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

(30) Priority: **31.10.2007 JP 2007282558**

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

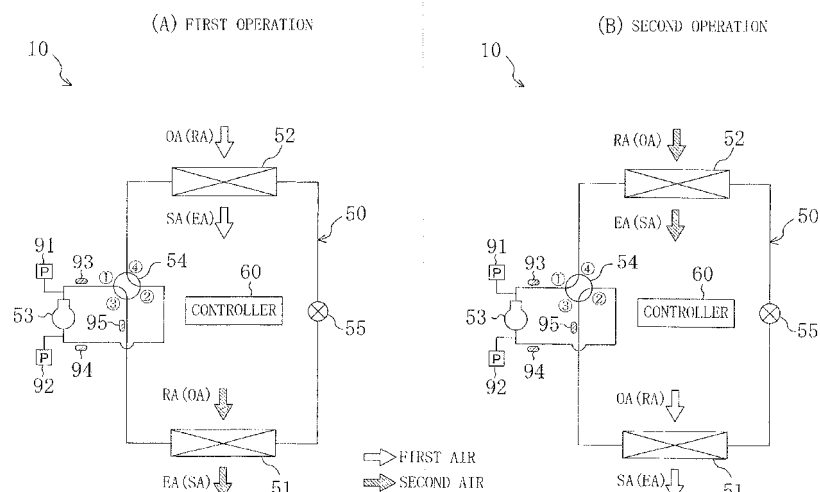
(71) Applicant: **Daikin Industries, Ltd.**
Osaka 530-8323 (JP)

(54) **HUMIDITY ADJUSTMENT DEVICE**

(57) A humidity control apparatus (10) alternately performs first and second operations at predetermined switching intervals. In the first operation, a first adsorption heat exchanger (51) serves as a condenser, and a second adsorption heat exchanger (52) serves as an evaporator, thereby humidifying second air by the first adsorption heat exchanger (51), and dehumidifying first air by the second adsorption heat exchanger (52). In the second operation, the second adsorption heat exchanger

(52) serves as the condenser, and the first adsorption heat exchanger (51) serves as the evaporator, thereby humidifying the second air by the second adsorption heat exchanger (52), and dehumidifying the first air by the first adsorption heat exchanger (51). The switching intervals between the first and second operations are shorter in dehumidification operation of supplying the dehumidified first air to the inside of a room than in humidification operation of supplying the humidified second air to the inside of the room.

FIG. 3



Description

TECHNICAL FIELD

[0001] The present invention relates to humidity control apparatuses for controlling air humidity using an adsorbent.

BACKGROUND ART

[0002] Humidity control apparatuses for controlling air humidity using an adsorbent have been known. Patent Document 1 describes a humidity control apparatus including an adsorption heat exchanger carrying an adsorbent on a surface thereof. The humidity control apparatus performs a so-called batch operation.

[0003] Specifically, the humidity control apparatus of Patent Document 1 includes a refrigerant circuit having two adsorption heat exchangers. The refrigerant circuit alternately performs first operation where a first adsorption heat exchanger serves as a condenser, and a second adsorption heat exchanger serves as an evaporator, and second operation where the second adsorption heat exchanger serves as the condenser, and the first adsorption heat exchanger serves as the evaporator at predetermined time intervals. In the adsorption heat exchanger serving as the evaporator, moisture in the air is adsorbed by the adsorbent. In the adsorption heat exchanger serving as the condenser, the moisture is desorbed from the adsorbent, and is given to the air.

[0004] The humidity control apparatus of Patent Document 1 supplies one of air flows that passed through the adsorption heat exchangers to the inside of a room, and discharges the other air flow outside the room. In the humidity control apparatus performing dehumidification operation, the air that passed through one of the first and second adsorption heat exchangers serving as the evaporator is supplied to the inside of the room, and the air that passed through the other adsorption heat exchanger serving as the condenser is discharged outside the room. In the humidity control apparatus performing humidification operation, the air that passed through one of the first and second adsorption heat exchangers serving as the evaporator is discharged outside the room, and the air that passed through the other adsorption heat exchanger serving as the condenser is supplied to the inside of the room.

Patent Document 1: Japanese Patent Publication No. 2006-078108

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0005] In the humidity control apparatus performing the dehumidification operation or the humidification operation, the adsorption heat exchanger adsorbs the mois-

ture in the air. In this case, switching between the first and second operations is preferably performed when the adsorption heat exchanger carrying the adsorbent is substantially saturated, because humidity control capability of the humidity control apparatus is exhibited to the maximum extent.

[0006] When the humidity control apparatus is required to perform the dehumidification operation, humidities of outside air and room air are generally high as compared with the case where the humidity control apparatus is required to perform the humidification operation. Specifically, in the dehumidification operation, the adsorption heat exchanger is substantially saturated in a shorter time than in the humidification operation.

[0007] Therefore, if switching intervals for switching between the first and second operations are set to a certain value which allows for the switching at a point in time when the adsorption heat exchanger is substantially saturated in the humidification operation, the switching is not performed in the dehumidification operation until a certain period of time has passed after the adsorption heat exchanger is substantially saturated. Further, if the switching intervals for switching between the first and second operations are set to a certain value that allows for the switching at a point in time when the adsorption heat exchanger is substantially saturated in the dehumidification operation, the switching is performed in the humidification operation before the adsorption heat exchanger is substantially saturated. Thus, if the switching intervals for switching between the first and second operations of the dehumidification operation are set to the same value as the switching intervals for switching between the first and second operations of the humidification operation, the humidity control capability of the humidity control apparatus is sufficiently exhibited only in one of the dehumidification operation and the humidification operation.

[0008] In view of the foregoing, the present invention has been achieved. An object of the invention is to provide a humidity control apparatus which performs a so-called batch operation, and which is capable of sufficiently exhibiting its humidity control capability in both of the dehumidification operation and the humidification operation.

SOLUTION TO THE PROBLEM

[0009] A first aspect of the invention is directed to a humidity control apparatus including: first and second adsorption units (51, 52, 111, 112), each of which includes an adsorbent to be brought into contact with air, wherein first operation of humidifying second air by recovering the adsorbent of the first adsorption unit (51, 111), and simultaneously dehumidifying first air by the second adsorption unit (52, 112), and second operation of recovering the adsorbent by the second adsorption unit (52, 112) to humidify the second air, and simultaneously dehumidifying the first air by the first adsorption unit (51,

111) are alternately performed at predetermined switching intervals, dehumidification operation of supplying the dehumidified first air to the inside of a room, and humidification operation of supplying the humidified second air to the inside of the room are selectively performed, and the switching intervals in the dehumidification operation are shorter than the switching intervals in the humidification operation.

[0010] The humidity control apparatus (10) according to the first aspect of the invention selectively performs the dehumidification operation and the humidification operation. In the dehumidification operation and the humidification operation, the humidity control apparatus (10) alternately repeatedly performs the first and second operations. In the humidity control apparatus (10) performing the first operation, the second air is sent to the first adsorption unit (51, 111), and the first air is sent to the second adsorption unit (52, 112). The first adsorption unit (51, 111) recovers the adsorbent, and gives the moisture desorbed from the adsorbent to the second air. The second adsorption unit (52, 112) adsorbs the moisture in the first air to the adsorbent. On the other hand, in the humidity control apparatus (10) performing the second operation, the first air is sent to the first adsorption unit (51, 111), and the second air is sent to the second adsorption unit (52, 112). The first adsorption unit (51, 111) adsorbs the moisture in the first air to the adsorbent. The second adsorption unit (52, 112) recovers the adsorbent, and gives the moisture desorbed from the adsorbent to the second air. The first air dehumidified by the adsorption unit (51, 52, 111, 112) is supplied to the inside of the room in the dehumidification operation, and the second air humidified by the adsorption unit (51, 52, 111, 112) is supplied to the inside of the room in the humidification operation.

[0011] The humidity control apparatus (10) of the first aspect of the invention alternately performs the first and second operations at predetermined switching intervals. In the humidity control apparatus (10), time intervals for switching between the first and second operations (i.e., the switching intervals) of the dehumidification operation are shorter than time intervals for switching between the first and second operations (i.e., the switching intervals) of the humidification operation. For example, when the first and second operations of the dehumidification operation are alternately performed every three minutes, the first and second operations of the humidification operation are alternately performed at time intervals longer than three minutes (e.g., four minutes). Specifically, in this humidity control apparatus (10), duration of one first/second operation of the dehumidification operation is shorter than duration of one first/second operation of the humidification operation.

[0012] In a second aspect of the invention related to the first aspect of the invention, outside air is admitted as the first air, and room air is admitted as the second air to supply the dehumidified first air to the inside of the room, and discharge the humidified second air outside

the room in the dehumidification operation, and the room air is admitted as the first air, and the outside air is admitted as the second air to supply the humidified second air to the inside of the room, and discharge the humidified first air in the humidification operation.

[0013] According to the second aspect of the invention, the humidity control apparatus (10) ventilates the room. Specifically, in the dehumidification operation, the humidity control apparatus (10) dehumidifies the outside air admitted as the first air by the adsorption unit (51, 52, 111, 112) to supply the dehumidified air to the inside of the room, and simultaneously, discharges the room air admitted as the second air outside the room together with the moisture desorbed from the adsorption unit (51, 52, 111, 112). In the humidification operation, the humidity control apparatus (10) humidifies the outside air admitted as the second air by the adsorption unit (51, 52, 111, 112) to supply the humidified air to the inside of the room, and simultaneously, dehumidifies the room air admitted as the first air by the adsorption unit (51, 52, 111, 112) to discharge the dehumidified air outside the room.

[0014] In a third aspect of the invention related to the first or second aspect of the invention, the humidity control apparatus further includes: a refrigerant circuit (50) which connects a plurality of adsorption heat exchangers (51, 52) each carrying an adsorbent on a surface thereof, and which is capable of switching between first refrigeration cycle operation where a first adsorption heat exchanger (51) serves as a radiator, and a second adsorption heat exchanger (52) serves as an evaporator, and second refrigeration cycle operation where the second adsorption heat exchanger (52) serves as the radiator, and the first adsorption heat exchanger (51) serves as the evaporator, wherein the refrigerant circuit (50) performs the first refrigeration cycle operation in the first operation, and performs the second refrigeration cycle operation in the second operation, and the first adsorption heat exchanger (51) constitutes the first adsorption unit (51, 111), and the second adsorption heat exchanger (52) constitutes the second adsorption unit (52, 112).

[0015] According to the third aspect of the invention, the humidity control apparatus (10) includes the refrigerant circuit (50) having the adsorption heat exchangers (51, 52), and the adsorption heat exchangers (51, 52) constitute the adsorption units. The refrigerant circuit (50) performs the first refrigeration cycle operation in the first operation, and performs the second refrigeration cycle operation in the second operation.

[0016] According to the third aspect of the invention, in the first refrigeration cycle operation, the second air is sent to the first adsorption heat exchanger (51) serving as the radiator, and the first air is sent to the second adsorption heat exchanger (52) serving as the evaporator. In the first adsorption heat exchanger (51), the adsorbent is recovered as it is heated by the refrigerant, and the moisture desorbed from the adsorbent is given to the second air. In the second adsorption heat exchanger (52), the adsorbent adsorbs the moisture in the first

air, and heat generated by the adsorption is absorbed by the refrigerant. On the other hand, in the second refrigeration cycle operation, the first air is sent to the first adsorption heat exchanger (51) serving as the evaporator, and the second air is sent to the second adsorption heat exchanger (52) serving as the radiator. In the first adsorption heat exchanger (51), the adsorbent adsorbs the moisture in the first air, and heat generated by the adsorption is absorbed by the refrigerant. In the second adsorption heat exchanger (52), the adsorbent is recovered as it is heated by the refrigerant, and the moisture desorbed from the adsorbent is given to the second air.

ADVANTAGES OF THE INVENTION

[0017] As described above, in the humidity control apparatus (10), humidity of the first air that loses the moisture to the adsorption unit (51, 52, 111, 112) is generally higher in the dehumidification operation, than in the humidification operation. Specifically, the adsorption unit (51, 52, 111, 112) is substantially saturated in a shorter time in the dehumidification operation than in the humidification operation.

[0018] In this regard, according to the humidity control apparatus (10) of the present invention, the switching intervals between the first and second operations of the dehumidification operation are set shorter than the switching intervals between the first and second operations of the humidification operation. Specifically, in the humidification operation where the humidity of the first air is relatively low, and the adsorption unit (51, 52, 111, 112) is substantially saturated in a relatively long time, the duration of the first/second operation is set long. On the other hand, in the dehumidification operation where the humidity of the first air is relatively high, and the adsorption unit (51, 52, 111, 112) is substantially saturated in a relatively short time, the duration of the first/second operation is set short.

[0019] Thus, according to the present invention, in both of the dehumidification operation and the humidification operation, a difference between a point in time when the adsorption unit (51, 52, 111, 112) is substantially saturated, and a point in time when one of the first and second operations is switched to the other can be reduced. As a result, the humidity control capability of the humidity control apparatus (10) can sufficiently be exhibited in both of the dehumidification operation and the humidification operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

[FIG. 1] FIG. 1 is a perspective view of a humidity control apparatus as viewed from the front, in which part of a casing and an electrical component box are omitted.

[FIG. 2] FIG. 2 schematically shows a plan view, a

right side view, and a left side view of the humidity control apparatus, partially omitted.

[FIG. 3] FIG. 3(A) is a piping diagram illustrating first operation in a refrigerant circuit, and FIG. 3(B) is a piping diagram illustrating second operation in the refrigerant circuit.

[FIG. 4] FIG. 4 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in first operation of dehumidification/ventilation operation.

[FIG. 5] FIG. 5 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in second operation of the dehumidification/ventilation operation.

[FIG. 6] FIG. 6 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in first operation of humidification/ventilation operation.

[FIG. 7] FIG. 7 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in second operation of the humidification/ventilation operation.

[FIG. 8] FIG. 8 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in simple ventilation operation.

[FIG. 9] FIG. 9 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in first operation of dehumidification/circulation operation.

[FIG. 10] FIG. 10 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in second operation of the dehumidification/circulation operation.

[FIG. 11] FIG. 11 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in first operation of humidification/circulation operation.

[FIG. 12] FIG. 12 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, together with a flow of air in second operation of the humidification/circulation operation.

[FIG. 13] FIG. 13(A) schematically shows first operation in a humidity control apparatus of a third alternative example of the embodiment, and FIG. 13(B) shows second operation in the humidity control apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0021]

- | | |
|----|----------------------------|
| 10 | Humidity control apparatus |
| 50 | Refrigerant circuit |

- 51 First adsorption heat exchanger (first adsorption unit)
- 52 Second adsorption heat exchanger (second adsorption unit)
- 111 First adsorption element (first adsorption unit)
- 112 Second adsorption element (second adsorption unit)

DESCRIPTION OF EMBODIMENTS

[0022] Embodiments of the present invention will be described in detail with reference to the drawings. A humidity control apparatus (10) of the present embodiment controls humidity of air in the room, and ventilates the room, i.e., controls the humidity of admitted outside air (OA) to supply the humidity-controlled air to the inside of the room, and discharges admitted room air (RA) outside the room.

<General Structure of Humidity Control Apparatus>

[0023] The humidity control apparatus (10) will be described with reference to FIGS. 1 and 2. The terms "upper," "lower," "left," "right," "front," "back," "frontward," and "backward" used in the following description indicate the directions relative to the humidity control apparatus (10) as seen from the front, unless otherwise specified.

[0024] The humidity control apparatus (10) includes a casing (11). A refrigerant circuit (50) is provided in the casing (11). The refrigerant circuit (50) connects a first adsorption heat exchanger (51), a second adsorption heat exchanger (52), a compressor (53), a four-way switching valve (54), and a motor-operated expansion valve (55). Details of the refrigerant circuit (50) will be described below.

[0025] The casing (11) is in the shape of a flat, relatively short rectangular parallelepiped. In the casing (11) shown in FIG. 1, a left front plane (i.e., a front plane) constitutes a front panel (12), and a right back plane (i.e., a back plane) constitutes a back panel (13). Further, a right front plane of the casing (11) constitutes a first side panel (14), and a left back plane constitutes a second side panel (15).

[0026] The casing (11) includes an outside air inlet (24), a room air inlet (23), a supply port (22), and a discharge port (21). The outside air inlet (24) and the room air inlet (23) are opened in the back panel (13). The outside air inlet (24) is formed in a lower portion of the back panel (13). The room air inlet (23) is formed in an upper portion of the back panel (13). The supply port (22) is arranged near an edge of the first side panel (14) close to the front panel (12). The discharge port (21) is arranged near an edge of the second side panel (15) close to the front panel (12).

[0027] The casing (11) contains an upstream divider plate (71), a downstream divider plate (72), a central divider plate (73), a first divider plate (74), and a second divider plate (75). Each of the divider plates (71-75) is

vertically arranged on a bottom plate of the casing (11), and divides space inside the casing (11) from the bottom plate to the top plate of the casing (11).

[0028] The upstream divider plate (71) and the downstream divider plate (72) are arranged parallel to the front panel (12) and the back panel (13) to have a predetermined gap therebetween in the front-back direction of the casing (11). The upstream divider plate (71) is arranged close to the back panel (13). The downstream divider plate (72) is arranged close to the front panel (12).

[0029] The first divider plate (74) and the second divider plate (75) are arranged parallel to the first side panel (14) and the second side panel (15). The first divider plate (74) is arranged to have a predetermined gap from the first side panel (14) to close space between the upstream divider plate (71) and the downstream divider plate (72) from the right. The second divider plate (75) is arranged to have a predetermined gap from the second side panel (15) to close the space between the upstream divider plate (71) and the downstream divider plate (72) from the left.

[0030] The central divider plate (73) is arranged between the upstream divider plate (71) and the downstream divider plate (72) to be orthogonal to the upstream divider plate (71) and the downstream divider plate (72). The central divider plate (73) is arranged to extend from the upstream divider plate (71) to the downstream divider plate (72), and divides the space between the upstream divider plate (71) and the downstream divider plate (72) into a right room and a left room.

[0031] In the casing (11), space between the upstream divider plate (71) and the back panel (13) is divided into an upper room and a lower room. The upper room constitutes a room air passage (32), and the lower room constitutes an outside air passage (34). The room air passage (32) communicates with the inside of the room through a duct connected to the room air inlet (23). A room air filter (27) and a room air humidity sensor (96) are provided in the room air passage (32). The outside air passage (34) communicates with the outside of the room through a duct connected to the outside air inlet (24). An outside air filter (28) and an outside air humidity sensor (97) are provided in the outside air passage (34).

[0032] The space between the upstream divider plate (71) and the downstream divider plate (72) in the casing (11) is divided into a right room and a left room by the central divider plate (73). The room on the right of the central divider plate (73) constitutes a first heat exchange chamber (37), and the room on the left of the central divider plate (73) constitutes a second heat exchange chamber (38). The first heat exchange chamber (37) contains a first adsorption heat exchanger (51). The second heat exchange chamber (38) contains a second adsorption heat exchanger (52). Although not shown, the first heat exchange chamber (37) also contains the motor-operated expansion valve (55) of the refrigerant circuit (50).

[0033] Each of the adsorption heat exchangers (51,

52) is a cross-fin type fin-and-tube heat exchanger carrying an adsorbent on a surface thereof, and constitutes an adsorption unit. Each of the adsorption heat exchangers (51, 52) is in the shape of a thick rectangular plate, or a flat rectangular parallelepiped. Each of the adsorption heat exchangers (51, 52) is vertically arranged in the corresponding heat exchange chamber (37, 38) with the front and back surfaces thereof parallel to the upstream divider plate (71) and the downstream divider plate (72).

[0034] In the casing (11), space extending along the front surface of the downstream divider plate (72) is divided into an upper room and a lower room. The upper room constitutes a supply air passage (31), and the lower room constitutes a discharge air passage (33).

[0035] The upstream divider plate (71) includes four open/close dampers (41-44). Each of the dampers (41-44) is substantially in the shape of a horizontally oriented rectangle. Specifically, a first room air damper (41) is attached to a portion (an upper portion) of the upstream divider plate (71) facing the room air passage (32) on the right of the central divider plate (73), and a second room air damper (42) is attached to the upper portion on the left of the central divider plate (73). A first outside air damper (43) is attached to a portion (a lower portion) of the upstream divider plate (71) facing the outside air passage (34) on the right of the central divider plate (73), and a second outside air damper (44) is attached to the lower portion on the left of the central divider plate (73).

[0036] The downstream divider plate (72) includes four open/close dampers (45-48). Each of the dampers (45-48) is substantially in the shape of a horizontally oriented rectangle. Specifically, a first supply air damper (45) is attached to a portion (an upper portion) of the downstream divider plate (72) facing the supply air passage (31) on the right of the central divider plate (73), and a second supply air damper (46) is attached to the upper portion on the right of the central divider plate (73). A first discharge air damper (47) is attached to a portion (a lower portion) of the downstream divider plate (72) facing the discharge air passage (33) on the right of the central divider plate (73), and a second discharge air damper (48) is attached to the lower portion on the left of the central divider plate (73).

[0037] In the casing (11), the space between the supply air passage (31) and the discharge air passage (33), and the front panel (12) is divided into a right room and a left room by a divider plate (77). The room on the right of the divider plate (77) constitutes a supply fan chamber (36), and the room on the left of the divider plate (77) constitutes a discharge fan chamber (35).

[0038] The supply fan chamber (36) contains a supply fan (26). The discharge fan chamber (35) contains a discharge fan (25). The supply fan (26) and the discharge fan (25) are multi-blade centrifugal fans (so-called sirocco fans). The supply fan (26) blows the air from the downstream divider plate (72) to the supply port (22). The discharge fan (25) blows the air from the downstream divider plate (72) to the discharge port (21).

[0039] The supply fan chamber (36) contains the compressor (53) and the four-way switching valve (54) of the refrigerant circuit (50). The compressor (53) and the four-way switching valve (54) are arranged in the supply fan chamber (36) between the supply fan (26) and the divider plate (77).

[0040] In the casing (11), space between the first divider plate (74) and the first side panel (14) constitutes a first bypass passage (81). A starting end of the first bypass passage (81) communicates only with the outside air passage (34), and is blocked from the room air passage (32). A terminal end of the first bypass passage (81) is blocked from the supply air passage (31), the discharge air passage (33), and the supply fan chamber (36) by a divider plate (78). A first bypass damper (83) is provided in the divider plate (78) to face the supply fan chamber (36).

[0041] In the casing (11), space between the second divider plate (75) and the second side panel (15) constitutes a second bypass passage (82). A starting end of the second bypass passage (82) communicates only with the room air passage (32), and is blocked from the outside air passage (34). A terminal end of the second bypass passage (82) is blocked from the supply air passage (31), the discharge air passage (33), and the discharge fan chamber (35) by a divider plate (79). A second bypass damper (84) is provided in the divider plate (79) to face the discharge fan chamber (35).

[0042] In the right side view and the left side view of FIG. 2, the first bypass passage (81), the second bypass passage (82), the first bypass damper (83), and the second bypass damper (84) are not shown.

<Structure of Refrigerant Circuit>

[0043] As shown in FIG. 3, the refrigerant circuit (50) is a closed circuit including the first adsorption heat exchanger (51), the second adsorption heat exchanger (52), the compressor (53), the four-way switching valve (54), and the motor-operated expansion valve (55). The refrigerant circuit (50) performs a vapor compression refrigeration cycle by circulating a refrigerant filled therein.

[0044] 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 is connected to a second port of the four-way switching valve (54). In the refrigerant circuit (50), the first adsorption heat exchanger (51), the motor-operated expansion valve (55), and the second adsorption heat exchanger (52) are sequentially connected between a third port and a fourth port of the four-way switching valve (54).

[0045] The four-way switching valve (54) is configured to be able to switch between a first state where the first and third ports communicate with each other, and the second and fourth ports communicate with each other (a state shown in FIG. 3(A)), and a second state where the first and fourth ports communicate with each other, and the second and third ports communicate with each other

(a state shown in FIG. 3(B)).

[0046] In the refrigerant circuit (50), a high pressure sensor (91) and a discharge pipe temperature sensor (93) are attached to a duct connecting the discharge side of the compressor (53) and the first port of the four-way switching valve (54). The high pressure sensor (91) measures a pressure of the refrigerant discharged from the compressor (53). The discharge pipe temperature sensor (93) measures a temperature of the refrigerant discharged from the compressor (53).

[0047] In the refrigerant circuit (50), a low pressure sensor (92) and a suction pipe temperature sensor (94) are attached to a duct connecting the suction side of the compressor (53) and the second port of the four-way switching valve (54). The low pressure sensor (92) measures a pressure of the refrigerant sucked into the compressor (53). The suction pipe temperature sensor (94) measures a temperature of the refrigerant sucked into the compressor (53).

[0048] In the refrigerant circuit (50), a duct temperature sensor (95) is attached to a duct connecting the third port of the four-way switching valve (54) and the first adsorption heat exchanger (51). The duct temperature sensor (95) is arranged on the duct near the four-way switching valve (54), and measures a temperature of the refrigerant flowing in the duct.

<Structure of Controller>

[0049] The humidity control apparatus (10) includes a controller (60) as a control section. Although not shown in FIGS. 1 and 2, an electrical component box is attached to the front panel (12) of the casing (11), and a control board contained in the electrical component box constitutes the controller (60).

[0050] The controller (60) receives measurements of the room air humidity sensor (96), a room air temperature sensor, the outside air humidity sensor (97), and an outside air temperature sensor. The controller (60) further receives measurements of the sensors (91, 92, ...) provided in the refrigerant circuit (50). The controller (60) controls the operation of the humidity control apparatus (10) based on the input measurements.

[0051] In the humidity control apparatus (10), dehumidification/ventilation operation, humidification/ventilation operation, and simple ventilation operation described later are switched by the control of the controller (60). During these operations, the controller (60) controls the operation of the dampers (41-48), the fans (25, 26), the compressor (53), the motor-operated expansion valve (55), and the four-way switching valve (54).

-Operation Mechanism-

[0052] The humidity control apparatus (10) of the present embodiment selectively performs dehumidification/ventilation operation which is dehumidification operation, humidification/ventilation operation which is hu-

midification operation, and simple ventilation operation. In the dehumidification/ventilation operation and the humidification/ventilation operation, the humidity control apparatus (10) admits outside air (OA) for humidity control to supply the humidity-controlled air to the inside of the room as supply air (SA), and simultaneously, the humidity control apparatus (10) admits room air (RA) to discharge it as exhaust air (EA). In the simple ventilation operation, the humidity control apparatus (10) admits the outside air (OA) to supply it to the inside of the room as the supply air (SA), and simultaneously, the humidity control apparatus (10) admits the room air (RA) to discharge it as the exhaust air (EA).

15 <Dehumidification/Ventilation Operation>

[0053] In the humidity control apparatus (10) performing the dehumidification/ventilation operation, first and second operations described later are alternately repeated every three minutes. In the dehumidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0054] In the dehumidification/ventilation operation, the humidity control apparatus (10) admits the outside air as first air into the casing (11) through the outside air inlet (24), and admits the room air as second air into the casing (11) through the room air inlet (23).

[0055] The first operation of the dehumidification/ventilation operation will be described below. As shown in FIG. 4, in the first operation, the first room air damper (41), the second outside air damper (44), the second supply air damper (46), and the first discharge air damper (47) are opened, and the second room air damper (42), the first outside air damper (43), the first supply air damper (45), and the second discharge air damper (48) are closed. In the first operation, the four-way switching valve (54) of the refrigerant circuit (50) is set to the first state (the state shown in FIG. 3(A)), in which the first adsorption heat exchanger (51) serves as the condenser, and the second adsorption heat exchanger (52) serves as the evaporator. That is, the refrigerant circuit (50) performs first refrigeration cycle operation.

[0056] The first air that entered the outside air passage (34), and passed through the outside air filter (28) passes through the second outside air damper (44) to enter the second heat exchange chamber (38), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture in the first air is adsorbed by the adsorbent, and heat generated by the adsorption is absorbed by the refrigerant. The first air dehumidified by the second adsorption heat exchanger (52) passes through the second supply air damper (46) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0057] The second air that entered the room air passage (32), and passed through the room air filter (27) passes through the first room air damper (41) to enter

the first heat exchange chamber (37), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air containing the moisture given by the first adsorption heat exchanger (51) passes through the first discharge air damper (47) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

[0058] The second operation of the dehumidification/ventilation operation will be described below. As shown in FIG. 5, in the second operation, the second room air damper (42), the first outside air damper (43), the first supply air damper (45), and the second discharge air damper (48) are opened, and the first room air damper (41), the second outside air damper (44), the second supply air damper (46), and the first discharge air damper (47) are closed. In the refrigerant circuit (50) performing the second operation, the four-way switching valve (54) is set to the second state (the state shown in FIG. 3(B)), in which the first adsorption heat exchanger (51) serves as the evaporator, and the second adsorption heat exchanger (52) serves as the condenser. That is, the refrigerant circuit (50) performs second refrigeration cycle operation.

[0059] The first air that entered the outside air passage (34), and passed through the outside air filter (28) passes through the first outside air damper (43) to enter the first heat exchange chamber (37), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air is adsorbed by the adsorbent, and heat generated by the adsorption is absorbed by the refrigerant. The first air dehumidified by the first adsorption heat exchanger (51) passes through the first supply air damper (45) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0060] The second air that entered the room air passage (32), and passed through the room air filter (27) passes through the second room air damper (42) to enter the second heat exchange chamber (38), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air containing the moisture given by the second adsorption heat exchanger (52) passes through the second discharge air damper (48) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

<Humidification/Ventilation Operation>

[0061] In the humidity control apparatus (10) perform-

ing the humidification/ventilation operation, first and second operations described later are alternately repeated every four minutes. In the humidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0062] In the humidification/ventilation operation, the humidity control apparatus (10) admits the outside air as the second air into the casing (11) through the outside air inlet (24), and admits the room air as the first air into the casing (11) through the room air inlet (23).

[0063] The first operation of the humidification/ventilation operation will be described below. As shown in FIG. 6, in the first operation, the second room air damper (42), the first outside air damper (43), the first supply air damper (45), and the second discharge air damper (48) are opened, and the first room air damper (41), the second outside air damper (44), the second supply air damper (46), and the first discharge air damper (47) are closed. In the first operation, the four-way switching valve (54) of the refrigerant circuit (50) is set to the first state (the state shown in FIG. 3(A)), in which the first adsorption heat exchanger (51) serves as the condenser, and the second adsorption heat exchanger (52) serves as the evaporator. That is, the refrigerant circuit (50) performs the first refrigeration cycle operation.

[0064] The first air that entered the room air passage (32), and passed through the room air filter (27) passes through the second room air damper (42) to enter the second heat exchange chamber (38), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture in the first air is adsorbed by the adsorbent, and heat generated by the adsorption is absorbed by the refrigerant. The first air that lost the moisture to the second adsorption heat exchanger (52) passes through the second discharge air damper (48) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

[0065] The second air that entered the outside air passage (34), and passed through the outside air filter (28) passes through the first outside air damper (43) to enter the first heat exchange chamber (37), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air humidified by the first adsorption heat exchanger (51) passes through the first supply air damper (45) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0066] The second operation of the humidification/ventilation operation will be described below. As shown in FIG. 7, in the second operation, the first room air damper (41), the second outside air damper (44), the second supply air damper (46), and the first discharge air damper (47) are opened, and the second room air damper (42),

the first outside air damper (43), the first supply air damper (45), and the second discharge air damper (48) are closed. In the second operation, the four-way switching valve (54) of the refrigerant circuit (50) is set to the second state (the state shown in FIG. 3(B)), in which the first adsorption heat exchanger (51) serves as the evaporator, and the second adsorption heat exchanger (52) serves as the condenser. That is, the refrigerant circuit (50) performs the second refrigeration cycle operation.

[0067] The first air that entered the room air passage (32), and passed through the room air filter (27) passes through the first room air damper (41) to enter the first heat exchange chamber (37), and then passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air is adsorbed by the adsorbent, and heat generated by the adsorption is absorbed by the refrigerant. The first air that lost the moisture to the first adsorption heat exchanger (51) passes through the first discharge air damper (47) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

[0068] The second air that entered the outside air passage (34), and passed through the outside air filter (28) passes through the second outside air damper (44) to enter the second heat exchange chamber (38), and then passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air humidified by the second adsorption heat exchanger (52) passes through the second supply air damper (46) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

<Simple Ventilation Operation>

[0069] The simple ventilation operation of the humidity control apparatus (10) will be described with reference to FIG. 8.

[0070] In the humidity control apparatus (10) performing the simple ventilation operation, 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 outside air damper (43), the second outside air damper (44), the first supply air damper (45), the second supply air damper (46), the first discharge air damper (47), and the second discharge air damper (48) are closed. In the simple ventilation operation, the compressor (53) of the refrigerant circuit (50) is suspended.

[0071] In the simple ventilation operation, the humidity control apparatus (10) admits the outside air into the casing (11) through the outside air inlet (24). The outside air that passed through the outside air inlet (24) to enter the outside air passage (34) passes through the first bypass passage (81) and the first bypass damper (83) to enter

the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0072] In the simple ventilation operation, the humidity control apparatus (10) admits the room air into the casing (11) through the room air inlet (23). The room air that passed through the room air inlet (23) to enter the room air passage (32) passes through the second bypass passage (82) and the second bypass damper (84) to enter the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

-Control Operation by the Controller-

[0073] The control operation performed by the controller (60) will be described below.

[0074] As described above, the controller (60) performs switching between the first and second operations by controlling the operation of the dampers (41-48), and the four-way switching valve (54) in the dehumidification/ventilation operation and the humidification/ventilation operation. The controller (60) alternately switches between the first and second operations of the dehumidification/ventilation operation every three minutes, and alternately switches between the first and second operations of the humidification/ventilation operation every four minutes.

[0075] In the controller (60) of the present embodiment, switching intervals for switching between the first and second operations are shorter in the dehumidification/ventilation operation than in the humidification/ventilation operation. The reason will be described below.

[0076] In the humidity control apparatus (10) performing the dehumidification/ventilation operation, the outside air admitted as the first air into the casing (11) is sent to the adsorption heat exchanger (51, 52) serving as the evaporator. On the other hand, in the humidity control apparatus (10) performing the humidification/ventilation operation, the room air admitted as the first air into the casing (11) is sent to the adsorption heat exchanger (51, 52) serving as the evaporator.

[0077] The dehumidification/ventilation operation is generally performed in a period when cooling of the inside of the room is required, such as in summer (a cooling season). The humidification/ventilation operation is generally performed in a period when heating of the inside of the room is required, such as in winter (a heating season). Usually, temperature and relative humidity of the outside air in the cooling season are higher than temperature and relative humidity of the room air in the heating season. Specifically, the relative humidity of the air sent as the first air to the adsorption heat exchanger (51, 52) serving as the evaporator is generally higher in the dehumidification/ventilation operation than in the humidification/ventilation operation.

[0078] An amount of moisture adsorbed by the adsorption heat exchanger (51, 52) per unit time is larger as the relative humidity of the air sent to the adsorption heat exchanger (51, 52) is higher. Therefore, time required

until the amount of moisture adsorbed by the adsorption heat exchanger (51, 52) increases to a considerable amount from the start of the first or second operation is shorter in the dehumidification/ventilation operation than in the humidification/ventilation operation.

[0079] Further, the amount of moisture adsorbed by the adsorption heat exchanger (51, 52) per unit time decreases as the amount of moisture that has already been adsorbed by the adsorption heat exchanger (51, 52) increases. Therefore, when the amount of moisture that has been adsorbed by the adsorption heat exchanger (51, 52) increases to a considerable amount, the amount of moisture newly adsorbed by the adsorption heat exchanger (51, 52) hardly increases even if the air is kept supplied to the adsorption heat exchanger (51, 52). That is, the adsorption heat exchanger (51, 52) is substantially saturated. Therefore, in the controller (60) of the present embodiment, the switching intervals for switching between the first and second operations are set shorter in the dehumidification/ventilation operation than in the humidification/ventilation operation.

[0080] In the controller (60) of the present embodiment, the switching intervals for switching between the first and second operations of the dehumidification/ventilation operation are set to three minutes, and the switching intervals for switching between the first and second operations of the humidification/ventilation operation are set to four minutes. However, the values are indicated only for the purpose of examples.

[0081] Specifically, the switching intervals for switching between the first and second operations are suitably selected depending on, for example, the size of the adsorption heat exchangers (51, 52), the performance of the adsorbent, etc. However, the switching intervals for switching between the first and second operations of the dehumidification/ventilation operation are preferably in the range of 60% to 90%, both inclusive, more preferably, in the range of 70% to 80%, both inclusive, of the switching intervals for switching between the first and second operations of the humidification/ventilation operation.

-Advantages of First Embodiment-

[0082] In the humidity control apparatus (10) of the present embodiment, the switching intervals for switching between the first and second operations of the dehumidification/ventilation operation are shorter than the switching intervals for switching between the first and second operations of the humidification/ventilation operation. Specifically, in the humidification operation where the humidity of the first air is relatively high, and the adsorption heat exchanger (51, 52) is almost saturated in a relatively long time, duration of the first/second operation is set long. On the other hand, in the dehumidification/ventilation operation where the humidity of the first air is relatively high, and the adsorption heat exchanger (51, 52) is almost saturated in a relatively short time, duration of the first and second operations is set short.

[0083] Thus, according to the present embodiment, in both of the dehumidification/ventilation operation and the humidification/ventilation operation, a difference between the point in time when the adsorption heat exchanger (51, 52) is substantially saturated, and the point in time when one of the first and second operations is switched to the other can be reduced. As a result, humidity control capability of the humidity control apparatus (10) can sufficiently be exhibited in both of the dehumidification/ventilation operation and the humidification/ventilation operation.

-First Alternative Example of First Embodiment-

[0084] The humidity control apparatus (10) of the present embodiment may further perform dehumidification/circulation operation as the dehumidification operation, and humidification/circulation operation as the humidification operation, in addition to the dehumidification/ventilation operation, the humidification/ventilation operation, and the simple ventilation operation. In this example, the humidity control apparatus (10) performing the dehumidification/circulation operation and the humidification/circulation operation will be described.

<Dehumidification/Circulation Operation>

[0085] In the dehumidification/circulation operation, the humidity control apparatus (10) admits the room air as the first air into the casing (11) through the room air inlet (23), and admits the outside air as the second air into the casing (11) through the outside air inlet (24). The humidity control apparatus (10) dehumidifies the room air admitted as the first air to supply the dehumidified air to the inside of the room, and discharges the outside air admitted as the second air outside the room together with the moisture desorbed from the adsorption heat exchanger (51, 52).

[0086] In the dehumidification/circulation operation, first and second operations are alternately performed every three minutes, like in the dehumidification/ventilation operation. The operation of the dampers (41-48) in the first and second operations of the dehumidification/circulation operation is different from that in the dehumidification/ventilation operation. However, the first bypass damper (83) and the second bypass damper (84) are kept closed like in the dehumidification/ventilation operation.

[0087] The first operation of the dehumidification/circulation operation will be described below. As shown in FIG. 9, in the first operation, the second room air damper (42), the first outside air damper (43), the second supply air damper (46), and the first discharge air damper (47) are opened, and the first room air damper (41), the second outside air damper (44), the first supply air damper (45), and the second discharge air damper (48) are closed. The refrigerant circuit (50) performs the first refrigeration cycle operation.

[0088] The first air that entered the room air passage (32) passes through the second room air damper (42) to enter the second heat exchange chamber (38), and is dehumidified as it passes through the second adsorption heat exchanger (52). The dehumidified first air passes through the second supply air damper (46) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0089] The second air that entered the outside air passage (34) passes through the first outside air damper (43) to enter the first heat exchange chamber (37), and receives moisture desorbed from the first adsorption heat exchanger (51). The second air that passed through the first adsorption heat exchanger (51) passes through the first discharge air damper (47) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

[0090] The second operation of the dehumidification/circulation operation will be described below. As shown in FIG. 10, in the second operation, the first room air damper (41), the second outside air damper (44), the first supply air damper (45), and the second discharge air damper (48) are opened, and the second room air damper (42), the first outside air damper (43), the second supply air damper (46), and the first discharge air damper (47) are closed. The refrigerant circuit (50) performs the second refrigeration cycle operation.

[0091] The first air that entered the room air passage (32) passes through the first room air damper (41) to enter the first heat exchange chamber (37), and is dehumidified as it passes through the first adsorption heat exchanger (51). The dehumidified first air passes through the first supply air damper (45) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0092] The second air that entered the outside air passage (34) passes through the second outside air damper (44) to enter the second heat exchange chamber (38), and receives moisture desorbed from the second adsorption heat exchanger (52). The second air that passed through the second adsorption heat exchanger (52) passes through the second discharge air damper (48) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

<Humidification/Circulation Operation>

[0093] In the humidification/circulation operation, the humidity control apparatus (10) admits the room air as the second air into the casing (11) through the room air inlet (23), and admits the outside air as the first air into the casing (11) through the outside air inlet (24). The humidity control apparatus (10) humidifies the room air admitted as the first air to supply the humidified air to the

inside of the room, and dehumidifies the outside air admitted as the second air to discharge the dehumidified air outside the room.

[0094] In the humidification/circulation operation, first and second operations are alternately performed every four minutes, like in the humidification/ventilation operation. The operation of the dampers (41-48) in the first and second operations of the humidification/circulation operation is different from that in the humidification/ventilation operation. However, the first bypass damper (83) and the second bypass damper (84) are kept closed like in the humidification/ventilation operation.

[0095] The first operation of the humidification/circulation operation will be described below. As shown in FIG. 11, in the first operation, the first room air damper (41), the second outside air damper (44), the first supply air damper (45), and the second discharge air damper (48) are opened, and the second room air damper (42), the first outside air damper (43), the second supply air damper (46), and the first discharge air damper (47) are closed. The refrigerant circuit (50) performs the first refrigeration cycle operation.

[0096] The first air that entered the outside air passage (34) passes through the second outside air damper (44) to enter the second heat exchange chamber (38), and is dehumidified as it passes through the second adsorption heat exchanger (52). The dehumidified first air passes through the second discharge air damper (48) to enter the discharge air passage (33), passes through the discharge fan chamber (35), and is discharged outside the room through the discharge port (21).

[0097] The second air that entered the room air passage (32) passes through the first room air damper (41) to enter the first heat exchange chamber (37), and receives moisture desorbed from the first adsorption heat exchanger (51). The second air humidified as it passed through the first adsorption heat exchanger (51) passes through the first supply air damper (45) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

[0098] The second operation of the humidification/circulation operation will be described below. As shown in FIG. 12, in the second operation, the second room air damper (42), the first outside air damper (43), the second supply air damper (46), and the first discharge air damper (47) are opened, and the first room air damper (41), the second outside air damper (44), the first supply air damper (45), and the second discharge air damper (48) are closed. The refrigerant circuit (50) performs the second refrigeration cycle operation.

[0099] The first air that entered the outside air passage (34) passes through the first outside air damper (43) to enter the first heat exchange chamber (37), and is dehumidified as it passes through the first adsorption heat exchanger (51). The dehumidified first air passes through the first discharge air damper (47) to enter the discharge air passage (33), passes through the discharge fan

chamber (35), and is discharged outside the room through the discharge port (21).

[0100] The second air that entered the room air passage (32) passes through the second room air damper (42) to enter the second heat exchange chamber (38), and receives moisture desorbed from the second adsorption heat exchanger (52). The second air humidified as it passed through the second adsorption heat exchanger (52) passes through the second supply air damper (46) to enter the supply air passage (31), passes through the supply fan chamber (36), and is supplied to the inside of the room through the supply port (22).

<Switching Interval for Switching Between First and Second Operations>

[0101] As described above, the room air is supplied as the first air to the adsorption heat exchanger (51, 52) in the dehumidification/circulation operation, and the outside air is supplied as the first air to the adsorption heat exchanger (51, 52) in the humidification/circulation operation. In general, the dehumidification/circulation operation is performed in the cooling season, such as in summer, like the dehumidification/ventilation operation. Further, the humidification/circulation operation is generally performed in the heating season, such as in winter, like the humidification/ventilation operation. Usually, the relative humidity of the air sent as the first air to the adsorption heat exchanger (51, 52) serving as the evaporator is higher in the dehumidification/circulation operation than in the humidification/circulation operation. Therefore, the controller (60) sets the switching intervals for switching between the first and second operations shorter in the dehumidification/circulation operation than in the humidification/circulation operation.

-Second Alternative Example of Embodiment-

[0102] In the refrigerant circuit (50) of the present embodiment, a supercritical refrigeration cycle may be performed in which a high pressure of the refrigeration cycle is set higher than a critical pressure of the refrigerant. In this case, one of the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) serves as a gas cooler, and the other serves as the evaporator.

-Third Alternative Example of Embodiment-

[0103] The humidity control apparatus (10) of the above-described embodiment may be configured as described below.

[0104] As shown in FIG. 13, a humidity control apparatus (10) of the present alternative example includes a refrigerant circuit (100), and two adsorption elements (111, 112). The refrigerant circuit (100) is a closed circuit sequentially connecting a compressor (101), a condenser (102), an expansion valve (103), and an evaporator (104). A vapor compression refrigeration cycle is per-

formed by circulating a refrigerant circulates in the refrigerant circuit (100). A first adsorption element (111) and a second adsorption element (112) include adsorbents such as zeolite etc., respectively. Each of the adsorption elements (111, 112) is provided with a plurality of air passages, and the air comes into contact with the adsorbent when the air passes through the air passages.

[0105] The humidity control apparatus (10) of the present alternative example selectively performs the dehumidification/ventilation operation, the humidification/ventilation operation, and the simple ventilation operation.

[0106] In the dehumidification/ventilation operation and the humidification/ventilation operation, the humidity control apparatus (10) alternately repeats the first and second operations at predetermined time intervals. The switching intervals for switching between the first and second operations are shorter in the dehumidification/ventilation operation than in the humidification/ventilation operation. In the dehumidification/ventilation operation, the humidity control apparatus (10) admits the outside air as the first air, and admits the room air as the second air. In the humidification/ventilation operation, the humidity control apparatus (10) admits the room air as the first air, and admits the outside air as the second air.

[0107] The first operation of the dehumidification/ventilation operation, and the first operation of the humidification/ventilation operation will be described with reference to FIG. 13(A). In the first operation, the humidity control apparatus (10) supplies the second air heated by the condenser (102) to the first adsorption element (111). In the first adsorption element (111), the adsorbent is heated by the second air, and moisture is desorbed from the adsorbent. Further, in the humidity control apparatus (10) performing the first operation, the first air is supplied to the second adsorption element (112), and moisture in the first air is adsorbed by the adsorbent of the second adsorption element (112). The first air that lost the moisture to the second adsorption element (112) is cooled as it passes through the evaporator (104).

[0108] The second operation of the dehumidification/ventilation operation, and the second operation of the humidification/ventilation operation will be described with reference to FIG. 13(B). In the second operation, the humidity control apparatus (10) supplies the second air heated by the condenser (102) to the second adsorption element (112). In the second adsorption element (112), the adsorbent is heated by the second air, and moisture is desorbed from the adsorbent. In the humidity control apparatus (10) performing the second operation, the first air is supplied to the first adsorption element (111), and moisture in the first air is adsorbed by the first adsorption element (111). The first air that lost the moisture to the first adsorption element (111) is cooled as it passes through the evaporator (104).

[0109] In the dehumidification/ventilation operation, the humidity control apparatus (10) supplies the dehumidified first air (the outside air) to the inside of the room,

and discharges the moisture desorbed from the adsorption element (111, 112) outside the room together with the second air (the room air). In the humidification/ventilation operation, the humidity control apparatus (10) supplies the humidified second air (the outside air) to the inside of the room, and discharges the first air (the room air) that lost the moisture to the adsorption element (111, 112) outside the room.

[0110] In the humidity control apparatus (10) performing the simple ventilation operation, the compressor (101) of the refrigerant circuit (100) is suspended, and the outside air passes through one of the first adsorption element (111) and the second adsorption element (112), and the room air passes through the other. The outside air is supplied to the inside of the room after passing through the adsorption element (111, 112), and the room air is discharged outside the room after passing through the adsorption element (111, 112). In the humidity control apparatus (10) performing the simple ventilation operation, flows passages of the outside air and the room air are not changed.

[0111] The above-described embodiments have been set forth merely for the purposes of preferred examples in nature, and are not intended to limit the scope, applications, and use of the invention.

INDUSTRIAL APPLICABILITY

[0112] As described above, the present invention is useful for humidity control apparatuses for controlling air humidity using an adsorbent.

Claims

1. A humidity control apparatus comprising:

first and second adsorption units (51, 52, 111, 112), each of which includes an adsorbent to be brought into contact with air, wherein
 first operation of humidifying second air by recovering the adsorbent of the first adsorption unit (51, 111), and simultaneously dehumidifying first air by the second adsorption unit (52, 112), and second operation of recovering the adsorbent by the second adsorption unit (52, 112) to humidify the second air, and simultaneously dehumidifying the first air by the first adsorption unit (51, 111) are alternately performed at predetermined switching intervals,
 dehumidification operation of supplying the dehumidified first air to the inside of a room, and humidification operation of supplying the humidified second air to the inside of the room are selectively performed, and
 the switching intervals in the dehumidification operation are shorter than the switching intervals in the humidification operation.

2. The humidity control apparatus of claim 1, wherein outside air is admitted as the first air, and room air is admitted as the second air to supply the dehumidified first air to the inside of the room, and discharge the humidified second air outside the room in the dehumidification operation, and
 the room air is admitted as the first air, and the outside air is admitted as the second air to supply the humidified second air to the inside of the room, and discharge the humidified first air in the humidification operation.

3. The humidity control apparatus of claim 1 or 2, further comprising:

a refrigerant circuit (50) which connects a plurality of adsorption heat exchangers (51, 52) each carrying an adsorbent on a surface thereof, and which is capable of switching between first refrigeration cycle operation where a first adsorption heat exchanger (51) serves as a radiator, and a second adsorption heat exchanger (52) serves as an evaporator, and second refrigeration cycle operation where the second adsorption heat exchanger (52) serves as the radiator, and the first adsorption heat exchanger (51) serves as the evaporator, wherein the refrigerant circuit (50) performs the first refrigeration cycle operation in the first operation, and performs the second refrigeration cycle operation in the second operation, and the first adsorption heat exchanger (51) constitutes the first adsorption unit (51, 111), and the second adsorption heat exchanger (52) constitutes the second adsorption unit (52, 112).

FIG. 1

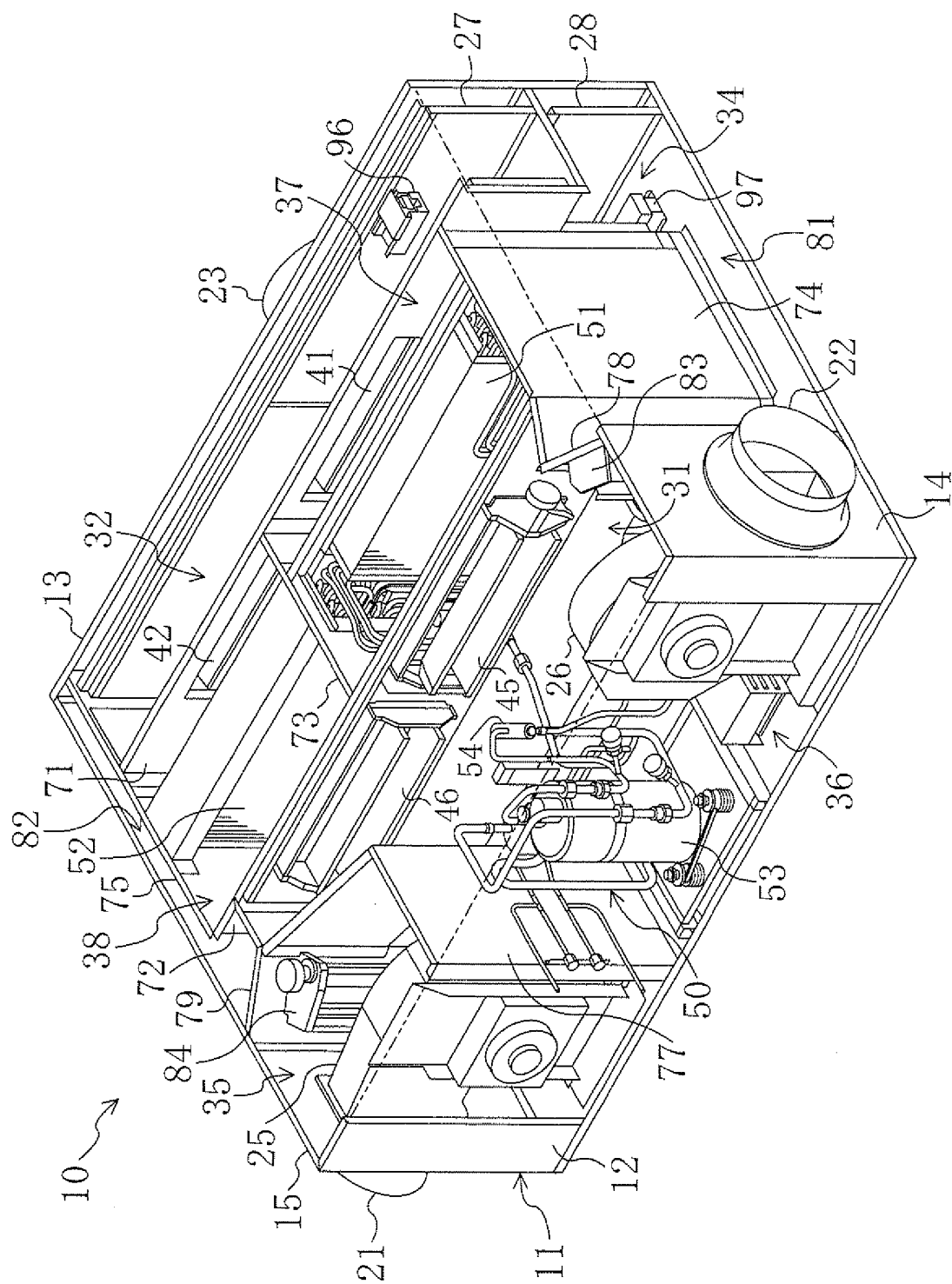


FIG. 2

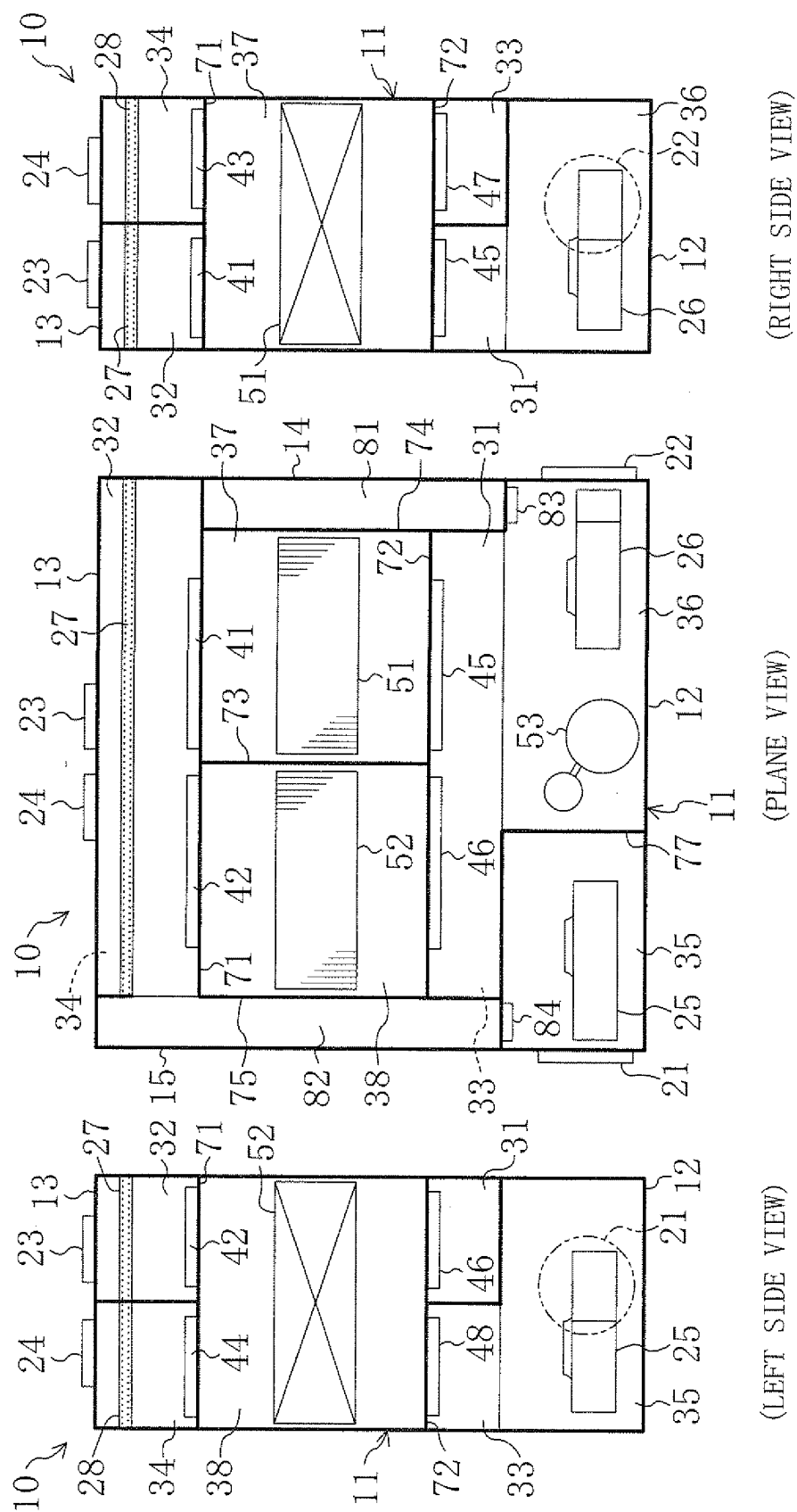


FIG. 3

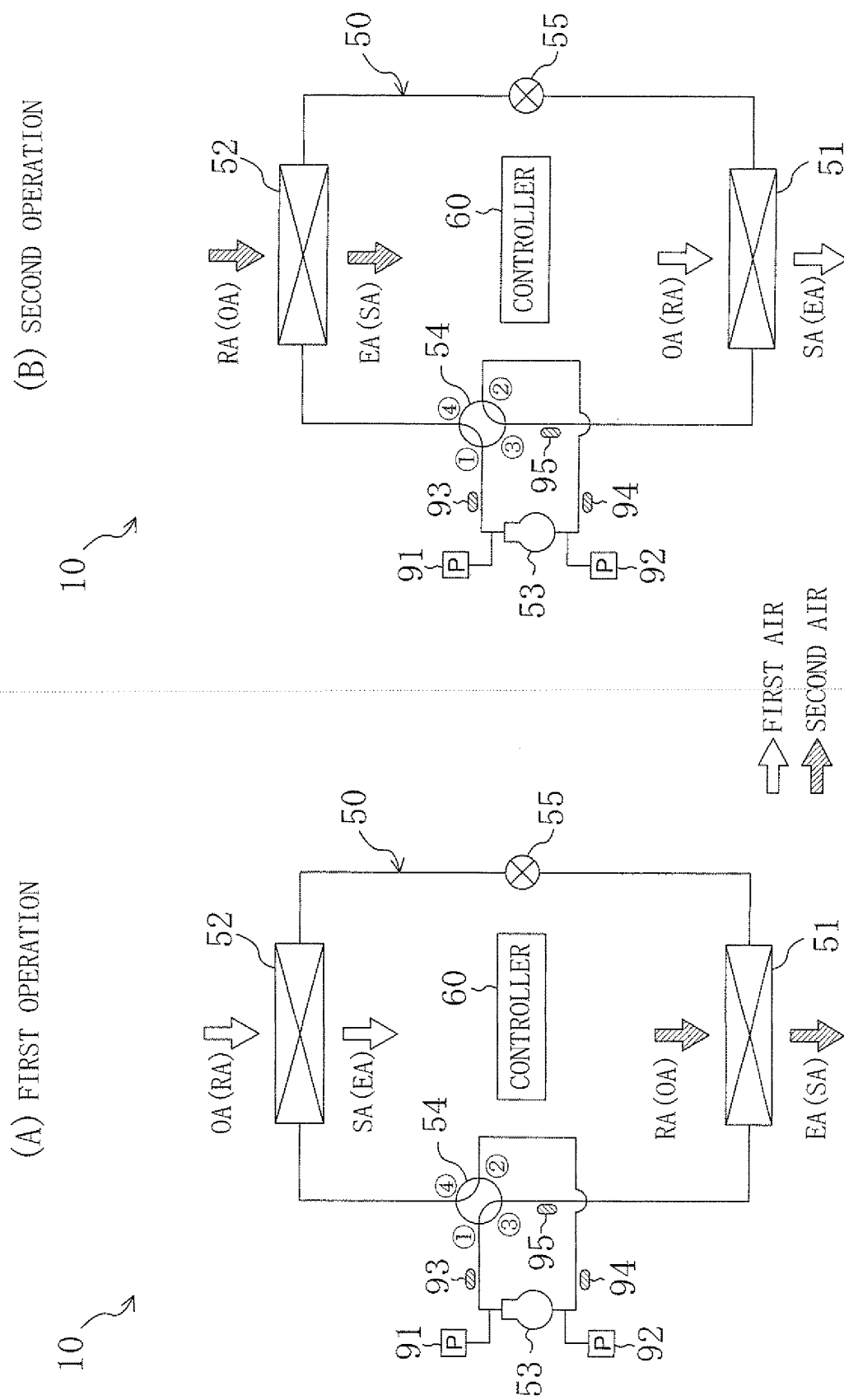


FIG. 4

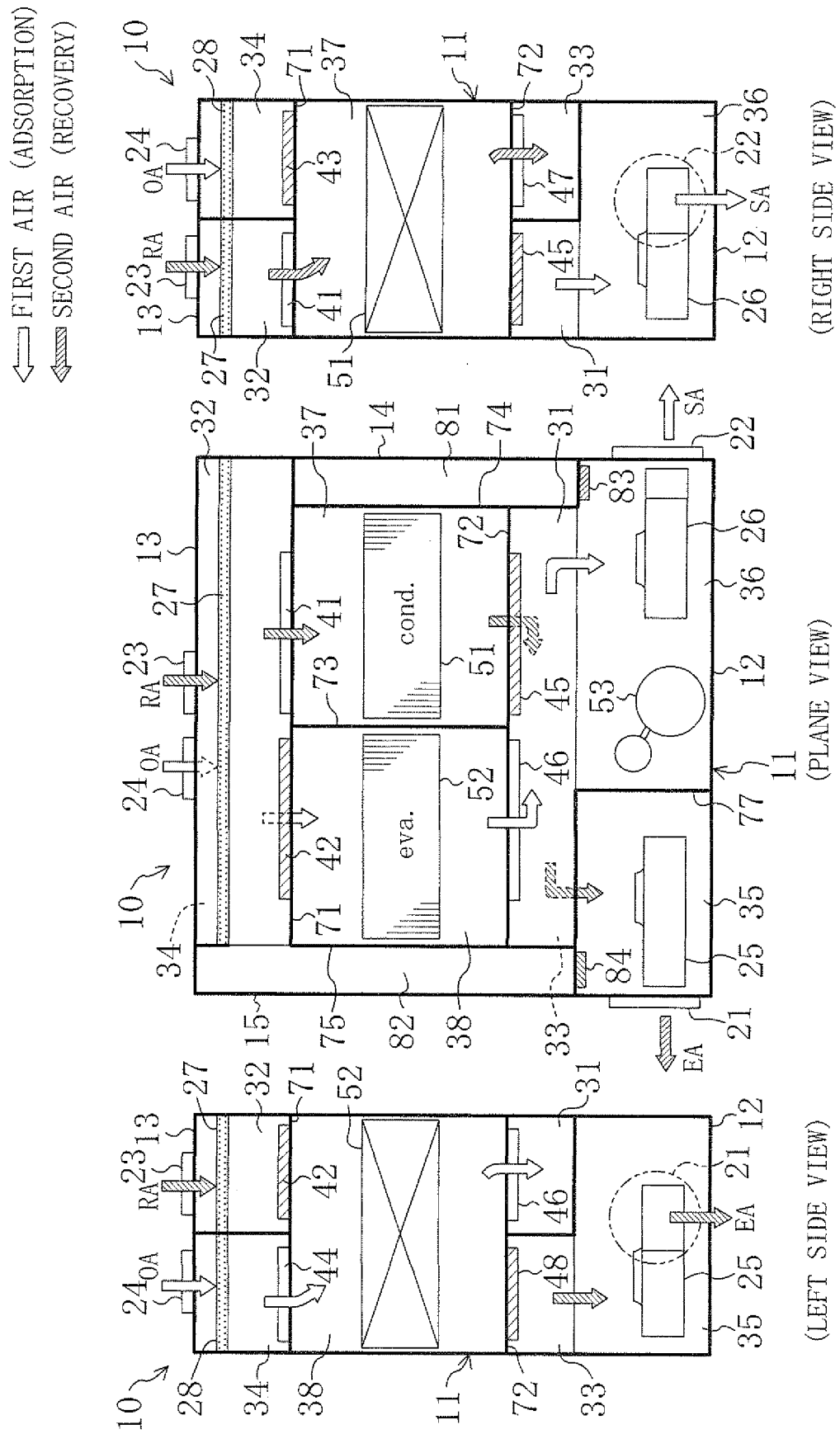


FIG. 5

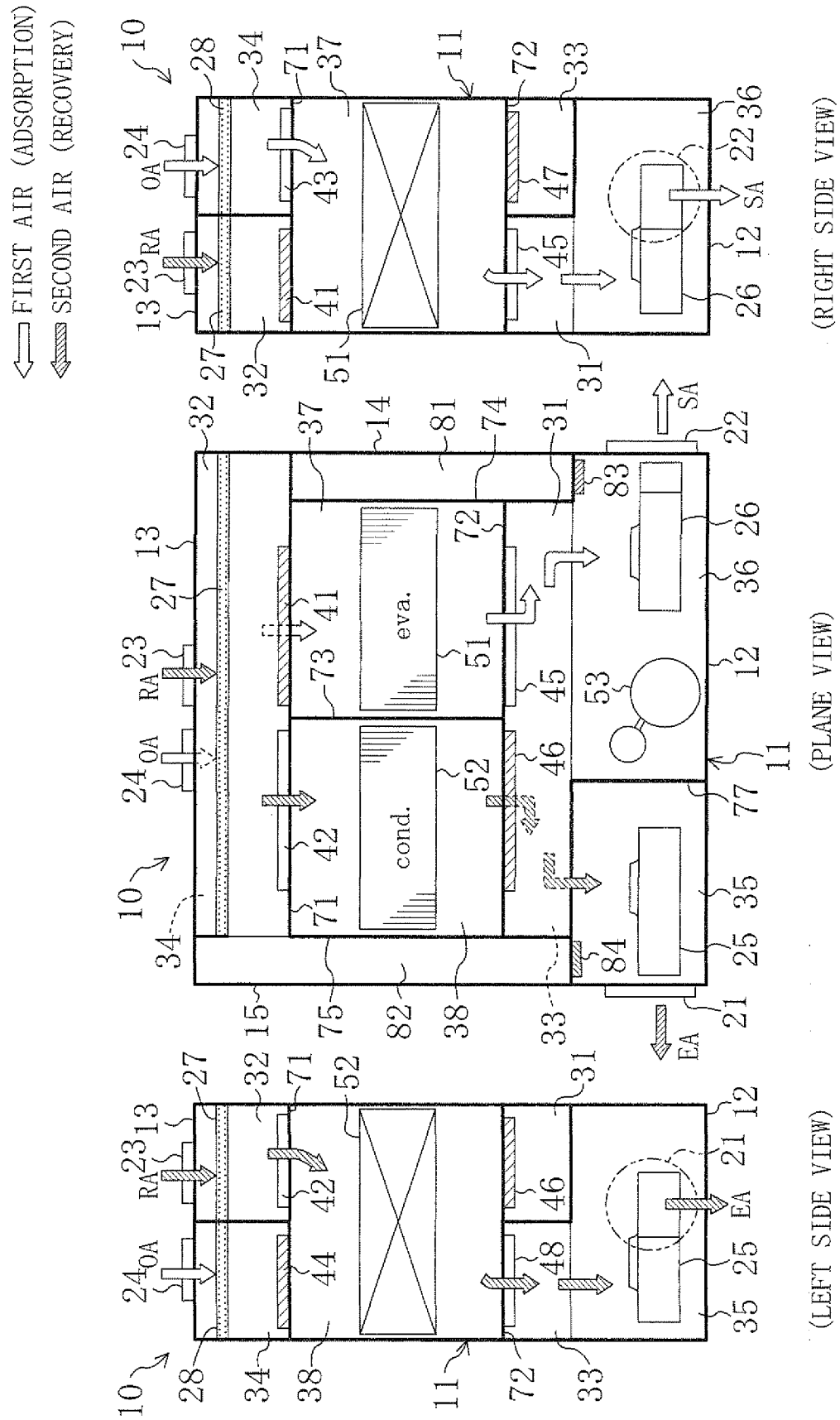


FIG. 6

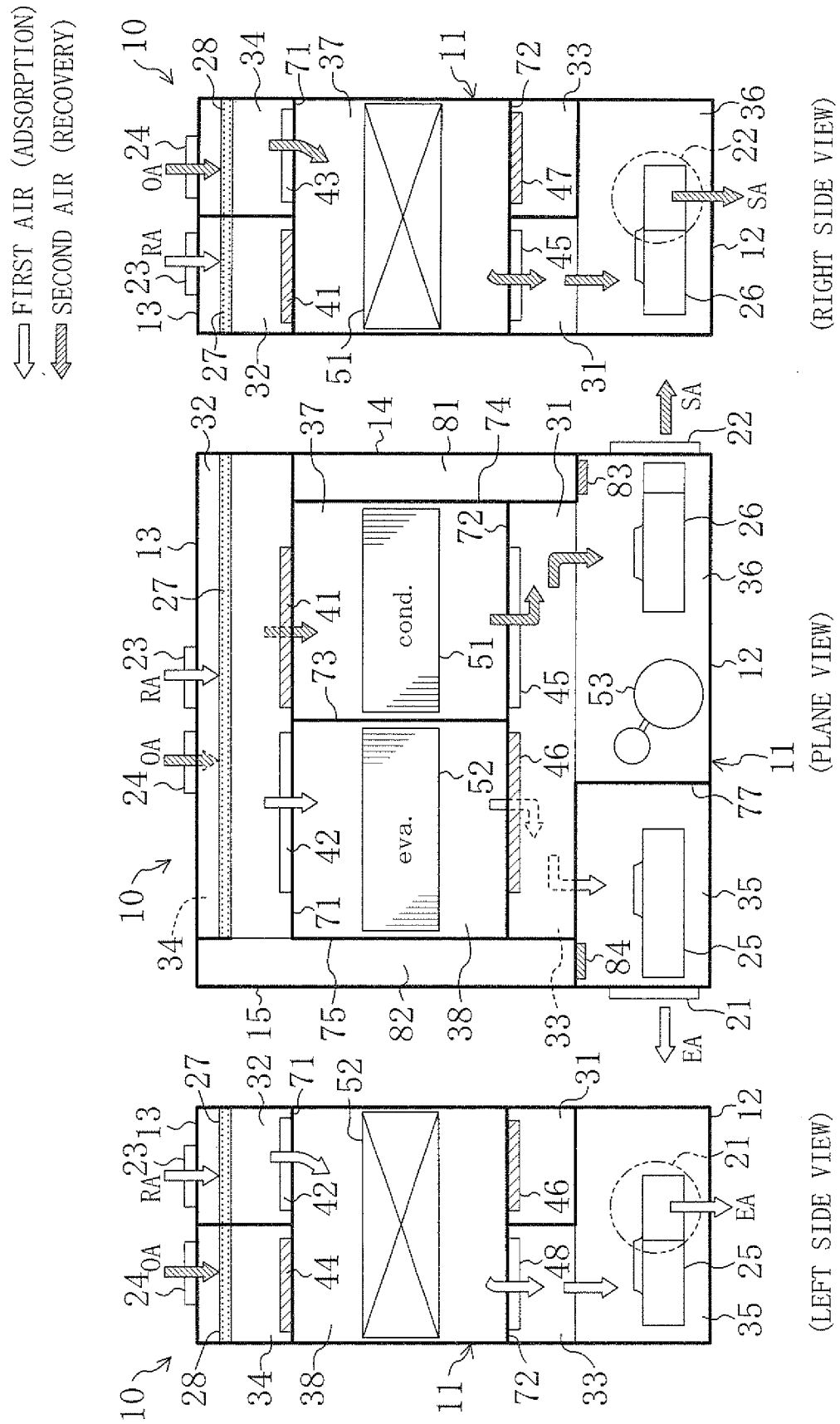


FIG. 7

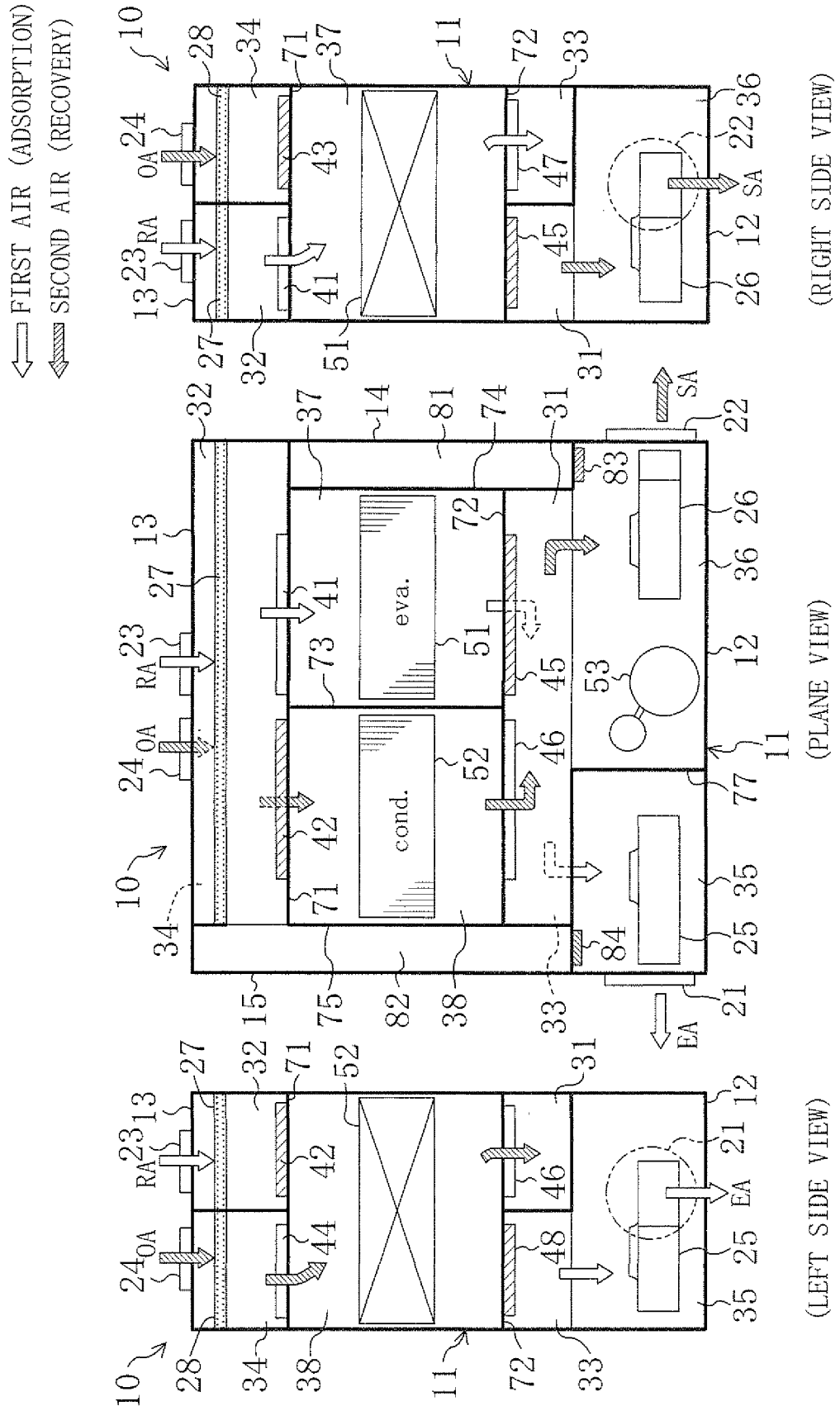


FIG. 8

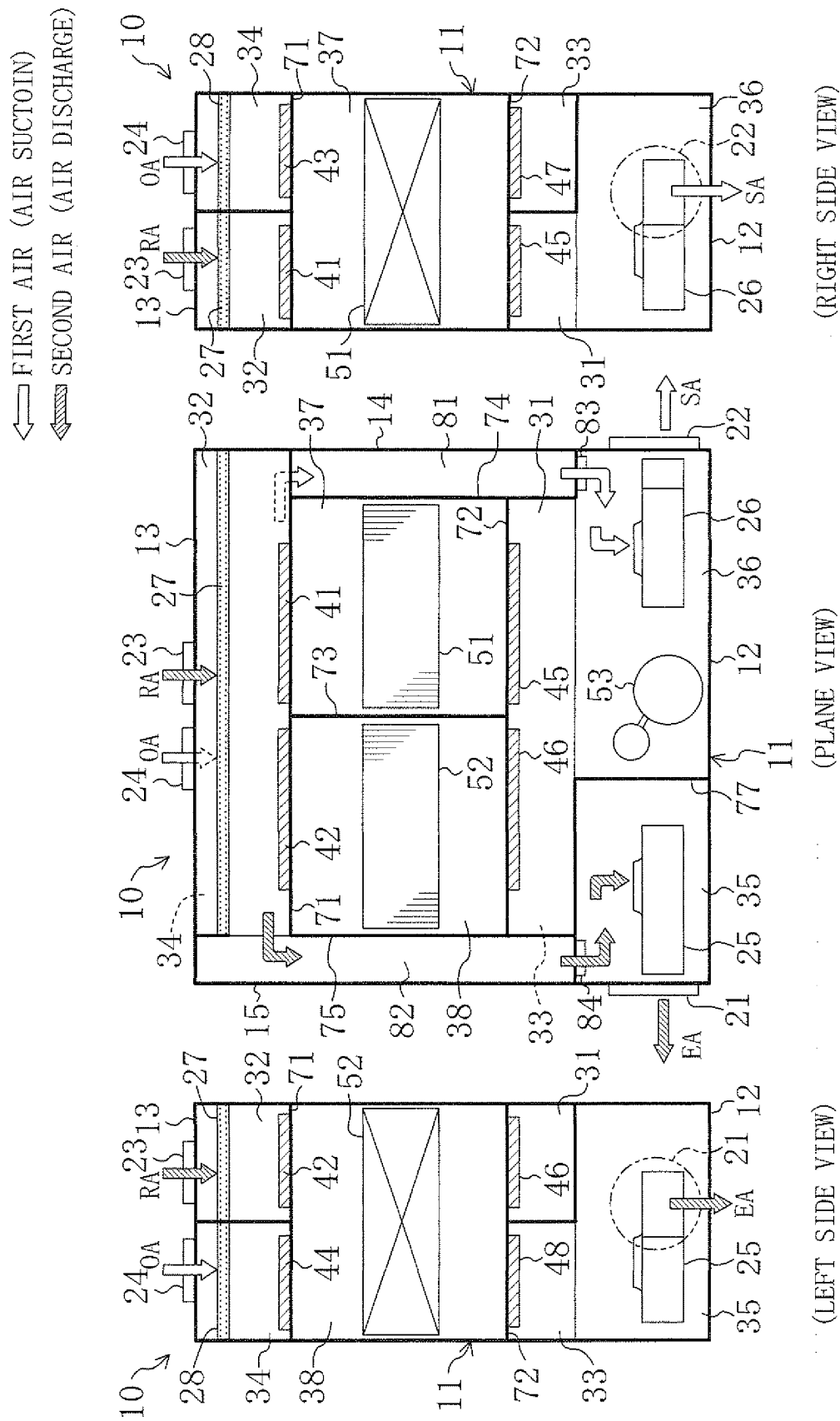


FIG. 9

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

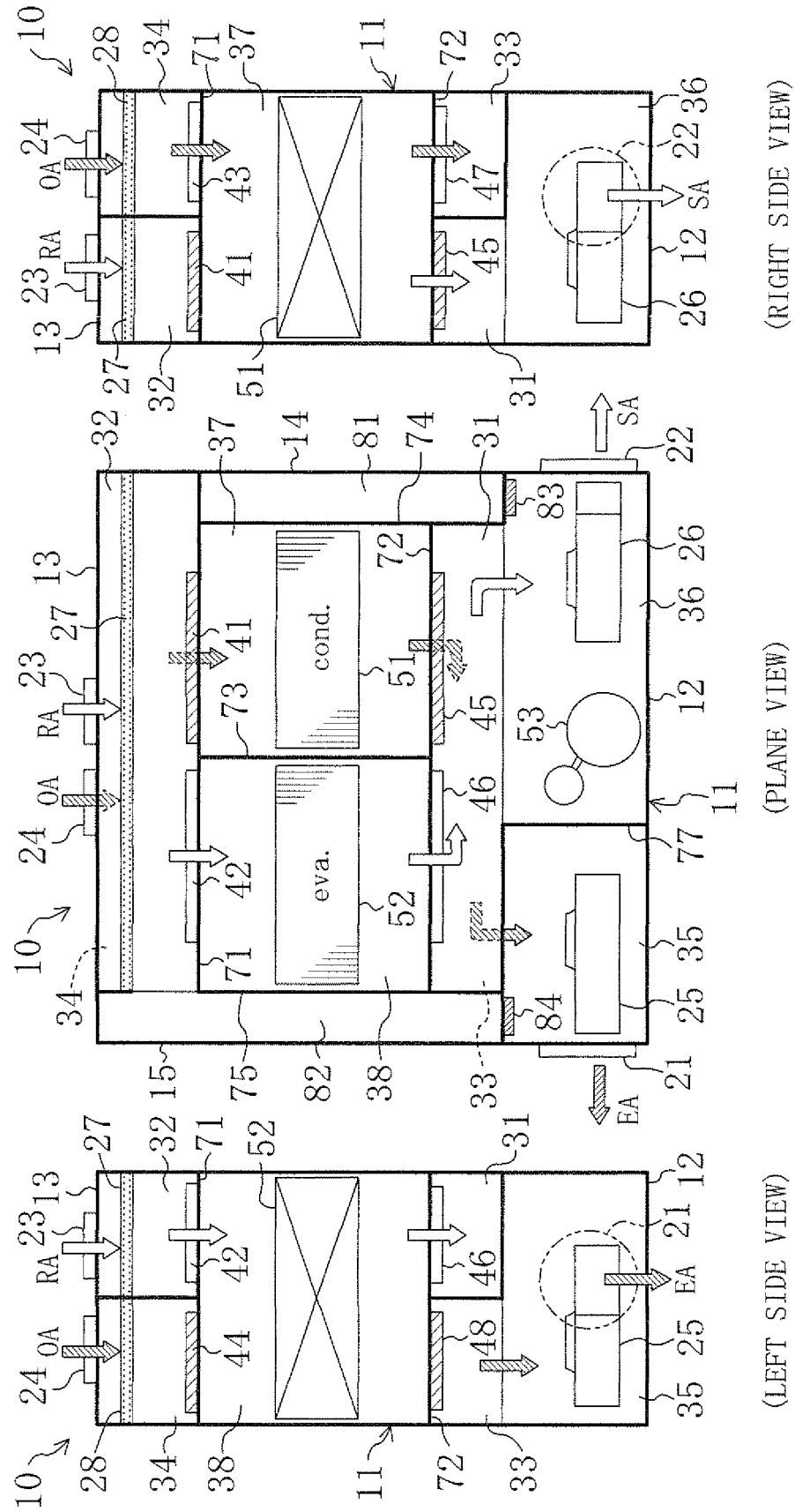


FIG. 10

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

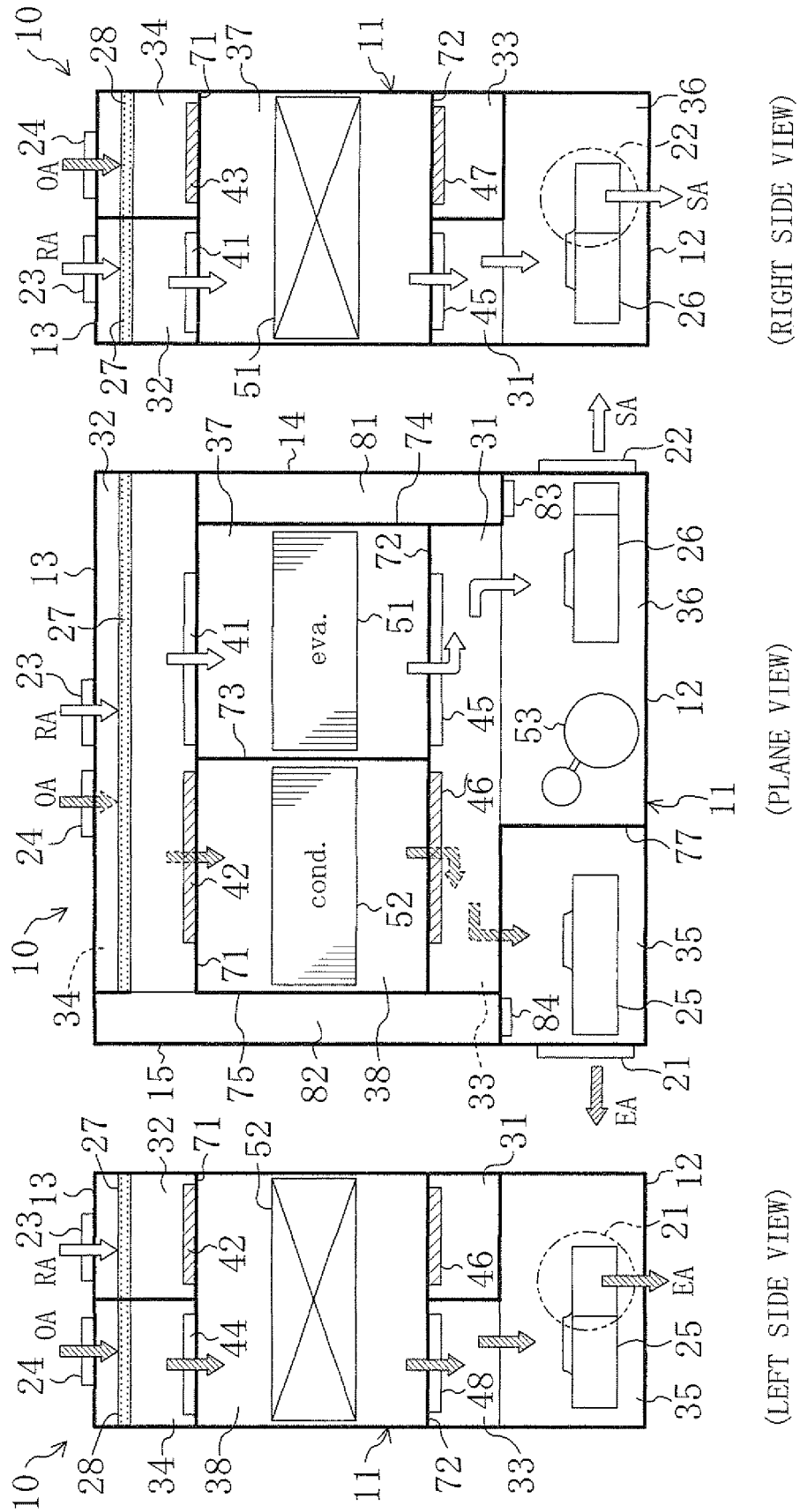


FIG. 11

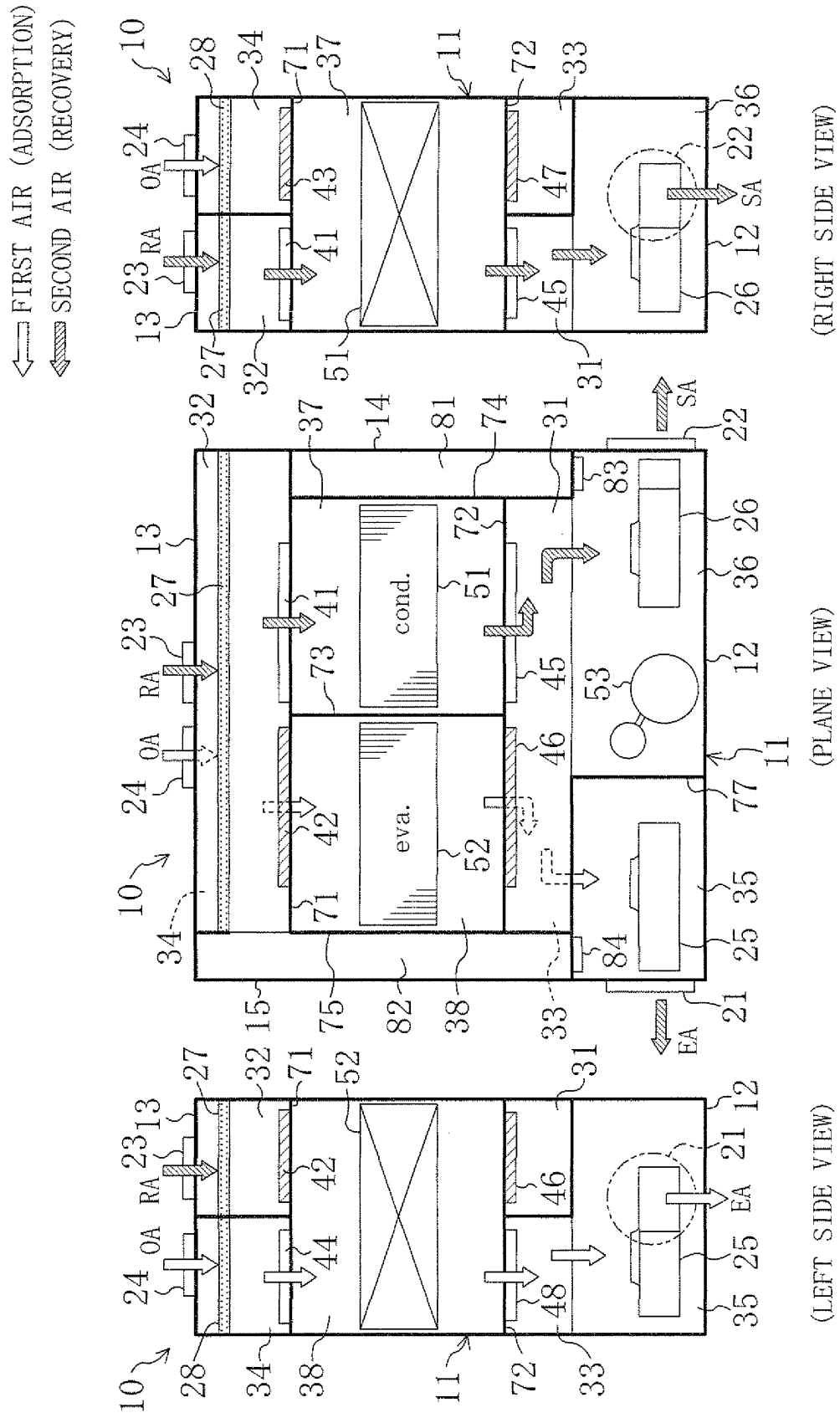


FIG. 12

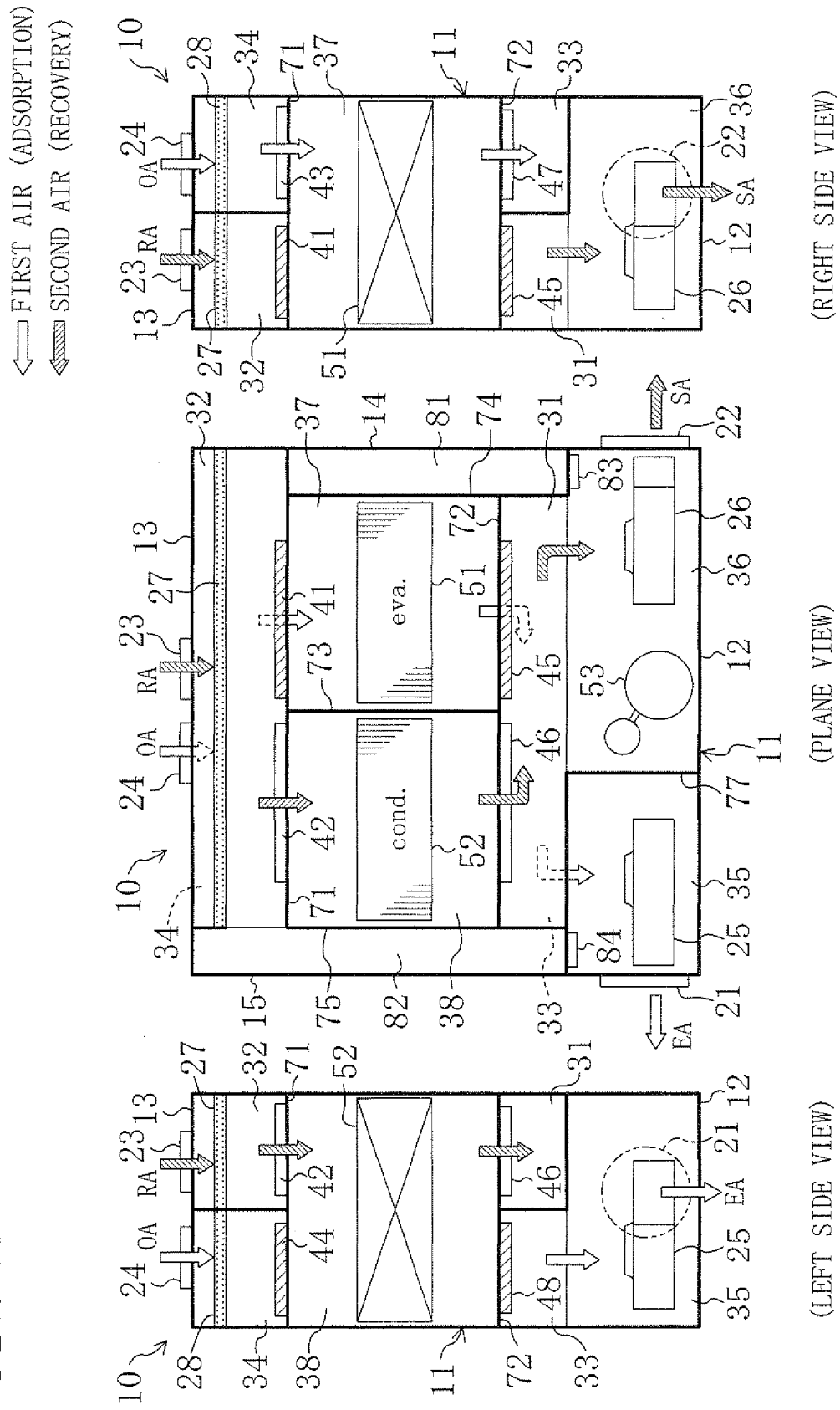
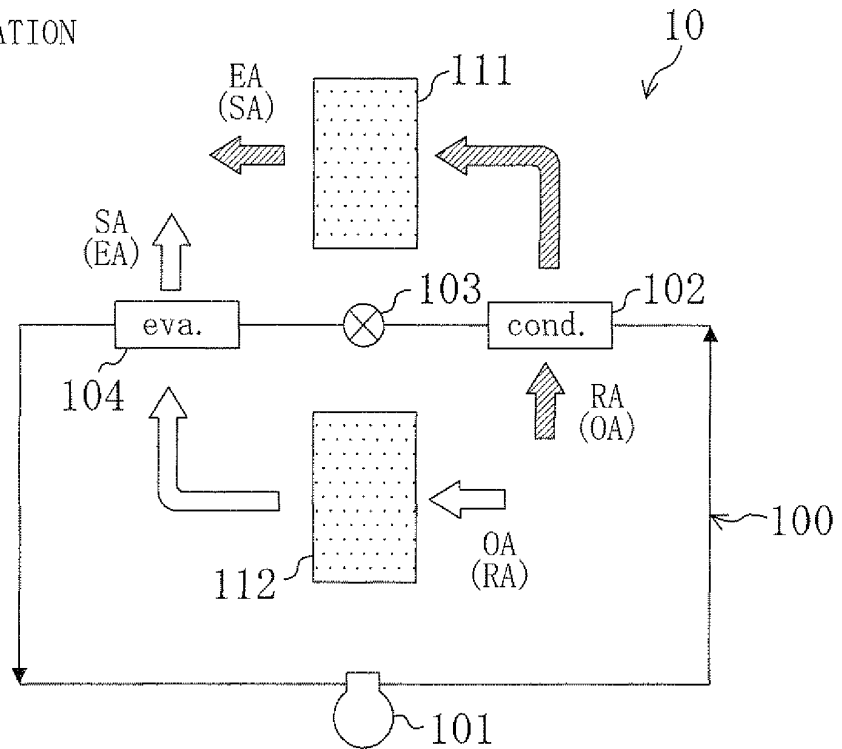
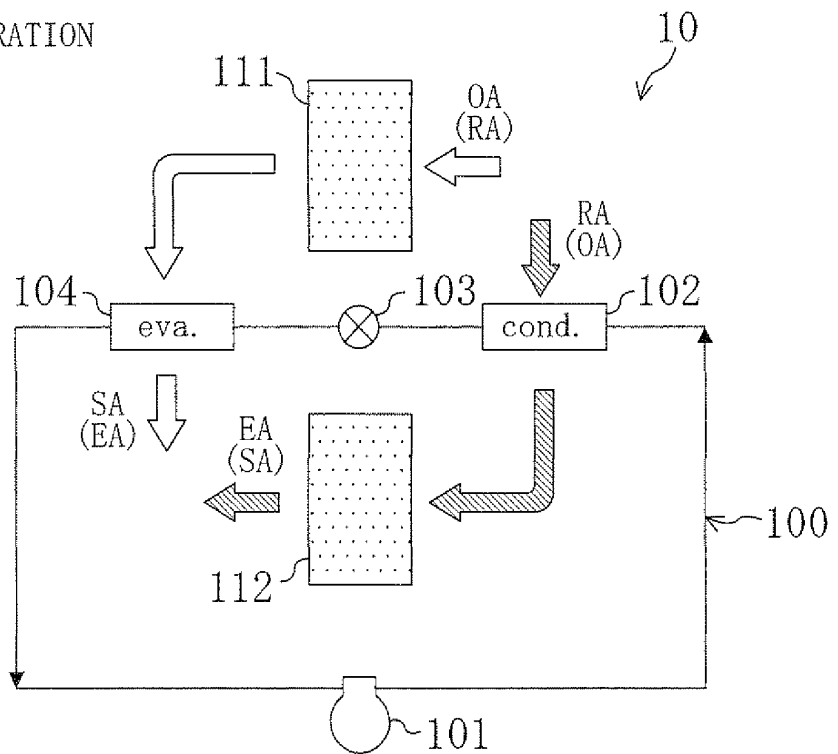


FIG. 13

(A) FIRST OPERATION



(B) SECOND OPERATION



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/003141

A. CLASSIFICATION OF SUBJECT MATTER <i>F24F3/14 (2006.01) i, F24F11/02 (2006.01) i</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) <i>F24F3/14, F24F11/02</i>		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched <i>Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008</i> <i>Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008</i>		
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.
A	JP 2004-353887 A (Daikin Industries, Ltd.), 16 December, 2004 (16.12.04), Claims 1, 2; Par. Nos. [0116] to [0121] & US 2007/0028639 A1 & EP 1630482 A1 & WO 2004/106813 A1 & KR 2006-20622 A & CN 1795349 A	1-3
A	WO 2005/098326 A1 (Daikin Industries, Ltd.), 20 October, 2005 (20.10.05), Page 42, line 16 to page 43, line 13 & JP 2005-291569 A & JP 2005-291572 & US 2007/0193287 A1 & EP 1752716 A1 & KR 2006-131825 A & CN 1946974 A	1-3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 19 November, 2008 (19.11.08)		Date of mailing of the international search report 02 December, 2008 (02.12.08)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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PCT/JP2008/003141

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 2005-114291 A (Daikin Industries, Ltd.), 28 April, 2005 (28.04.05), Claims 1, 9, 10 & US 2007/0039343 A1 & EP 1688674 A1 & WO 2005/036063 A1 & KR 2006/85691 A & CN 1864033 A	1-3
A	JP 2005-291570 A (Daikin Industries, Ltd.), 20 October, 2005 (20.10.05), Claims 12, 13 & US 2007/0144189 A1 & EP 1757872 A1 & WO 2005/098325 A1 & KR 2006/121946 A & CN 1930423 A	1-3
A	JP 2006-329469 A (Daikin Industries, Ltd.), 07 December, 2006 (07.12.06), Claims 8, 9 & EP 1898161 A1 & WO 2006/126605 A1 & CN 1163923 A & KR 2008-23305 A	1-3

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Patent documents cited in the description

- JP 2006078108 A [0004]