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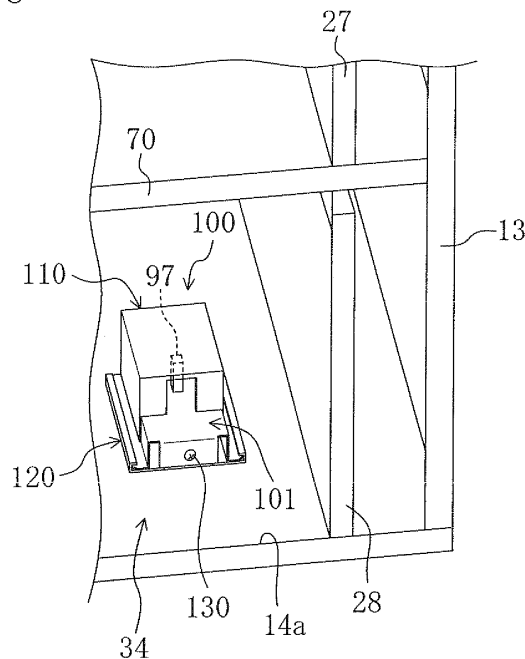
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(54) **HUMIDITY CONTROLLER**

(57) A casing includes a first air passage in which outdoor air flows, and a second air passage in which room air flows divided by a divider plate. In each of the

air passages, a humidity sensor is arranged on one of passage surfaces facing the air passage except for a surface of the divider plate.

FIG. 8



Description

TECHNICAL FIELD

[0001] The present invention relates to humidity control apparatuses including a first air passage in which outdoor air flows, and a second air passage in which indoor air flows defined by a divider plate arranged in a casing, particularly to humidity control apparatuses including humidity sensors in the first and second air passages, respectively.

BACKGROUND ART

[0002] Humidity control apparatus for controlling humidities of outdoor air and indoor air, and supplying the humidity-controlled air to the inside of a room have been known. Patent Document 1 shows a humidity control apparatus including an adsorption heat exchanger carrying an adsorbent on a surface thereof.

[0003] The humidity control apparatus of Patent Document 1 contains a refrigerant circuit including two adsorption heat exchangers. The refrigerant circuit alternately performs operation in which a first adsorption heat exchanger functions as a condenser, and a second adsorption heat exchanger functions as an evaporator, and operation in which the second adsorption heat exchanger functions as a condenser, and the first adsorption heat exchanger functions as an evaporator. In the adsorption heat exchanger functioning as the evaporator, the adsorbent adsorbs moisture in the air. In the adsorption heat exchanger functioning as the condenser, the moisture is released from the adsorbent, and is contained in the air.

[0004] The humidity control apparatus of Patent Document 1 supplies one of the flows of the air that passed through the adsorption heat exchangers, and discharges the other flow. For example, in the humidity control apparatus in dehumidifying operation, an air flow passage in the casing is determined in such a manner that the air that passed through one of the first and second adsorption heat exchangers functioning as the evaporator is supplied to the inside of the room, and the air that passed through the other adsorption heat exchanger functioning as the condenser is discharged outside the room.

[0005] In the humidity control apparatus of Patent Document 1, the outdoor air and the indoor air are introduced in the casing. For example, in the humidity control apparatus in the dehumidifying operation, the introduced outdoor air is dehumidified by the adsorption heat exchanger functioning as the evaporator, and is supplied to the inside of the room, and simultaneously, the introduced indoor air is discharged outside the room together with the moisture released from the adsorption heat exchanger functioning as the condenser. Thus, humidity control and ventilation of the room are simultaneously performed.

[0006] Further, in the humidity control apparatus of Patent Document 1, humidity control capability is adjusted

ed based on humidity of the air detected by a humidity sensor. Specifically, the casing includes an outdoor air passage (a first air passage) in which the introduced outdoor air flows, and an indoor air passage (a second air passage) in which the introduced indoor air flows. The outdoor air passage and the indoor air passage are divided by a single divider plate. The outdoor and indoor air passages are provided with humidity sensors, respectively. When the humidity control apparatus is operated, the humidities of the outdoor air and the indoor air are detected by the humidity sensors, and the humidity control capability of the adsorption heat exchangers is adjusted based on the detected humidities.

15 CITATION LIST

[0007]

PATENT DOCUMENT: Japanese Patent Publication No. 2006-349304

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0008] In the humidity control apparatus as taught by Patent Document 1, temperature of the outdoor air flowing in the first air passage greatly varies from temperature of the indoor air flowing in the second air passage. Specifically, for example, in summer, the temperature of the indoor air is lower than the temperature of the outdoor air. In winter, the temperature of the outdoor temperature is lower than the temperature of the indoor air.

[0009] In the humidity control apparatus of Patent Document 1, for example, the humidity sensor for detecting the humidity of the outdoor air is attached to a surface of the divider plate. Therefore, when the apparatus is operated in summer, for example, the heat of the humidity sensor is transmitted to the low temperature passage (the indoor air) through the divider plate, thereby cooling the air around the humidity sensor. As a result, dew condensation occurs around the humidity sensor, thereby wetting the humidity sensor, or causing errors in humidity detection by the humidity sensor.

[0010] In view of the foregoing, the present invention has been achieved. The invention is directed to a humidity control apparatus for controlling the humidities of the outdoor air and the indoor air introduced therein, and it is an object of the invention to reduce condensed water generated near the humidity sensor, and to avoid wetting of the humidity sensor, and errors in humidity detection.

SOLUTION TO THE PROBLEM

[0011] A first aspect of the invention is directed to a humidity control apparatus including: a casing (11); a divider plate (70) arranged in the casing (11) to provide a first air passage (34) in which outdoor air flows, and a

second air passage (32) in which room air flows, with the divider plate (70) interposed therebetween; humidity controllers (51, 52) for controlling humidities of the room air and the outdoor air flowing in the air passages (32, 34); and humidity sensors (96, 97) arranged in the air passages (32, 34), respectively, to detect air humidity in the corresponding air passages (32, 34). In this humidity control apparatus, each of the humidity sensors (96, 97) is attached to one of passage surfaces facing the corresponding air passage (32, 34) except for a surface of the divider plate (70).

[0012] According to the first aspect of the invention, the divider plate (70) is arranged in the casing (11) to provide the first air passage (34) and the second air passage (32) in the casing (11). Humidity of the outdoor air entering the first air passage (34), and humidity the room air entering the second air passage (32) are controlled by the humidity controllers (51, 52). The humidity-controlled air is supplied to the inside of a room, for example, thereby controlling the humidity in the room. The air passages (32, 34) include the humidity sensors (96, 97), respectively. Each of the humidity sensors (96, 97) detects the humidity of the air. The humidities detected by the humidity sensors (96, 97) are used for controlling humidity control capability of the humidity controllers (51, 52), for example.

[0013] Each of the humidity sensors (96, 97) of the present invention is attached to one of passage surfaces facing the corresponding air passage (32, 34) except for a surface of the divider plate (70). Specifically, in the present invention, each of the humidity sensors (96, 97) is not attached to the surface of the divider plate (70) which easily transfers heat due to temperature difference between the air passages (32, 34), but each of the humidity sensors (96, 97) is attached to the corresponding passage surface. This can avoid heat transfer from the humidity sensor (96, 97) to the counterpart air passage (32, 34) through the divider plate (70), thereby preventing dew condensation near the humidity sensors (96, 97).

[0014] In a second aspect of the invention, the humidity control apparatus of the first aspect of the invention further includes a support stage (101) on which each of the humidity sensors (96, 97) is supported; and an attachment (120) provided on the passage surface of the corresponding air passage (32, 34) so as to detachably attach the support stage (101) thereto.

[0015] According to the second aspect of the invention, the attachment (120) is provided on the passage surface of the corresponding air passage (32, 34) except for the surface of the divider plate (70). Each of the humidity sensors (96, 97) is supported by the support stage (101), and is detachably attached to the attachment (120) through the support stage (101). This allows for easy attachment and detachment of the humidity sensors (96, 97), thereby allowing for easy maintenance and replacement of the humidity sensors (96, 97). With each of the humidity sensors (96, 97) supported by the support stage (101), a certain distance can be kept between the humid-

ity sensor (96, 97) and the passage surface. This can reduce heat transfer between the humidity sensor (96, 97) and the passage surface even if the passage surface except for the divider plate (70) is cooled, thereby preventing the dew condensation near the humidity sensor (96, 97).

[0016] In a third aspect of the invention related to the humidity control apparatus of the second aspect of the invention, the attachment (120) includes a rail (122) extending along the passage surface of the corresponding air passage (32, 34), and having a guide groove (123) extending between longitudinal ends of the rail (122), and the support stage (101) includes a guide (104) arranged at an end thereof to fit in the guide groove (123) of the rail (122) to be slidably supported on the rail (122).

[0017] According to the third aspect of the invention, the attachment (120) includes the rail (122), and the support stage (101) is provided with the guide (104) engaging with the guide groove (123) of the rail (122). The support stage (101) is attached to the attachment (120) by fitting the guide (104) of the support stage (101) in the guide groove (123). This configuration allows for easy attachment/detachment of the support stage (101) to/from the attachment (120).

[0018] In a fourth aspect of the invention related to the humidity control apparatus of the first aspect of the invention, a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), and both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11).

[0019] According to the fourth aspect of the invention, the maintenance opening (14a) is formed in the side plane (14) of the casing (11). Each of the humidity sensors (96, 97) is arranged in the corresponding air passage (32, 34) near the side plane (14) of the casing (11), i.e., near the maintenance opening (14a). This allows for easy maintenance and replacement of both of the humidity sensors (96, 97) from the side plane (14) of the casing (11) through the maintenance opening (14a).

[0020] In a fifth aspect of the invention related to the humidity control apparatus of the second or third aspect of the invention, a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11), and the attachment (120) includes a coupling section (125) arranged to face the maintenance opening (14a) for fixing the support stage (101) to the attachment (120).

[0021] According to the fifth aspect of the invention, like the fourth aspect of the invention, the maintenance opening (14a) is formed in the side plane (14) of the casing (11), and the humidity sensors (96, 97) are arranged near the maintenance opening (14a). Further, the attachment (120) of the present invention includes the coupling section (125) arranged to face the maintenance opening (14a) for fixing the support stage (101). This allows for

easy fixing of the support stage (101) to the attachment (120) with the coupling section (125) interposed therebetween through the maintenance opening (14a).

[0022] In a sixth aspect of the invention related to the humidity control apparatus of the third aspect of the invention, a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11), a plate (124) is arranged to vertically stand at an end of the rail (122) near the maintenance opening (14a) in such a manner that the support stage (101) abut thereto, and the plate (124) includes a coupling section (125) for fixing the support stage (101) to the attachment (120).

[0023] According to the sixth aspect of the invention, like the fourth aspect of the invention, the maintenance opening (14a) is formed in the side plane (14) of the casing (11), and the humidity sensors (96, 97) are arranged near the maintenance opening (14a). Further, the plate (124) is arranged to vertically stand at the end of the rail (122) near the maintenance opening (14a). The plate (124) comes into contact with the support stage (101) sliding back and forth along the rail (122), thereby serving as a member for preventing the guide (104) from slipping from the rail (122).

[0024] The plate (124) includes the coupling section (125) for fixing the support stage (101) to the attachment (120). The plate (124) is arranged near the maintenance opening (14a). This allows for easy fixing of the support stage (101) to the attachment (120) with the coupling section (125) interposed therebetween through the maintenance opening (14a).

[0025] In a seventh aspect of the invention related to the humidity control apparatus of any one of the first to sixth aspects of the invention, the casing (11) includes humidity control chambers (37, 38) containing the humidity controllers (51, 52), respectively, and a damper-carrying divider plate (71) dividing the humidity control chambers (37, 38) from the air passages (34, 32), and carrying a plurality of dampers (41-44) for connecting/disconnecting the humidity control chambers (37, 38) to/from the air passages (34, 32), and one or both of the humidity sensors (96, 97) is attached to a surface of the damper-carrying divider plate (71) facing the corresponding air passage (32, 34).

[0026] According to the seventh aspect of the invention, the damper-carrying divider plate (71) divides the first and second air passages (34, 32) from the humidity control chambers (37, 38). The damper-carrying divider plate (71) includes a plurality of dampers (41-44). Opening/closing the dampers (41-44) connects/disconnects the humidity control chambers (37, 38) to/from the first air passage (34) or the second air passage (32), thereby changing the path of air flow in the casing (11).

[0027] In the present invention, one or both of the humidity sensors (96, 97) is attached to the surface of the damper-carrying divider plate (71) facing the correspond-

ing air passage (32, 34). Thus, wires of the dampers (41-44) and wires of the humidity sensors (96, 97) are gathered, thereby simplifying routing of the wires.

[0028] In an eighth aspect of the invention related to the humidity control apparatus of any one of the first to sixth aspects of the invention, each of the humidity sensors (96, 97) is attached to one of the passage surfaces facing the corresponding air passage (32, 34) and opposing the divider plate (70).

[0029] According to the eighth aspect of the invention, each of the humidity sensors (96, 97) in the corresponding air passage (32, 34) is attached to the passage surface opposing the divider plate (70). Specifically, each of the humidity sensors (96, 97) is relatively spaced from the divider plate (70). This can reduce the heat transfer from the humidity sensors (96, 97) to the divider plate (70), thereby reliably preventing the dew condensation near the humidity sensors (96, 97).

ADVANTAGES OF THE INVENTION

[0030] According to the present invention, each of the humidity sensors (96, 97) arranged in the corresponding air passage (32, 34) is attached to the passage surface except for the surface of the divider plate (70). Thus, the present invention can reduce the heat transfer from the humidity sensors (96, 97) to the divider plate (70), thereby preventing the dew condensation near the surfaces of the humidity sensors (96, 97). This can avoid adhesion of the condensed water to the humidity sensors (96, 97), and local increase in humidity around the humidity sensors (96, 97). This can prevent failure of the humidity sensors (96, 97), and error in humidity detection by the humidity sensors (96, 97) due to the condensed water, thereby ensuring the reliability of the humidity control apparatus.

[0031] According to the second aspect of the invention, each of the humidity sensors (96, 97) is supported by the support stage (101), and the support stage (101) is detachably attached to the attachment (120) on the passage surface. Thus, the present invention allows for easy attachment/detachment of the humidity sensors (96, 97), thereby allowing for easy maintenance. Further, with the provision of a certain distance between the passage surface on which the attachment (120) is provided and the humidity sensors (96, 97), heat of the humidity sensors (96, 97) is less likely to be transmitted to the passage surface. This can avoid the dew condensation near the humidity sensors (96, 97) with more reliability, thereby preventing wetting of the humidity sensors (96, 97), and detection errors due to the condensed water.

[0032] According to the third aspect of the invention, the attachment (120) provided on the passage surface includes the rail (122), and the guide (104) of the support stage (101) is fitted in the guide groove (123) of the rail (122), thereby attaching the support stage (101) to the attachment (120). This allows for easy attachment and detachment of the support stage (101) to and from the

attachment (120) by sliding the support stage (101) along the rail (122).

[0033] According to the fourth aspect of the invention, both of the humidity sensors (96, 97) are arranged near the maintenance opening (14a) formed in the side plane (14) of the casing (11). This allows for easy maintenance of the humidity sensors (96, 97) from the same direction.

[0034] According to the fifth aspect of the invention, the coupling section (125) for fixing the support stage (101) to the attachment (120) is arranged to face the maintenance opening (14a). This allows a worker to easily fix the support stage (101) and the attachment (120).

[0035] According to the sixth aspect of the invention, the provision of the plate (124) at the end of the rail (122) of the attachment (120) makes it possible to prevent the guide (104) of the support stage (101) from slipping from the end of the rail (122). With the plate (124) in which the coupling section (125) is formed is arranged near the maintenance opening (14a), the worker can easily fix the support stage (101) and the attachment (120). In fixing them, the guide (104) of the support stage (101) is brought into contact with the plate (124) to reliably position the support stage (101), thereby fixing the support stage (101) to the attachment (120).

[0036] According to the seventh aspect of the invention, the humidity sensors (96, 97) are attached to the surface of the damper-carrying divider plate (71) facing the air passage. Therefore, wires of the dampers (41-44) and wires of the humidity sensors (96, 97) are gathered, thereby simplifying routing of the wires. With the provision of the humidity sensors (96, 97) on the damper-carrying divider plate (71), the wire routing and operations of the dampers (41-44) and the humidity sensors (96, 97) can be checked with a casing plate (e.g., a top plate) constituting the other passage surface facing the corresponding air passage detached, and then the casing plate such as the top plate, etc., can be attached. This can facilitate assembly and maintenance of the humidity control apparatus.

[0037] According to the eighth aspect of the invention, each of the humidity sensors (96, 97) is attached to a passage surface facing the corresponding air passage and opposing the divider plate (70). This can provide a sufficient distance between the divider plate (70) and the humidity sensors (96, 97). Accordingly, the heat transfer from the humidity sensors (96, 97) to the divider plate (70) is reduced more efficiently, thereby reliably preventing the dew condensation near the humidity sensors (96, 97). This can prevent adhesion of the condensed water to the humidity sensors (96, 97), and local increase in humidity around the humidity sensors (96, 97).

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

[FIG. 1] FIG. 1 is a perspective view illustrating a humidity control apparatus viewed from the front with

a top plate of the casing not shown.

[FIG. 2] FIG. 2 is a perspective view illustrating the humidity control apparatus viewed from the front with part of the casing and an electrical component box not shown.

[FIG. 3] FIG. 3 is a plan view illustrating the humidity control apparatus with the top plate of the casing not shown.

[FIG. 4] FIG. 4 is a perspective view illustrating the humidity control apparatus viewed from the back with the top plate of the casing not shown.

[FIG. 5] FIG. 5 schematically shows a plan view, a right side view, and a left side view of the humidity control apparatus, partially omitted.

[FIG. 6] FIG. 6(A) is a piping diagram illustrating the structure of a refrigerant circuit in first operation, and FIG. 6(B) is a piping diagram illustrating the same in second operation.

[FIG. 7] FIG. 7 is a schematic perspective view of an adsorption heat exchanger.

[FIG. 8] FIG. 8 is a perspective view illustrating a sensor unit in an attached state and its vicinity.

[FIG. 9] FIG. 9 is a perspective view of the sensor unit in a disassembled state.

[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 first operation of dehumidification/ventilation 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 second operation of the dehumidification/ventilation 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 first operation of humidification/ventilation operation.

[FIG. 13] FIG. 13 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. 14] FIG. 14 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. 15] FIG. 15 is a perspective view of a humidity control apparatus of another embodiment viewed from the back with a top plate of a casing not shown.

DESCRIPTION OF EMBODIMENTS

[0039] Embodiments of the present invention will be described in detail with reference to the drawings. A humidity control apparatus (10) of the present embodiment performs humidity control and ventilation of the inside of a room. The humidity control apparatus takes outdoor air (OA) therein for humidity control, and supplies the hu-

midity-controlled air to the inside of the room, and simultaneously, the humidity control apparatus takes room air (RA) therein, and discharges the room air outside the room.

<General Structure of Humidity Control Apparatus>

[0040] The humidity control apparatus (10) will be described with reference to FIGS. 1 to 5. The terms "upper," "slower," "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.

[0041] The humidity control apparatus (10) includes a casing (11). A refrigerant circuit (50) is provided in the casing (11). The refrigerant circuit (50) contains 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.

[0042] The casing (11) is in the shape of a flat, relatively short rectangular parallelepiped. The casing (11) has a dimension in the lateral direction larger than a dimension in the fore-and-aft direction (see FIG. 3). In the casing (11), a left front plane in FIG. 1 (i.e., a front plane) constitutes a front panel (12), and a right back plane in FIG. 1 (i.e., a back plane) constitutes a back panel (13). Further, a right front plane of the casing (11) in FIG. 1 constitutes a first side panel (14), and a left back plane in FIG. 1 constitutes a second side panel (15). The casing (11) is configured in such a manner that the front panel (12) and the back panel (13) face each other, and the first side panel (14) and the second side panel (15) face each other.

[0043] The casing (11) further includes an outdoor air inlet (24), an indoor air inlet (23), a supply port (22), and a discharge port (21).

[0044] The outdoor air inlet (24) and the indoor air inlet (23) are opened in the back panel (13) (see FIGS. 3 and 4). The outdoor air inlet (24) is formed in a lower portion of the back panel (13), and is shifted from the lateral center of the back panel (13) toward the second side panel (15). The indoor air inlet (23) is formed in an upper portion of the back panel (13), and is shifted from the lateral center of the back panel (13) toward the first side panel (14).

[0045] 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).

[0046] 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).

[0047] The upstream divider plate (71) and the downstream divider plate (72) are arranged parallel to the front panel (12) and the back panel (13). In the space inside the casing (11), the upstream divider plate (71) is arranged close to the back panel (13), and the downstream divider plate (72) is arranged close to the front panel (12).

[0048] A lateral dimension of the upstream divider plate (71) is smaller than a lateral dimension of the casing (11). A right end of the upstream divider plate (71) is joined to the first side panel (14). A gap is formed between a left end of the upstream divider plate (71) and the second side panel (15).

[0049] A lateral dimension of the downstream divider plate (72) is smaller than a lateral dimension of the upstream divider plate (71). A gap is formed between a right end of the downstream divider plate (72) and the first side panel (14). A gap is formed between a left end of the downstream divider plate (72) and the second side panel (15).

[0050] The first divider plate (74) is arranged to close the space between the upstream divider plate (71) and the downstream divider plate (72) from the right. Specifically, the first divider plate (74) is arranged parallel to the first side panel (14), and orthogonally to the upstream divider plate (71) and the downstream divider plate (72). A front end of the first divider plate (74) is joined to the right end of the downstream divider plate (72). A back end of the first divider plate (74) is joined to the upstream divider plate (71).

[0051] The second divider plate (75) is arranged to close the space between the upstream divider plate (71) and the downstream divider plate (72) from the left. Specifically, the second divider plate (75) is arranged parallel to the second side panel (15), and orthogonally to the upstream divider plate (71) and the downstream divider plate (72). A front end of the second divider plate (75) is joined to a left end of the downstream divider plate (72). A back end of the second divider plate (75) is joined to the back panel (13). The left end of the upstream divider plate (71) is joined to the second divider plate (75).

[0052] 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) extends between the upstream divider plate (71) and 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. The central divider plate (73) is slightly shifted from the lateral center of the upstream divider plate (71) and the downstream divider plate (72) toward the second side panel (15).

[0053] The casing (11) further contains a passage divider plate (70) therein (see FIGS. 2, 4, and 5). The passage divider plate (70) is horizontally arranged between the upstream divider plate (71) and the back panel (13) to be orthogonal to the upstream divider plate (71) and back panel (13). The passage divider plate (70) divides

space between the upstream divider plate (71) and the back panel (13) into two vertically aligned rooms. An upper room constitutes a room air passage (32), and a lower room constitutes an outdoor air passage (34). That is, the passage divider plate (70) constitutes a divider plate for providing the room air passage (32) and the outdoor air passage (34), with the passage divider plate (70) interposed between the passages (32, 34).

[0054] The outdoor air passage (34) communicates with the outside of the room through a duct connected to the outdoor air inlet (24). Specifically, the outdoor air passage (34) constitutes a first air passage in which the outdoor air that entered the casing (11) flows. The outdoor air passage (34) includes an outdoor air filter (28) for removing dust, etc., from the air. The outdoor air filter (28) is in the shape of a rectangular plate with a long side thereof extending in the lateral direction, and is vertically arranged to extend across the outdoor air passage (34). The outdoor air filter (28) divides the outdoor air passage (34) into two rooms aligned in the fore-and-aft direction. An outdoor air humidity sensor (97) for detecting the humidity of the outdoor air flowing in the outdoor air passage (34) is arranged in the outdoor air passage (34) in front of (downstream of) the outdoor air filter (28).

[0055] The room air passage (32) communicates with the inside of the room through a duct connected to the indoor air inlet (23). Specifically, the room air passage (32) constitutes a second air passage in which the room air that entered the casing (11) flows. The room air passage (32) includes a room air filter (27) for removing dust, etc. from the air. The room air filter (27) is in the shape of a rectangular plate with a long side thereof extending in the lateral direction, and is vertically arranged to extend across the room air passage (32). The room air filter (27) divides the room air passage (32) into two rooms aligned in the fore-and-aft direction. A room air humidity sensor (96) for detecting the humidity of the room air flowing in the room air passage (32) is arranged in the room air passage (32) in front of (downstream of) the room air filter (27). The humidities detected by the humidity sensors (96, 97) are used to control humidity control capability of the humidity control apparatus (10). Details of the outdoor air humidity sensor (97) and the room air humidity sensor (96) will be described later.

[0056] As described above, the space between the upstream divider plate (71) and the downstream divider plate (72) in the casing (11) is vertically divided into two rooms 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) (see FIGS. 1 and 3). Each of the heat exchange chambers (37, 38) constitutes a humidity control chamber for controlling air humidity.

[0057] The first heat exchange chamber (37) contains the first adsorption heat exchanger (51). The second heat exchange chamber (38) contains the second adsorption heat exchanger (52). Each of the adsorption heat ex-

changers (51, 52) is in the shape of a thick rectangular plate, or a flat rectangular parallelepiped. Details of the adsorption heat exchangers (51, 52) will be described later.

[0058] Each of the adsorption heat exchangers (51, 52) is arranged to stand 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). Specifically, the adsorption heat exchangers (51, 52) are arranged to extend across the heat exchange chambers (37, 38). Each of the adsorption heat exchangers (51, 52) divides the corresponding heat exchange chamber (37, 38) into two rooms aligned in the fore-and-aft direction. In each of the heat exchange chambers (37, 38), the adsorption heat exchanger (51, 52) is arranged closer to the upstream divider plate (71) than to the fore-and-aft center of the heat exchange chamber (37, 38). The adsorption heat exchangers (51, 52) are substantially aligned with each other in the lateral direction.

[0059] Each of the adsorption heat exchangers (51, 52) includes a liquid separator (61), and a gas header (62). Every part of the first adsorption heat exchanger (51) including the liquid separator (61) and the gas header (62) is contained in the first heat exchange chamber (37). On the other hand, almost every part of the second adsorption heat exchanger (52) including fins (57) is contained in the second heat exchange chamber (38), but a part of which penetrates the central divider plate (73), and is exposed in the first heat exchange chamber (37). Specifically, the liquid separator (61) and the gas header (62) of the second adsorption heat exchanger (52) are arranged in the first heat exchange chamber (37). Further, a U-shaped tube (59) arranged at an end of the second adsorption heat exchanger (52) at which the liquid separator (61) and the gas header (62) are connected is also exposed in the first heat exchange chamber (37). The first heat exchange chamber (37) further contains the motor-operated expansion valve (55) of the refrigerant circuit (50).

[0060] In the casing (11), space extending along the front surface of the downstream divider plate (72) is horizontally divided into two rooms (see FIGS. 2, 3, and 5). An upper room constitutes a supply air passage (31), and a lower room constitutes a discharge air passage (33).

[0061] The upstream divider plate (71) defines the heat exchange chambers (37, 38), the room air passage (32), and the outdoor air passage (34), and constitutes a damper-carrying divider plate having a plurality of dampers (41-44). Specifically, the upstream divider plate (71) is provided with four open/close dampers (41-44) for connecting/disconnecting the heat exchange chambers (37, 38) to/from the room air passage (32) and the outdoor air passage (34) (see FIGS. 3 and 5). 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 outdoor air damper (43) is attached to a portion (a lower portion) of the upstream divider plate (71) facing the outdoor air passage (34) on the right of the central divider plate (73), and a second outdoor air damper (44) is attached to the lower portion on the left of the central divider plate (73).

[0062] Opening or closing the first room air damper (41) connects or disconnects the room air passage (32) and the first heat exchange chamber (37). Opening or closing the second room air damper (42) connects or disconnects the room air passage (32) and the second heat exchange chamber (38). Opening or closing the first outdoor air damper (43) connects or disconnects the outdoor air passage (34) and the first heat exchange chamber (37). Opening or closing the second outdoor air damper (44) connects or disconnects the outdoor air passage (34) and the second heat exchange chamber (38).

[0063] In the upstream divider plate (71), the first outdoor air damper (43) is arranged immediately below the first room air damper (41). The first room air damper (41) and the first outdoor air damper (43) are arranged in such a manner that their lateral centers are slightly shifted toward the central divider plate (73) (i.e., toward the second side panel (15)) relative to the lateral center of the first heat exchange chamber (37) (see FIG. 3).

[0064] In the upstream divider plate (71), the second outdoor air damper (44) is arranged immediately below the second room air damper (42). The second room air damper (42) and the second outdoor air damper (44) are arranged in such a manner that their lateral centers are slightly shifted toward the central divider plate (73) (i.e., toward the first side panel (14)) relative to the lateral center of the second heat exchange chamber (38) (see FIG. 3).

[0065] The downstream divider plate (72) has four open/close dampers (45-48) (see FIGS. 3 and 5). 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 left 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 damper (48) is attached to the lower portion on the left of the central divider plate (73).

[0066] Opening or closing the first supply air damper (45) connects or disconnects the supply air passage (31) and the first heat exchange chamber (37). Opening or closing the second supply air damper (46) connects or disconnects the supply air passage (31) and the second heat exchange chamber (38). Opening or closing the first

discharge air damper (47) connects or disconnects the discharge air passage (33) and the first heat exchange chamber (37). Opening or closing the second discharge air damper (48) connects or disconnects the discharge air passage (33) and the second heat exchange chamber (38).

[0067] In the downstream divider plate (72), the first discharge air damper (47) is arranged immediately below the first supply air damper (45). The first supply air damper (45) and the first discharge air damper (47) are arranged in such a manner that their lateral centers are slightly shifted toward the central divider plate (73) (i.e., toward the second side panel (15)) relative to the lateral center of the first heat exchange chamber (37) (see FIG. 3).

[0068] In the downstream divider plate (72), the second discharge air damper (48) is arranged immediately below the second supply air damper (46). The second discharge air damper (48) and the second supply air damper (46) are arranged in such a manner that their lateral centers are slightly shifted toward the central divider plate (73) (i.e., toward the first side panel (14)) relative to the lateral center of the second heat exchange chamber (38) (see FIG. 3).

[0069] In the casing (11), the space between the supply air passage (31) and the discharge air passage (33), and the front panel (12) is vertically divided into two rooms by a supply/discharge air divider plate (77). One of the rooms on the right of the supply/discharge air divider plate (77) constitutes a supply fan chamber (36), and the other room on the left of the supply/discharge air divider plate (77) constitutes a discharge fan chamber (35). The supply/discharge air divider plate (77) stands closer to the second side panel (15) than the central divider plate (73). The supply fan chamber (36) and the discharge fan chamber (35) are rooms extending from the bottom plate to the top plate of the casing (11), respectively.

[0070] The supply fan chamber (36) contains a supply fan (26). The discharge fan chamber (35) contains a discharge fan (25). Each of the supply fan (26) and the discharge fan (25) is a multi-blade centrifugal fan (a so-called sirocco fan).

[0071] Specifically, each of the fans (25, 26) includes a fan rotor, a fan casing (86), and a fan motor (89). Although not shown, the fan rotor is in the shape of a cylinder having a length in the axial direction shorter than a diameter thereof, and a plurality of blades are arranged on a circumferential surface thereof. The fan rotor is contained in the fan casing (86). The fan casing (86) has an inlet (87) opened in one of side surfaces thereof (a side surface orthogonal to the axial direction of the fan rotor). The fan casing (86) further includes a protrusion protruding from a circumferential surface thereof, and an outlet (88) is opened at the protruding end thereof. The fan motor (89) is attached to one of the side surfaces of the fan casing (86) opposite the inlet (87). The fan motor (89) is connected to the fan rotor to drive the fan rotor to rotate.

[0072] In the supply fan (26) and the discharge fan

(25), when the fan rotor is driven to rotate by the fan motor (89), the air is sucked into the fan casing (86) through the inlet (87), and the air in the fan casing (86) is blown out through the outlet (88).

[0073] In the supply fan chamber (36), the supply fan (26) is arranged in such a manner that the inlet (87) of the fan casing (86) faces the downstream divider plate (72). The outlet (88) of the fan casing (86) of the supply fan (26) is attached to the first side panel (14) to communicate with the supply port (22).

[0074] In the discharge fan chamber (35), the discharge fan (25) is arranged in such a manner that the inlet (87) of the fan casing (86) faces the downstream divider plate (72). The outlet (88) of the fan casing (86) of the discharge fan (25) is attached to the second side panel (15) to communicate with the discharge port (21).

[0075] 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 supply/discharge air divider plate (77).

[0076] Communication pipes (65) extending from the gas headers (62) of the adsorption heat exchangers (51, 52) are connected to the four-way switching valve (54). The connection pipes (65) penetrate the downstream divider plate (72). Specifically, the communication pipes (65) penetrate 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) (i.e., a portion facing the first heat exchange chamber (37)). One of the liquid separators (61) of the adsorption heat exchangers (51, 52) is connected to an end of the motor-operated expansion valve (55), and the other liquid separator is connected to the other end of the motor-operated expansion valve (55).

[0077] In the casing (11), space between the first divider plate (74) and the first side panel (14) constitutes a first bypass passage (81) (see FIGS. 2 and 3). Further, space between the second divider plate (75) and the second side panel (15) in the casing (11) constitutes a second bypass passage (82) (see FIGS. 3 and 4). The first bypass passage (81) and the second bypass passage (82) are rooms extending from the bottom plate to the top plate of the casing (11). The first bypass passage (81) is wider than the second bypass passage (82).

[0078] A starting end (an end near the back panel (13)) of the first bypass passage (81) communicates only with the outdoor air passage (34), and is blocked from the room air passage (32). The first bypass passage (81) communicates with a downstream portion of the outdoor air filter (28) in the outdoor air passage (34). A terminal end (an end near the front panel (12)) of the first bypass passage (81) is separated 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 formed in a portion of the divider plate (78) facing the supply fan chamber (36). The first bypass

damper (83) is substantially in the shape of a horizontally oriented rectangle. Opening or closing the first bypass damper (83) connects or disconnects the first bypass passage (81) and the supply fan chamber (36).

[0079] A starting end (an end near the back panel (13)) of the second bypass passage (82) communicates only with the room air passage (32), and is blocked from the outdoor air passage (34). The second bypass passage (82) communicates with a downstream portion of the room air filter (27) in the room air passage (32) through a communication port (76) formed in the second divider plate (75). A terminal end (an end near the front panel (12)) of the second bypass passage (82) is separated 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 formed in a portion of the divider plate (79) facing the discharge fan chamber (35). The second bypass damper (84) is substantially in the shape of a horizontally oriented rectangle. Opening or closing the second bypass damper (84) connects or disconnects the second bypass passage (82) and the discharge fan chamber (35).

[0080] In the right side view and the left side view of FIG. 5, the first bypass passage (81), the second bypass passage (82), the first bypass damper (83), and the second bypass damper (84) are not shown.

[0081] In the first side panel (14) which is one of the side planes of the casing (11), a first maintenance opening (14a) is formed in a portion facing the room air passage (32) and the outdoor air passage (34), and a second maintenance opening (14b) is formed in a portion facing the first bypass passage (81) constitutes (see FIG. 2). A first open/close panel (17) is detachably attached to the first maintenance opening (14a), and a second open/close panel (16) is detachably attached to the second maintenance opening (14b) (see FIGS. 1 and 3).

[0082] An electrical component box (90) is attached to a right portion of the front panel (12) of the casing (11). In FIGS. 2 and 5, the electrical component box (90) is not shown. The electrical component box (90) is a rectangular parallelepiped box, and contains a control board (91), and a power supply board (92). The control board (91) and the power supply board (92) are attached to an inner side surface of one of side plates of the electrical component box (90) (i.e., a back plate) adjacent to the front panel (12). An inverter of the power supply board (92) includes a radiator fin (93). The radiator fin (93) protrudes from a back surface of the power supply board (92) to penetrate the back plate of the electrical component box (90) and the front panel (12) of the casing (11), and is exposed in the supply fan chamber (36) (see FIGS. 3 and 4).

[0083] In the casing (11), lead wires connected to the compressor (53), the fans (25, 26), the dampers (41-48), the humidity sensors (96, 97), etc., extend toward the inside of the electrical component box (90). Among them, a lead wire connected to a drive motor of the dampers (41-44) attached to the upstream divider plate (71), and

lead wires connected to the humidity sensors (96, 97) extend to the electrical component box (90) through the first bypass passage (81).

<Structure of Refrigerant Circuit>

[0084] The refrigerant circuit (50) will be described with reference to FIG. 6.

[0085] 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.

[0086] 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). An end of the first adsorption heat exchanger (51) is connected to a third port of the four-way switching valve (54). The other end of the first adsorption heat exchanger (51) is connected to an end of the second adsorption heat exchanger (52) through the motor-operated expansion valve (55). The other end of the second adsorption heat exchanger (52) is connected to a fourth port of the four-way switching valve (54).

[0087] 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. 6(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. 6(B)).

[0088] As shown in FIG. 7, the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) are cross-fin type fin-and-tube heat exchangers, respectively. Each of the adsorption heat exchangers (51, 52) constitutes a humidity controller for controlling humidities of the outdoor air (OA) and the room air (RA). Each of the adsorption heat exchangers (51, 52) includes copper heat transfer tubes (58), and aluminum fins (57). Each of the fins (57) of the adsorption heat exchangers (51, 52) is in the shape of a rectangular plate, and they are arranged at regular intervals. The heat transfer tubes (58) extend in the direction of alignment of the fins (57) in serpentine form. That is, the heat transfer tube (58) includes straight parts penetrating the fins (57), and U-shaped parts (59) connecting the adjacent straight parts, which are alternately connected.

[0089] In each of the adsorption heat exchangers (51, 52), an adsorbent is supported on the surfaces of the fins (57) so as to contact with the air passing between the fins (57). The adsorbent may be a material capable of adsorbing vapor in the air, such as zeolite, silica gel, activated carbon, an organic polymer material having a hydrophilic functional group, etc.

[0090] In the humidity control apparatus (10) of the present embodiment, the refrigerant circuit (50) constitutes a heating medium circuit. In the refrigerant circuit (50), a high pressure gaseous refrigerant is supplied as a heating fluid medium to one of the two adsorption heat exchangers (51, 52) serving as a condenser, and a low pressure gas-liquid two-phase refrigerant is supplied as a cooling fluid medium to the other adsorption heat exchanger (51, 52) serving as an evaporator.

<Structure of Humidity Sensor>

[0091] As described above, the outdoor air humidity sensor (97) is provided in the outdoor air passage (34), and the room air humidity sensor (96) is provided in the room air passage (32). The outdoor air humidity sensor (97) is attached to an upper surface of the bottom plate of the casing (11), and the room air humidity sensor (96) is attached to a lower surface of the top plate of the casing (11) (see the right side view in FIG. 5). That is, each of the humidity sensors (96, 97) is attached to one of the surfaces facing the corresponding air passage (32, 34) except for a surface of the passage divider plate (70) and opposing the passage divider plate (70).

[0092] The outdoor air humidity sensor (97) is arranged in the outdoor air passage (34) close to the first side panel (14) (see FIG. 2). Specifically, the outdoor air humidity sensor (97) is arranged near the first maintenance opening (14a). The room air humidity sensor (96) is arranged in the room air passage (32) close to the first side panel (14). Specifically, the room air humidity sensor (96) is also arranged near the first maintenance opening (14a).

[0093] The humidity sensors (96, 97) are included in sensor units (100), respectively. The sensor units (100) will be described with reference to FIGS. 8 and 9. The structures of the two sensor units (100) are basically the same. Therefore, the sensor unit (100) including the outdoor air humidity sensor (97) will be described in detail. The sensor unit (100) includes a support stage (101), a sensor cover (110), and an attachment (120).

[0094] The support stage (101) constitutes a support member for supporting the outdoor air humidity sensor (97). The support stage (101) is a plate with a center portion protruded in the shape of U when viewed in vertical section. Specifically, the support stage (101) includes a support plate (102), leg sections (103), and guide sections (104).

[0095] The support plate (102) is a substantially rectangular plate. A holding portion for holding the outdoor air humidity sensor (97) is formed in the center of the support plate (102). The support plate (102) is supported parallel to the bottom plate of the casing (11) at a certain distance from the bottom plate. Thus, the outdoor air humidity sensor (97) is positioned at the certain distance from the bottom plate.

[0096] Each of the leg sections (103) is a substantially narrow rectangular plate. The leg sections (103) contin-

uously extend downward from the widthwise ends of the support plate (102) (the ends in the lateral direction in FIG. 9), respectively, to be orthogonal to the support plate (102).

[0097] Each of the guide sections (104) is a substantially narrow rectangular plate. The guide sections (104) continuously extend laterally outward from the lower ends of the leg sections (103), respectively, to be orthogonal to the leg sections (103), and parallel to the support plate (102).

[0098] The support stage (101) includes a substantially rectangular first coupling plate (105). The first coupling plate (105) is continuously formed at one of longitudinal ends of the support plate (102) close to the first side panel (14). The first coupling plate (105) extends downward from the support plate (102) to be orthogonal to the support plate (102), and parallel to the first side panel (14). The height of the first coupling plate (105) is almost the same as that of the leg sections (103). A round- or oval-shaped first screw hole (106) is formed in the center of the first coupling plate (105). The first screw hole (106) is opened to face the first maintenance opening (14a).

[0099] The sensor cover (110) constitutes a protective cover for covering the outdoor air humidity sensor (97). The sensor cover (110) is in the shape of a box with an open bottom. A pair of side plates (111, 111) of the sensor cover (110) parallel to the first coupling plate (105) is shorter than the other pair of side plates (112, 112). The sensor cover (110) is detachably attached to the support stage (101) in such a manner that lower ends of the pair of side plates (111, 111) abut the support plate (102), and lower ends of the other pair of side plates (112, 112) abut the guide sections (104), respectively.

[0100] The pair of side plates (111, 111) have slits (112, 112), respectively. Each of the slits (112, 112) is rectangular, and is formed to cut out a center portion of the corresponding side plate (111, 111) from below. The slits (112, 112) constitute a pair of air flow ports between the side plates (111) and the support plate (102) for guiding the air to the inside of the sensor cover (110), or discharging the air to the outside of the sensor cover.

[0101] The attachment (120) is a member for attaching the support stage (101) onto the corresponding surface of the passages (32, 34). Specifically, in the outdoor air passage (34), the attachment (120) is fixed to an upper surface of the bottom plate of the casing (11). In the room air passage (32), the attachment (120) is fixed to a lower surface of the top plate of the casing (11). Although not shown, a heat insulator is provided between the passage surfaces and the attachment (120).

[0102] The attachment (120) includes a substrate (121), and a pair of rails (122) formed at the lateral ends of the substrate (121). The substrate (121) is a rectangular plate laid on the corresponding passage surface. The longitudinal and lateral dimensions of the substrate (121) are almost the same as those of the support stage (101). The pair of rails (122) extend parallel to each other, and orthogonally to the first maintenance opening (14a).

The rails (122) are formed by inwardly bending the lateral ends of the attachment (120). Specifically, each of the rails (122) is in the shape of U with an opening facing inward when viewed in section. A guide groove (123) for fitting the guide (104) of the support stage (101) therein is formed in the inside of each of the rails (122). The guide groove (123) is formed between the longitudinal ends of the rail (122). The guide sections (104) of the support stage (101) are fitted in the guide grooves (123) to be slidably held by the rails (122).

[0103] The attachment (120) is provided with a second coupling plate (124) as a plate. The second coupling plate (124) is substantially in the same shape as the first coupling plate (105), i.e., in the shape of a rectangle. The second coupling plate (124) is continuously formed at one of longitudinal ends of the substrate (121) (i.e., the ends in the longitudinal direction of the rails (122)) near the first maintenance opening (14a). The second coupling plate (124) stands at the lateral center of the end of the substrate (121). The second coupling plate (124) is able to abut the first coupling plate (105) of the support stage (101) slidably held by the guide grooves (123).

[0104] A round- or oval-shaped second screw hole (125) is formed in the center of the second coupling plate (124). The second screw hole (125) is opened to face the first maintenance opening (14a). The second screw hole (125) constitutes a coupling section for fixing the support stage (101) to the attachment (120).

[0105] The sensor unit (100) includes a screw (130) for fixing the support stage (101) and the attachment (120) with the support stage (101) attached to the attachment (120). The screw (130) is fastened to the screw holes (106, 125) with the first coupling plate (105) and the second coupling plate (124) abutting each other. The attachment and detachment of the support stage (101) and the attachment (120) will be described later in detail.

-Operation Mechanism-

[0106] The humidity control apparatus (10) of the present embodiment selectively performs dehumidification/ventilation operation, humidification/ventilation operation, and simple ventilation operation. During the dehumidification/ventilation operation and the humidification/ventilation operation, the humidity control apparatus (10) takes the outdoor air (OA) therein for humidity control, and the humidity-controlled air is supplied to the inside of the room as supply air (SA), and simultaneously, the humidity control apparatus (10) takes the indoor air (RA) and discharges it as exhaust air (EA). During the simple ventilation operation, the humidity control apparatus (10) takes the outdoor air (OA) and supplies it to the inside of the room as the supply air (SA), and simultaneously, the humidity control apparatus (10) takes the room air (RA), and discharges it as the exhaust air (EA).

<Dehumidification/Ventilation Operation>

[0107] In the humidity control apparatus (10) performing the dehumidification/ventilation operation, first operation and second operation described later are alternately performed at predetermined time intervals (e.g., every three minutes). In the dehumidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0108] When the supply fan (26) of the humidity control apparatus (10) is operated in the dehumidification/ventilation operation, the outdoor air enters the casing (11) through the outdoor air inlet (24) as first air. When the discharge fan (25) is operated, the room air enters the casing (11) through the indoor air inlet (23) as second air.

[0109] The first operation of the dehumidification/ventilation operation will be described below. As shown in FIG. 10, in the first operation, the first room air damper (41), the second outdoor 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 outdoor air damper (43), the first supply air damper (45), and the second discharge air damper (48) are closed.

[0110] In the first operation, the four-way switching valve (54) in the refrigerant circuit (50) is set to the first state as shown in FIG. 6(A). In this state, the refrigerant in the refrigerant circuit (50) circulates to perform a refrigeration cycle. In this case, in the refrigerant circuit (50), the refrigerant discharged from the compressor (53) sequentially passes the first adsorption heat exchanger (51), the motor-operated expansion valve (55), and the second adsorption heat exchanger (52). The first adsorption heat exchanger (51) functions as a condenser, and the second adsorption heat exchanger (52) functions as an evaporator.

[0111] The first air that entered the outdoor air passage (34), and passed through the outdoor air filter (28) passes through the second outdoor 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 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).

[0112] The second air that entered the room air passage (32), and passed through 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), the adsorbent heated by the refrigerant releases the moisture, and the released 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).

[0113] The second operation of the dehumidification/ventilation operation will be described below. As shown in FIG. 11, in the second operation, the second room air damper (42), the first outdoor 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 outdoor air damper (44), the second supply air damper (46), and the first discharge air damper (47) are closed.

[0114] In the second operation, the four-way switching valve (54) in the refrigerant circuit (50) is set to the second state as shown in FIG. 6(B). In this state, the refrigerant in the refrigerant circuit (50) circulates to perform a refrigeration cycle. In this case, in the refrigerant circuit (50), the refrigerant discharged from the compressor (53) sequentially passes through the second adsorption heat exchanger (52), the motor-operated expansion valve (55), and the first adsorption heat exchanger (51). The first adsorption heat exchanger (51) functions as the evaporator, and the second adsorption heat exchanger (52) functions as the condenser.

[0115] The first air that entered the outdoor air passage (34), and passed through the outdoor air filter (28) passes through the first outdoor 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).

[0116] 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), the adsorbent heated by the refrigerant releases the moisture, and the released 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>

[0117] In the humidity control apparatus (10) performing the humidification/ventilation operation, first operation

tion and second operation described later are alternately performed at predetermined time intervals (e.g., every three minutes). In the humidification/ventilation operation, the first bypass damper (83) and the second bypass damper (84) are kept closed.

[0118] When the supply fan (26) of the humidity control apparatus (10) is operated in the humidification/ventilation operation, the outdoor air enters the casing (11) through the outdoor air inlet (24) as second air. When the discharge fan (25) is operated, the room air enters the casing (11) through the indoor air inlet (23) as first air.

[0119] The first operation of the humidification/ventilation operation will be described below. As shown in FIG. 12, in the first operation, the second room air damper (42), the first outdoor 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 outdoor air damper (44), the second supply air damper (46), and the first discharge air damper (47) are closed.

[0120] In the first operation, the four-way switching valve (54) in the refrigerant circuit (50) is set to the first state as shown in FIG. 6(A). In this state, like the first operation in the dehumidification/ventilation operation, the first adsorption heat exchanger (51) functions as the condenser, and the second adsorption heat exchanger (52) functions as the evaporator.

[0121] 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 in 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).

[0122] The second air that entered the outdoor air passage (34), and passed through the outdoor air filter (28) passes through the first outdoor 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), the adsorbent heated by the refrigerant releases the moisture, and the released 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).

[0123] The second operation of the humidification/ventilation operation will be described below. As shown in FIG. 13, in the second operation, the first room air damper (41), the second outdoor 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 outdoor air damper (43), the first supply air damper (45), and the second discharge air damper (48) are closed.

[0124] In the second operation, the four-way switching valve (54) in the refrigerant circuit (50) is set to the second state as shown in FIG. 6(B). In this state, in the refrigerant circuit (50), like the second operation of the dehumidification/ventilation operation, the first adsorption heat exchanger (51) functions as the evaporator, and the second adsorption heat exchanger (52) functions as the condenser.

[0125] 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 in 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).

[0126] The second air that entered the outdoor air passage (34), and passed through the outdoor air filter (28) passes through the second outdoor 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), the adsorbent heated by the refrigerant releases the moisture, and the released 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>

[0127] Operation of the humidity control apparatus (10) during the simple ventilation operation will be described with reference to FIG. 14. The simple ventilation operation is performed when direct supply of the outdoor air to the inside of the room does not affect comfortability of the inside the room (e.g., in an intermediate season, such as spring and summer). Specifically, the simple ventilation operation is performed when the humidity control of the air supplied to the inside of the room is not required, but the ventilation of the inside of the room is required.

[0128] In the simple ventilation operation, the first and second bypass dampers (83, 84) are opened, and the first and second room air dampers (41, 42), the first and second outdoor air dampers (43, 44), the first and second supply air dampers (45, 46), and the first and second discharge air dampers (47, 48) are closed. In the simple ventilation operation, the compressor (53) in the refrigerant

erant circuit (50) is suspended. That is, the refrigeration cycle is not performed in the refrigerant circuit (50) in the simple ventilation operation.

[0129] In the simple ventilation operation, when the supply fan (26) of the humidity control apparatus (10) is operated, the outdoor air enters the casing (11) through the outdoor air inlet (24). The outdoor air that entered the outdoor air passage (34) through the outdoor air inlet (24) passes through the outdoor air filter (28) to enter the first bypass passage (81), and passes through the first bypass damper (83) to enter the supply fan chamber (36). The outdoor air that entered the supply fan chamber (36) is sucked by the supply fan (26), and is supplied to the inside of the room through the supply port (22).

[0130] In the simple ventilation operation, when the discharge fan (25) of the humidity control apparatus (10) is operated, the room air enters the casing (11) through the indoor air inlet (23). The room air that entered the room air passage (32) through the indoor air inlet (23) passes through the room air filter (27) to enter the second bypass passage (82), and passes through the second bypass damper (84) to enter the discharge fan chamber (35). The room air that entered the discharge fan chamber (35) is sucked by the discharge fan (25), and is discharged outside the room through the discharge port (21).

-Measures against Wetting of Humidity Sensor-

[0131] As described above, during the above-described operations of the humidity control apparatus (10), the outdoor air (OA) enters the outdoor air passage (34), and the room air (RA) simultaneously enters the room air passage (32). Specifically, in the casing (11), the room air (RA) flows above the passage divider plate (70), and the outdoor air (OA) flows below the passage divider plate (70). In summer or winter, for example, when there is a large temperature difference between the outdoor air (OA) and the room air (RA), heat transfer between the outdoor air passage (34) and the room air passage (32) easily occurs through the passage divider plate (70). In conventional apparatuses, the humidity sensor is attached to the divider plate. Therefore, the heat of the humidity sensor is transferred to the divider plate, thereby causing dew condensation near the humidity sensor.

[0132] As a solution to this, the humidity sensors (96, 97) of the present embodiment are attached to the passage surfaces of the corresponding passage (32, 34) except for the surface of the passage divider plate (70) (i.e., the bottom plate and the top plate of the casing (11)). Accordingly, the heat transfer from the humidity sensors (96, 97) to the passage divider plate (70) is reduced, thereby preventing the dew condensation near the humidity sensors (96, 97). Thus, condensed water no longer adheres to the humidity sensors (96, 97), and the humidity around the humidity sensors (96, 97) does not locally increase. The present embodiment can avoid failure of the humidity sensors (96, 97) and error in humidity de-

tection by the humidity sensors (96, 97) due to wetting of the humidity sensors (96, 97). Therefore, the humidity control apparatus (10) can suitably control the humidity control capability based on the humidities detected by the humidity sensors (96, 97) (e.g., control of the amount of circulating refrigerant by controlling operation frequency of the compressor (53)).

-Attachment/Detachment of Sensor Unit-

[0133] Attachment and detachment of the sensor unit (100) including the room air humidity sensor (96) and the outdoor air humidity sensor (97) will be described below.

[0134] For maintenance of the humidity sensor (96), etc., the first open/close panel (17) (see FIG. 1) is detached from the casing (11), thereby exposing the first maintenance opening (14a) to a worker (see FIG. 8).

[0135] The worker detaches the screw (130) from the first coupling plate (105) and the second coupling plate (124), thereby releasing the coupling of the support stage (101) and the attachment (120). Then, the support stage (101) is allowed to slide forward along the rails (122) shown in FIG. 9, thereby detaching the guide sections (104) from the guide grooves (123). In this manner, the support stage (101) is detached from the attachment (120).

[0136] In attaching the support stage (101) to the attachment (120), the guide sections (104) of the support stage (101) are inserted in the guide grooves (123) from the front ends of the guide grooves (123). Then, the support stage (101) is slid backward to bring the first coupling plate (105) and the second coupling plate (124) into contact with each other. In this state, the first coupling plate (105) and the second coupling plate (124) are fastened by the screw (130), thereby coupling and fixing the support stage (101) and the attachment (120).

-Advantages of Embodiment-

[0137] According to the embodiment described above, each of the humidity sensors (96, 97) in the outdoor air passage (34) and the room air passage (32) is attached to the passage surface except for the surface of the passage divider plate (70). This can reduce the heat transfer from the humidity sensors (96, 97) to the passage divider plate (70), thereby preventing the dew condensation near the humidity sensors (96, 97). Accordingly, condensed water no longer adheres to the humidity sensors (96, 97), and the humidity around the humidity sensors (96, 97) does not locally increase. This can prevent failure of the humidity sensors (96, 97), and error in humidity detection by the humidity sensors (96, 97) due to the adhesion of the condensed water to the humidity sensors (96, 97). Therefore, the reliability of the humidity control apparatus (10) can be ensured.

[0138] In particular, according to the present embodiment, the room air humidity sensor (96) is attached to the lower surface of the top plate of the casing (11), and

the outdoor air humidity sensor (97) is attached to the upper surface of the bottom plate of the casing (11). Specifically, each of the humidity sensors (96, 97) is attached to the passage surface opposing the passage divider plate (70). Thus, a sufficient distance can be kept between the passage divider plate (70) and each of the humidity sensors (96, 97), thereby effectively reducing the heat transfer from the humidity sensors (96, 97) to the passage divider plate (70). This can effectively prevent the adhesion of the condensed water to the humidity sensors (96, 97), and the local increase in humidity around the humidity sensors (96, 97).

[0139] In the above-described embodiment, each of the humidity sensors (96, 97) is supported on the support stage (101), and the support stage (101) is detachably attached to the attachment (120) arranged on the passage surface. This allows for easy attachment/detachment of the humidity sensors (96, 97), thereby allowing for easy maintenance. Further, the attachment (120) is provided with the rails (122), and the support stage (101) is attached to the attachment (120) by fitting the guide sections (104) of the support stage (101) in the guide grooves (123) of the rails (122). This allows for easy attachment and detachment of the support stage (101) to and from the attachment (120) by sliding the support stage (101) along the rails (122).

[0140] The humidity sensors (96, 97) are both arranged near the same side plate of the casing (11), i.e., near the first maintenance opening (14a). This allows for maintenance of the humidity sensors (96, 97) from the same direction. Further, the second screw hole (125) for fixing the support stage (101) to the attachment (120) is arranged to face the first maintenance opening (14a). This allows the worker to easily fix the support stage (101) and the attachment (120). The second coupling plate (124) provided at one of the longitudinal ends of the rails (122) can be used as a member for preventing the guide sections (104) from slipping off. In fastening the second coupling plate (124) and the first coupling plate (105) with the screw (130), the second coupling plate (124) can be used for positioning the support stage (101).

[Other Embodiment]

[0141] The above-described embodiment may be modified in the following manner.

[0142] The positions of attachment of the humidity sensors (96, 97) are not limited to those described in the embodiment. For example, one or both of the humidity sensors (96, 97) may be attached to the surface of the back panel (13), the surface of the first open/close panel (17), or the surface of the upstream divider plate (71) facing the outdoor air passage (34) or the room air passage (32).

[0143] Specifically, in an example shown in FIG. 15, the room air humidity sensor (96) is attached to the surface of the upstream divider plate (71) facing the passage, and the outdoor air humidity sensor (97) is attached

to the surface of the bottom plate of the casing (11) facing the passage, like the above-described embodiment. The room air humidity sensor (96) is included in the sensor unit (100) similar to that of the above-described embodiment. The room air humidity sensor (96) is arranged near the first open/close panel (17) like the embodiment described above, thereby allowing the worker to easily perform the maintenance with the first open/close panel (17) detached. In this example, the room air filter (27) is arranged in the room air passage (32) upstream of the room air humidity sensor (96). This can prevent adhesion of dust contained in the air, etc., to the room air humidity sensor (96).

[0144] As shown in the example of FIG. 15, attaching the room air humidity sensor (96) to the upstream divider plate (71) facilitates wire routing for the room air humidity sensor (96) in assembling the humidity control apparatus (10). Specifically, in assembling the humidity control apparatus (10), wires of the room air humidity sensor (96), and wires of the first and second room air dampers (41, 42) on the upstream divider plate (71) are routed with the top plate of the casing (11) detached. The wires are introduced in the electrical component box (90) through the first bypass passage (81). After checking whether or not the room air humidity sensor (96), and the first and second room air dampers (41, 42) operate normally, the top plate is attached to the casing (11).

[0145] If the room air humidity sensor (96) is arranged on the surface of the top plate facing the passage, the room air humidity sensor (96) is also detached together with the top plate of the casing (11). In view of the attachment/detachment of the top plate, the wire extending from the electrical component box (90) to the room air humidity sensor (96) has to have enough length. Alternatively, the wire routing for the room air humidity sensor (96) has to be performed after checking the dampers (41, 42), etc., and attaching the top plate to the casing (11).

[0146] In this way, in the example shown in FIG. 15, the room air humidity sensor (96) is attached to the surface of the upstream divider plate (71) facing the passage and carrying the dampers (41, 42). This makes it possible to connect the electrical component box (90) and the room air humidity sensor (96) with a relatively short wire, irrespective of whether the top plate is attached or not. Further, the wires of the dampers (41, 42) and the wire of the room air humidity sensor (96) can be routed in the same path, thereby facilitating the wire routing.

[0147] In the above-described embodiment, the room air passage (32) is provided above the passage divider plate (70), and the outdoor air passage (34) is provided below the passage divider plate (70). However, conversely, the outdoor air passage (34) may be provided above the passage divider plate (70), and the room air passage (32) may be provided below the passage divider plate (70). The passage divider plate (70) may be arranged vertically too provide the outdoor air passage (34) and the room air passage (32) on the left and right of the passage divider plate (70). In this structure, the same

advantages as those of the above-described embodiment can be provided by attaching the humidity sensors (96, 97) to the passage surface except for the surface of the passage divider plate (70).

[0148] In the above-described embodiment, the air is humidified by the humidity controller including the two adsorption heat exchangers (51, 52). However, the humidity controller is not limited to this structure. For example, an adsorption rotor carrying an adsorbent on a rotor plate, and a total heat exchanger for exchanging sensible heat and latent heat between the outdoor air and the room air can also be used.

[0149] The above-described embodiments are merely preferred embodiments in nature, and are not intended to limit the scope, applications and use of the invention.

INDUSTRIAL APPLICABILITY

[0150] As described above, the present invention is useful for a humidity control apparatus for adjusting room air humidity.

DESCRIPTION OF REFERENCE CHARACTERS

[0151]

- | | | |
|-----|--|----|
| 10 | Humidity control apparatus | |
| 11 | Casing | |
| 14 | First side panel (a side plane of the casing) | |
| 14a | First maintenance opening (maintenance opening) | 30 |
| 32 | Room air passage (second air passage) | |
| 34 | Outdoor air passage (first air passage) | |
| 41 | First room air damper (damper) | |
| 42 | Second room air damper (damper) | 35 |
| 43 | First outdoor air damper (damper) | |
| 44 | Second outdoor air damper (damper) | |
| 51 | First adsorption heat exchanger (humidity controller) | |
| 52 | Second adsorption heat exchanger (humidity controller) | 40 |
| 70 | Passage divider plate (divider plate) | |
| 71 | Upstream divider plate (damper divider plate) | |
| 96 | Room air humidity sensor (humidity sensor) | |
| 97 | Outdoor air humidity sensor (humidity sensor) | 45 |
| 101 | Support stage | |
| 104 | Guide | |
| 120 | Attachment | |
| 122 | Rail | |
| 123 | Guide groove | 50 |
| 124 | Second coupling plate (plate) | |
| 125 | Second screw hole (coupling section) | |

Claims

1. A humidity control apparatus comprising:

a casing (11);
a divider plate (70) arranged in the casing (11) to provide a first air passage (34) in which outdoor air flows, and a second air passage (32) in which room air flows, with the divider plate (70) interposed therebetween;
humidity controllers (51, 52) for controlling humidities of the room air and the outdoor air flowing in the air passages (32, 34); and
humidity sensors (96, 97) arranged in the air passages (32, 34), respectively, to detect air humidity in the corresponding air passages (32, 34), wherein
each of the humidity sensors (96, 97) is attached to one of passage surfaces facing the corresponding air passage (32, 34) except for a surface of the divider plate (70).

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

a support stage (101) on which each of the humidity sensors (96, 97) is supported; and
an attachment (120) provided on the passage surface of the corresponding air passage (32, 34) so as to detachably attach the support stage (101) thereto.

3. The humidity control apparatus of claim 2, wherein the attachment (120) includes a rail (122) extending along the passage surface of the corresponding air passage (32, 34), and having a guide groove (123) extending between longitudinal ends of the rail (122), and
the support stage (101) includes a guide (104) arranged at an end thereof to fit in the guide groove (123) of the rail (122) to be slidably supported on the rail (122).

4. The humidity control apparatus of claim 1, wherein a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), and both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11).

5. The humidity control apparatus of claim 2 or 3, wherein
a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11), and the attachment (120) includes a coupling section (125) arranged to face the maintenance opening (14a) for fixing the support stage (101) to the attachment (120).

6. The humidity control apparatus of claim 3, wherein a maintenance opening (14a) facing both of the first air passage (34) and the second air passage (32) is formed in a side plane (14) of the casing (11), both of the humidity sensors (96, 97) are arranged near the side plane (14) of the casing (11), a plate (124) is arranged to vertically stand at an end of the rail (122) near the maintenance opening (14a) in such a manner that the support stage (101) abut thereto, and the plate (124) includes a coupling section (125) for fixing the support stage (101) to the attachment (120). 5 10
7. The humidity control apparatus of any one of claims 1 to 6, wherein the casing (11) includes humidity control chambers (37, 38) containing the humidity controllers (51, 52), respectively, and a damper-carrying divider plate (71) dividing the humidity control chambers (37, 38) from the air passages (34, 32), and carrying a plurality of dampers (41-44) for connecting/disconnecting the humidity control chambers (37, 38) to/from the air passages (34, 32), and one or both of the humidity sensors (96, 97) is attached to a surface of the damper-carrying divider plate (71) facing the corresponding air passage (32, 34). 15 20 25
8. The humidity control apparatus of any one of claims 1 to 6, wherein each of the humidity sensors (96, 97) is attached to one of the passage surfaces facing the corresponding air passage (32, 34) and opposing the divider plate (70). 30 35

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FIG. 1

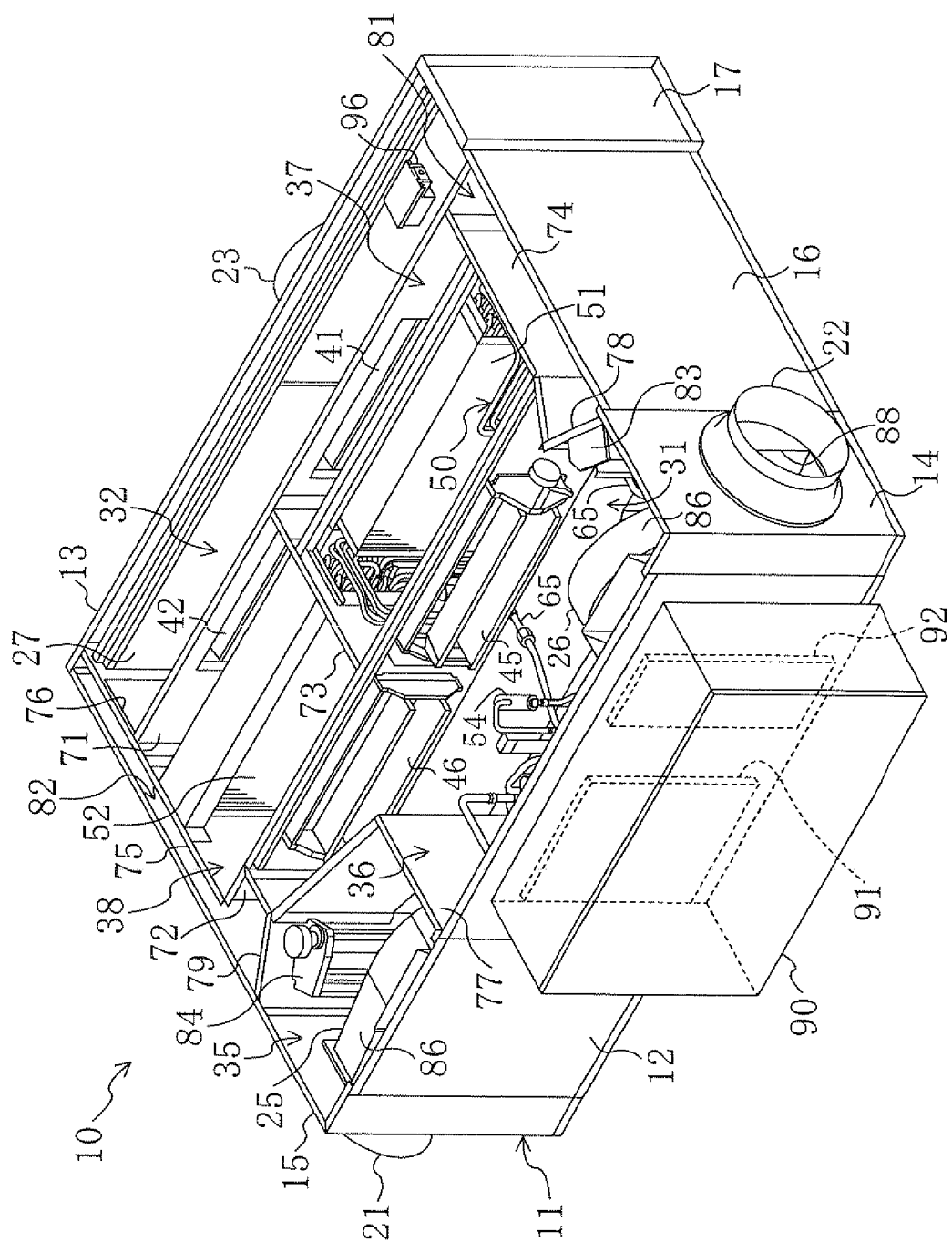


FIG. 2

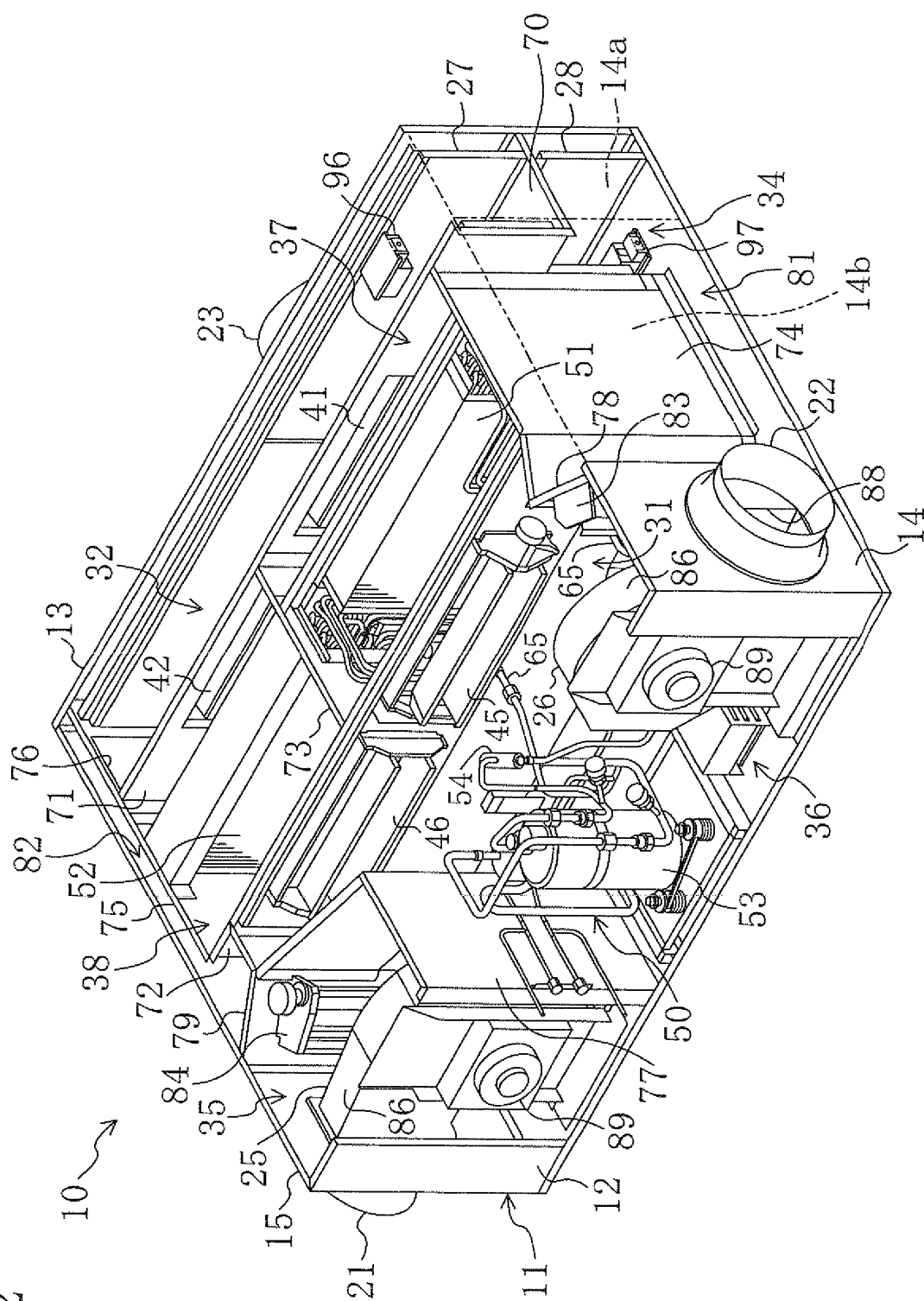


FIG. 3

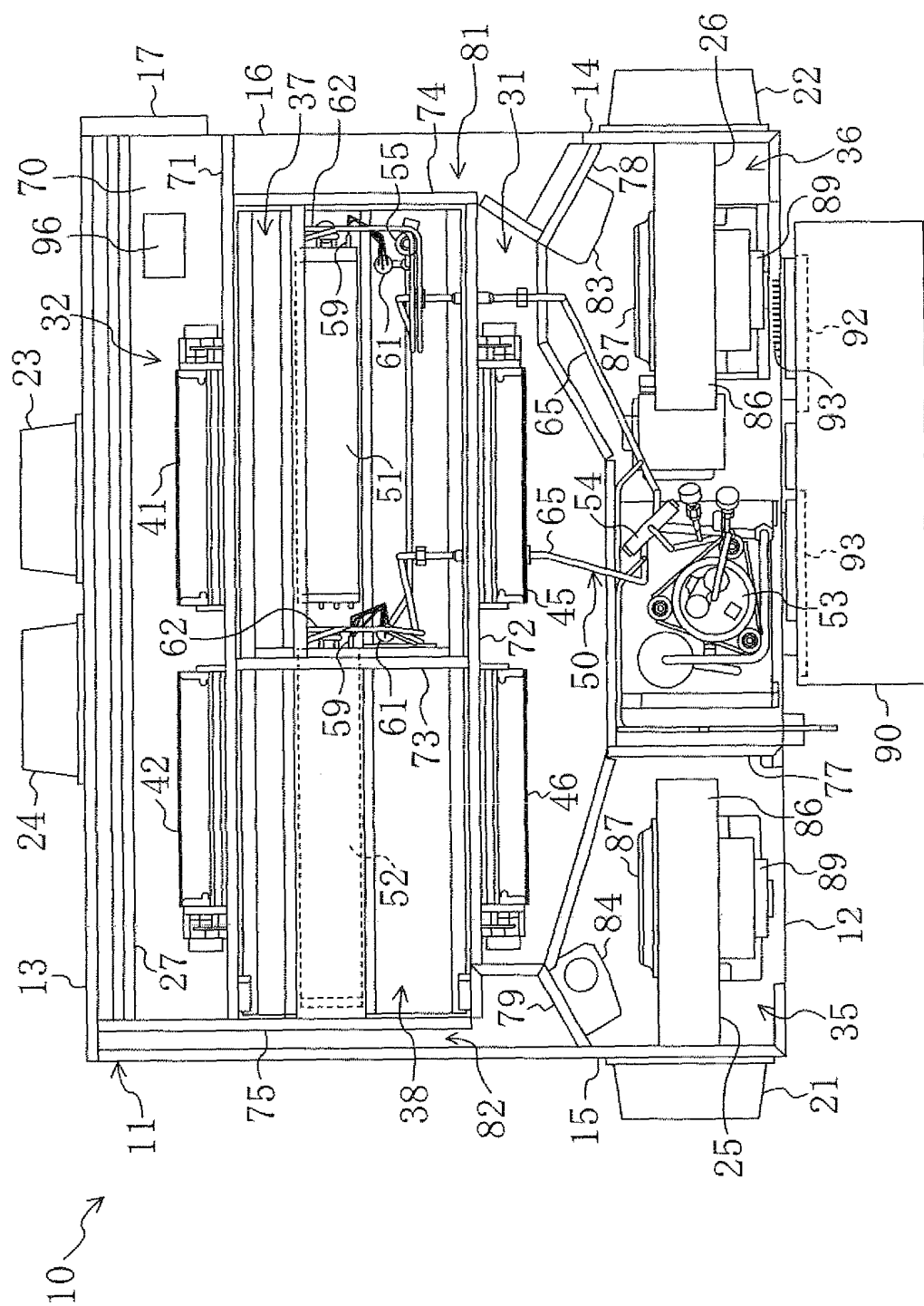


FIG. 4

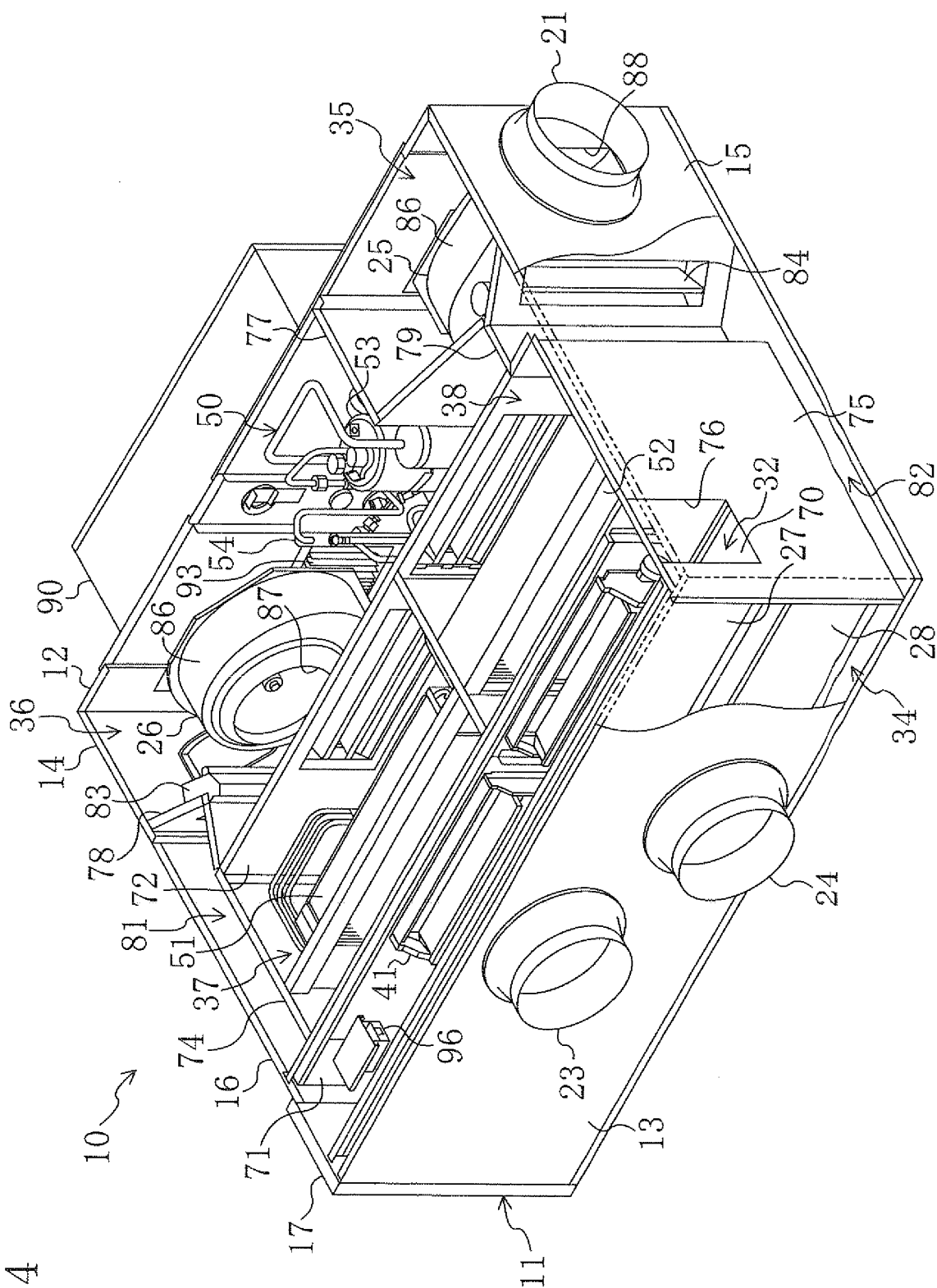


FIG. 5

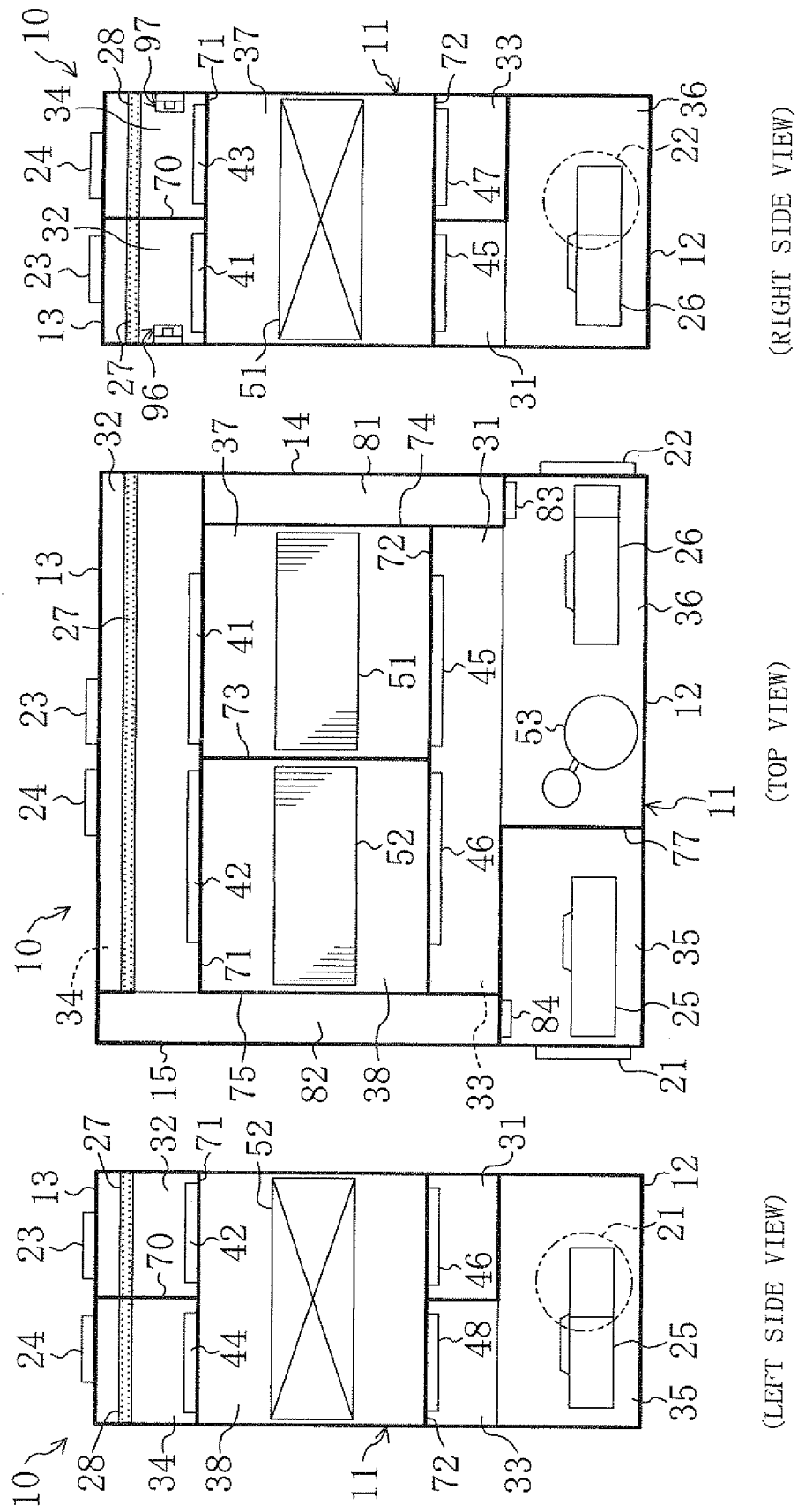


FIG. 6A FIRST OPERATION

10

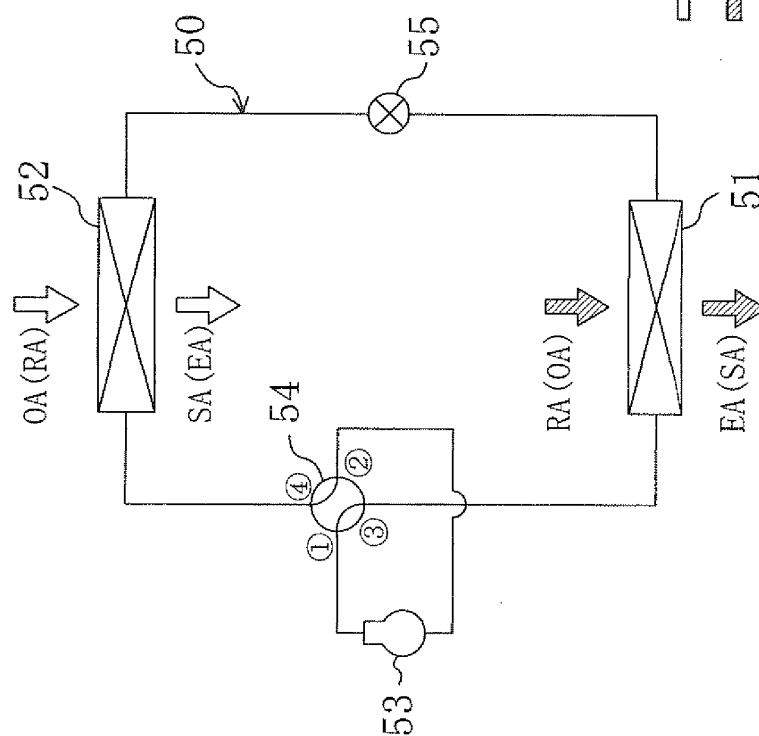


FIG. 6B SECOND OPERATION

10

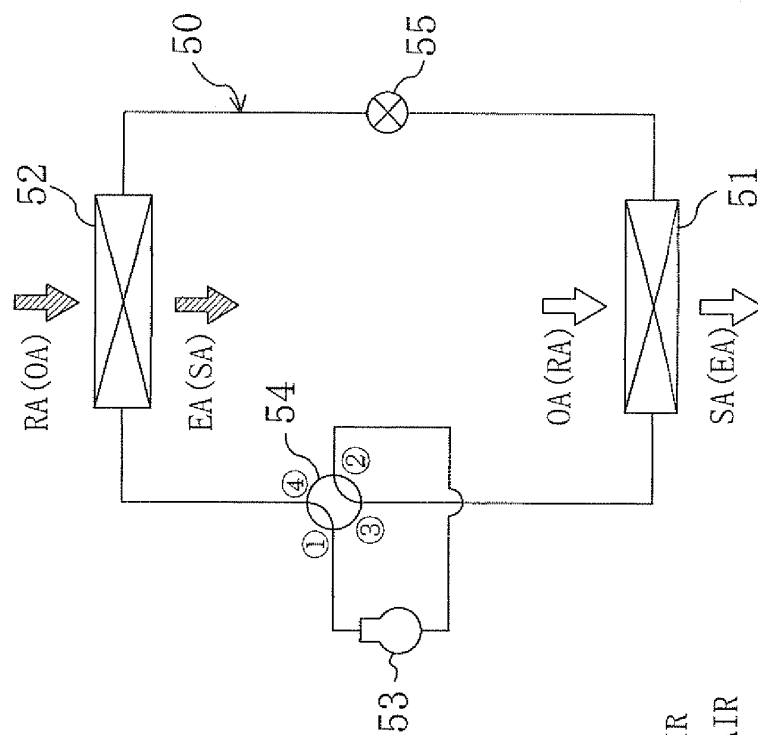


FIG. 7

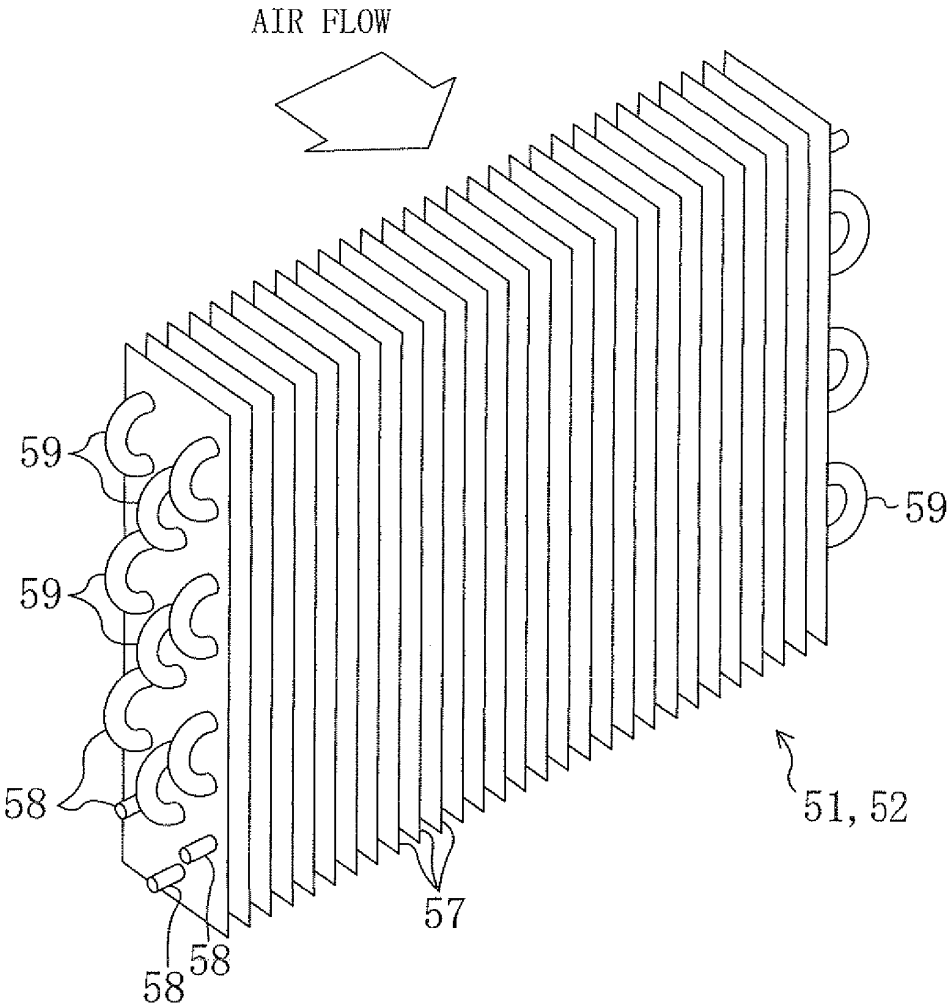


FIG. 8

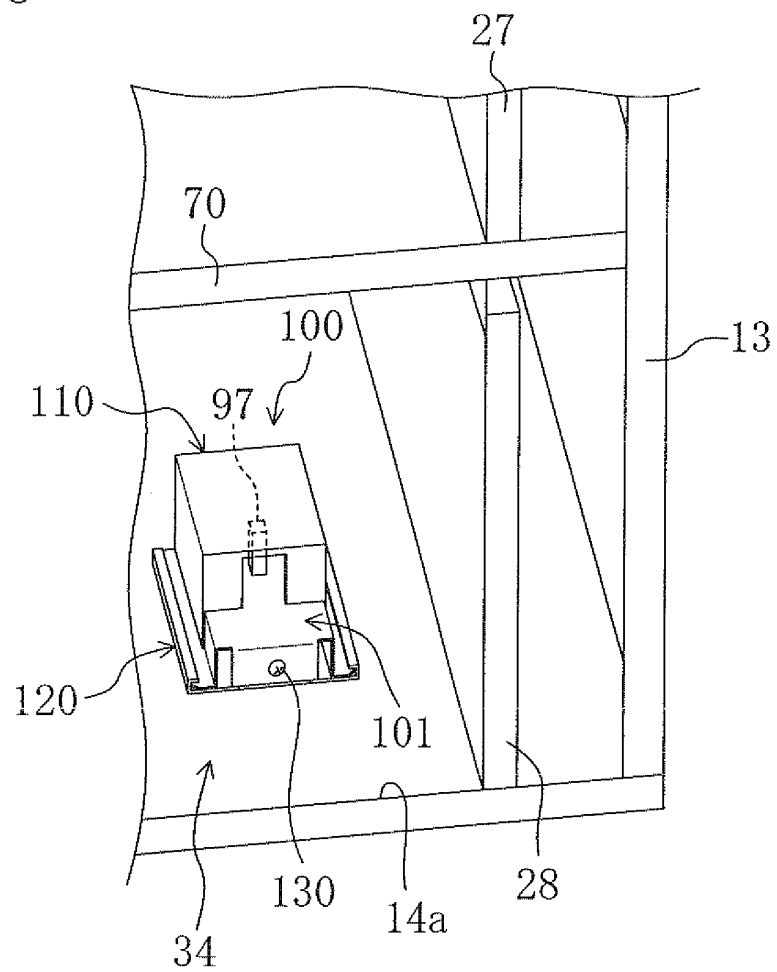


FIG. 9

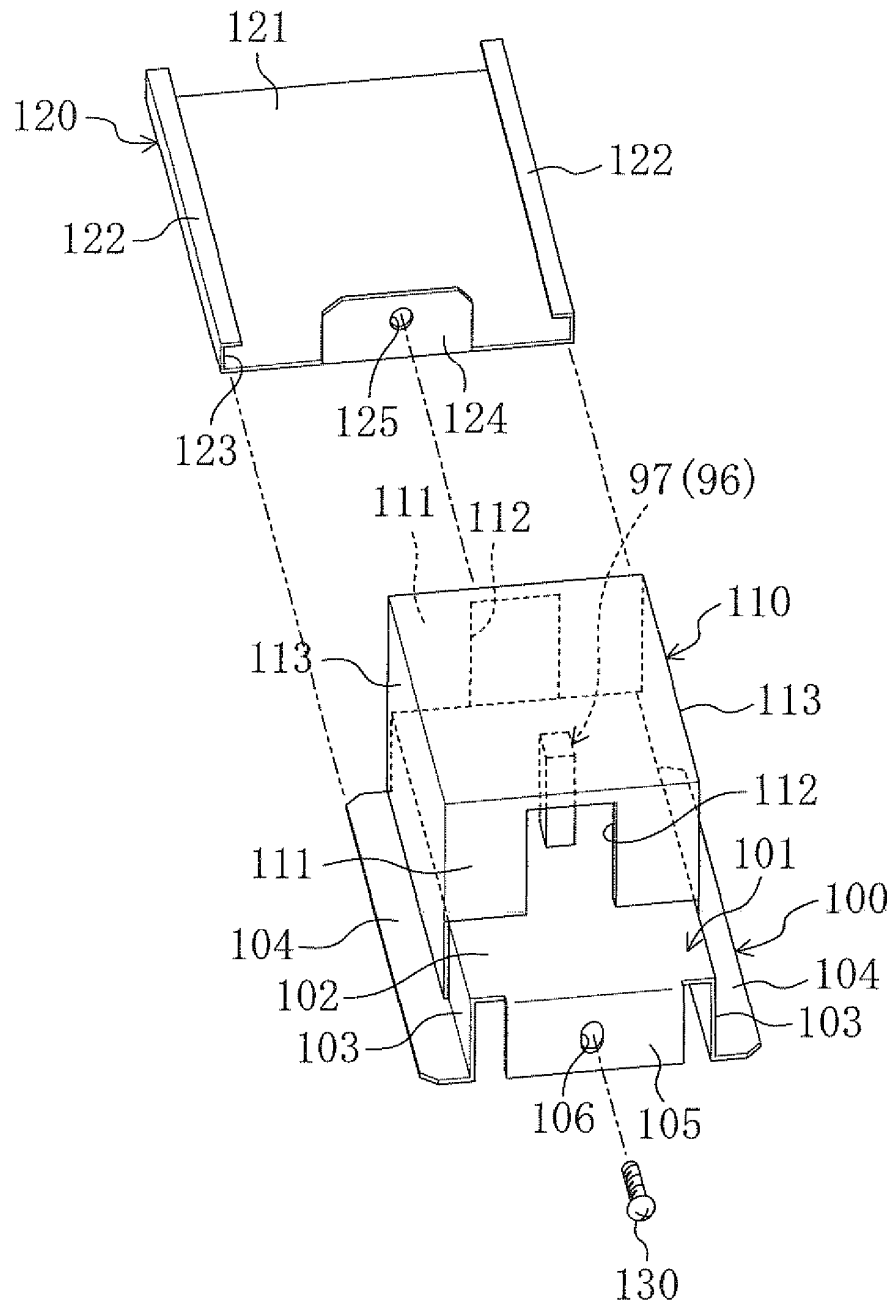


FIG. 10

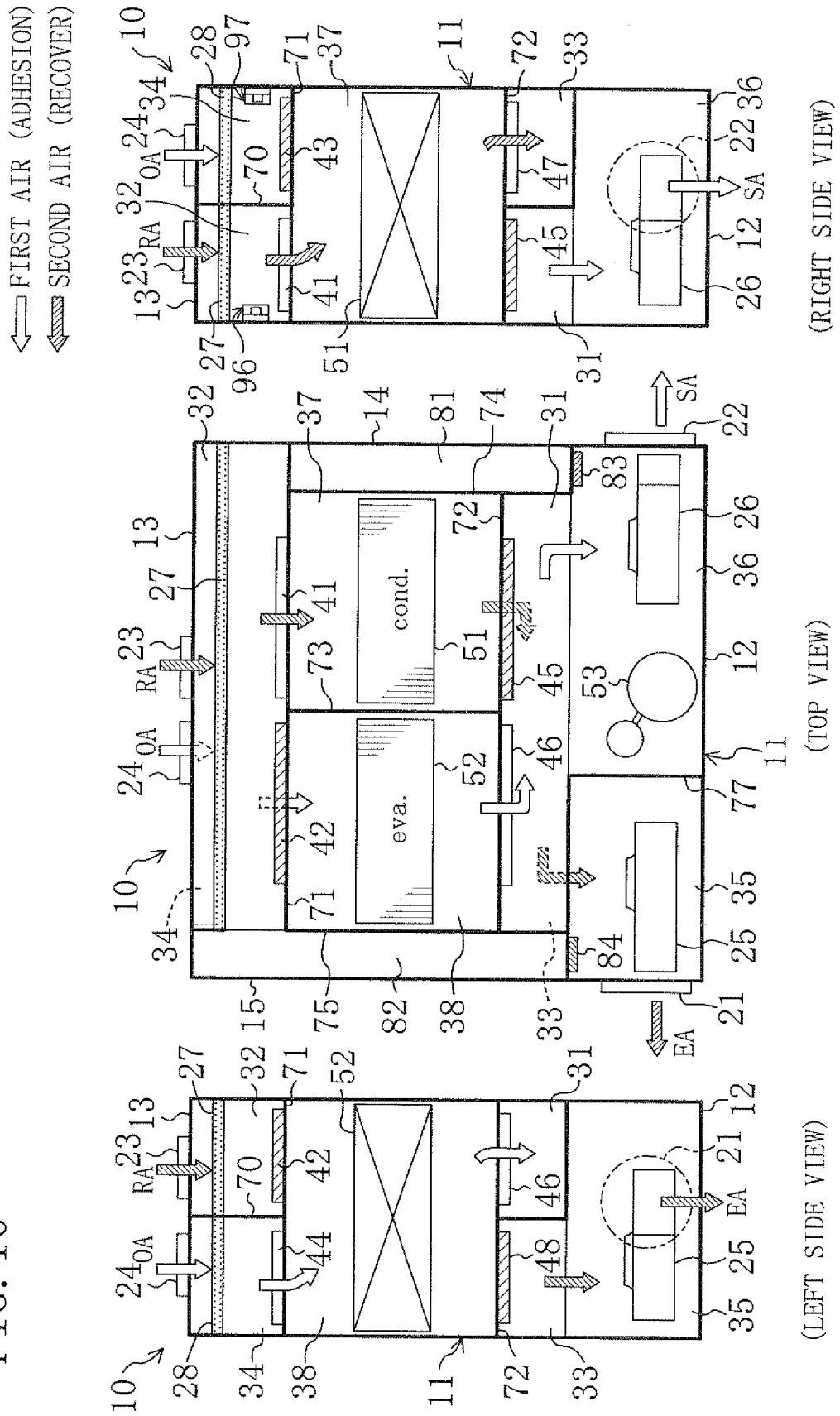


FIG. 11

⇐ FIRST AIR (ADHESION)
⇐ SECOND AIR (RECOVER)

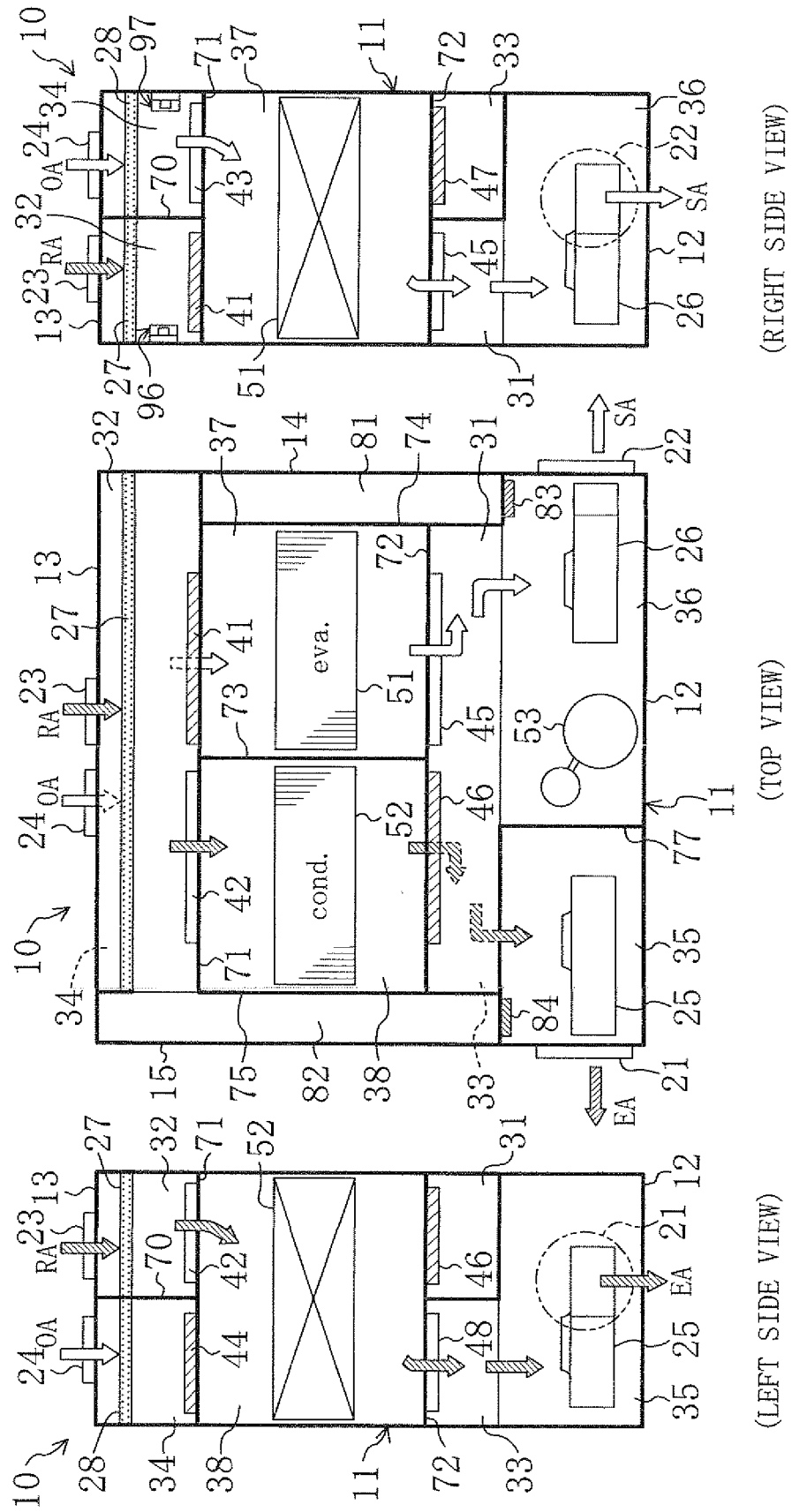


FIG. 12

 FIRST AIR (ADHESION)
 SECOND AIR (RECOVER)

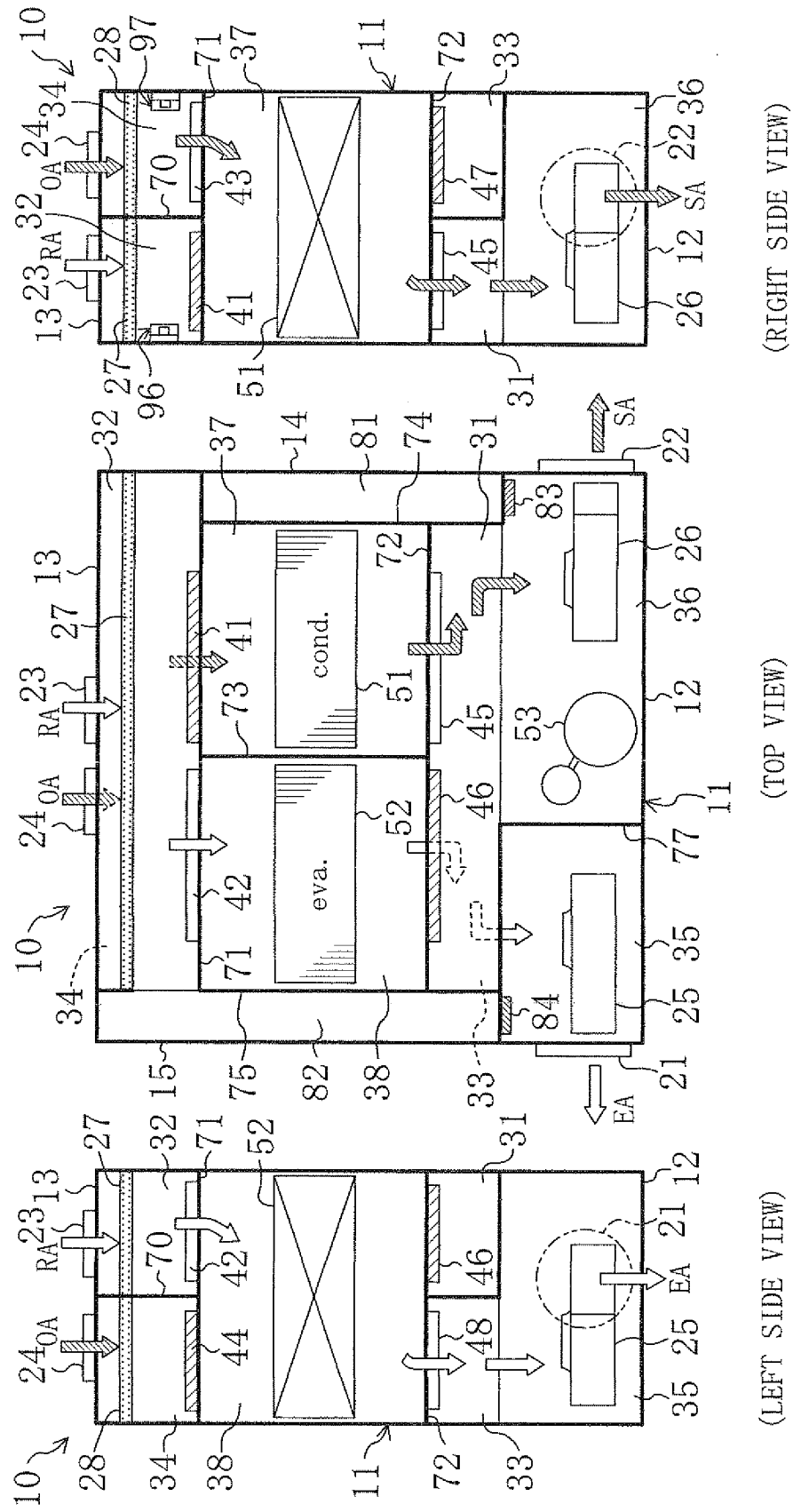
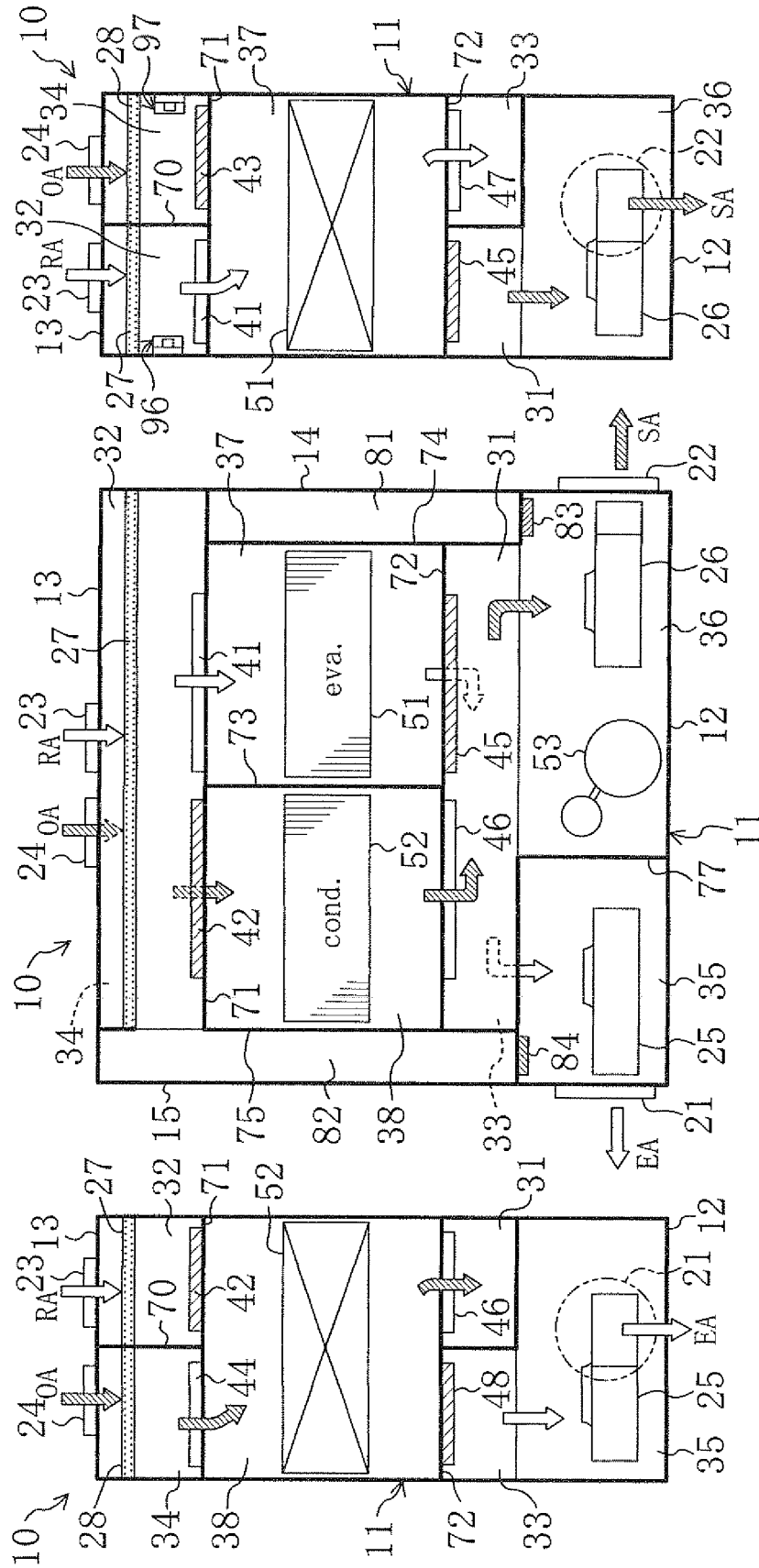


FIG. 13

 FIRST AIR (ADHESION)
 SECOND AIR (RECOVER)

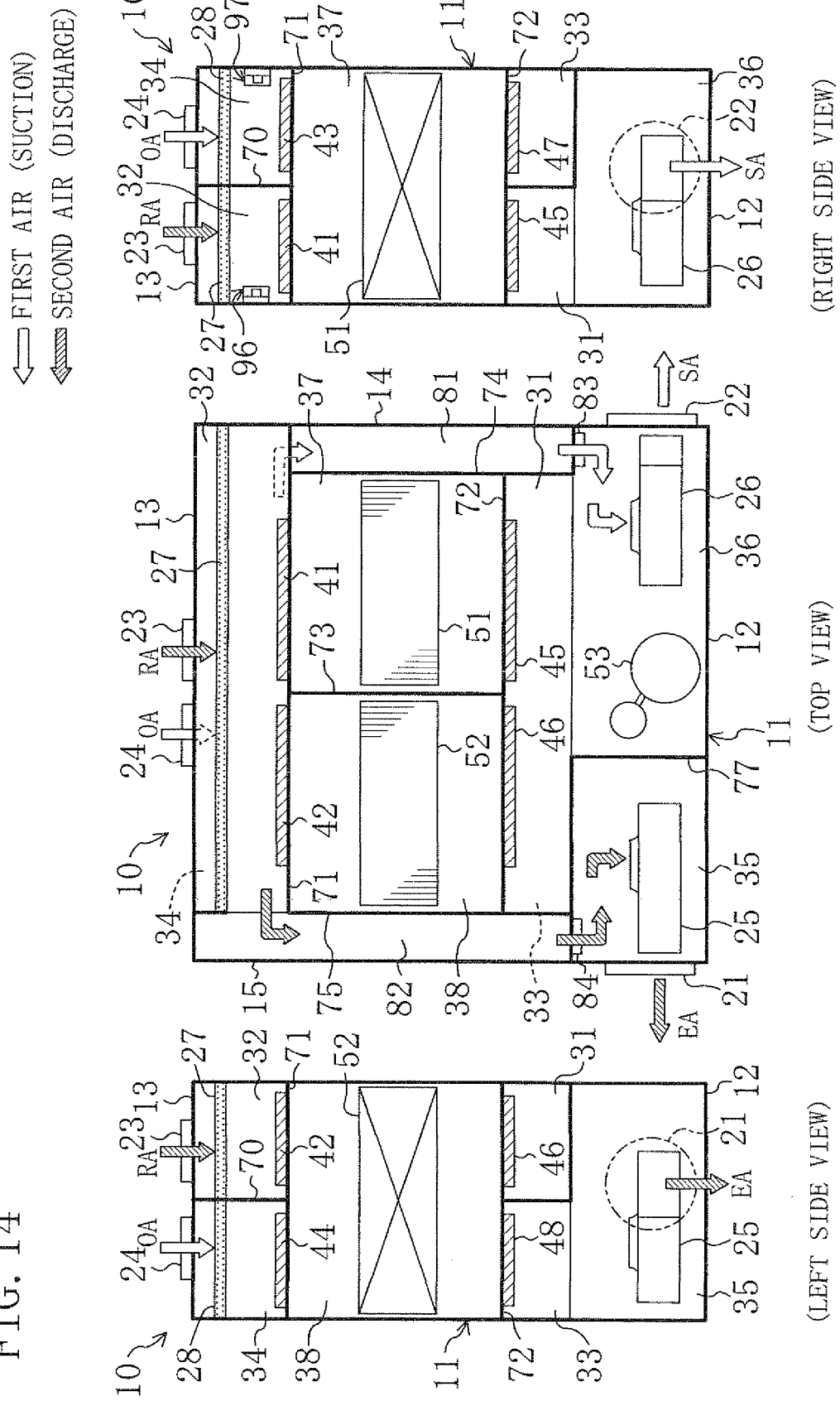


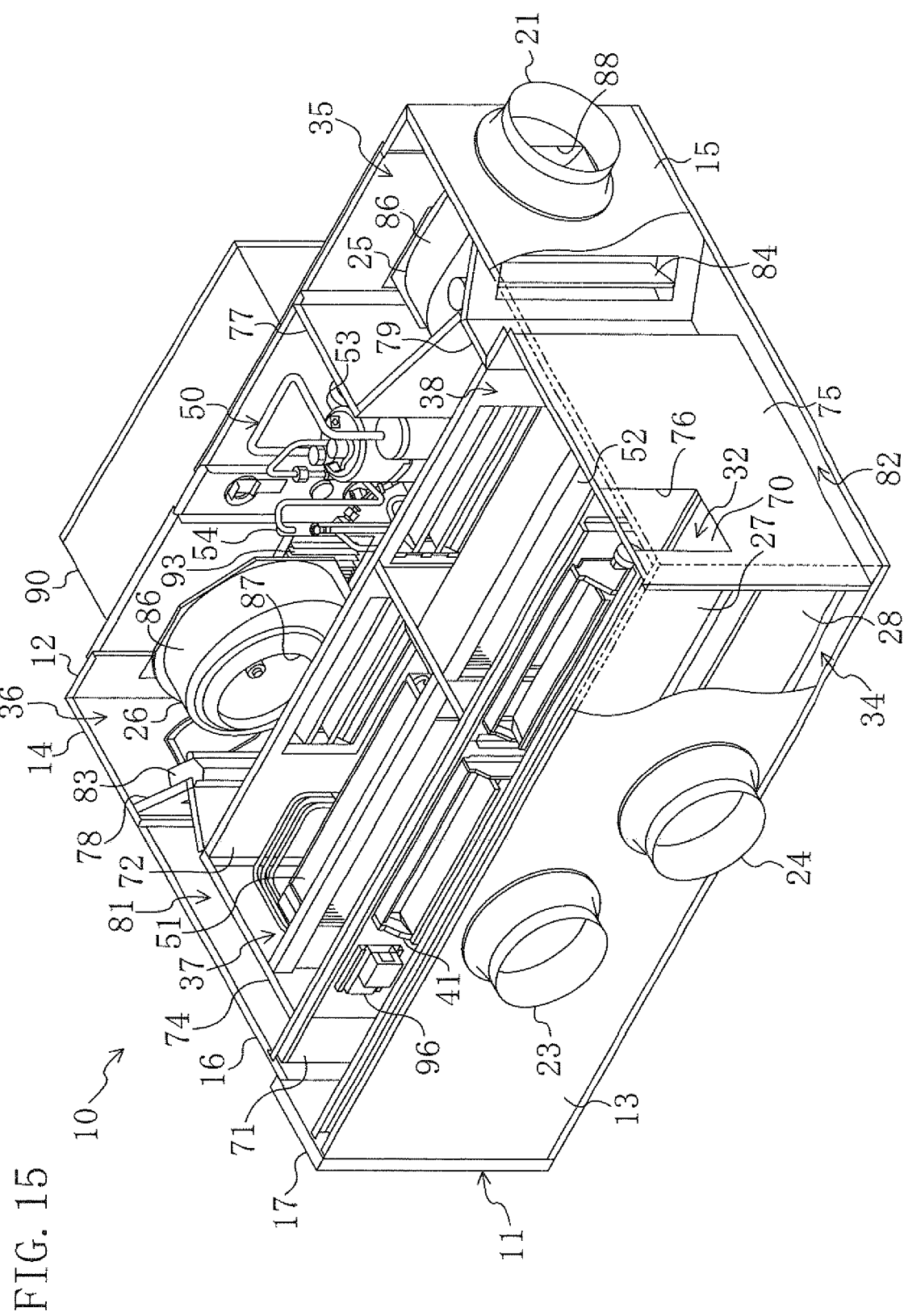
(LEFT SIDE VIEW)

(TOP VIEW)

(RIGHT SIDE VIEW)

FIG. 14





INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/002225

A. CLASSIFICATION OF SUBJECT MATTER F24F3/14 (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) F24F3/14		
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 1996-2008 Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008		
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 2007-10229 A (Daikin Industries, Ltd.), 18 January, 2007 (18.01.07), Claims; Par. Nos. [0001] to [0122]; Figs. 1 to 12 & WO 2007/004557 A1	1-8
Y	JP 2004-257588 A (Hitachi Plant Engineering & Construction Co., Ltd.), 16 September, 2004 (16.09.04), Claims; Par. Nos. [0001] to [0039]; Figs. 1 to 6 (Family: none)	1-8
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 06 October, 2008 (06.10.08)		Date of mailing of the international search report 21 October, 2008 (21.10.08)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/002225

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 59-1937 A (Toho Gas Co., Ltd.), 07 January, 1984 (07.01.84), Page 2, upper left column, line 17 to upper right column, line 10; Fig. 3 (Family: none)	1-8
Y	JP 2005-188915 A (Daikin Industries, Ltd.), 14 July, 2005 (14.07.05), Claims; Par. Nos. [0001] to [0258]; Figs. 1 to 36 (Family: none)	1-8
Y	JP 2003-14251 A (Hitachi Plant Engineering & Construction Co., Ltd.), 15 January, 2003 (15.01.03), Par. No. [0031]; Fig. 2 (Family: none)	1-8
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 406003/1990 (Laid-open No. 87446/1993) (Daikin Industries, Ltd.), 26 November, 1993 (26.11.93), Claims; Par. Nos. [0001] to [0034]; Figs. 1 to 19 (Family: none)	1-8
A	JP 2006-349304 A (Daikin Industries, Ltd.), 28 December, 2006 (28.12.06), Full text; all drawings (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006349304 A [0007]