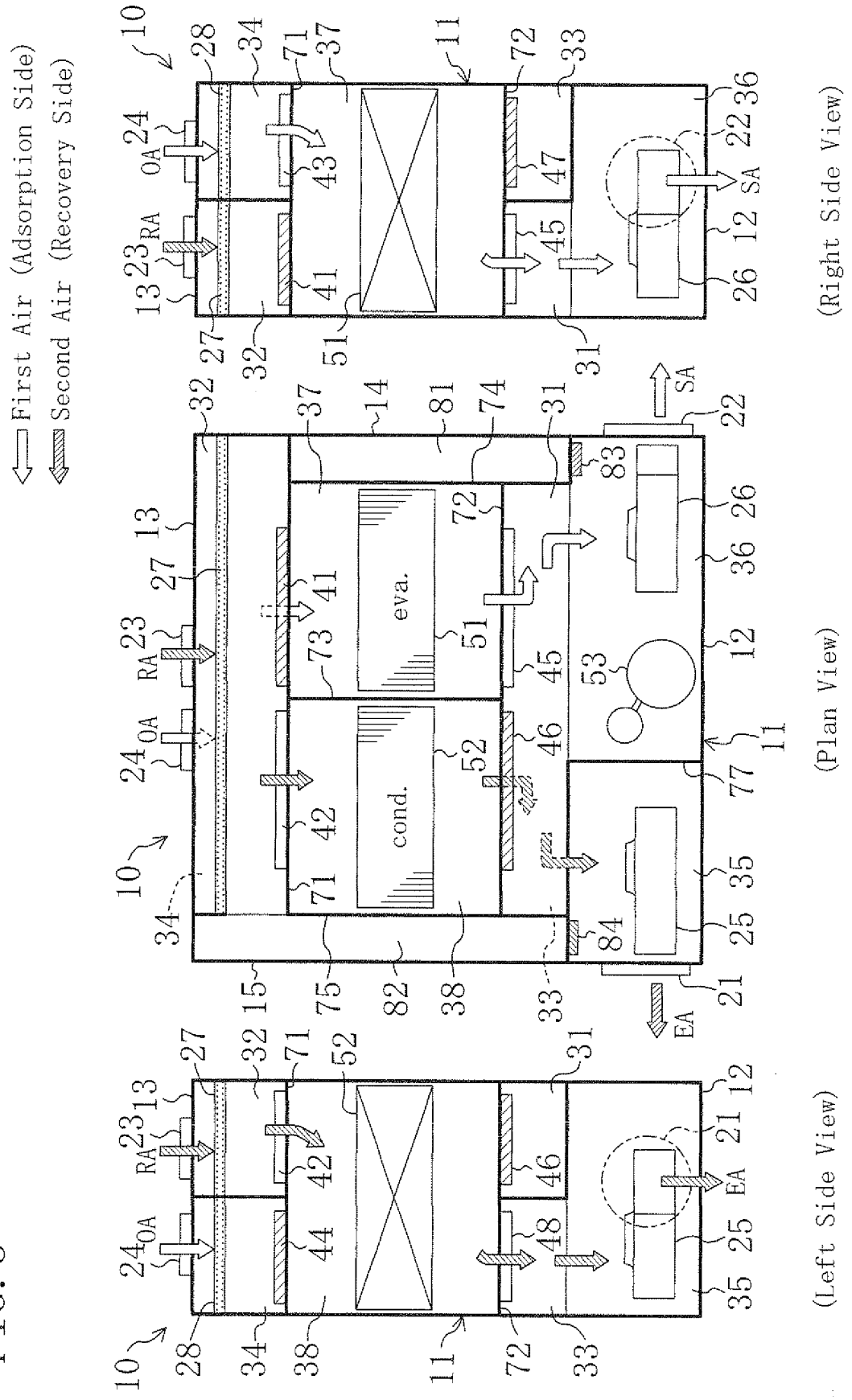

First Air (Adsorption Side)
Second Air (Recovery Side)
eva.
cond.
OA
RA
SA
EA
(Left Side View)
(Plan View)
(Right Side View)

FIG. 6

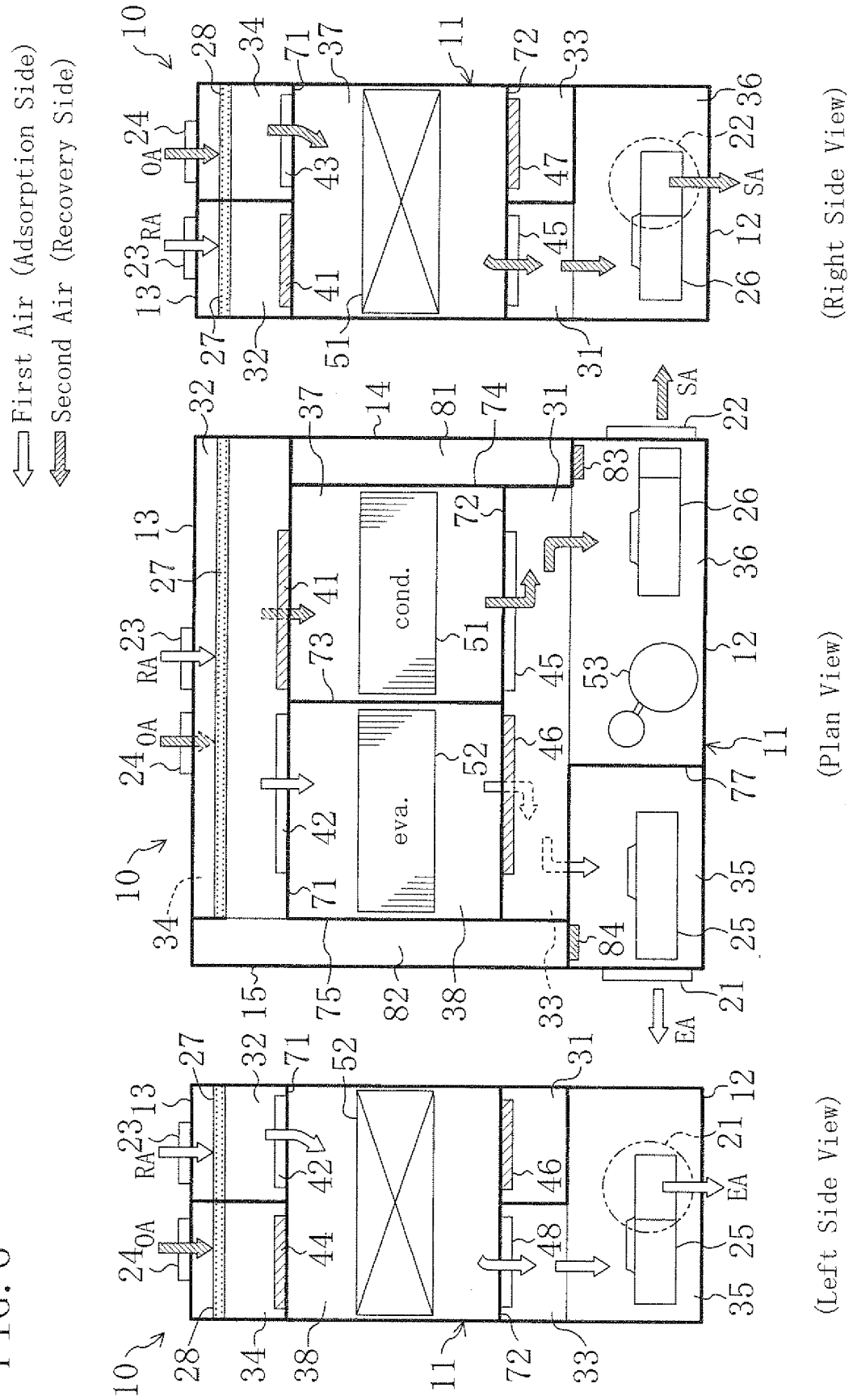

First Air (Adsorption Side)
Second Air (Recovery Side)
cond.
eva.
OA
RA
SA
EA
(Right Side View)
(Plan View)
(Left Side View)

FIG. 7

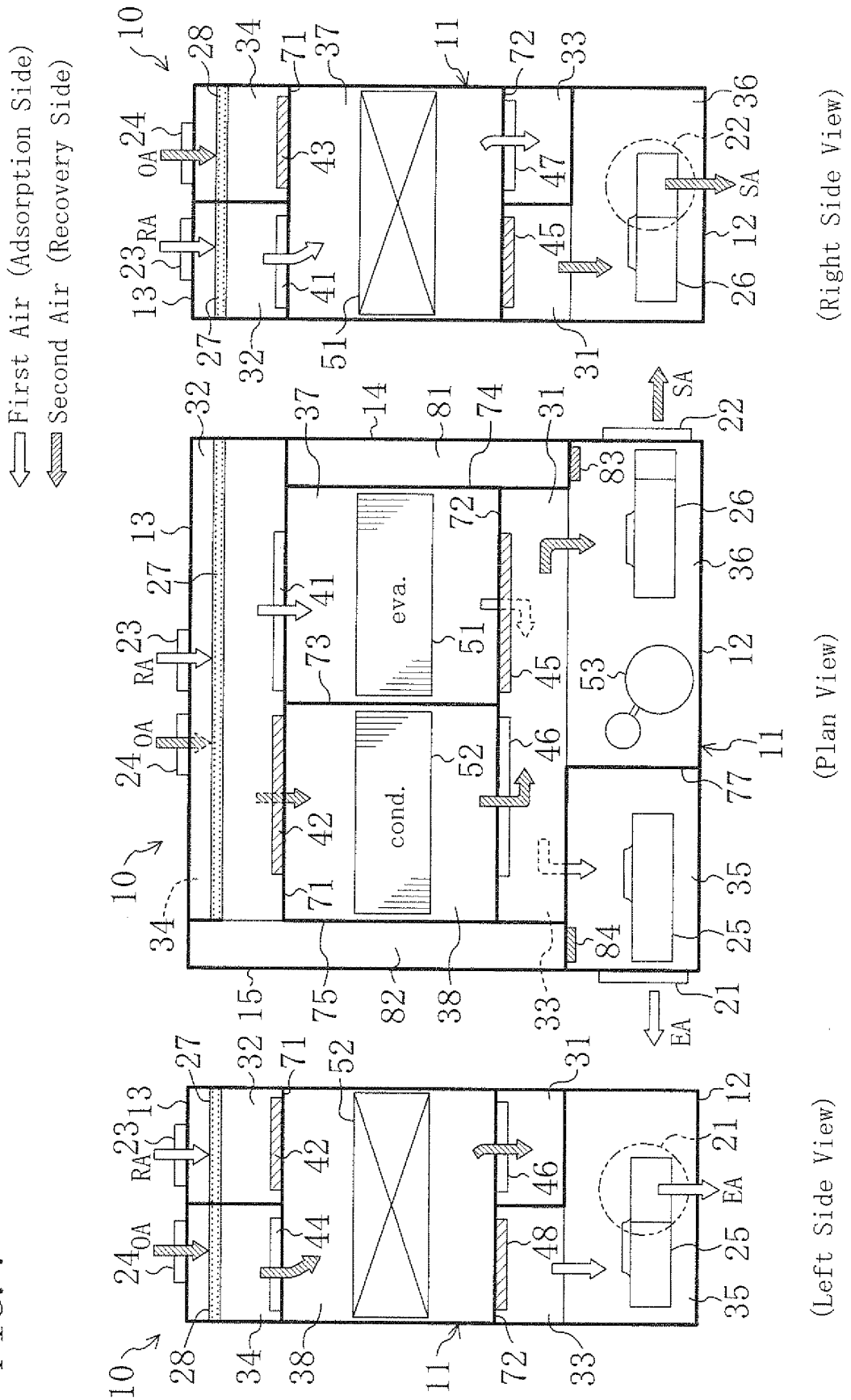

First Air (Adsorption Side)
Second Air (Recovery Side)
eva.
cond.
OA
RA
SA
EA
(Left Side View)
(Plan View)
(Right Side View)

FIG. 8

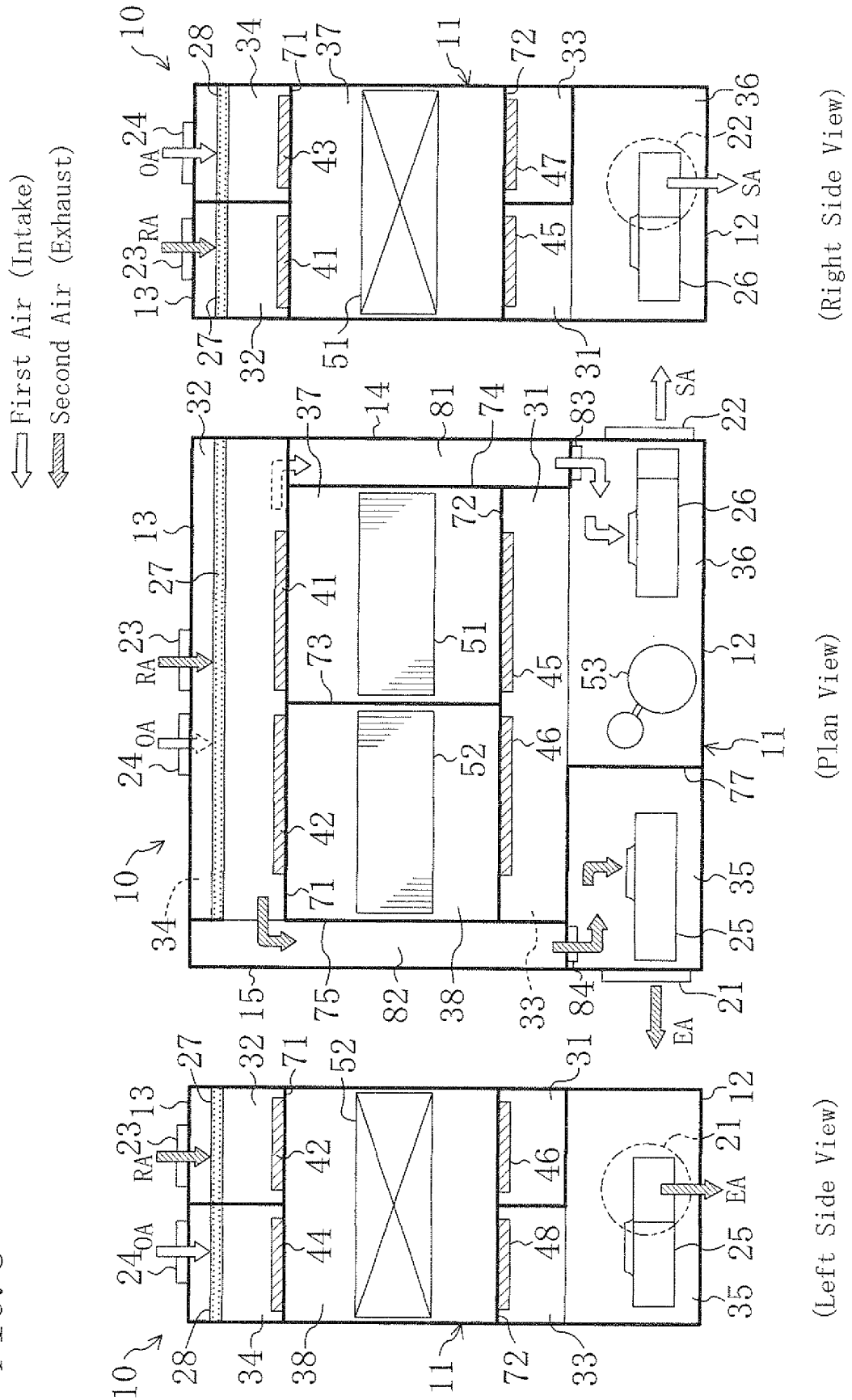

First Air (Intake)
Second Air (Exhaust)
(Left Side View)
(Plan View)
(Right Side View)
RA
OA
SA
EA

FIG. 9

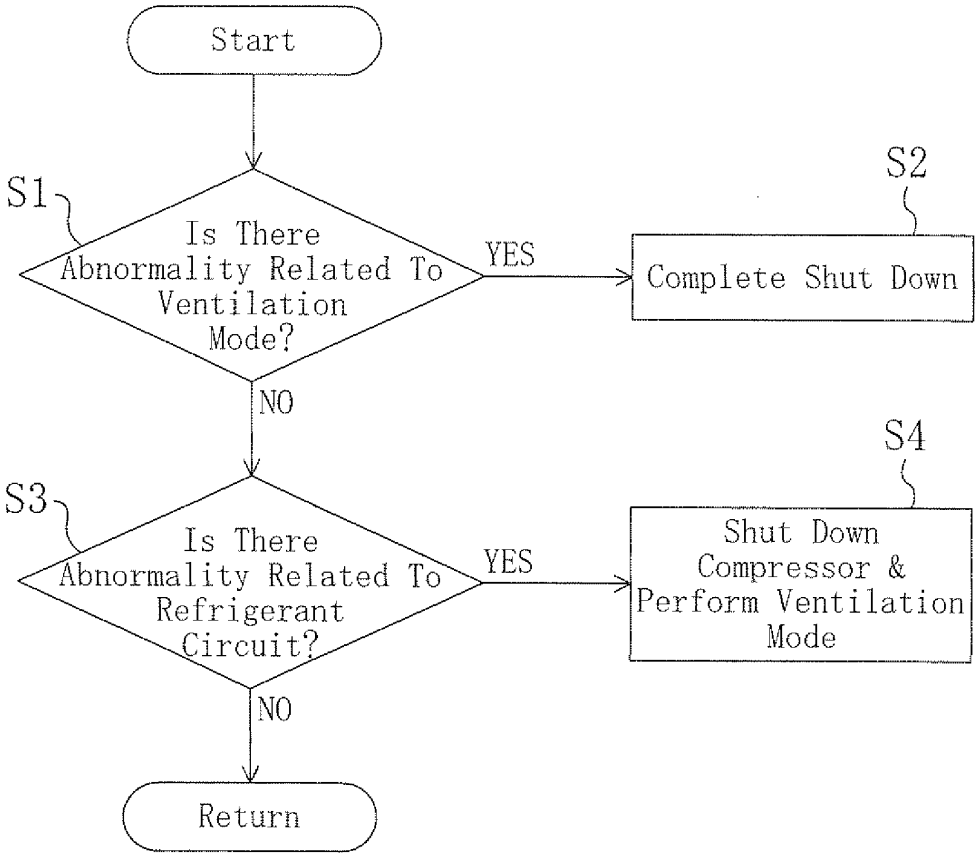
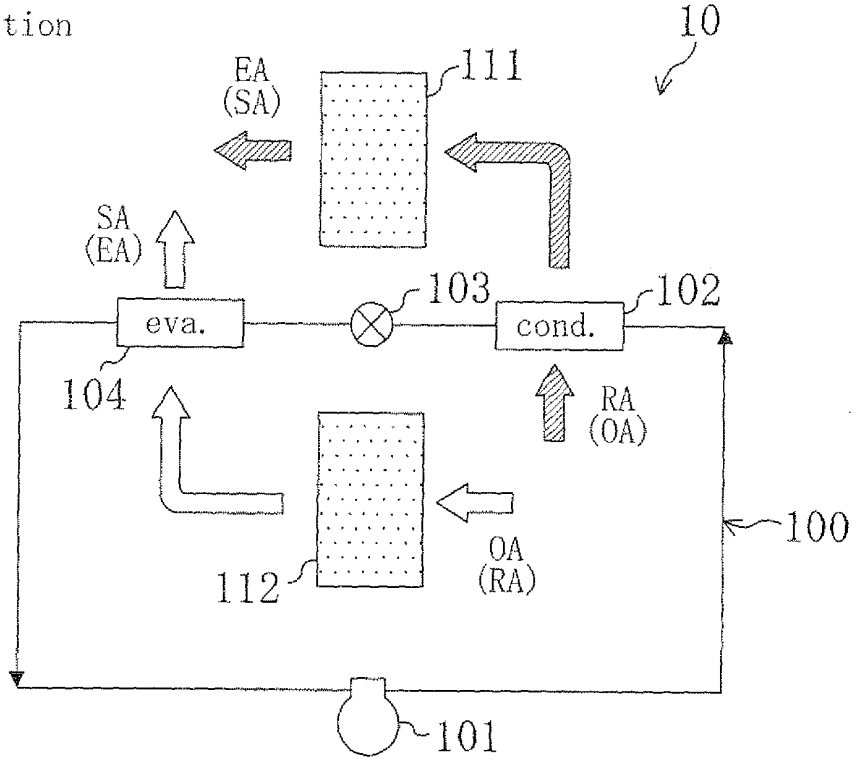

Start
S1
Is There Abnormality Related To Ventilation Mode?
YES
S2
Complete Shut Down
NO
S3
Is There Abnormality Related To Refrigerant Circuit?
YES
S4
Shut Down Compressor & Perform Ventilation Mode
NO
Return

FIG. 10

(A) First Operation



(B) Second Operation

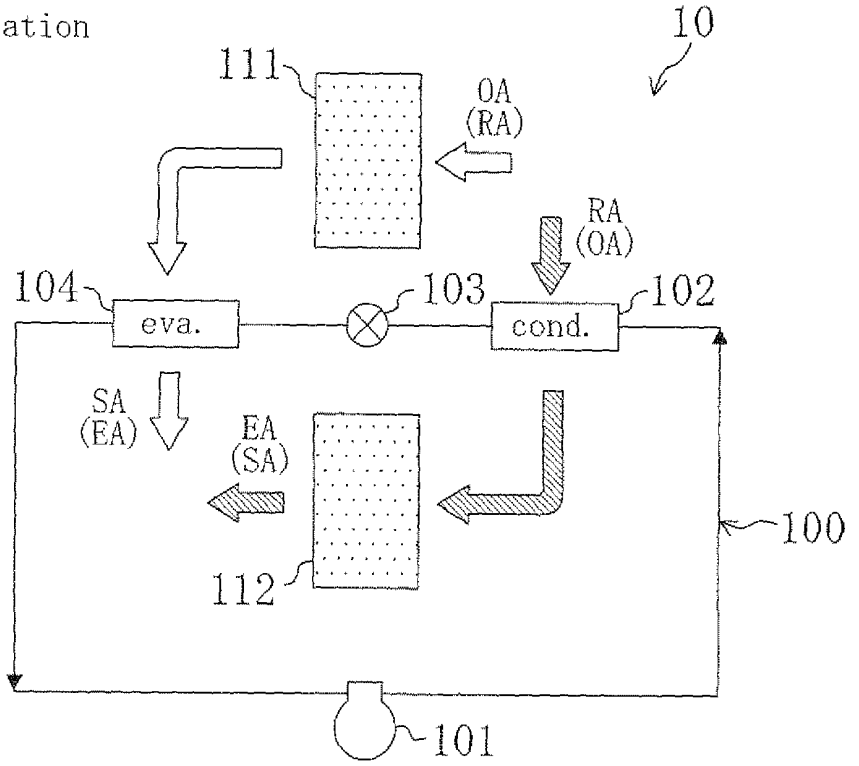
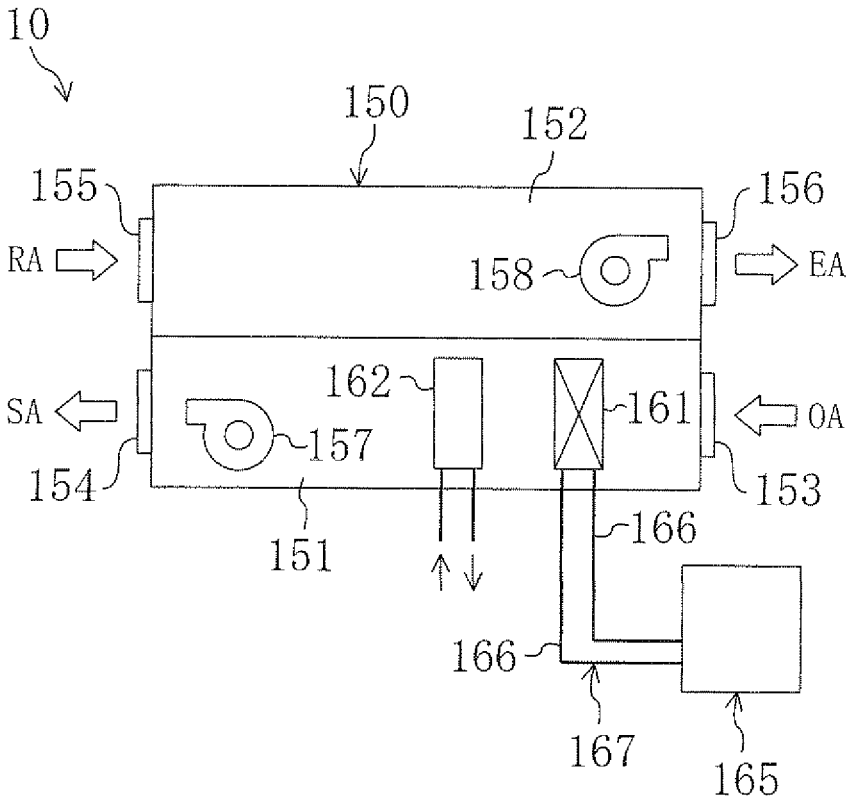


FIG. 11


10
150
152
155
156
RA
158
EA
162
161
SA
157
OA
154
153
151
166
166
167
165

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/003110

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/02(2006.01)i, *F24F3/147*(2006.01)i, *F24F7/007*(2006.01)i, *F24F7/08*(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, F24F3/147, F24F7/007, F24F7/08

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 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-329593 A (Daikin Industries, Ltd.), 07 December, 2006 (07.12.06), Claim 1; Par. Nos. [0087] to [0118] & EP 1890090 A1 & WO 2006/129544 A1 & KR 10-2008-0007407 A & CN 101184957 A	1-5
Y	JP 5-141747 A (Mitsubishi Electric Corp.), 08 June, 1993 (08.06.93), Par. Nos. [0031] to [0033]; Figs. 5 to 7 (Family: none)	1-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 January, 2009 (13.01.09)	27 January, 2009 (27.01.09)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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Patent documents cited in the description

- JP 2005283053 A **[0006]**