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

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

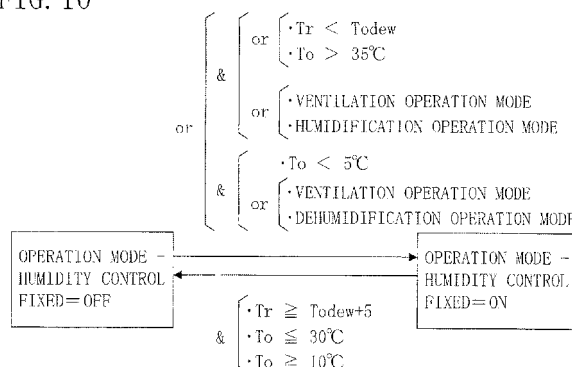
(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **HUMIDITY CONTROL DEVICE**

(57) During a simple ventilation operation, in an outdoor-air conditioner (10) which is a humidity control apparatus, a first bypass damper (83) is opened to supply outdoor air to a room in unchanged form. When the outdoor temperature exceeds 35°C during the simple ventilation operation, an operation of the outdoor-air conditioner (10) is forcibly switched to a dehumidification/ventilation operation, and then outdoor air passing through an adsorption heat exchanger (51, 52) operating as an evaporator is supplied to the room. When the outdoor temperature falls below 5°C during the simple ventilation

operation, the operation of the outdoor-air conditioner (10) is forcibly switched to a humidification/ventilation operation, and then outdoor air passing through the adsorption heat exchanger (51, 52) operating as a condenser is supplied to the room. That is, when the operation of the outdoor-air conditioner (10) is switched from the simple ventilation operation to the dehumidification/ventilation operation or the humidification/ventilation operation, a difference between the temperature of air to be supplied to the room and the room temperature is reduced as compared to that during the simple ventilation operation.

FIG. 10



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Description

TECHNICAL FIELD

[0001] The present invention relates to a humidity control apparatus for controlling air humidity, and ventilating a room.

BACKGROUND ART

[0002] Conventionally, humidity control apparatuses are known, and such a humidity control apparatus performs an operation in which outdoor air is dehumidified to be supplied to a room. Patent Document 1 discloses a humidity control apparatus including adsorption heat exchangers with adsorbent deposited on surfaces thereof. Such a humidity control apparatus performs a so-called "batch" action.

[0003] Specifically, the humidity control apparatus disclosed in Patent Document 1 includes a refrigerant circuit with two adsorption heat exchangers. At predetermined time intervals, the refrigerant circuit alternately performs a first action in which the first adsorption heat exchanger serves as a condenser, and the second adsorption heat exchanger serves as an evaporator; and a second action in which the second adsorption heat exchanger serves as the condenser, and the first adsorption heat exchanger serves as the evaporator. In the adsorption heat exchanger operating as the evaporator, moisture in air adsorbs to the adsorbent, and, at the same time, air temperature drops to some extent. In the adsorption heat exchanger operating as the condenser, moisture desorbs from the adsorbent to be imparted to air, and, at the same time, air temperature rises to some extent.

[0004] The humidity control apparatus disclosed in Patent Document 1 supplies a part of air passing through the adsorption heat exchangers to the room, and discharges the remaining air to outside. During a dehumidification operation, in the humidity control apparatus, outdoor air passing through one of the first and second adsorption heat exchangers, which operates as the evaporator, is supplied to the room; and room air passing through the other adsorption heat exchanger which operates as the condenser is discharged to the outside. During a humidification operation, in the humidity control apparatus, room air passing through one of the first and second adsorption heat exchangers, which operates as the evaporator, is discharged to the outside; and outdoor air passing through the other adsorption heat exchanger which operates as the condenser is supplied to the room.

CITATION LIST

PATENT DOCUMENT

[0005] PATENT DOCUMENT 1: Japanese Patent Publication No. 2006-078108

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0006] As described above, the humidity control apparatus described in Patent Document 1 performs the operation in which the humidity of outdoor air is controlled to supply such air to the room. During transitional periods such as spring and autumn, a loss of comfort may not be caused in the room even if outdoor air is supplied to the room without controlling the humidity of such air. Thus, it is useless to continue the outdoor air humidity control during such periods. However, it is necessary to ventilate the room throughout the year, and therefore it is necessary to continue supplying outdoor air to the room.

[0007] In order to satisfy such requirements, it may be necessary that the humidity control apparatus performs not only a humidity control operation (i.e., dehumidification and humidification operations) in which the humidity of outdoor air is controlled to supply such air to the room, but also a simple ventilation operation in which outdoor air is supplied to the room without controlling the humidity of such air. In such a case, it is conceivable that, if the humidity control operation and the simple ventilation operation are switched based only on user's switching operations etc., the simple ventilation operation is continuously performed even in a case where the humidity control operation is desired. When performing the simple ventilation operation under significantly-high outdoor temperature or significantly-low outdoor temperature, a difference between the room temperature and the temperature of outdoor air to be supplied to the room increases, thereby possibly providing discomfort to person(s) in the room.

[0008] The present invention has been made in view of the foregoing, and it is an object of the present invention to prevent the discomfort from being provided to the person(s) in the room during the simple ventilation operation in the humidity control apparatus which can perform the humidity control operation and the simple ventilation operation.

SOLUTION TO THE PROBLEM

[0009] A first aspect of the invention is intended for a humidity control apparatus. The humidity control apparatus includes at least humidity control means (50, 115, 170) for dehumidifying and cooling air, and enables a dehumidification/ventilation operation in which the humidity control means (50, 115, 170) dehumidifies and cools outdoor air to be supplied to a room, and a simple ventilation operation in which the humidity control means (50, 115, 170) is stopped to supply taken outdoor air to the room in unchanged form. The humidity control apparatus further includes an outdoor temperature detecting means (99) for detecting an outdoor temperature; and a control means (64) for forcibly switching from the simple ventilation operation to the dehumidification/ventilation

operation when the outdoor temperature detected by the outdoor temperature detecting means (99) during the simple ventilation operation exceeds a predetermined maximum value.

[0010] In the first aspect of the invention, the dehumidification/ventilation operation and the simple ventilation operation are performed in a humidity control apparatus (10). A room is generally air-conditioned when an outdoor temperature is high. Outdoor air having a high temperature is supplied to the air-conditioned room in unchanged form, thereby possibly providing discomfort to person(s) in the room. Thus, when the outdoor temperature exceeds the predetermined maximum value during the simple ventilation operation, the control means (64) forcibly switches an operation of the humidity control apparatus (10) from the simple ventilation operation to the dehumidification/ventilation operation. During the dehumidification/ventilation operation, the humidity control means (50, 115, 170) dehumidifies and cools outdoor air. Consequently, when the operation of the humidity control apparatus (10) is switched from the simple ventilation operation to the dehumidification/ventilation operation, air having the temperature lower than the air temperature during the simple ventilation operation is supplied to the room.

[0011] A second aspect of the invention is intended for the humidity control apparatus of the first aspect of the invention, in which the control means (64) stops an outdoor-air supply to the room when the outdoor temperature detected by the outdoor temperature detecting means (99) exceeds the predetermined maximum value in the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited.

[0012] In the humidity control apparatus (10), the dehumidification/ventilation operation may be prohibited. For example, when the humidity control means (50, 115, 170) is not properly operated due to malfunctions etc., the dehumidification/ventilation operation is prohibited. On the other hand, the simple ventilation operation may be carried out even when the humidity control means (50, 115, 170) is not properly operated. In such a case, the simple ventilation operation is performed in the humidity control apparatus (10) under circumstances in which the dehumidification/ventilation operation is prohibited.

[0013] Even during the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited, a difference between the room temperature and the temperature of outdoor air to be supplied to the room is significantly increased, thereby causing a loss of comfort of person(s) in the room. However, since the dehumidification/ventilation operation is prohibited in such a case, a decline in the comfort cannot be prevented by switching the operation of the humidity control apparatus (10) from the simple ventilation operation to the dehumidification/ventilation operation. In such a case, the control means (64) of

the second aspect of the invention stops the outdoor-air supply to the room in order to prevent the decline in the comfort.

[0014] A third aspect of the invention is intended for the humidity control apparatus of the first or second aspect of the invention, in which the humidity control means (50, 115) includes adsorption units (51, 52, 111, 112) with adsorbent to be exposed to air, and dehumidifies air by adsorbing moisture in the air onto the adsorption unit (51, 52, 111, 112).

[0015] In the third aspect of the invention, the adsorption units (51, 52, 111, 112) are provided in the humidity control means (50, 115). During the dehumidification/ventilation operation, the humidity control means (50, 115) allows the adsorbent of the adsorption unit (51, 52, 111, 112) to be exposed to outdoor air, thereby adsorbing moisture in the outdoor air onto the adsorption unit (51, 52, 111, 112).

[0016] A fourth aspect of the invention is intended for a humidity control apparatus. The humidity control apparatus includes at least humidity control means (50, 115, 170) for humidifying and heating air, and enables a humidification/ventilation operation in which the humidity control means (50, 115, 170) humidifies and heats outdoor air to be supplied to a room, and a simple ventilation operation in which the humidity control means (50, 115, 170) is stopped to supply taken outdoor air to the room in unchanged form. The humidity control apparatus further includes outdoor temperature detecting means (99) for detecting an outdoor temperature; and control means (64) for forcibly switching from the simple ventilation operation to the humidification/ventilation operation when the outdoor temperature detected by the outdoor temperature detecting means (99) during the simple ventilation operation falls below a predetermined minimum value.

[0017] In the fourth aspect of the invention, the humidification/ventilation operation and the simple ventilation operation are performed in a humidity control apparatus (10). A room is generally heated when an outdoor temperature is low. Outdoor air having a low temperature is supplied to the heated room in unchanged form, thereby possibly providing discomfort to person(s) in the room. Thus, when the outdoor temperature falls below the predetermined minimum value during the simple ventilation operation, the ventilation control section (64) forcibly switches the operation of the humidity control apparatus (10) from the simple ventilation operation to the humidification/ventilation operation. During the humidification/ventilation operation, the humidity control means (50, 115, 170) humidifies and heats outdoor air. Consequently, when the operation of the humidity control apparatus (10) is switched from the simple ventilation operation to the humidification/ventilation operation, air having the temperature higher than the air temperature during the simple ventilation operation is supplied to the room.

[0018] A fifth aspect of the invention is intended for the humidity control apparatus of the fourth aspect of the

invention, in which the control means (64) stops an outdoor-air supply to the room when the outdoor temperature detected by the outdoor temperature detecting means (99) falls below the predetermined minimum value in the simple ventilation operation performed under circumstances in which the humidification/ventilation operation is prohibited.

[0019] In the humidity control apparatus (10), the humidification/ventilation operation may be prohibited. For example, when the humidity control means (50, 115, 170) is not properly operated due to malfunctions etc., the humidification/ventilation operation is prohibited. On the other hand, the simple ventilation operation may be carried out even when the humidity control means (50, 115, 170) is not properly operated. In such a case, the simple ventilation operation is performed in the humidity control apparatus (10) under circumstances in which the humidification/ventilation operation is prohibited.

[0020] Even during the simple ventilation operation performed under circumstances in which the humidification/ventilation operation is prohibited, the difference between the room temperature and the temperature of outdoor air to be supplied to the room is significantly increased, thereby causing the loss of comfort of person (s) in the room. However, since the humidification/ventilation operation is prohibited in such a case, the decline in the comfort cannot be prevented by switching the operation of the humidity control apparatus (10) from the simple ventilation operation to the humidification/ventilation operation. In such a case, the control means (64) of the fifth aspect of the invention stops the outdoor-air supply to the room in order to prevent the decline in the comfort.

[0021] A sixth aspect of the invention is intended for the humidity control apparatus of the fourth or fifth aspect of the invention, in which the humidity control means (50, 115) includes adsorption units (51, 52, 111, 112) with adsorbent to be exposed to air, and humidifies air by imparting moisture desorbed from the adsorbent of the adsorption unit (51, 52, 111, 112), to the air.

[0022] In the sixth aspect of the invention, the adsorption units (51, 52, 111, 112) are provided in the humidity control means (50, 115). During the humidification/ventilation operation, the humidity control means (50, 115) allows the adsorbent of the adsorption unit (51, 52, 111, 112) to be exposed to outdoor air, thereby imparting moisture desorbed from the adsorbent, to the outdoor air.

[0023] A seventh aspect of the invention is intended for the humidity control apparatus of the third aspect of the invention, in which the humidity control means includes adsorption heat exchangers (51, 52) with adsorbent deposited on surfaces thereof as the adsorption units, and includes a refrigerant circuit (50) in which the adsorption heat exchangers (51, 52) are connected to each other to perform a refrigeration cycle; and the refrigerant circuit (50) performs an adsorption action in which the adsorbent of the adsorption heat exchanger (51, 52) is cooled by refrigerant to adsorb moisture in air onto the

adsorption heat exchanger (51, 52), and a recovery action in which the adsorbent of the adsorption heat exchanger (51, 52) is heated by refrigerant for recovery of the adsorbent in the adsorption heat exchanger (51, 52).

[0024] A eighth aspect of the invention is intended for the humidity control apparatus of the sixth aspect of the invention, in which the humidity control means adsorption heat exchangers (51, 52) with adsorbent deposited on surfaces thereof as the adsorption units, and includes a refrigerant circuit (50) in which the adsorption heat exchangers (51, 52) are connected to each other to perform a refrigeration cycle; and the refrigerant circuit (50) performs an adsorption action in which the adsorbent of the adsorption heat exchanger (51, 52) is cooled by refrigerant to adsorb moisture in air onto the adsorption heat exchanger (51, 52), and a recovery action in which the adsorbent of the adsorption heat exchanger (51, 52) is heated by refrigerant for recovery of the adsorbent in the adsorption heat exchanger (51, 52).

[0025] In the seventh and eighth aspects of the invention, the refrigerant circuit (50) is provided in the humidity control means. The adsorption heat exchangers (51, 52) serving as the adsorption units are connected to the refrigerant circuit (50). The refrigerant circuit (50) performs the adsorption action and the recovery action. During the adsorption action, in the adsorption heat exchanger (51, 52), moisture in air adsorbs to the adsorbent, and adsorption heat generated thereupon is removed by refrigerant. At this point, the air passing through the adsorption heat exchanger (51, 52) during the adsorption action is cooled by refrigerant, thereby decreasing the temperature thereof to some extent. During the recovery action, in the adsorption heat exchanger (51, 52), moisture desorbs from the adsorbent heated by refrigerant. At this point, the air passing through the adsorption heat exchanger (51, 52) during the recovery action is heated by refrigerant, thereby increasing the temperature thereof to some extent. In the refrigerant circuit (50) of these aspects of the invention, a single adsorption heat exchanger may be connected to selectively perform the adsorption action and the recovery action, or two adsorption heat exchangers may be connected to each other so that the adsorption action in one of the adsorption heat exchangers, and the recovery action in the other adsorption heat exchanger are performed simultaneously, i.e., in parallel.

ADVANTAGES OF THE INVENTION

[0026] In the first aspect of the invention, when the outdoor temperature exceeds the predetermined maximum value during the simple ventilation operation, the control means (64) forcibly switches the operation of the humidity control apparatus (10) from the simple ventilation operation to the dehumidification/ventilation operation, thereby decreasing the temperature of air sent into the room. In addition, in the fourth aspect of the invention, when the outdoor temperature falls below the predeter-

mined minimum value during the simple ventilation operation, the control means (64) forcibly switches the operation of the humidity control apparatus (10) from the simple ventilation operation to the humidification/ventilation operation, thereby increasing the temperature of air sent into the room. Thus, according to the present invention, the difference between the temperature of air supplied from the humidity control apparatus (10) to the room and the room temperature can be prevented from increasing, thereby ensuring the comfort in the room.

[0027] In the second aspect of the invention, when the outdoor temperature exceeds the predetermined maximum value during the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited, the control means (64) stops the outdoor-air supply to the room. In addition, in the fifth aspect of the invention, when outdoor temperature falls below the predetermined minimum value during the simple ventilation operation performed under circumstances in which the humidification/ventilation operation is prohibited, the control means (64) stops the outdoor-air supply to the room. Thus, according to these aspects of the invention, even if the dehumidification/ventilation operation or the humidification/ventilation operation cannot be carried out, the decline in the comfort in the room can be reliably prevented.

[0028] In the seventh and eighth aspects of the invention, the refrigerant circuit (50) provided in the humidity control means performs the adsorption action and the recovery action. The dehumidification and cooling of air are performed in parallel in the adsorption heat exchanger (51, 52) during the adsorption action, and the humidification and heating of air are performed in parallel in the adsorption heat exchanger (51, 52) during the recovery action. That is, in the humidity control means, the air humidity and temperature controls are performed at a single section. Thus, according to these aspects of the invention, the structure of the outdoor-air conditioner (10) can be simplified as compared to a case where the air humidity and temperature controls are performed by using separate members.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

[FIG. 1] FIG. 1 is a perspective view of an outdoor-air conditioner as viewed from a front side, which is illustrated without a part of a casing and an electrical component box.

[FIG. 2] FIGS. 2 are plan, right side, and left side views which are schematically illustrated without a part of the outdoor-air conditioner.

[FIG. 3] FIGS. 3 are plumbing diagrams illustrating a structure of a refrigerant circuit. FIG. 3(A) illustrates a first action. FIG. 3(B) illustrates a second action.

[FIG. 4] FIGS. 4 are schematic plan, right side, and left side views of the outdoor-air conditioner, which

illustrate an air flow in a first action of a dehumidification/ventilation operation.

[FIG. 5] FIGS. 5 are schematic plan, right side, and left side views of the outdoor-air conditioner, which illustrate an air flow in a second action of the dehumidification/ventilation operation.

[FIG. 6] FIGS. 6 are schematic plan, right side, and left side views of the outdoor-air conditioner, which illustrate an air flow in a first action of a humidification/ventilation operation.

[FIG. 7] FIGS. 7 are schematic plan, right side, and left side views of the outdoor-air conditioner, which illustrate an air flow in a second action of the humidification/ventilation operation.

[FIG. 8] FIGS. 8 are schematic plan, right side, and left side views of the outdoor-air conditioner, which illustrate an air flow in a simple ventilation operation.

[FIG. 9] FIG. 9 is a block diagram of a structure of a controller (60) of the outdoor-air conditioner.

[FIG. 10] FIG. 10 is a state transition diagram of an action performed by a ventilation control section (64) of the controller (60).

[FIG. 11] FIG. 11 is a state transition diagram of an action performed by the ventilation control section (64) of the controller (60).

[FIG. 12] FIGS. 12 are schematic diagrams of a structure of an outdoor-air conditioner of a third variation of an embodiment. FIG. 12(A) illustrates a first action. FIG. 12(B) illustrates a second action.

[FIG. 13] FIG. 13 is a schematic diagram of a structure of an outdoor-air conditioner of a fourth variation of the embodiment.

DESCRIPTION OF REFERENCE CHARACTERS

[0030]

10	Outdoor-Air Conditioner (Humidity Control Apparatus)
50	Refrigerant Circuit (Humidity Control Means)
51	First Adsorption Heat Exchanger (Adsorption Unit)
52	Second Adsorption Heat Exchanger (Adsorption Unit)
64	Ventilation Control Section (Control Means)
99	External-Air Temperature Sensor (Outdoor-Air Temperature Detecting Means)
111	First Adsorption Element (Adsorption Unit)
112	Second Adsorption Element (Adsorption Unit)
115	Humidity Control Means
170	Humidity Control Means

DESCRIPTION OF EMBODIMENTS

[0031] An embodiment of the present invention will be described in detail hereinafter with reference to the drawings. An outdoor-air conditioner (10) of the present embodiment is for controlling humidity in a room, and ven-

tilating the room, and serves as a humidity control apparatus. The outdoor-air conditioner (10) controls the humidity of taken outdoor air (OA) to supply such air to the room, and, at the same time, discharges taken room air (RA) to outside.

<Entire Structure of Outdoor-Air Conditioner

[0032] The outdoor-air conditioner (10) will be described with reference to FIGS. 1 and 2 as necessary. Unless otherwise specified, terms "upper," "lower," "left," "right," "front," "rear," "near," and "back" used herein designate directions when the outdoor-air conditioner (10) is viewed from a frontal side.

[0033] The outdoor-air conditioner (10) includes a casing (11). A refrigerant circuit (50) is accommodated in the casing (11). In the refrigerant circuit (50), a first adsorption heat exchanger (51), a second adsorption heat exchanger (52), a compressor (53), a four-way switching valve (54), and an electric-operated expansion valve (55) are connected to each other. The refrigerant circuit (50) will be described in detail later.

[0034] The casing (11) is formed in an approximately-flat rectangular-parallelepiped shape with a relatively-low height. In the casing (11) illustrated in FIG. 1, a side surface on a near-left side (i.e., frontal surface) serves as a frontal panel section (12); a side surface on a back-right side (i.e., dorsal surface) serves as a dorsal panel section (13); a side surface on a near-right side serves as a first side panel section (14); and a side surface on a back-left side serves as a second side panel section (15).

[0035] The casing (11) includes an outdoor air suction port (24); a room air suction port (23); an air supply port (22); and an air discharge port (21). The outdoor air suction port (24) and the room air suction port (23) open in the dorsal panel section (13). The outdoor air suction port (24) is arranged in a lower portion of the dorsal panel section (13). The room air suction port (23) is arranged in an upper portion of the dorsal panel section (13). The air supply port (22) is arranged close to an end portion of the first side panel section (14) on the frontal panel section (12) side. The air discharge port (21) is arranged close to an end portion of the second side panel section (15) on the frontal panel section (12) side.

[0036] An inner space of the casing (11) includes an upstream partition plate (71); a downstream partition plate (72); a central partition plate (73); a first partition plate (74); and a second partition plate (75). The partition plates (71-75) are vertically arranged on a bottom plate of the casing (11), and extend from the bottom plate to an top plate of the casing (11) to divide the inner space of the casing (11).

[0037] The upstream partition plate (71) and the downstream partition plate (72) are arranged in a front-rear direction of the casing (11) at predetermined intervals so as to be parallel to the frontal panel section (12) and the dorsal panel section (13). The upstream partition plate (71) is arranged closer to the dorsal panel section (13).

The downstream partition plate (72) is arranged closer to the frontal panel section (12).

[0038] The first partition plate (74) and the second partition plate (75) are arranged so as to be parallel to the first side panel section (14) and the second side panel section (15). The first partition plate (74) is arranged at a predetermined interval from the first side panel section (14) so as to close a space between the upstream partition plate (71) and the downstream partition plate (72) from the right side. The second partition plate (75) is arranged at a predetermined interval from the second side panel section (15) so as to close the space between the upstream partition plate (71) and the downstream partition plate (72) from the left side.

[0039] The central partition plate (73) is arranged between the upstream partition plate (71) and the downstream partition plate (72) so as to be perpendicular to the upstream partition plate (71) and the downstream partition plate (72). The central partition plate (73) is provided so as to extend from the upstream partition plate (71) to the downstream partition plate (72), and divides the space between the upstream partition plate (71) and the downstream partition plate (72) into right and left spaces.

[0040] In the casing (11), a space between the upstream partition plate (71) and the dorsal panel section (13) is divided into two upper and lower spaces. The upper space serves as a room air path (32), and the lower space serves as an outdoor air path (34). The room air path (32) communicates with the room through a duct connected to the room air suction port (23). In the room air path (32), a room air filter (27), a room air humidity sensor (96), and a room air temperature sensor (98) are installed. The outdoor air path (34) communicates with an outdoor space through a duct connected to the outdoor air suction port (24). In the outdoor air path (34), an outdoor air filter (28), an outdoor air humidity sensor (97), and an outdoor air temperature sensor (99) are installed.

[0041] The room air humidity sensor (96) measures the relative humidity of room air flowing into the room air path (32). The room air temperature sensor (98) measures the temperature of room air flowing into the room air path (32). The room air temperature sensor (98) serves as a room temperature detecting means for detecting a room temperature. The outdoor air humidity sensor (97) measures the relative humidity of outdoor air flowing into the outdoor air path (34). The outdoor air temperature sensor (99) measures the temperature of outdoor air flowing into the outdoor air path (34). The outdoor air temperature sensor (99) serves as an outdoor temperature detecting means for detecting an outdoor temperature.

[0042] The space between the upstream partition plate (71) and the downstream partition plate (72) in the casing (11) is divided into the right and left spaces by the central partition plate (73). The right space with respect to the central partition plate (73) serves as a first heat exchange chamber (37), and the left space with respect to the cen-

tral partition plate (73) serves as a second heat exchange chamber (38). The first adsorption heat exchanger (51) is accommodated in the first heat exchange chamber (37). The second adsorption heat exchanger (52) is accommodated in the second heat exchange chamber (38). Although not illustrated in the figure, the electric-operated expansion valve (55) of the refrigerant circuit (50) is accommodated in the first heat exchange chamber (37).

[0043] Each of the adsorption heat exchangers (51, 52) is a so-called "cross-fin-type fin-and-tube heat exchanger" with adsorbent deposited on a surface thereof, and is formed in a thick rectangular plate-like shape or a flat rectangular-parallelepiped shape as a whole. The adsorption heat exchangers (51, 52) serve as adsorption units for exposing the adsorbent to air. The adsorption heat exchangers (51, 52) are vertically arranged in the heat exchange chambers (37, 38) so that frontal and dorsal surfaces thereof are parallel to the upstream partition plate (71) and the downstream partition plate (72).

[0044] In the inner space of the casing (11), a space along a frontal surface of the downstream partition plate (72) is divided into upper and lower spaces. The upper portion of the horizontally-divided spaces serves as an air supply path (31), and the lower portion serves as an air discharge path (33).

[0045] Four openable dampers (41-44) are provided in the upstream partition plate (71). Each of the dampers (41-44) is formed in an approximately horizontally-elongated rectangular shape. Specifically, in a portion of the upstream partition plate (71), which faces the room air path (32) (upper portion), a first room air damper (41) is attached on the right side with respect to the central partition plate (73), and a second room air damper (42) is attached on the left side with respect to the central partition plate (73). In a portion of the upstream partition plate (71), which faces the outdoor air path (34) (lower portion), a first outdoor air damper (43) is attached on the right side with respect to the central partition plate (73), and a second outdoor air damper (44) is attached on the left side with respect to the central partition plate (73).

[0046] Four openable dampers (45-48) are provided in the downstream partition plate (72). Each of the dampers (45-48) is formed in an approximately horizontally-elongated rectangular shape. Specifically, in a portion of the downstream partition plate (72), which faces the air supply path (31) (upper portion), a first air supply damper (45) is attached on the right side with respect to the central partition plate (73), and a second air supply damper (46) is attached on the left side with respect to the central partition plate (73). In a portion of the downstream partition plate (72), which faces the air discharge path (33) (lower portion), a first air discharge damper (47) is attached on the right side with respect to the central partition plate (73), and a second air discharge damper (48) is attached on the left side with respect to the central partition plate (73).

[0047] In the casing (11), a space between the air sup-

ply path (31) and the air discharge path (33), and the frontal panel section (12) is divided into right and left spaces by a partition plate (77). The right space with respect to the partition plate (77) serves as an air supply fan chamber (36), and the left space with respect to the partition plate (77) serves as an air discharge fan chamber (35).

[0048] An air supply fan (26) is accommodated in the air supply fan chamber (36). An air discharge fan (25) is accommodated in the air discharge fan chamber (35). The air supply fan (26) and the air discharge fan (25) are centrifugal multi-blade fans (so-called "sirocco" fans). The air supply fan (26) blows air sucked from the downstream partition plate (72) side, through the air supply port (22). The air discharge fan (25) blows air sucked from the downstream partition plate (72) side, through the air discharge port (21).

[0049] The compressor (53) and the four-way switching valve (54) of the refrigerant circuit (50) are accommodated in the air supply fan chamber (36). The compressor (53) and the four-way switching valve (54) are arranged between the air supply fan (26) and the partition plate (77) in the air supply fan chamber (36).

[0050] In the casing (11), a space between the first partition plate (74) and the first side panel section (14) serves as a first bypass path (81). A start point of the first bypass path (81) communicates only with the outdoor air path (34), and is isolated from the room air path (32). A terminal point of the first bypass path (81) is separated from the air supply path (31), the air discharge path (33), and the air supply fan chamber (36) by a partition plate (78). A portion of the partition plate (78), which faces the air supply fan chamber (36), is provided with a first bypass damper (83).

[0051] In the casing (11), a space between the second partition plate (75) and the second side panel section (15) serves as a second bypass path (82). A start point of the second bypass path (82) communicates only with the room air path (32), and is isolated from the outdoor air path (34). A terminal point of the second bypass path (82) is separated from the air supply path (31), the air discharge path (33), and the air discharge fan chamber (35) by a partition plate (79). A portion of the partition plate (79), which faces the air discharge fan chamber (35), is provided with a second bypass damper (84).

[0052] The right and left side views of FIGS. 2 are illustrated without the first bypass path (81), the second bypass path (82), the first bypass damper (83), and the second bypass damper (84).

<Structure of Refrigerant Circuit>

[0053] As illustrated in FIGS. 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-operated expansion valve (55). In the refrigerant circuit (50), filled refrigerant circulates to

perform a vapor compression refrigeration cycle. The refrigerant circuit (50) serves as a humidity control means.

[0054] In the refrigerant circuit (50), a discharge side of the compressor (53) is connected to a first port of the four-way switching valve (54), and a suction side thereof is connected to a second port of the four-way switching valve (54). In addition, in the refrigerant circuit (50), the first adsorption heat exchanger (51), the electric-operated expansion valve (55), and the second adsorption heat exchanger (52) are sequentially connected to each other from a third port toward a fourth port of the four-way switching valve (54).

[0055] The four-way switching valve (54) can be switched between a first state (state illustrated in FIG. 3 (A)) in which the first port communicates with the third port with the second port communicating with the fourth port, and a second state (state illustrated in FIG. 3(B)) in which the first port communicates with the fourth port with the second port communicating with the third port.

[0056] In the refrigerant circuit (50), a high-pressure sensor (91) and a discharge pipe temperature sensor (93) are attached to a pipe connecting between the discharge side of the compressor (53) and the first port of the four-way switching valve (54). The high-pressure sensor (91) measures the pressure of refrigerant discharged from the compressor (53). The discharge pipe temperature sensor (93) measures the temperature of refrigerant discharged from the compressor (53).

[0057] In addition, in the refrigerant circuit (50), a low-pressure sensor (92) and a suction pipe temperature sensor (94) are attached to a pipe connecting between the suction side of the compressor (53) and the second port of the four-way switching valve (54). The low-pressure sensor (92) measures the pressure of refrigerant sucked into the compressor (53). The suction pipe temperature sensor (94) measures the temperature of refrigerant sucked into the compressor (53).

[0058] Further, in the refrigerant circuit (50), a pipe temperature sensor (95) is attached to a pipe connecting between the third port of the four-way switching valve (54) and the first adsorption heat exchanger (51). The pipe temperature sensor (95) is arranged close to the four-way switching valve (54) in such a pipe, and measures the temperature of refrigerant flowing through the pipe.

<Structure of Controller>

[0059] A controller (60) is provided in the outdoor-air conditioner (10). Although not illustrated in FIGS. 1 and 2, an electrical component box is attached to the frontal panel section (12) of the casing (11), and a control board accommodated in the electrical component box serves as the controller (60).

[0060] As illustrated in FIG. 9, the controller (60) includes an outdoor air absolute humidity calculating section (61); an outdoor air dew-point temperature calculating section (62); an operation command input section

(63); and a ventilation control section (64). Measured values of the room air humidity sensor (96), the room air temperature sensor (98), the outdoor air humidity sensor (97), and the outdoor air temperature sensor (99) are inputted to the controller (60). Further, measured values of the sensors (91, 92, ...) provided in the refrigerant circuit (50) are inputted to the controller (60). The controller (60) controls an operation of the outdoor-air conditioner (10) based on such inputted measured values.

[0061] The outdoor air absolute humidity calculating section (61) calculates the absolute humidity of outdoor air by using the outdoor air relative humidity measured by the outdoor air humidity sensor (97), and using the outdoor air temperature measured by the outdoor air temperature sensor (99). The outdoor air dew-point temperature calculating section (62) calculates the dew-point temperature of outdoor air by using the outdoor air absolute humidity calculated by the outdoor air absolute humidity calculating section (61). As described above, in the outdoor-air conditioner (10) of the present embodiment, an outdoor dew-point temperature detecting means (65) is constituted by the outdoor air humidity sensor (97), the outdoor air temperature sensor (99), the outdoor air absolute humidity calculating section (61), and the outdoor air dew-point temperature calculating section (62).

[0062] A command signal is inputted to the operation command input section (63) by a user with a remote controller etc. In the outdoor-air conditioner (10) of the present embodiment, four operation modes (dehumidification mode, humidification mode, humidity control mode, and ventilation mode) can be selected. Basically, only a dehumidification/ventilation operation which will be described later is performed in the dehumidification mode; only a humidification/ventilation operation which will be described later is performed in the humidification mode; and only a simple ventilation operation which will be described later is performed in the ventilation mode. In addition, basically, one of the dehumidification/ventilation operation and the humidification/ventilation operation is automatically selected in the humidity control mode. When a user selects any of the four operation modes by an operation of a remote controller etc., a command signal corresponding to the selected operation mode is inputted to the operation command input section (63). The controller (60) controls actions of the dampers (41-48) etc. so that the operation mode corresponding to the command signal inputted to the operation command input section (63) is executed in the outdoor-air conditioner (10).

[0063] When predetermined conditions are satisfied, the ventilation control section (64) forcibly switches the operation of the outdoor-air conditioner (10) to either one of the dehumidification/ventilation operation and the humidification/ventilation operation. When the predetermined conditions are satisfied during the simple ventilation operation, the ventilation control section (64) forcibly stops the air supply fan (26). As described above, the

ventilation control section (64) serves as a control means. A control operation of the ventilation control section (64) will be described in detail later.

Operation

[0064] The outdoor-air conditioner (10) of the present embodiment selectively performs the dehumidification/ventilation operation, the humidification/ventilation operation, and the simple ventilation operation. During the dehumidification/ventilation operation or the humidification/ventilation operation, the outdoor-air conditioner (10) controls the humidity of taken outdoor air (OA) to supply such air to the room as supply air (SA), and, at the same time, discharges taken room air (RA) to the outside as exhaust air (EA). On the other hand, during the simple ventilation operation, the outdoor-air conditioner (10) supplies taken outdoor air (OA) to the room as supply air (SA) in unchanged form, and, at the same time, discharges taken room air (RA) to the outside as exhaust air (EA) in unchanged form.

<Dehumidification/Ventilation Operation>

[0065] In the dehumidification/ventilation operation, the outdoor-air conditioner (10) alternately repeats first and second actions which will be described later, at predetermined time intervals (e.g., three-minute intervals). During the dehumidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0066] In the dehumidification/ventilation operation, the outdoor-air conditioner (10) takes outdoor air into the casing (11) through the outdoor air suction port (24) as first air, and takes room air into the casing (11) through the room air suction port (23) as second air.

[0067] First, the first action of the dehumidification/ventilation operation will be described. As illustrated in FIGS. 4, during the first action, the first room air damper (41), the second outdoor air damper (44), the second air supply damper (46), and the first air discharge damper (47) are opened; and the second room air damper (42), the first outdoor air damper (43), the first air supply damper (45), and the second air discharge damper (48) are closed. During the first action, the four-way switching valve (54) is set to the first state (state illustrated in FIG. 3(A)) in the refrigerant circuit (50). The first adsorption heat exchanger (51) serves as a condenser, and the second adsorption heat exchanger (52) serves as an evaporator. That is, in the refrigerant circuit (50), a recovery action in the first adsorption heat exchanger (51) and an adsorption action in the second adsorption heat exchanger (52) are performed simultaneously, i.e., in parallel.

[0068] The first air flows into the outdoor air path (34) to pass through the outdoor air filter (28), and then flows into the second heat exchange chamber (38) through the second outdoor air damper (44). Subsequently, the first air passes through the second adsorption heat exchanger

(52). In the second adsorption heat exchanger (52), moisture in the first air adsorbs to the adsorbent, and then adsorption heat generated thereupon is absorbed by refrigerant. The first air dehumidified in the second adsorption heat exchanger (52) flows into the air supply path (31) through the second air supply damper (46). After the first air passes through the air supply fan chamber (36), the first air is supplied to the room through the air supply port (22).

[0069] On the other hand, the second air flows into the room air path (32) to pass through the room air filter (27), and then flows into the first heat exchange chamber (37) through the first room air damper (41). Subsequently, the second air passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture desorbs from the adsorbent heated by refrigerant, and then the desorbed moisture is imparted to the second air. The second air to which moisture is imparted in the first adsorption heat exchanger (51) flows into the air discharge path (33) through the first air discharge damper (47). After the second air passes through the air discharge fan chamber (35), the second air is discharged to the outside through the air discharge port (21).

[0070] Next, the second action of the dehumidification/ventilation operation will be described. As illustrated in FIGS. 5, during the second action, the second room air damper (42), the first outdoor air damper (43), the first air supply damper (45), and the second air discharge damper (48) are opened; and the first room air damper (41), the second outdoor air damper (44), the second air supply damper (46), and the first air discharge damper (47) are closed. During the second action, the four-way switching valve (54) is set to the second state (state illustrated in FIG. 3(B)) in the refrigerant circuit (50). The first adsorption heat exchanger (51) serves as the evaporator, and the second adsorption heat exchanger (52) serves as the condenser. That is, in the refrigerant circuit (50), the adsorption action in the first adsorption heat exchanger (51) and the recovery action in the second adsorption heat exchanger (52) are performed simultaneously, i.e., in parallel.

[0071] The first air flows into the outdoor air path (34) to pass through the outdoor air filter (28), and then flows into the first heat exchange chamber (37) through the first outdoor air damper (43). Subsequently, the first air passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air adsorbs to the adsorbent, and then adsorption heat generated thereupon is absorbed by refrigerant. The first air dehumidified in the first adsorption heat exchanger (51) flows into the air supply path (31) through the first air supply damper (45). After the first air passes through the air supply fan chamber (36), the first air is supplied to the room through the air supply port (22).

[0072] On the other hand, the second air flows into the room air path (32) to pass through the room air filter (27), and then flows into the second heat exchange chamber (38) through the second room air damper (42). Subse-

quently, the second air passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture desorbs from the adsorbent heated by refrigerant, and then the desorbed moisture is imparted to the second air. The second air to which moisture is imparted in the second adsorption heat exchanger (52) flows into the air discharge path (33) through the second air discharge damper (48). After the second air passes through the air discharge fan chamber (35), the second air is discharged to the outside through the air discharge port (21).

<Humidification/Ventilation Operation>

[0073] In the humidification/ventilation operation, the outdoor-air conditioner (10) alternately repeats first and second actions which will be described later, at predetermined time intervals (e.g., four-minute intervals). During the humidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0074] In the humidification/ventilation operation, the outdoor-air conditioner (10) takes outdoor air into the casing (11) through the outdoor air suction port (24) as second air, and takes room air into the casing (11) through the room air suction port (23) as first air.

[0075] First, the first action of the humidification/ventilation operation will be described. As illustrated in FIGS. 6, during the first action, the second room air damper (42), the first outdoor air damper (43), the first air supply damper (45), and the second air discharge damper (48) are opened; and the first room air damper (41), the second outdoor air damper (44), the second air supply damper (46), and first air discharge damper (47) are closed. During the first action, the four-way switching valve (54) is set to the first state (state illustrated in FIG. 3(A)) in the refrigerant circuit (50). The first adsorption heat exchanger (51) serves as the condenser, and the second adsorption heat exchanger (52) serves as the evaporator. That is, in the refrigerant circuit (50), the recovery action in the first adsorption heat exchanger (51) and the adsorption action in the second adsorption heat exchanger (52) are performed simultaneously, i.e., in parallel.

[0076] The first air flows into the room air path (32) to pass through the room air filter (27), and then flows into the second heat exchange chamber (38) through the second room air damper (42). Subsequently, the first air passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture in the first air adsorbs to the adsorbent, and then adsorption heat generated thereupon is absorbed by refrigerant. The first air from which moisture is removed in the second adsorption heat exchanger (52) flows into the air discharge path (33) through the second air discharge damper (48). After the first air passes through the air discharge fan chamber (35), the first air is discharged to the outside through the air discharge port (21).

[0077] On the other hand, the second air flows into the

outdoor air path (34) to pass through the outdoor air filter (28), and then flows into the first heat exchange chamber (37) through the first outdoor air damper (43). Subsequently, the second air passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture desorbs from the adsorbent heated by refrigerant, and then the desorbed moisture is imparted to the second air. The second air humidified in the first adsorption heat exchanger (51) flows into the air supply path (31) through the first air supply damper (45). After the second air passes through the air supply fan chamber (36), the second air is supplied to the room through the air supply port (22).

[0078] Next, the second action of the humidification/ventilation operation will be described. As illustrated in FIGS. 7, during the second action, the first room air damper (41), the second outdoor air damper (44), the second air supply damper (46), and the first air discharge damper (47) are opened; and the second room air damper (42), the first outdoor air damper (43), the first air supply damper (45), and the second air discharge damper (48) are closed. During the second action, the four-way switching valve (54) is set to the second state (state illustrated in FIG. 3(B)) in the refrigerant circuit (50). The first adsorption heat exchanger (51) serves as the evaporator, and the second adsorption heat exchanger (52) serves as the condenser. That is, in the refrigerant circuit (50), the adsorption action in the first adsorption heat exchanger (51) and the recovery action in the second adsorption heat exchanger (52) are performed simultaneously, i.e., in parallel.

[0079] The first air flows into the room air path (32) to pass through the room air filter (27), and then flows into the first heat exchange chamber (37) through the first room air damper (41). Subsequently, the first air passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air adsorbs to the adsorbent, and then adsorption heat generated thereupon is absorbed by refrigerant. The first air from which moisture is removed in the first adsorption heat exchanger (51) flows into the air discharge path (33) through the first air discharge damper (47). After the first air passes through the air discharge fan chamber (35), the first air is discharged to the outside through the air discharge port (21).

[0080] On the other hand, the second air flows into the outdoor air path (34) to pass through the outdoor air filter (28), and then flows into the second heat exchange chamber (38) through the second outdoor air damper (44). Subsequently, the second air passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture desorbs from the adsorbent heated by refrigerant, and then the desorbed moisture is imparted to the second air. The second air humidified in the second adsorption heat exchanger (52) flows into the air supply path (31) through the second air supply damper (46). After the second air passes through the air supply fan chamber (36), the second air

is supplied to the room through the air supply port (22).

<Simple Ventilation Operation>

[0081] An action of the outdoor-air conditioner (10) in the simple ventilation operation will be described with reference to FIGS. 8.

[0082] During the simple ventilation operation, in the outdoor-air conditioner (10), the first bypass damper (83) and the second bypass damper (84) are opened; and the first room air damper (41), the second room air damper (42), the first outdoor air damper (43), the second outdoor air damper (44), the first air supply damper (45), the second air supply damper (46), the first air discharge damper (47), and the second air discharge damper (48) are closed. Further, in the simple ventilation operation, the compressor (53) of the refrigerant circuit (50) is stopped.

[0083] During the simple ventilation operation, in the outdoor-air conditioner (10), outdoor air is taken into the casing (11) through the outdoor air suction port (24). The outdoor air flows into the outdoor air path (34) through the outdoor air suction port (24), and then flows from the first bypass path (81) into the air supply fan chamber (36) through the first bypass damper (83). Subsequently, the outdoor air is supplied to the room through the air supply port (22).

[0084] Further, during the simple ventilation operation, in the outdoor-air conditioner (10), room air is taken into the casing (11) through the room air suction port (23). The room air flows into the room air path (32) through the room air suction port (23), and then flows from the second bypass path (82) into the air discharge fan chamber (35) through the second bypass damper (84). Subsequently, the room air is discharged to the outside through the air discharge port (21).

Control Operation of Controller

[0085] The control operation performed by the ventilation control section (64) of the controller (60) will be described. A room air temperature T_r measured by the room air temperature sensor (98), an outdoor air temperature T_o measured by the outdoor air temperature sensor (99), and an outdoor air dew-point temperature T_{dew} calculated in the outdoor air dew-point temperature calculating section (62) are inputted to the ventilation control section (64).

[0086] As described above, in the state in which the ventilation operation mode is selected, the simple ventilation operation is performed, thereby supplying outdoor air taken into the casing (11), to the room in unchanged form. However, when performing the simple ventilation operation under circumstances in which a difference between the outdoor temperature and the room temperature is large, outdoor air having the temperature which significantly differs from the room temperature is supplied to the room in unchanged form, thereby possibly providing discomfort to person(s) in the room.

[0087] In addition, when performing the simple ventilation operation under circumstances in which the humidity of outdoor air is high, there is a possibility of causing condensation of moisture in outdoor air in course of such air flowing into the room through the inner space of the casing (11). That is, the temperature at a portion of the casing (11), through which room air flows, is approximately equal to the room temperature. The air supply port (22) of the casing (11) is connected to, e.g., an anemo-type (anemostat-type) outlet through a duct. However, such an outlet is installed in a ceiling surface etc. so as to be exposed to the room, and the temperature thereof is approximately equal to the room temperature. When the portion having the temperature which is approximately equal to the room temperature is exposed to outdoor air under circumstances in which the room temperature is lower than the outdoor air dew-point temperature, condensation of moisture in outdoor air is caused in such a portion. If the condensation of moisture in outdoor air is caused, there are possibilities that dew condensation water enters components accommodated in the casing (11), resulting in malfunctions; or that dew condensation water drops to the room through the outlet, resulting in damage of goods in the room.

[0088] In order to prevent the above-described problems from being caused when the ventilation operation mode is selected, the ventilation control section (64) of the controller (60) performs the control operation in which, when predetermined conditions are satisfied, the simple ventilation operation is prohibited to limit the operation of the outdoor-air conditioner (10) to either one of the dehumidification/ventilation operation and the humidification/ventilation operation. Such a control operation will be described hereinafter with reference to FIG. 10.

[0089] Four switching conditions are set in the ventilation control section (64). A first switching condition is a condition where "at least one of conditions are satisfied, where the room air temperature T_r is lower than the outdoor air dew-point temperature T_{dew} ($T_r < T_{dew}$), and the outdoor air temperature T_o is higher than 35°C ($T_o > 35^\circ\text{C}$).". A second switching condition is a condition where "the operation mode set by a user is either one of the ventilation operation mode and the humidification operation mode." A third switching condition is a condition where "the outdoor air temperature T_o is lower than 5°C ($T_o < 5^\circ\text{C}$).". A fourth switching condition is a condition where "the operation mode set by a user is either one of the ventilation operation mode and the humidification operation mode."

[0090] When not prohibiting the simple ventilation operation, if the first and second switching conditions or the third and fourth switching conditions are satisfied, then the ventilation control section (64) prohibits the simple ventilation operation to limit the operation of the outdoor-air conditioner (10) to either one of the dehumidification/ventilation operation and the humidification/ventilation operation. Specifically, when the first and second switch-

ing conditions are satisfied, the ventilation control section (64) limits the operation of the outdoor-air conditioner (10) to the dehumidification/ventilation operation. On the other hand, when the third and fourth switching conditions are satisfied, the ventilation control section (64) limits the operation of the outdoor-air conditioner (10) to the humidification/ventilation operation.

[0091] When the first switching condition is satisfied during the simple ventilation operation, outdoor air having a temperature higher than 35°C, or outdoor air having a dew-point temperature higher than a room temperature is supplied to the room in unchanged form. In addition, when the first switching condition is satisfied during the humidification/ventilation operation, the outdoor air having the temperature higher than 35°C, or the outdoor air having the dew-point temperature higher than the room temperature passes through the adsorption heat exchanger (51, 52) operating as the condenser, to be supplied to the room.

[0092] When the first and second switching conditions are satisfied, the ventilation control section (64) forcibly switches the operation of the outdoor-air conditioner (10) from the simple ventilation operation or the humidification/ventilation operation to the dehumidification/ventilation operation. In the dehumidification/ventilation operation, outdoor air dehumidified and cooled in the adsorption heat exchanger (51, 52) operating as the evaporator is supplied to the room. That is, as compared to the simple ventilation operation and the humidification/ventilation operation, both of the absolute humidity and temperature of air supplied to the room fall. This allows a difference between the temperature of air supplied from the outdoor-air conditioner (10) to the room and the room temperature to be reduced, thereby alleviating the discomfort of person(s) in the room. In addition, since the dew-point temperature of air supplied from the outdoor-air conditioner (10) to the room is higher than the room temperature, the condensation of moisture in outdoor air is not caused in course of such air flowing into the room through the casing (11).

[0093] On the other hand, when the third switching condition is satisfied during the simple ventilation operation, outdoor air having a temperature lower than 5°C is supplied to the room in unchanged form. In addition, when the first switching condition is satisfied during the dehumidification/ventilation operation, the outdoor air having the temperature lower than 5°C is supplied to the room through the adsorption heat exchanger (51, 52) operating as the evaporator.

[0094] When the third switching condition is satisfied, the ventilation control section (64) forcibly switches the operation of the outdoor-air conditioner (10) from the simple ventilation operation or the dehumidification/ventilation operation to the humidification/ventilation operation. In the humidification/ventilation operation, outdoor air humidified and heated in the adsorption heat exchanger (51, 52) operating as the condenser is supplied to the room. That is, as compared to the simple ventilation op-

eration and the dehumidification/ventilation operation, the temperature of air supplied to the room rises. This allows a difference between the temperature of air supplied from the outdoor-air conditioner (10) to the room and the room temperature to be reduced, thereby alleviating the discomfort of person(s) in the room.

[0095] An operation reset condition is set in the ventilation control section (64). The operation reset condition is a condition where "all conditions are satisfied, where the room air temperature T_r is higher than the outdoor air dew-point temperature T_{odew} by 5°C or more ($T_r \geq T_{odew} + 5$), the outdoor air temperature T_o is equal to or less than 30°C ($T_o \leq 30^\circ\text{C}$), and the outdoor air temperature T_o is equal to or greater than 10°C ($T_o \geq 10^\circ\text{C}$)."

[0096] When limiting the operation of the outdoor-air conditioner (10) to either one of the dehumidification/ventilation operation and the humidification/ventilation operation, if the operation reset condition is satisfied, then the ventilation control section (64) resets the operation of the outdoor-air conditioner (10) to the operation before the operation of the outdoor-air conditioner (10) is limited. That is, if the operation of the outdoor-air conditioner (10) is forcibly switched from the simple ventilation operation to the dehumidification/ventilation operation or the humidification/ventilation operation, the ventilation control section (64) returns the operation of the outdoor-air conditioner (10) from the dehumidification/ventilation operation or the humidification/ventilation operation to the simple ventilation operation. In addition, if the operation of the outdoor-air conditioner (10) is forcibly switched from the humidification/ventilation operation to the dehumidification/ventilation operation, the ventilation control section (64) returns the operation of the outdoor-air conditioner (10) from the dehumidification/ventilation operation to the humidification/ventilation operation. Further, if the operation of the outdoor-air conditioner (10) is forcibly switched from the dehumidification/ventilation operation to the humidification/ventilation operation, the ventilation control section (64) returns the operation of the outdoor-air conditioner (10) from the humidification/ventilation operation to the dehumidification/ventilation operation.

[0097] In the outdoor-air conditioner (10), the dehumidification/ventilation operation and the humidification/ventilation operation may be prohibited to enable only the simple ventilation operation to be performed. When causing malfunctions in, e.g., the compressor (53) or the four-way switching valve (54), the refrigerant cycle cannot be performed in the refrigerant circuit (50), thereby not performing the dehumidification/ventilation operation or the humidification/ventilation operation. An operation mode in which ventilation of the room is continued during nighttime during which there is no person(s) in the room may be set to the outdoor-air conditioner (10). In such a case, it is useless to perform the dehumidification/ventilation operation or the humidification/ventilation operation during the nighttime during which there is no person(s) in the room, and therefore the dehumidification/ven-

tilation operation and the humidification/ventilation operation are prohibited to perform only the simple ventilation operation.

[0098] During the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation and the humidification/ventilation operation are prohibited, it is possible that the difference between the room and outdoor temperatures increases, or that the outdoor air dew-point temperature is higher than the room temperature. When continuing the simple ventilation operation with the large difference between the room and outdoor temperatures, the room temperature becomes closer to the outdoor temperature, thereby increasing an air-conditioning load when starting air-conditioning of the room on the following morning etc. In addition, when continuing the simple ventilation operation performed under circumstances in which the outdoor air dew-point temperature is higher than the room temperature, condensation of moisture in outdoor air is caused within the casing (11) or in the outlet etc. exposed to the room. However, in such a case, the dehumidification/ventilation operation or the humidification/ventilation operation is prohibited, and therefore the above-described problems cannot be prevented by forcibly switching the operation of the outdoor-air conditioner (10) from the simple ventilation operation to the dehumidification/ventilation operation or the humidification/ventilation operation.

[0099] When performing the simple ventilation operation under circumstances in which the dehumidification/ventilation operation or the humidification/ventilation operation is prohibited, the ventilation control section (64) performs a control operation for stopping the air supply fan (26) when a predetermined condition is satisfied, in order to prevent the above-described problems from being caused. Such a control operation will be described hereinafter with reference to FIG. 11.

[0100] A fan stopping condition is set in the ventilation control section (64). The fan stopping condition is a condition where "at least one of conditions is satisfied and maintained for 20 seconds or more, where the room air temperature T_r is lower than the outdoor air dew-point temperature T_{odew} ($T_r < T_{odew}$), the outdoor air temperature T_o is higher than 35°C ($T_o > 35^\circ\text{C}$), and the outdoor air temperature T_o is lower than 5°C ($T_o < 5^\circ\text{C}$)."

[0101] When the fan stopping condition is satisfied, the ventilation control section (64) stops the air supply fan (26). At this point, the ventilation control section (64) continues an operation of the air discharge fan (25), and stops only the air supply fan (26). When stopping the air supply fan (26), an outdoor air flow from the outside to the room through the inner space of the casing (11) is stopped. This reduces a change in the room temperature due to the outdoor air supply to the room, or prevents the condensation of moisture in outdoor air on inner walls of the casing (11) or in the outlet. The ventilation control section (64) stops the air supply fan (26) when the fan stopping condition is satisfied, and then starts a timer for

measuring time elapsed after the air supply fan (26) is stopped.

[0102] In addition, a fan resuming condition is set in the ventilation control section (64). The fan resuming condition is a condition where "the time elapsed after the fan stopping condition is satisfied to stop the air supply fan (26) is equal to or more than 1 hour." When the fan resuming condition is satisfied, the ventilation control section (64) resumes an operation of the air supply fan (26). In addition, when the fan resuming condition is satisfied, the time measured by the timer is reset to zero in the ventilation control section (64).

[0103] When the air supply fan (26) is stopped, outdoor air does not flow through the casing (11), thereby not measuring outdoor air states (temperature and humidity) by the outdoor air humidity sensor (97) and the outdoor air temperature sensor (99) installed in the casing (11). Thus, as long as the air supply fan (26) is stopped, it is not determined whether or not the operation of the air supply fan (26) can be resumed.

[0104] When 1 hour has elapsed after the fan stopping condition is satisfied to stop the air supply fan (26), the ventilation control section (64) temporarily resumes the operation of the air supply fan (26). When the air supply fan (26) is activated, the outdoor air states (temperature and humidity) can be measured by using the outdoor air humidity sensor (97) and the outdoor air temperature sensor (99). The ventilation control section (64) continues the operation of the air supply fan (26) if the fan stopping condition is not satisfied under such circumstances; and stops the air supply fan (26) again if the fan stopping condition is satisfied.

Advantages of Embodiment

[0105] In the outdoor-air conditioner (10) of the present embodiment, when the room temperature becomes lower than the outdoor air dew-point temperature during the simple ventilation operation, the ventilation control section (64) of the controller (60) forcibly switches the operation of the outdoor-air conditioner (10) from the simple ventilation operation to the dehumidification/ventilation operation. This prevents the simple ventilation operation from being continued under circumstances in which the room temperature is lower than the outdoor air dew-point temperature, thereby shifting to the dehumidification/ventilation operation in which the dehumidified outdoor air is supplied to the room, in such a state. Thus, according to the present embodiment, the condensation of moisture in outdoor air during the simple ventilation operation can be prevented, and the disadvantages such as the malfunctions due to the condensation, and the dropping of dew condensation water to the room can be prevented in advance.

[0106] In the outdoor-air conditioner (10) of the present embodiment, when the outdoor temperature exceeds the predetermined maximum value (35°C in the present embodiment) during the simple ventilation operation, the

ventilation control section (64) of the controller (60) forcibly switches the operation of the outdoor-air conditioner (10) from the simple ventilation operation to the dehumidification/ventilation operation, thereby decreasing the temperature of air sent into the room. In addition, in the outdoor-air conditioner (10), when the outdoor temperature falls below the predetermined minimum value (5°C in the present embodiment) during the simple ventilation operation, the ventilation control section (64) of the controller (60) forcibly switches the operation of the outdoor-air conditioner (10) from the simple ventilation operation to the humidification/ventilation operation, thereby increasing the temperature of air sent into the room. Thus, according to the present embodiment, the difference between the temperature of air supplied from the outdoor-air conditioner (10) to the room and the room temperature can be prevented from significantly increasing, thereby ensuring comfort in the room.

[0107] In the outdoor-air conditioner (10) of the present embodiment, when the room temperature is lower than the outdoor air dew-point temperature during the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited, the ventilation control section (64) of the controller (60) stops the air supply fan (26). Thus, according to the present embodiment, even if the dehumidification/ventilation operation cannot be carried out, the condensation of moisture in outdoor air can be reliably prevented from being caused in the portion from the inner space of the casing (11) to the room.

[0108] In the outdoor-air conditioner (10) of the present embodiment, when the outdoor temperature exceeds the predetermined maximum value (35°C in the present embodiment) during the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited, the ventilation control section (64) of the controller (60) stops the air supply fan (26). In addition, in the outdoor-air conditioner (10), when the outdoor temperature falls below the predetermined minimum value (5°C in the present embodiment) during the simple ventilation operation performed under circumstances in which the humidification/ventilation operation is prohibited, the ventilation control section (64) of the controller (60) stops the air supply fan (26). Thus, according to the present embodiment, even if the dehumidification/ventilation operation or the humidification/ventilation operation cannot be carried out, a decline in the comfort in the room and an increase in the air-conditioning load can be reduced.

[0109] In the outdoor-air conditioner (10) of the present embodiment, the recovery action and the adsorption action are performed in the refrigerant circuit (50). The dehumidification and cooling of air are performed in parallel in the adsorption heat exchanger (51, 52) during the adsorption action (i.e., during operating the adsorption heat exchanger as the evaporator), and the humidification and heating of air are performed in parallel in the adsorption heat exchanger (51, 52) during the recovery

action (i.e., during operating the adsorption heat exchanger as the condenser). That is, in the outdoor-air conditioner (10), the air humidity and temperature controls are performed at a single section. Thus, according to the present embodiment, the structure of the outdoor-air conditioner (10) can be simplified as compared to a case where the air humidity and temperature controls are performed by using separate members.

10 First Variation of Embodiment

[0110] In a refrigerant circuit (50) of the present embodiment, a supercritical cycle may be performed, in which a high pressure of a refrigeration cycle is set to a value higher than a critical pressure of refrigerant. In such a case, one of a first adsorption heat exchanger (51) and a second adsorption heat exchanger (52) operates as a gas cooler, and the other operates as an evaporator.

20 Second Variation of Embodiment

[0111] In an outdoor-air conditioner (10) of the present embodiment, adsorbent deposited on a first adsorption heat exchanger (51) and a second adsorption heat exchanger (52) is heated or cooled by refrigerant, but the adsorbent may be heated or cooled by supplying cold or hot water to the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52).

30 Third Variation of Embodiment

[0112] In the foregoing embodiment, an outdoor-air conditioner (10) may be configured as follows.

[0113] As illustrated in FIGS. 12, the outdoor-air conditioner (10) of the present variation includes a refrigerant circuit (100) and two adsorption elements (111, 112). In the outdoor-air conditioner (10), the refrigerant circuit (100) and the adsorption elements (111, 112) serve as a humidity control means (115).

[0114] The refrigerant circuit (100) is a closed circuit in which a compressor (101), a condenser (102), an expansion valve (103), and an evaporator (104) are sequentially connected to each other. When circulating refrigerant in the refrigerant circuit (100), a vapor compression refrigeration cycle is performed. The first adsorption element (111) and the second adsorption element (112) are provided with adsorbent such as zeolite. Many air paths are formed in each of the adsorption elements (111, 112), and air is exposed to the adsorbent when passing through such air paths. Each of the adsorption elements (111, 112) serves as an adsorption unit.

[0115] The outdoor-air conditioner (10) of the present variation selectively performs a dehumidification/ventilation operation, a humidification/ventilation operation, and a simple ventilation operation.

[0116] During the dehumidification/ventilation operation or the humidification/ventilation operation, the outdoor-air conditioner (10) alternately repeats first and sec-

ond actions at predetermined time intervals. During the dehumidification/ventilation operation, the outdoor-air conditioner (10) takes outdoor air as first air, and takes room air as second air. On the other hand, during the humidification/ventilation operation, the outdoor-air conditioner (10) takes room air as first air, and takes outdoor air as second air.

[0117] First, the first action of the dehumidification/ventilation operation and of the humidification/ventilation operation will be described with reference to FIG. 12(A). During the first action, the outdoor-air conditioner (10) supplies the second air heated in the condenser (102), to the first adsorption element (111). In the first adsorption element (111), the adsorbent is heated by the second air, thereby desorbing moisture from the adsorbent. In addition, during the first action, the outdoor-air conditioner (10) supplies the first air to the second adsorption element (112) to adsorb moisture in the first air onto the second adsorption element (112). The first air from which moisture is removed by the second adsorption element (112) is cooled when passing through the evaporator (104).

[0118] Next, the second action of the dehumidification/ventilation operation and of the humidification/ventilation operation will be described with reference to FIG. 12(B). During the second action, the outdoor-air conditioner (10) supplies the second air heated in the condenser (102), to the second adsorption element (112). In the second adsorption element (112), the adsorbent is heated by the second air, thereby desorbing moisture from the adsorbent. In addition, during the first action, the outdoor-air conditioner (10) supplies the first air to the first adsorption element (111) to adsorb moisture in the first air to the first adsorption element (111). The first air from which moisture is removed by the first adsorption element (111) is cooled when passing through the evaporator (104).

[0119] During the dehumidification/ventilation operation, the outdoor-air conditioner (10) supplies the dehumidified first air (outdoor air) to the room, and discharges the moisture desorbed from the adsorption element (111, 112) to the outside together with the second air (room air). During the humidification/ventilation operation, the outdoor-air conditioner (10) supplies the humidified second air (outdoor air) to the room, and discharges the first air (room air) from which the moisture is removed by the adsorption element (111, 112), to the outside.

[0120] During the simple ventilation operation, in the outdoor-air conditioner (10), the compressor (101) of the refrigerant circuit (100) is stopped. In addition, outdoor air passes through one of the first adsorption element (111) and the second adsorption element (112), and room air passes through the other. The outdoor air passes through the adsorption element (111, 112) to be supplied to the room, and the room air passes through the adsorption element (111, 112) to be discharged to the outside. During the simple ventilation operation, in the outdoor-air conditioner (10), circulation paths of outdoor and room air are not switched.

Fourth Variation of Embodiment

[0121] In the foregoing structure, an outdoor-air conditioner (10) may be configured as follows.

[0122] As illustrated in FIG. 13, the outdoor-air conditioner (10) of the present variation includes a body unit (150) and a heat source unit (165).

[0123] An inner space of the body unit (150) is divided into an air supply path (151) and an air discharge path (152). A start point of the air supply path (151) communicates with an outdoor air suction port (153), and a terminal point thereof communicates with an air supply port (154). In the air supply path (151), an application-side heat exchanger (161), a humidification element (162), and an air supply fan (157) are sequentially arranged from the start point toward the terminal point. A start point of the air discharge path (152) communicates with a room air suction port (155), and a terminal point thereof communicates with an air discharge port (156). In the air discharge path (152), an air discharge fan (158) is arranged.

[0124] The heat source unit (165) is connected to the application-side heat exchanger (161) through a pair of connecting pipes (166). Although not illustrated in the figure, the heat source unit (165) includes a compressor, an expansion valve, etc. The heat source unit (165) and the application-side heat exchanger (161) form a refrigerant circuit (167). The application-side heat exchanger (161) is an air heat exchanger for exchanging heat between air and refrigerant. The refrigerant circuit (167) selectively performs a refrigeration cycle action in which the application-side heat exchanger (161) serves as an evaporator; and a refrigeration cycle action in which the application-side heat exchanger (161) serves as a condenser. In the outdoor-air conditioner (10) of the present variation, the refrigerant circuit (167) and the humidification element (162) constitute a humidity control means (170).

[0125] Although not illustrated in the figure, in the humidification element (162), a water path and an air path are formed with a moisture permeable film being interposed therebetween. Tap water supplied from outside flows in the water path. Air flowing in the air supply path (151) circulates in the air path. The moisture permeable film does not allow water which is liquid to pass through the moisture permeable film, and allows only water vapor to pass therethrough.

[0126] The outdoor-air conditioner (10) of the present variation selectively performs a dehumidification/ventilation operation, a humidification/ventilation operation, and a simple ventilation operation.

[0127] During the dehumidification/ventilation operation, in the outdoor-air conditioner (10), the refrigerant circuit (167) performs the refrigeration cycle action in which the application-side heat exchanger (161) serves as the evaporator, and a water supply to the humidification element (162) is stopped. In such an operation, the evaporation temperature of refrigerant in the application-side heat exchanger (161) is set to a value lower than

the outdoor air dew-point temperature. Outdoor air flowing into the air supply path (151) is cooled when passing through the application-side heat exchanger (161), and moisture in the outdoor air is condensed to be drain water. The outdoor air passing through the application-side heat exchanger (161) passes through the humidification element (162), followed by being supplied to a room through the air supply port (154). The drain water generated in the application-side heat exchanger (161) is discharged to outside. Room air flowing into the air discharge path (152) is discharged to the outside through the air discharge port (156).

[0128] During the humidification/ventilation operation, in the outdoor-air conditioner (10), the refrigerant circuit (167) performs the refrigeration cycle action in which the application-side heat exchanger (161) serves as the condenser, and water is supplied to the humidification element (162). Outdoor air flowing into the air supply path (151) is heated when passing through the application-side heat exchanger (161), and then is sent to the humidification element (162). In the humidification element (162), water vapor passing through the moisture permeable film is imparted to air. The air humidified in the humidification element (162) is supplied to the room through the air supply port (154). Room air flowing into the air discharge path (152) is discharged to the outside through the air discharge port (156).

[0129] During the simple ventilation operation, in the outdoor-air conditioner (10), both of the operation of the refrigerant circuit (167) and the water supply to the humidification element (162) are stopped, and only the air supply fan (157) and the air discharge fan (158) are operated. Outdoor air flowing into the air supply path (151) sequentially passes through the application-side heat exchanger (161) and the humidification element (162), and then is supplied to the room through the air supply port (154). Room air flowing into the air discharge path (152) is discharged to the outside through the air discharge port (156).

[0130] The foregoing embodiments have been set forth merely for purposes of preferred examples in nature, and are not intended to limit the scope, applications, and use of the invention.

INDUSTRIAL APPLICABILITY

[0131] As described above, the present invention is useful in a humidity control apparatus for controlling humidity in a room.

Claims

1. A humidity control apparatus including at least humidity control means (50, 115, 170) for dehumidifying and cooling air, which enables a dehumidification/ventilation operation in which the humidity control means (50, 115, 170) dehumidifies and cools

outdoor air to be supplied to a room, and a simple ventilation operation in which the humidity control means (50, 115, 170) is stopped to supply taken outdoor air to the room in unchanged form, the humidity control apparatus comprising:

outdoor temperature detecting means (99) for detecting an outdoor temperature; and control means (64) for forcibly switching from the simple ventilation operation to the dehumidification/ventilation operation when the outdoor temperature detected by the outdoor temperature detecting means (99) during the simple ventilation operation exceeds a predetermined maximum value.

2. The humidity control apparatus of claim 1, wherein the control means (64) stops an outdoor-air supply to the room when the outdoor temperature detected by the outdoor temperature detecting means (99) exceeds the predetermined maximum value in the simple ventilation operation performed under circumstances in which the dehumidification/ventilation operation is prohibited.
3. The humidity control apparatus of claim 1 or 2, wherein the humidity control means (50, 115) includes adsorption units (51, 52, 111, 112) with adsorbent to be exposed to air, and dehumidifies air by adsorbing moisture in the air onto the adsorption unit (51, 52, 111, 112).
4. A humidity control apparatus including at least humidity control means (50, 115, 170) for humidifying and heating air, which enables a humidification/ventilation operation in which the humidity control means (50, 115, 170) humidifies and heats outdoor air to be supplied to a room, and a simple ventilation operation in which the humidity control means (50, 115, 170) is stopped to supply taken outdoor air to the room in unchanged form, the humidity control apparatus comprising:

outdoor temperature detecting means (99) for detecting an outdoor temperature; and control means (64) for forcibly switching from the simple ventilation operation to the humidification/ventilation operation when the outdoor temperature detected by the outdoor temperature detecting means (99) during the simple ventilation operation falls below a predetermined minimum value.

5. The humidity control apparatus of claim 4, wherein the control means (64) stops an outdoor-air supply to the room when the outdoor temperature detected by the outdoor temperature detecting means (99)

falls below the predetermined minimum value in the simple ventilation operation performed under circumstances in which the humidification/ventilation operation is prohibited.

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6. The humidity control apparatus of claim 4 or 5, wherein
the humidity control means (50, 115) includes adsorption units (51, 52, 111, 112) with adsorbent to be exposed to air, and humidifies air by imparting moisture desorbed from the adsorbent of the adsorption unit (51, 52, 111, 112), to the air. 10
7. The humidity control apparatus of claim 3, wherein
the humidity control means includes adsorption heat exchangers (51, 52) with adsorbent deposited on surfaces thereof as the adsorption units, and includes a refrigerant circuit (50) in which the adsorption heat exchangers (51, 52) are connected to each other to perform a refrigeration cycle; and 15
the refrigerant circuit (50) performs an adsorption action in which the adsorbent of the adsorption heat exchanger (51, 52) is cooled by refrigerant to adsorb moisture in air onto the adsorption heat exchanger (51, 52), and a recovery action in which the adsorbent of the adsorption heat exchanger (51, 52) is heated by refrigerant for recovery of the adsorbent in the adsorption heat exchanger (51, 52). 20 25
8. The humidity control apparatus of claim 6, wherein
the humidity control means adsorption heat exchangers (51, 52) with adsorbent deposited on surfaces thereof as the adsorption units, and includes a refrigerant circuit (50) in which the adsorption heat exchangers (51, 52) are connected to each other to perform a refrigeration cycle; and 30
the refrigerant circuit (50) performs an adsorption action in which the adsorbent of the adsorption heat exchanger (51, 52) is cooled by refrigerant to adsorb moisture in air onto the adsorption heat exchanger (51, 52), and a recovery action in which the adsorbent of the adsorption heat exchanger (51, 52) is heated by refrigerant for recovery of the adsorbent in the adsorption heat exchanger (51, 52). 35 40

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50

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FIG. 1

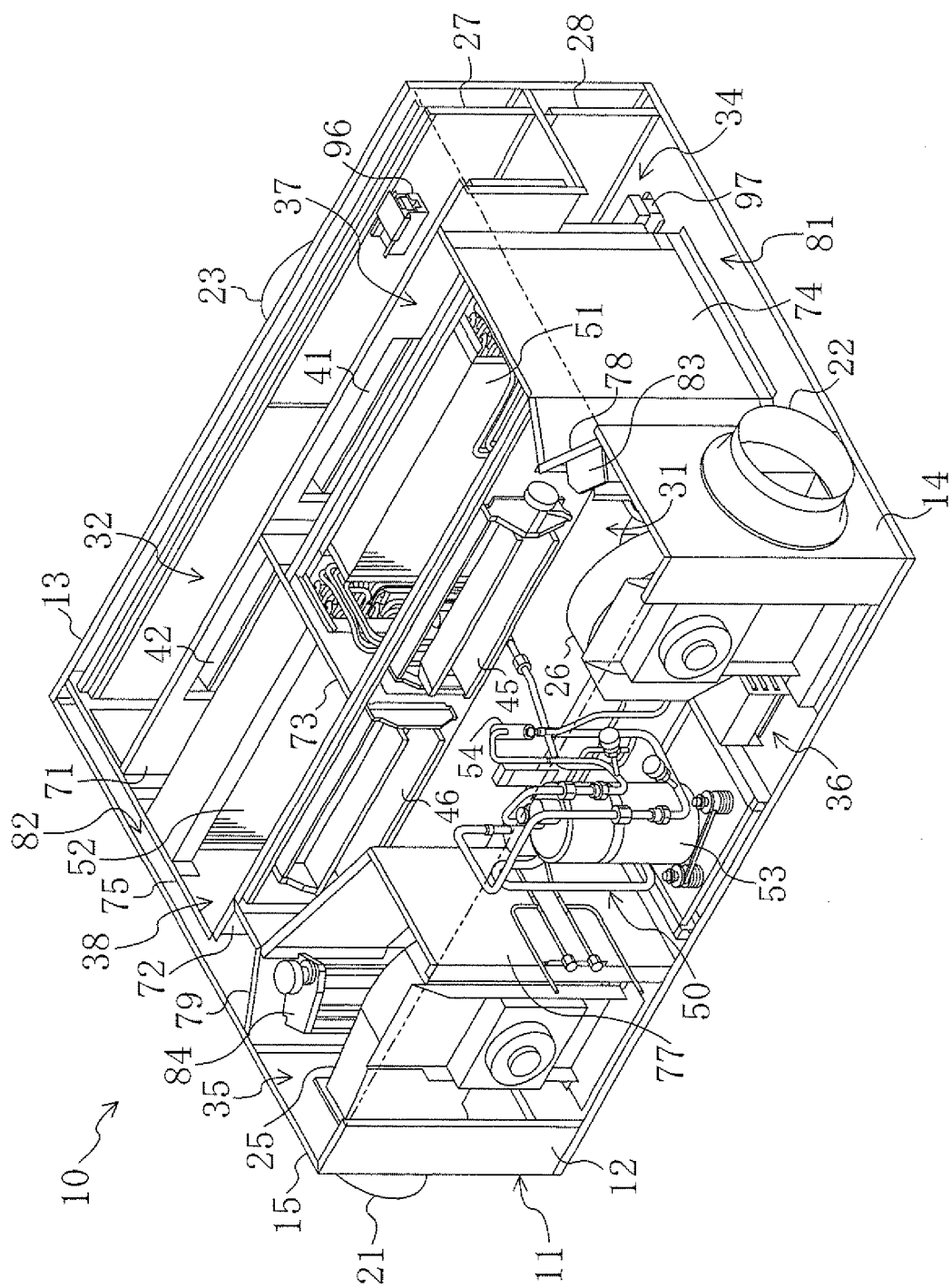


FIG. 2

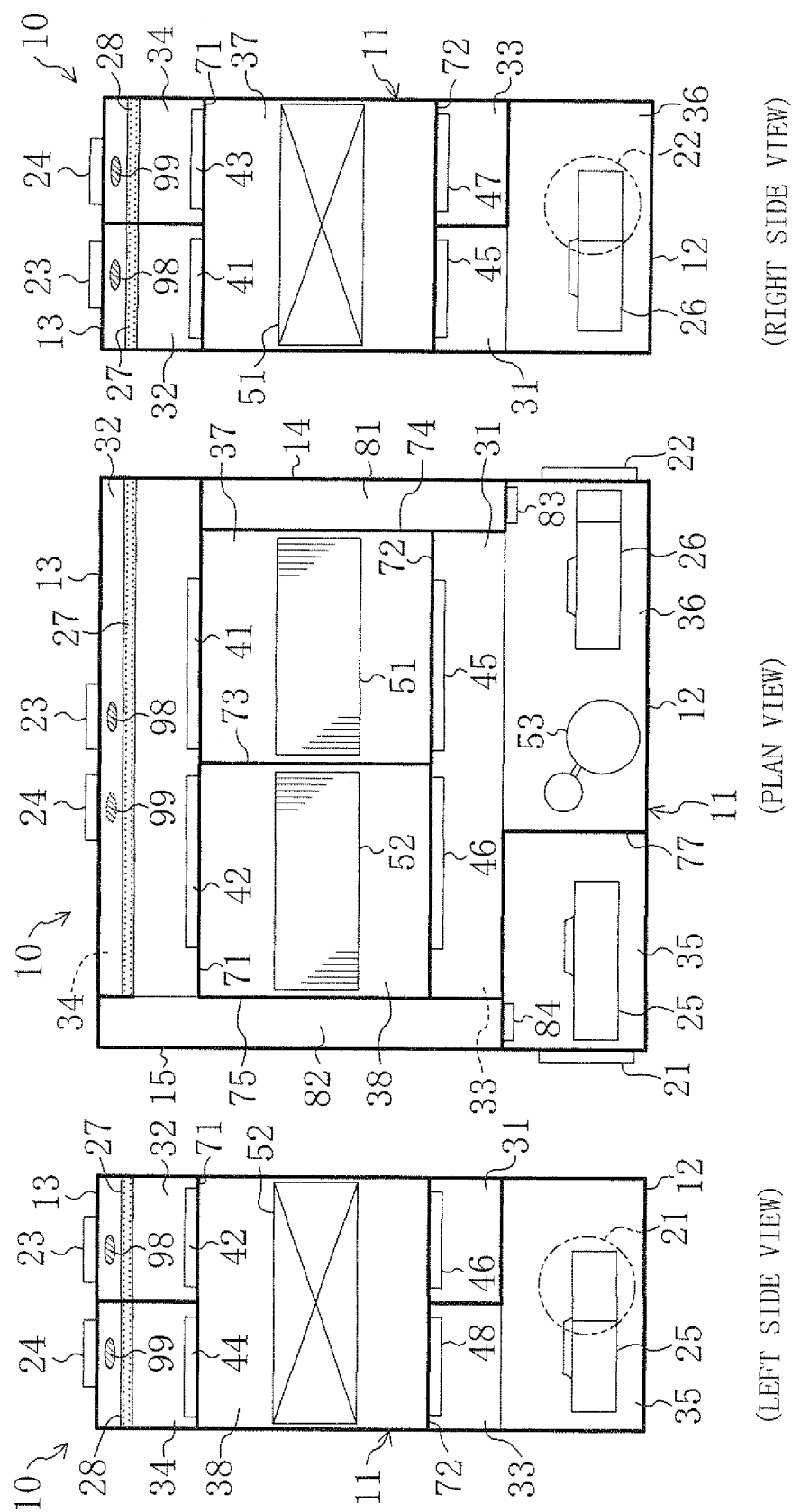


FIG. 3

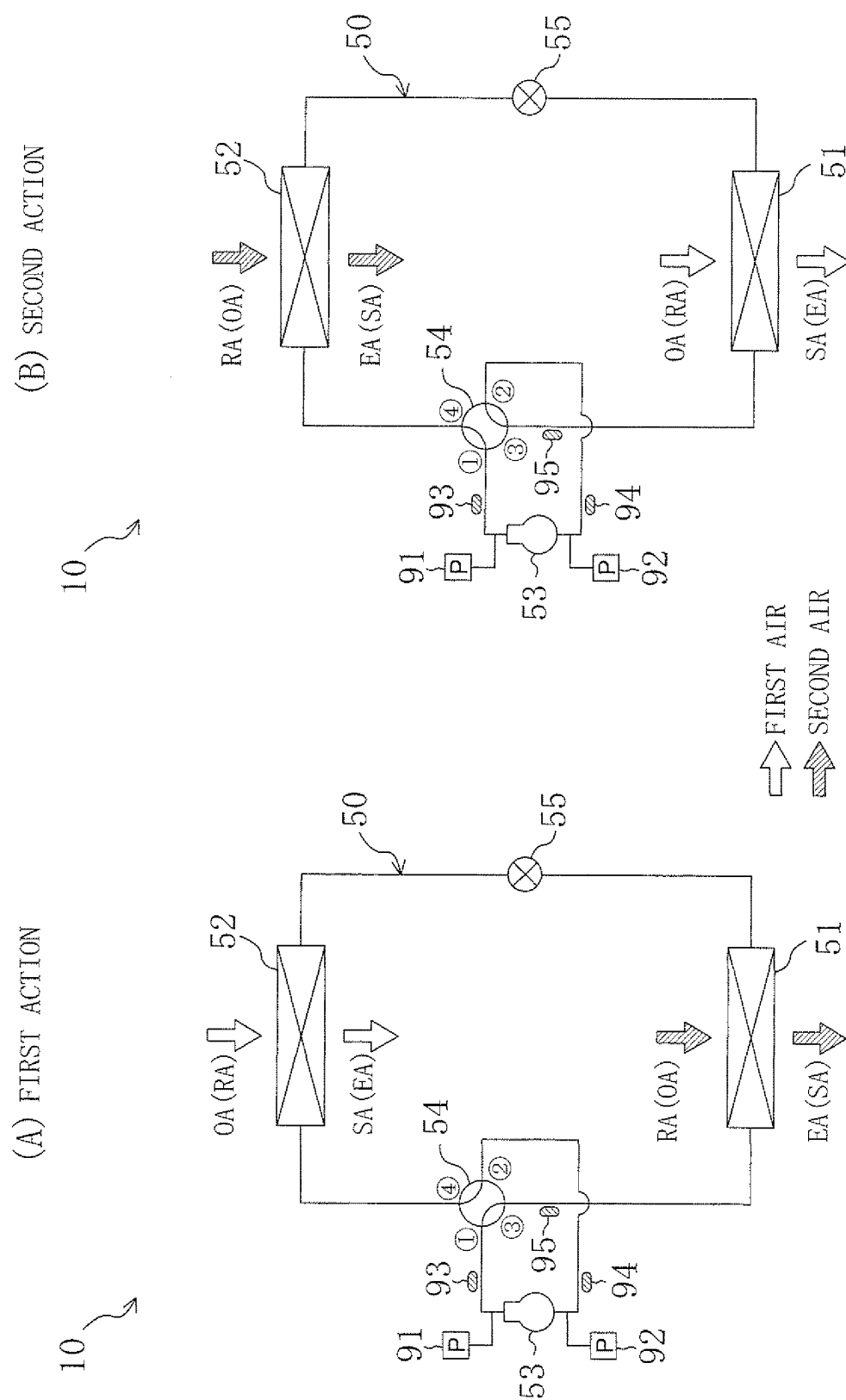


FIG. 4

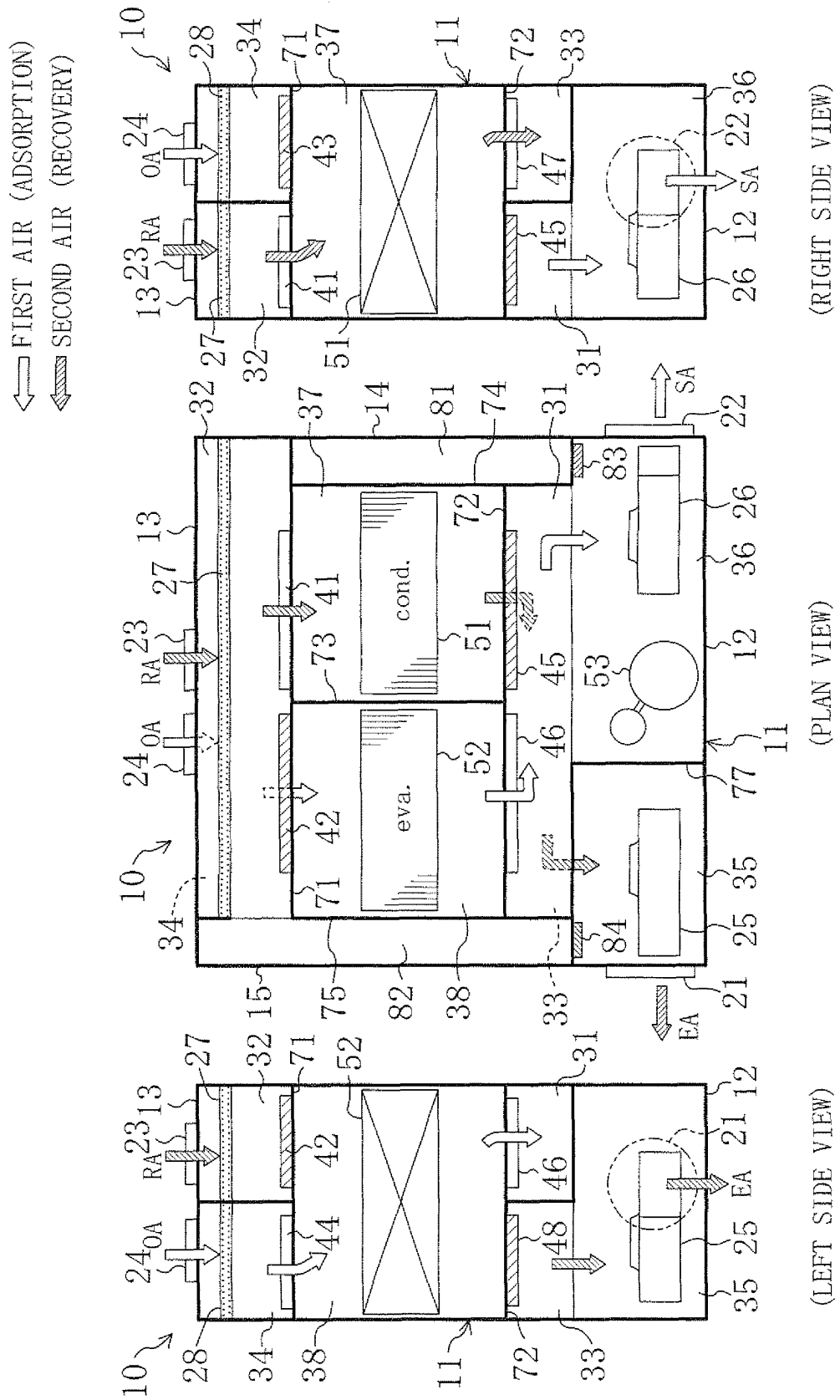


FIG. 5

⇐ FIRST AIR (ADSORPTION)
 ⇐ SECOND AIR (RECOVERY)

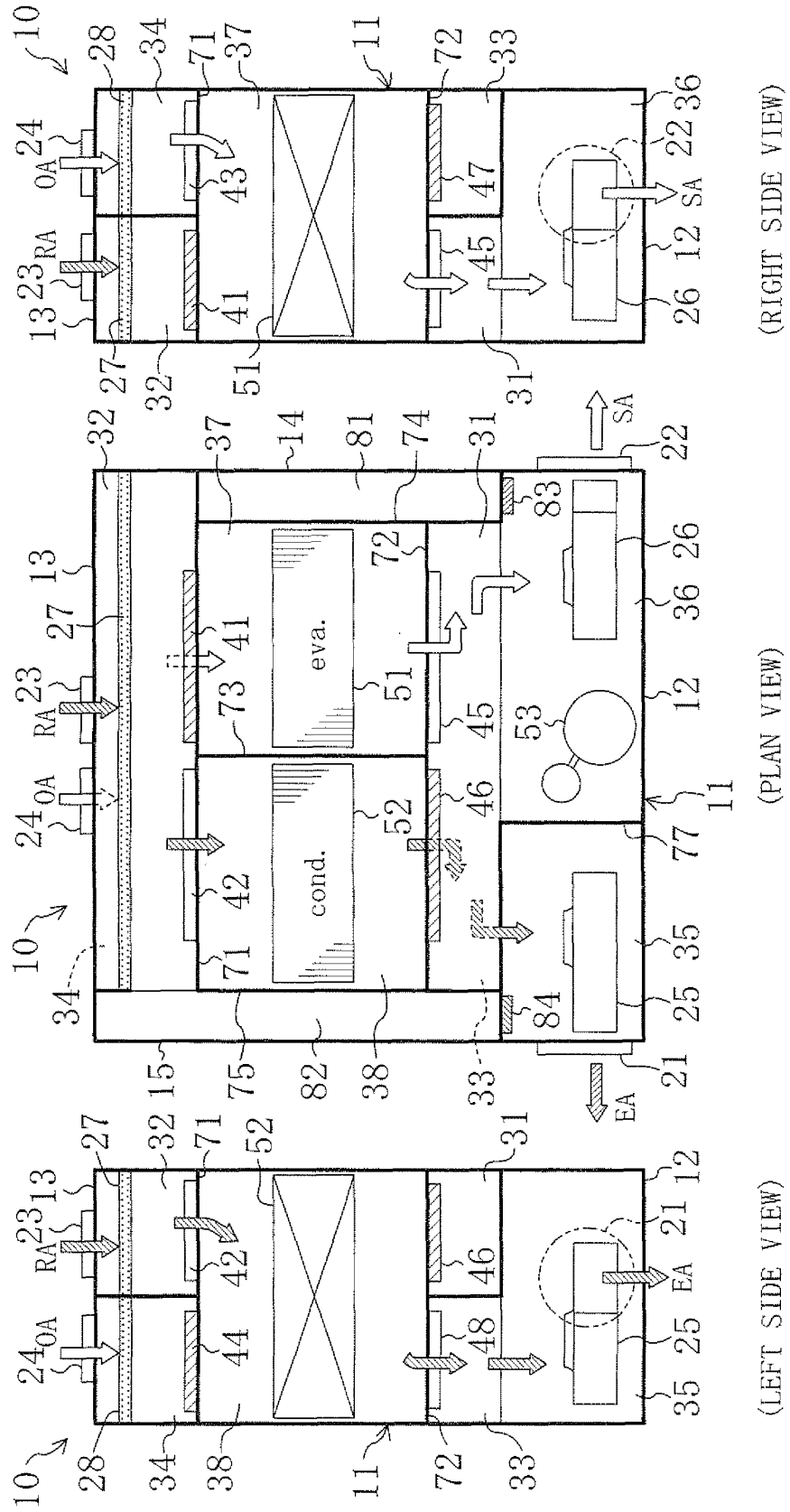


FIG. 6

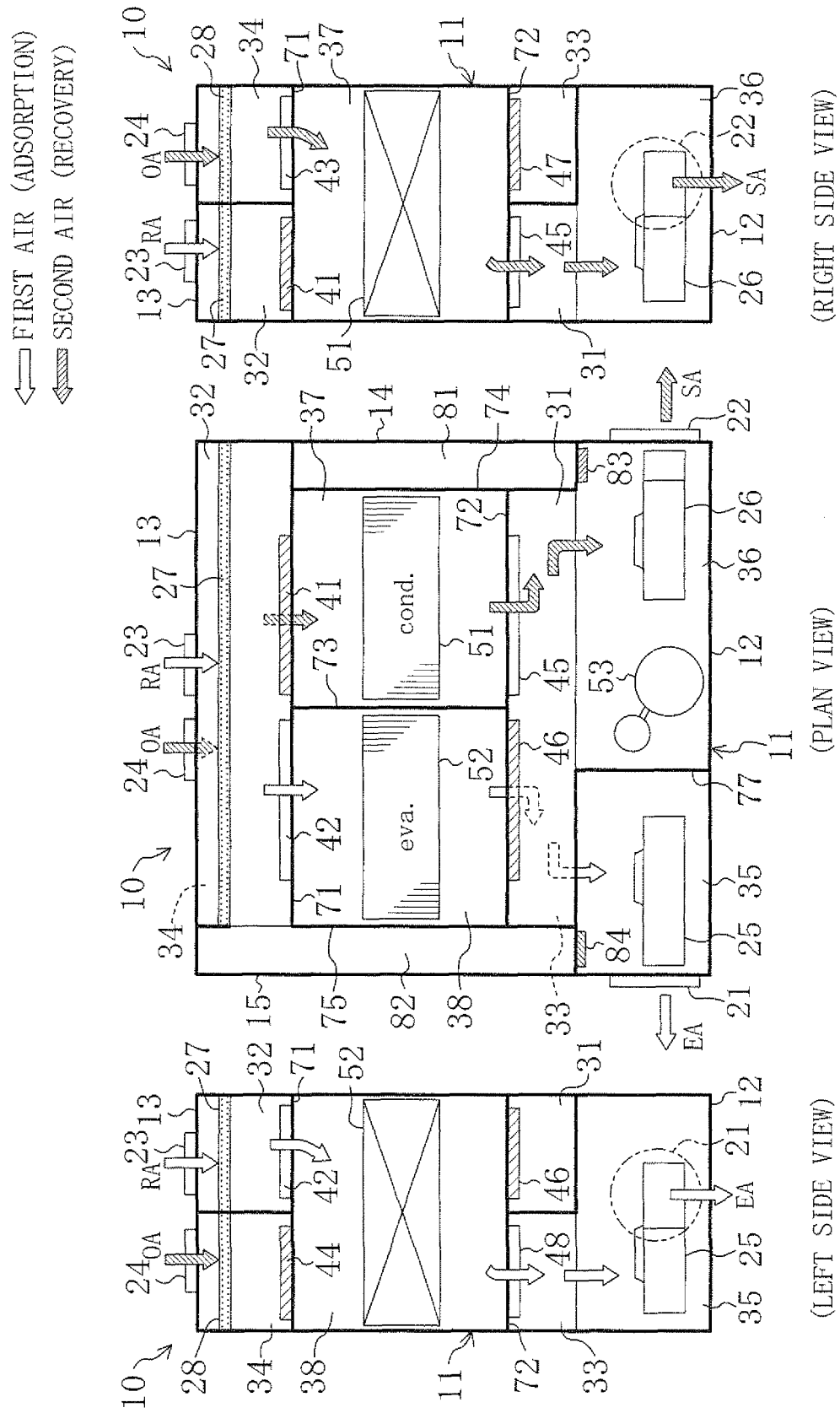


FIG. 7

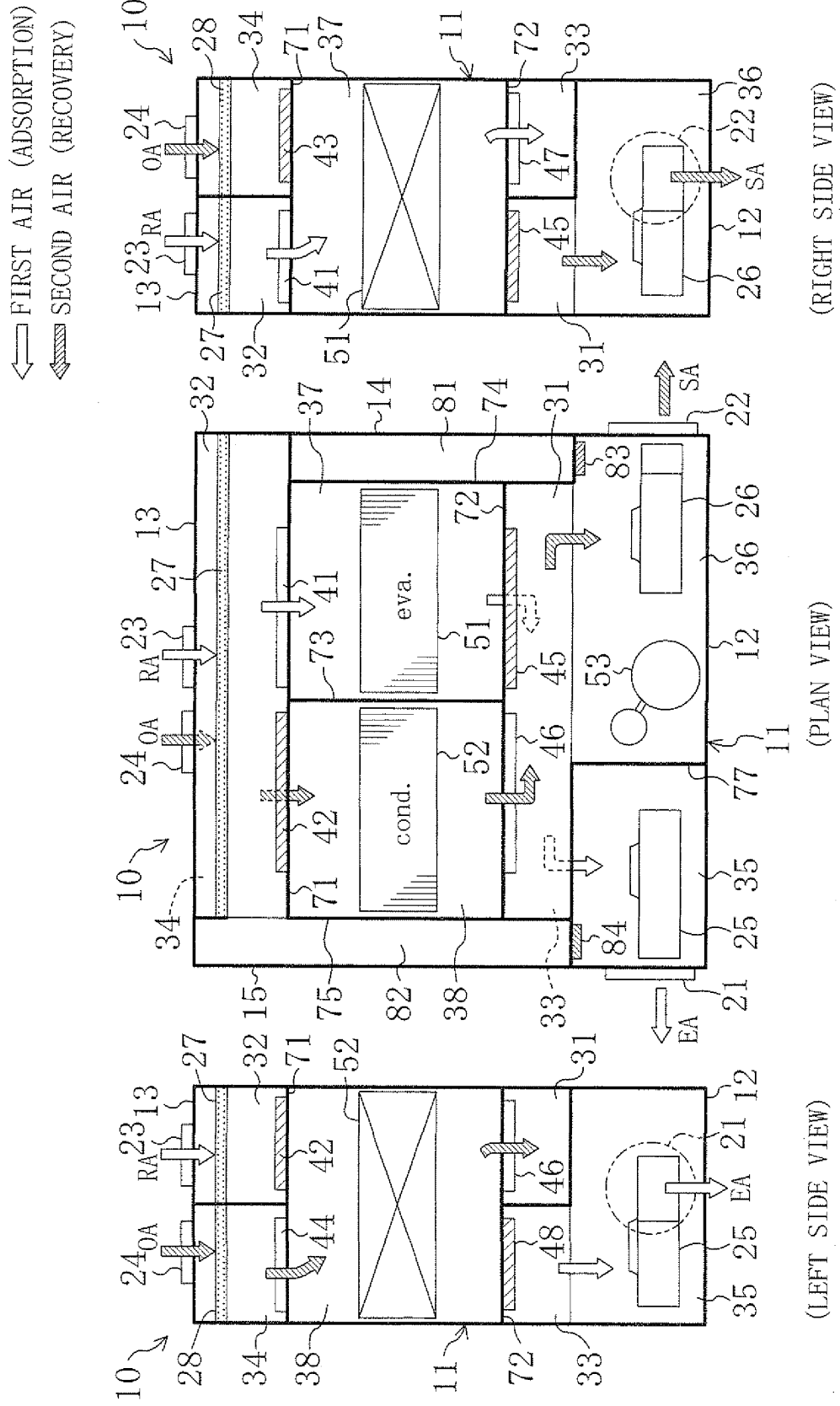


FIG. 8

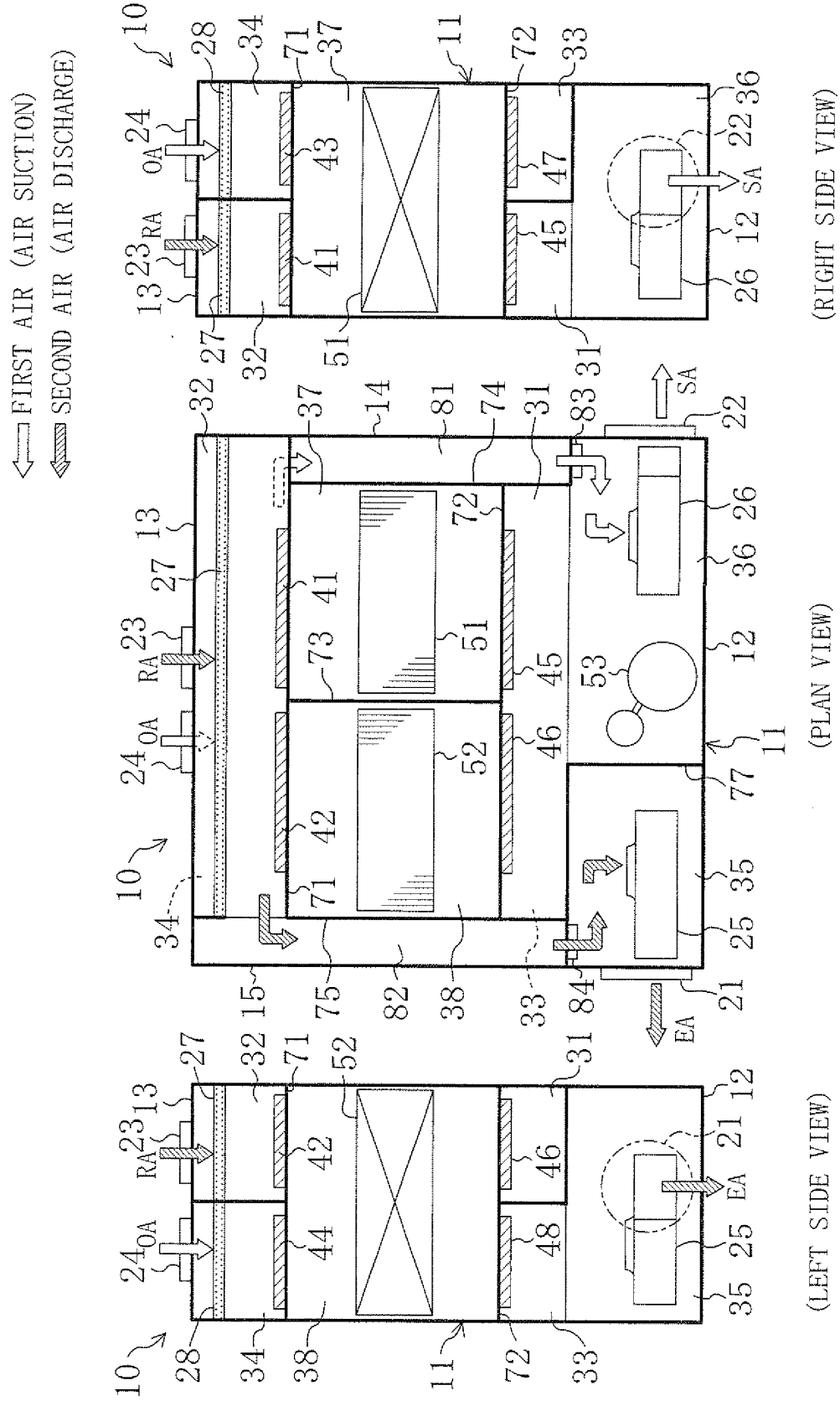


FIG. 9

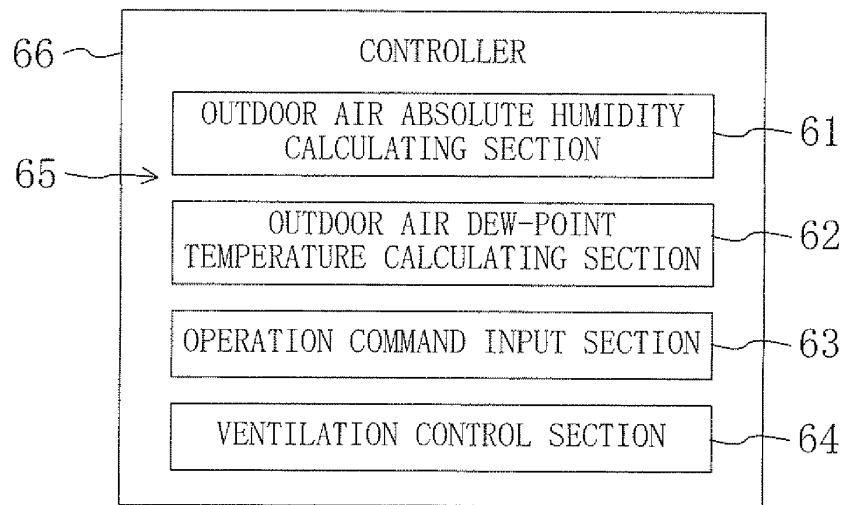


FIG. 10

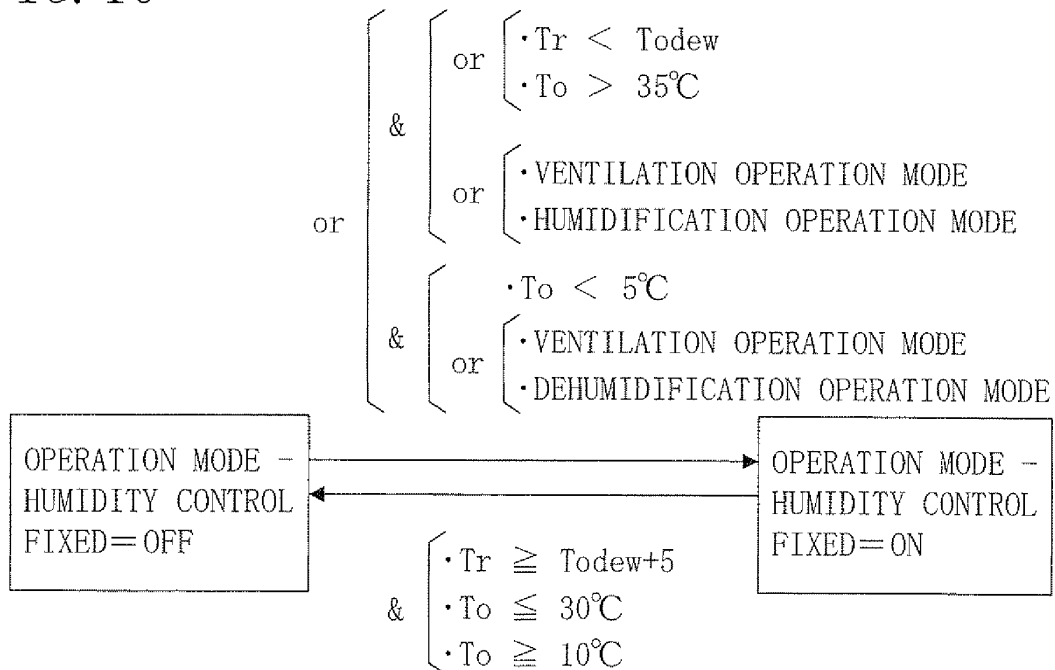


FIG. 11

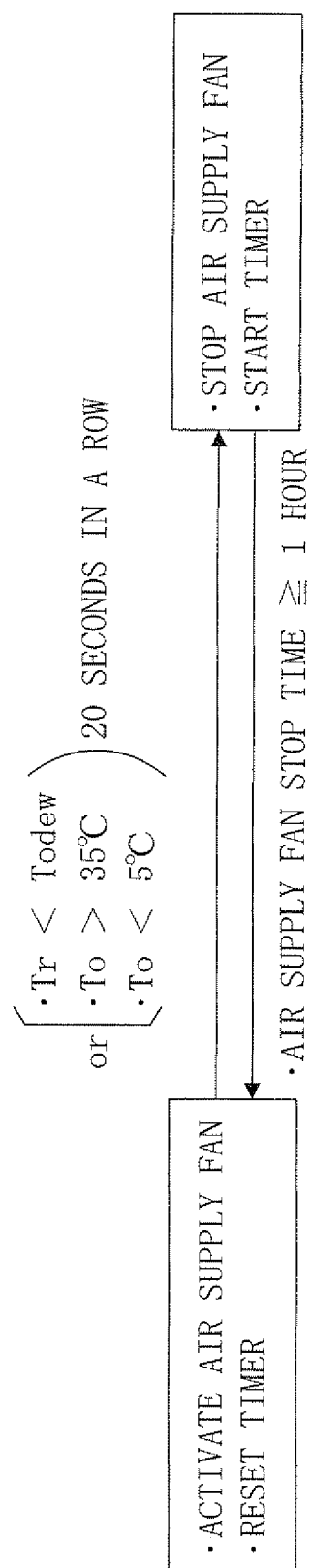
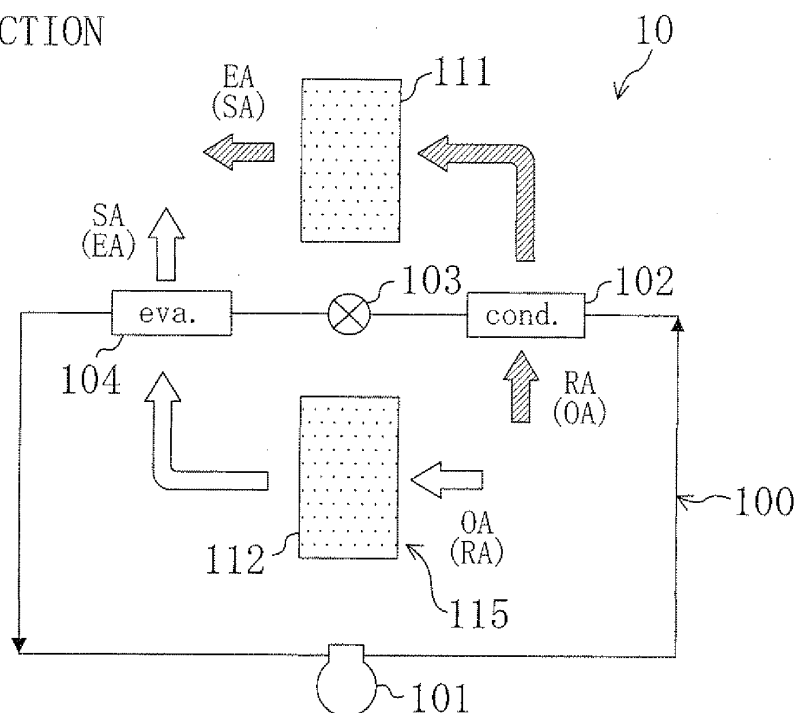


FIG. 12

(A) FIRST ACTION



(B) SECOND ACTION

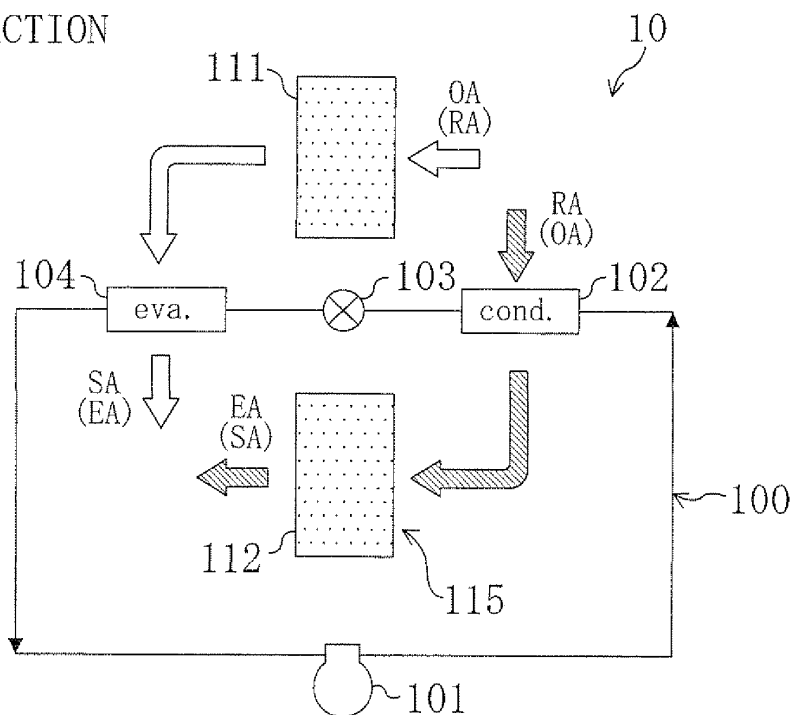
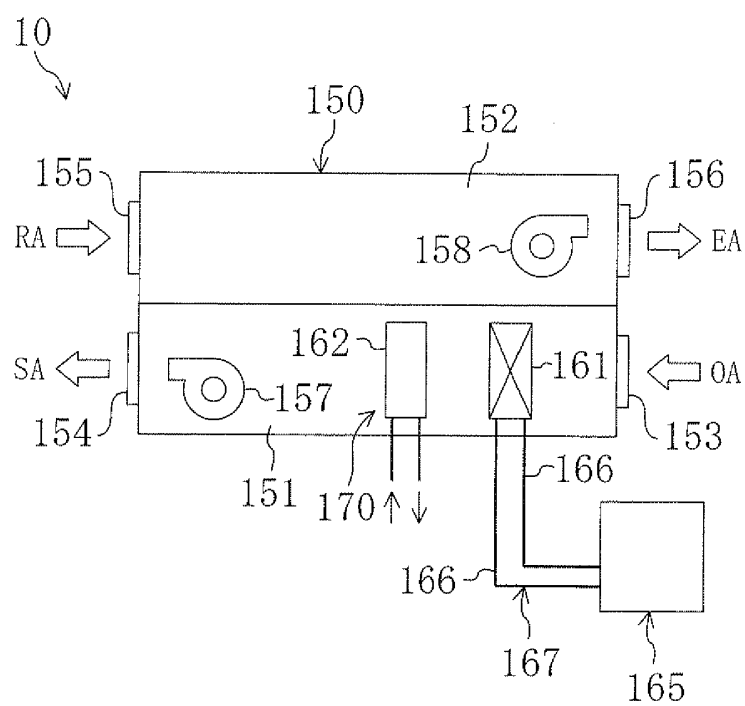


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/003140

A. CLASSIFICATION OF SUBJECT MATTER

F24F11/02(2006.01)i, F24F3/14(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, F24F3/14, 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. [0006], [0087] to [0118] & EP 1890090 A1 & WO 2006/129544 A1 & KR 10-2008-0007407 A & CN 101184957 A	1-8
Y	JP 2005-155958 A (Asahi Breweries, Ltd.), 16 June, 2005 (16.06.05), Claims 1, 2; Par. Nos. [0034] to [0042] (Family: none)	1-8
Y	JP 4-62350 A (Sanyo Electric Co., Ltd.), 27 February, 1992 (27.02.92), Claims; page 2, lower right column, lines 4 to 14; Fig. 1 (Family: none)	4-6, 8

☒ 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
19 January, 2009 (19.01.09)Date of mailing of the international search report
03 February, 2009 (03.02.09)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/003140

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 2005-9849 A (Sanyo Electric Co., Ltd.), 13 January, 2005 (13.01.05), Claim 1; Par. Nos. [0040] to [0078]; Figs. 6 to 8 & KR 10-2004-0101045 A & CN 1573250 A	4-6, 8
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 91668/1991 (Laid-open No. 42947/1993) (Mitsubishi Electric Corp.), 11 June, 1993 (11.06.93), Claim 1; Fig. 2 (Family: none)	4-6, 8

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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