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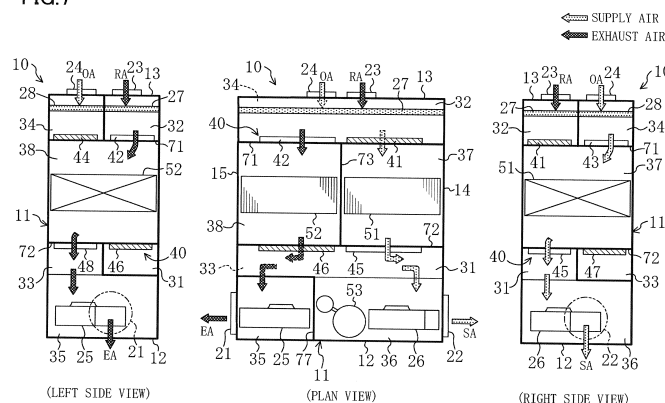
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(54) **HUMIDITY CONTROL DEVICE**

(57) A refrigerant circuit (50) of a humidity control apparatus (10) is provided with two adsorption heat exchangers (51, 52). In the refrigerant circuit (50), refrigerant can circulate in reverse directions. A switching mechanism (40) of the humidity control apparatus (10) switches between a transfer path of the outdoor air to be supplied into a room and a transfer path of the indoor air to be exhausted to the outside the room. In a first operation of the humidity control apparatus (10), a direction of re-

frigerant circulation and a flow path of the air are changed every predetermined period. In a second operation of the humidity control apparatus (10), the refrigerant circuit (50) is stopped, and the flow path of the air is changed every predetermined period. In the second operation, although the refrigerant circuit (50) is stopped, the outdoor air whose temperature and humidity are controlled is supplied into the room to ensure comfort of the room.

FIG.7



Description

TECHNICAL FIELD

[0001] The present disclosure relates to humidity control apparatuses which dehumidify and humidify air using an adsorption heat exchanger carrying an adsorbent.

BACKGROUND ART

[0002] Humidity control apparatuses which dehumidify or humidify air using an adsorbent have been known. For example, Patent Document 1 discloses a humidity control apparatus which has an adsorption heat exchanger carrying an adsorbent.

[0003] In the humidity control apparatus of Patent Document 1, a refrigerant circuit which performs a refrigeration cycle is provided with two adsorption heat exchangers. The refrigerant circuit performs a refrigeration cycle operation in which a first adsorption heat exchanger serves as a radiator and a second adsorption heat exchanger serves as an evaporator, and a refrigeration cycle operation in which the second adsorption heat exchanger serves as a radiator and the first adsorption heat exchanger serves as an evaporator, alternately every predetermined period (e.g., three minutes).

[0004] Further, the humidity control apparatus of Patent Document 1 ventilates indoor space. That is, the humidity control apparatus supplies outdoor air to an indoor space, and exhausts indoor air to an outdoor space. Specifically, the humidity control apparatus has a plurality of dampers which can be opened and closed. The humidity control apparatus switches a flow path of the air by opening and closing the dampers. Specifically, the flow path of the air of the humidity control apparatus is switched between a first path in which the outdoor air is supplied to the indoor space after passing through the first adsorption heat exchanger and in which the indoor air is exhausted to the outdoor space after passing through the second adsorption heat exchanger, and a second path in which the outdoor air is supplied to the indoor space after passing through the second adsorption heat exchanger and in which the indoor air is exhausted to the outdoor space after passing through the first adsorption heat exchanger.

[0005] In the humidity control apparatus of Patent Document 1, the switching of the refrigeration cycle operations in the refrigerant circuit and the switching of the flow path of the air are performed in conjunction with each other. The humidity control apparatus in a dehumidifying operation supplies the outdoor air dehumidified by the adsorption heat exchanger serving as an evaporator to the indoor space, and discharges the moisture desorbed from the adsorption heat exchanger serving as a radiator to the outdoor space together with the indoor air. The humidity control apparatus in a humidifying operation supplies the outdoor air humidified by the adsorption heat exchanger serving as a radiator to the indoor space, and

discharge the indoor air whose moisture is taken by the adsorption heat exchanger serving as an evaporator, to the outdoor space.

5 CITATION LIST

PATENT DOCUMENT

[0006] Patent Document 1: Japanese Unexamined Patent Publication No. 2007-010231

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007] In a humidity control apparatus having such a refrigerant circuit as disclosed in Patent Document 1, the humidity control capability (i.e., a dehumidification amount and a humidification amount per unit time) may sometimes be controlled. The humidity control capability is controlled by adjusting operation capacity of a compressor (specifically, rotating speed of the compressor).

[0008] However, the rotating speed of the compressor needs to be maintained at a certain degree or more so that the compressor can operate properly. That is, the adjustable range of the operation capacity of the compressor has a lower limit, and it is impossible to set the operation capacity of the compressor to be less than the lower limit. For example, in the case where the lower limit of the adjustable range of the operation capacity of the compressor is 20% of the maximum capacity, it is impossible to set the operation capacity of the compressor to be 10% of the maximum capacity. This means that the humidity control capability cannot be set below a certain lower limit in the humidity control apparatus having a compressor.

[0009] Thus, in the conventional humidity control apparatus, the compressor is stopped when the humidity control capability is excessive even if the operation capacity of the compressor is set to a minimum capacity. Further, in the humidity control apparatus which does not only control humidity of air, but also ventilates the indoor space, such as the apparatus disclosed in Patent Document 1, the indoor space needs to be continuously ventilated even in the state where the compressor is stopped. Thus, in the conventional humidity control apparatus, if the humidity control capability is excessive when the compressor is in operation, the compressor is stopped, and supply of the outdoor air into the indoor space and the exhaustion of the indoor air to the outdoor space are continuously performed.

[0010] The conventional humidity control apparatus does not switch the flow path of the air during the operation in which the compressor is stopped and the ventilation is continuously performed. Thus, during this operation, the outdoor air keeps passing through one of the adsorption heat exchangers, and the indoor air keeps passing through the other adsorption heat exchanger.

This means that the outdoor air is supplied to the indoor space without control of temperature and humidity, which may reduce comfort of the indoor space.

[0011] The present disclosure is therefore intended to control temperature and humidity of air to be supplied to an indoor space even when a refrigeration cycle operation of a refrigerant circuit is stopped, and ensure comfort of the indoor space, in a humidity control apparatus which has a refrigerant circuit to dehumidify and humidify outdoor air to be supplied to the indoor space.

SOLUTION TO THE PROBLEM

[0012] The first aspect of the present disclosure is intended for a humidity control apparatus. The humidity control apparatus includes: a refrigerant circuit (50) which includes a compressor (53), and a first adsorption heat exchanger (51) and a second adsorption heat exchanger (52) each carrying an adsorbent, and which performs a first refrigeration cycle operation in which the first adsorption heat exchanger (51) serves as a radiator and the second adsorption heat exchanger (52) serves as an evaporator, and a second refrigeration cycle operation in which the second adsorption heat exchanger (52) serves as a radiator and the first adsorption heat exchanger (51) serves as an evaporator; an air supply fan (26) configured to supply outdoor air to an indoor space; an exhaust fan (25) configured to exhaust indoor air to an outdoor space; and a switching mechanism (40) configured to switch a flow path of the air between a first path in which the outdoor air passes through the first adsorption heat exchanger (51) and thereafter flows into the indoor space, and the indoor air passes through the second adsorption heat exchanger (52) and is thereafter exhausted to the outdoor space, and a second path in which the outdoor air passes through the second adsorption heat exchanger (52) and thereafter flows into the indoor space, and the indoor air passes through the first adsorption heat exchanger (51) and is thereafter exhausted to the outdoor space, wherein the humidity control apparatus performs a first operation in which the air supply fan (26) and the exhaust fan (25) are actuated; the refrigerant circuit (50) alternately performs the first refrigeration cycle operation and the second refrigeration cycle operation every predetermined period of time; and the switching mechanism (40) alternately sets the flow path of the air to the first path and the second path in conjunction with the alternate change of the refrigeration cycle operation of the refrigerant circuit (50), thereby dehumidifying or humidifying the outdoor air to be supplied to the indoor space, and a second operation in which the air supply fan (26) and the exhaust fan (25) are actuated; the compressor (53) of the refrigerant circuit (50) is stopped; and the switching mechanism (40) alternately sets the flow path of the air to the first path and the second path every predetermined period of time.

[0013] In the first aspect of the present disclosure, the humidity control apparatus (10) performs the first oper-

ation and the second operation. In the humidity control apparatus (10) in the first operation, the compressor (53) of the refrigerant circuit (50) is actuated, and the refrigerant circuit (50) alternately performs the first refrigeration cycle operation and the second refrigeration cycle operation. That is, in the refrigerant circuit (50), the first refrigeration cycle operation and the second refrigeration cycle operation are alternately performed every predetermined period of time. In the adsorption heat exchanger (51, 52) serving as a radiator, the adsorbent carried on the surface of the adsorption heat exchanger (51, 52) is heated by the refrigerant, and moisture is desorbed from the adsorbent. The moisture desorbed from the adsorbent is given to the air passing through the adsorption heat exchanger (51, 52). On the other hand, in the adsorption heat exchanger (51, 52) serving as an evaporator, moisture in the air passing through the adsorption heat exchanger (51, 52) is adsorbed to the adsorbent. The refrigerant flowing in the adsorption heat exchanger (51, 52) absorbs adsorption heat, which is generated when the moisture in the air is adsorbed to the adsorbent, and evaporates.

[0014] In the humidity control apparatus (10) in the first operation, the switching mechanism (40) switches the flow path of the air between the first path and the second path. The switching mechanism (40) switches the flow path of the air in conjunction with the alternate change of the refrigeration cycle operation of the refrigerant circuit (50). That is, when the operation of the refrigerant circuit (50) is switched from one to the other of the first refrigeration cycle operation and the second refrigeration cycle operation, the flow path of the air is switched from one to the other of the first path and the second path.

[0015] In the humidity control apparatus (10) in the first operation, dehumidified outdoor air is supplied to the indoor space and humidified indoor air is exhausted to the outdoor space, when the switching mechanism (40) sets the flow path of the air to the second path in the first refrigeration cycle operation of the refrigerant circuit (50), and the switching mechanism (40) sets the flow path of the air to the first path in the second refrigeration cycle operation of the refrigerant circuit (50). Further, in the humidity control apparatus (10) in the first operation, humidified outdoor air is supplied to the indoor space, and dehumidified indoor air is exhausted to the outdoor space, when the switching mechanism (40) sets the flow path of the air to the first path in the first refrigeration cycle operation of the refrigerant circuit (50), and the switching mechanism (40) sets the flow path of the air to the second path in the second refrigeration cycle operation of the refrigerant circuit (50).

[0016] According to the first aspect of the present disclosure, in the humidity control apparatus (10) in the second operation, the compressor (53) of the refrigerant circuit (50) is stopped, whereas the air supply fan (26) and the exhaust fan (25) are continuously actuated. During the second operation, as well, the switching mechanism (40) alternately switches the flow path of the air between

the first path and the second path. Thus, the humidity control apparatus (10) in the second operation alternately performs an operation in which the outdoor air passes through the first adsorption heat exchanger (51) and is thereafter supplied into the indoor space, and the indoor air passes through the second adsorption heat exchanger (52) and is thereafter exhausted to the outdoor space, and an operation in which the outdoor air passes through the second adsorption heat exchanger (52) and is thereafter supplied into the indoor space, and the indoor air passes through the first adsorption heat exchanger (51) and is thereafter exhausted to the outdoor space.

[0017] First, of the second operation of the humidity control apparatus (10), an example in which the temperature and the absolute humidity of the outdoor air are slightly higher than those of the indoor air (e.g., a case in which the room is cooled in late spring or early autumn) will be described. In this case, the humidity control apparatus (10) in the second operation cools and dehumidifies the outdoor air to be supplied to the indoor space. The mechanism will be described below.

[0018] A state in which the flow path of the air is set to the first path will be described first. In this state, the outdoor air passes through the first adsorption heat exchanger (51), and the indoor air passes through the second adsorption heat exchanger (52).

[0019] Even during a period when the compressor (53) is stopped, the liquid refrigerant remains in the first adsorption heat exchanger (51). When the outdoor air passes through the first adsorption heat exchanger (51), the liquid refrigerant in the first adsorption heat exchanger (51) absorbs the adsorption heat, which is generated when the moisture in the outdoor air is adsorbed to the adsorbent, and further absorbs heat from the outdoor air and evaporates.

[0020] On the other hand, the indoor air whose temperature is lower than the outdoor air flows in the second adsorption heat exchanger (52). Thus, the refrigerant evaporated in the first adsorption heat exchanger (51) flows into the second adsorption heat exchanger (52) and is condensed. In the second adsorption heat exchanger (52), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent and is given to the indoor air. In the second adsorption heat exchanger (52), the heat transferred by the refrigerant from the first adsorption heat exchanger (51) is dissipated into the indoor air.

[0021] After that, the flow path of the air is switched from the first path to the second path. That is, the air passing through the first adsorption heat exchanger (51) is changed from the outdoor air to the indoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the indoor air to the outdoor air.

[0022] As described above, in the state where the flow path of the air is set to the first path, moisture is desorbed from the adsorbent in the second adsorption heat exchanger (52). Thus, after the flow path of the air is switched to the second path, the moisture contained in

the outdoor air is adsorbed to the second adsorption heat exchanger (52). The refrigerant in the second adsorption heat exchanger (52) absorbs adsorption heat, which is generated when the moisture in the outdoor air is adsorbed to the adsorbent, and further absorbs heat from the outdoor air and evaporates. Thus, the temperature and the absolute humidity of the outdoor air passing through the second adsorption heat exchanger (52) are reduced. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of air in the indoor space.

[0023] On the other hand, the indoor air whose temperature is lower than the temperature of the outdoor air flows in the first adsorption heat exchanger (51). Thus, the refrigerant which has evaporated in the second adsorption heat exchanger (52) flows into the first adsorption heat exchanger (51) and is condensed. In the first adsorption heat exchanger (51), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent. That is, in the first adsorption heat exchanger (51), moisture in the outdoor air is adsorbed when the flow path of the air is set to the first path, and the moisture is released into the indoor air when the flow path of the air is set to the second path. Further, in the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) is dissipated into the indoor air.

[0024] After that, in the humidity control apparatus (10) in the second operation, the flow path of the air is switched from the second path to the first path again. That is, the air passing through the first adsorption heat exchanger (51) is changed from the indoor air to the outdoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the outdoor air to the indoor air. As described above, the outdoor air is cooled and dehumidified in the first adsorption heat exchanger (51). As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of the indoor space. Further, the second adsorption heat exchanger (52) releases heat transferred by the refrigerant from the first adsorption heat exchanger (51), and moisture adsorbed when the flow path of the air is set to the second path, into the indoor air.

[0025] Next, of the second operation of the humidity control apparatus (10), an example in which the temperature and the absolute humidity of the outdoor air are slightly lower than those of the indoor air (e.g., a case in which the room is heated in early spring or late autumn) will be described. In this case, the humidity control apparatus (10) in the second operation heats and humidifies the outdoor air to be supplied into the indoor space. The mechanism will be described below.

[0026] A state in which the flow path of the air is set to the first path will be described first. In this state, the outdoor air passes through the first adsorption heat exchanger (51), and the indoor air passes through the sec-

ond adsorption heat exchanger (52).

[0027] Even during a period when the compressor (53) is stopped, the liquid refrigerant remains in the second adsorption heat exchanger (52). When the indoor air passes through the second adsorption heat exchanger (52), the liquid refrigerant in the second adsorption heat exchanger (52) absorbs the adsorption heat, which is generated when the moisture in the indoor air is adsorbed to the adsorbent, and further absorbs heat from the indoor air and evaporates.

[0028] On the other hand, the outdoor air whose temperature is lower than the temperature of the indoor air flows in the first adsorption heat exchanger (51). Thus, the refrigerant evaporated in the second adsorption heat exchanger (52) flows into the first adsorption heat exchanger (51) and is condensed. In the first adsorption heat exchanger (51), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent and is given to the outdoor air. In the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) is dissipated into the outdoor air.

[0029] After that, the flow path of the air is switched from the first path to the second path. That is, the air passing through the first adsorption heat exchanger (51) is changed from the outdoor air to the indoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the indoor air to the outdoor air.

[0030] As described above, in the state where the flow path of the air is set to the first path, moisture is desorbed from the adsorbent in the first adsorption heat exchanger (51). Thus, after the flow path of the air is switched to the second path, the moisture contained in the indoor air is adsorbed to the first adsorption heat exchanger (51). The refrigerant in the first adsorption heat exchanger (51) absorbs adsorption heat, which is generated when the moisture in the indoor air is adsorbed to the adsorbent, and further absorbs heat from the indoor air and evaporates.

[0031] On the other hand, the outdoor air whose temperature is lower than the temperature of the indoor air flows in the second adsorption heat exchanger (52). Thus, the refrigerant which has evaporated in the first adsorption heat exchanger (51) flows into the second adsorption heat exchanger (52) and is condensed. In the second adsorption heat exchanger (52), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent. That is, in the second adsorption heat exchanger (52), moisture in the indoor air is adsorbed when the flow path of the air is set to the first path, and the moisture is released into the outdoor air when the flow path of the air is set to the second path. Further, in the second adsorption heat exchanger (52), the heat transferred by the refrigerant from the first adsorption heat exchanger (51) is dissipated into the outdoor air. Thus, the temperature and the absolute humidity of the outdoor air passing

through the second adsorption heat exchanger (52) are increased. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of air in the indoor space.

[0032] After that, in the humidity control apparatus (10) in the second operation, the flow path of the air is switched from the second path to the first path again. That is, the air passing through the first adsorption heat exchanger (51) is changed from the indoor air to the outdoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the outdoor air to the indoor air. As described above, in the second adsorption heat exchanger (52), the adsorbent adsorbs the moisture in the indoor air, and the refrigerant absorbs heat from the indoor air. Further, in the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) and moisture adsorbed when the flow path of the air is set to the second path are given to the outdoor air. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of the indoor space.

[0033] As described above, even during the second operation where the compressor (53) is stopped, the humidity control apparatus (10) controls the temperature and the absolute humidity of the outdoor air to be supplied to the indoor space. However, a flow rate of the refrigerant which moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) in the refrigerant circuit (50) in the second operation is lower than a flow rate of the refrigerant which circulates in the refrigerant circuit (50) in the first operation. Thus, the humidity control properties of the humidity control apparatus (10) in the second operation are lower than the humidity control properties of the humidity control apparatus (10) in the first operation.

[0034] The second aspect of the present disclosure is that in the first aspect of the present disclosure, the humidity control apparatus further includes a controller (90) which controls an operation capacity of the compressor (53) according to a humidity control load during the first operation, wherein the controller (90) switches an operation of the humidity control apparatus (10) from the first operation to the second operation if it is considered that even if the operation capacity of the compressor (53) is set to a minimum capacity during the first operation, a humidity control capability is high relative to the humidity control load, and the controller (90) switches the operation of the humidity control apparatus (10) from the second operation to the first operation if it is considered that the humidity control capability is low relative to the humidity control load during the second operation.

[0035] In the second aspect of the present disclosure, the controller (90) controls the operation capacity of the compressor (53) according to the humidity control load. The humidity control capability of the humidity control apparatus (10) changes when the operation capacity of the compressor (53) is changed. The term "humidity con-

trol load" means a dehumidification amount or a humidification amount required of the humidity control apparatus (10).

[0036] According to the second aspect of the present disclosure, the controller (90) stops the compressor (53) and switches the operation of the humidity control apparatus (10) to the second operation when it determines that even if the operation capacity of the compressor (53) is set to the minimum capacity in the first operation, the humidity control capability is high relative to the humidity control load. The humidity control capability of the humidity control apparatus (10) in the second operation is lower than the humidity control capability of the humidity control apparatus (10) in the first operation at a time when the operation capacity of the compressor (53) is set to the minimum capacity. Further, the controller (90) actuates the compressor (53) and switches the operation of the humidity control apparatus (10) to the first operation when it determines that the humidity control capability is low relative to the humidity control load in the second operation.

[0037] The third aspect of the present disclosure is that in the first or second aspect of the present disclosure, the refrigerant circuit (50) is provided with an expansion valve (55) whose degree of opening is variable, at a location between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52), and the expansion valve (55) is maintained in a fully open state during the second operation.

[0038] In the third aspect of the present disclosure, the expansion valve (55) is maintained in a fully open state during the second operation. As described above, in the refrigerant circuit (50) in the second operation, a gas refrigerant moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52). Thus, the expansion valve (55) provided between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) and maintained in the fully open state can reduce the pressure loss that is caused when the refrigerant moving between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) passes through the expansion valve (55).

[0039] The fourth aspect of the present disclosure is that in any one of the first to third aspects of the present disclosure, a time interval between switching operations of the switching mechanism (40) during the second operation, for alternately switching the flow path of the air between the first path and the second path, is less than or equal to a time interval between switching operations of the switching mechanism (40) during the first operation, for alternately switching the flow path of the air between the first path and the second path.

[0040] According to the fourth aspect of the present disclosure, the time interval between switching operations of the switching mechanism (40) in the second operation for alternately switching the flow path of the air between the first path and the second path is less than

or equal to the time interval between switching operations in the first operation. For example, in the case where the flow path of the air is alternately switched between the first path and the second path every three minutes in the first operation, the flow path of the air is alternately switched between the first path and the second path every three minutes or less than three minutes in the second operation.

10 ADVANTAGES OF THE INVENTION

[0041] In the present disclosure, the humidity control apparatus (10) performs the first operation and the second operation. As described above, the humidity control capability of the humidity control apparatus (10) in the second operation is lower than the humidity control capability of the humidity control apparatus (10) in the first operation. Thus, the humidity control apparatus (10) of the present disclosure can supply dehumidified or humidified outdoor air into the indoor space even under an operational condition in which, in the conventional humidity control apparatus (10), the only way to supply the outdoor air into the indoor space is by stopping the compressor (53) and supplying the outdoor air without control (that is, an operational condition in which the humidity control load is small). Thus, the temperature and the absolute humidity of the outdoor air to be supplied to the indoor space in the state where the compressor (53) is stopped can be close to the temperature and the absolute humidity of the air in the indoor space. According to the present disclosure, a reduction in comfort caused by supplying the outdoor air to the indoor space without control can be prevented, and it is possible to ensure comfort of the indoor space even in the situation in which the compressor (53) is stopped.

[0042] In the second aspect of the present disclosure, the controller (90) determines which operation, the first operation or the second operation, the humidity control apparatus (10) should perform, in consideration of the relationship between the humidity control capability of the humidity control apparatus (10) and the humidity control load. The controller (90) switches the operation of the humidity control apparatus (10) from the first operation to the second operation, in the case where the humidity control capability is excessive even if the humidity control capability of the humidity control apparatus (10) is set to the minimum capability during the first operation. As described above, the humidity control capability of the humidity control apparatus (10) in the second operation is lower than the humidity control capability of the humidity control apparatus (10) in the first operation. Thus, according to the present disclosure, the adjustable range of the humidity control capability of the humidity control apparatus (10) can be increased, and the humidity control apparatus (10) can have the humidity control capability suitable for various operational conditions.

[0043] In the third aspect of the present disclosure, the refrigerant circuit (50) is provided with an expansion valve

(55), and the expansion valve (55) is maintained in a fully open state in the second operation. Thus, it is possible to ensure sufficient flow rate of the refrigerant that moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) in the second operation, and possible to increase the humidity control capability of the humidity control apparatus (10) in the second operation.

[0044] In the fourth aspect of the present disclosure, the time interval between switching operations of the switching mechanism (40) in the second operation for switching the flow path of the air between the first path and the second path is less than or equal to the time interval between switching operations of the switching mechanism (40) in the first operation for switching the flow path of the air between the first path and the second path. The amount of moisture exchanged between the adsorption heat exchanger and air passing through the adsorption heat exchanger abruptly increases in a short time after supply of the air into the adsorption heat exchanger starts, and gradually decreases thereafter. In the present disclosure, the frequencies of the switching operations of the switching mechanism (40) which alternately switches the flow path of the air between the first path and the second path, are the same between the first operation and the second operation, or higher in the second operation than in the first operation. Thus, according to the present disclosure, it is possible to increase the humidity control capability of the humidity control apparatus (10) in the second operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

FIG. 1 shows a plan view, a right side view, and a left side view which schematically illustrate a configuration of a humidity control apparatus of an embodiment.

FIG. 2 shows piping system diagrams illustrating a configuration of a refrigerant circuit. FIG. 2(A) shows an operation during a first refrigeration cycle, and FIG. 2(B) shows an operation during a second refrigeration cycle.

FIG. 3 shows a plan view, a right side view, and a left side view of the humidity control apparatus which schematically illustrate flow of air during a first batch operation of a dehumidifying operation.

FIG. 4 shows a plan view, a right side view, and a left side view of the humidity control apparatus which schematically illustrate flow of air during a second batch operation of the dehumidifying operation.

FIG. 5 shows a plan view, a right side view, and a left side view of the humidity control apparatus which schematically illustrate flow of air during a first batch operation of a humidifying operation.

FIG. 6 shows a plan view, a right side view, and a left side view of the humidity control apparatus which

schematically illustrate flow of air during a second batch operation of the humidifying operation.

FIG. 7 shows a plan view, a right side view, and a left side view of the humidity control apparatus which schematically illustrate a state in which a flow path of the air is set to a first path during a low-performance operation.

FIG. 8 shows a plan view, a right side view, and a left side view of the humidity control apparatus which schematically illustrate a state in which a flow path of the air is set to a second path during the low-performance operation.

FIG. 9 shows a piping system diagram of the refrigerant circuit, illustrating flow of the refrigerant during the low-performance operation performed when a temperature and absolute humidity of outdoor air are higher than those of indoor air. FIG. 9(A) shows the flow of the refrigerant when the flow path of the air is set to the first path. FIG. 9(B) shows the flow of the refrigerant when the flow path of the air is set to the second path.

FIG. 10 shows a piping system diagram of the refrigerant circuit, illustrating flow of the refrigerant during the low-performance operation performed when a temperature and absolute humidity of outdoor air are lower than those of indoor air. FIG. 10(A) shows the flow of the refrigerant when the flow path of the air is set to the first path. FIG. 10(B) shows the flow of the refrigerant when the flow path of the air is set to the second path.

FIG. 11 is a flow chart showing control operation by a controller.

DESCRIPTION OF EMBODIMENTS

[0046] An embodiment of the present disclosure will be described in detail based on the drawings. The following embodiment is merely a preferred example in nature, and is not intended to limit the scope, applications, and use of the invention.

[0047] A humidity control apparatus (10) of the present embodiment controls humidity of an indoor space, and also ventilates the indoor space. The humidity control apparatus (10) controls humidity of outdoor air (OA) taken therein to supply the outdoor air (OA) to the indoor space, and simultaneously exhausts indoor air (RA) taken therein to an outdoor space.

<General Configuration of Humidity Control Apparatus>

[0048] The humidity control apparatus (10) will be described with reference to FIG. 1. The terms "upper," "lower," "left," "right," "front," "rear," "near" and "far" as used herein correspond to the directions when the humidity control apparatus (10) is viewed from its front surface side, unless otherwise defined.

[0049] The humidity control apparatus (10) has a casing (11). A refrigerant circuit (50) is accommodated in the

casing (11). A first adsorption heat exchanger (51), a second adsorption heat exchanger (52), a compressor (53), a four-way valve (54), and an electric expansion valve (55) are connected to the refrigerant circuit (50). Details of the refrigerant circuit (50) will be described later.

[0050] The casing (11) is formed in a rectangular parallelepiped shape that is slightly flattened and has a relatively low height. The casing (11) is provided with an outside-air inlet (24), a room-air inlet (23), an air supply opening (22), and an exhaust opening (21).

[0051] The outside-air inlet (24) and the room-air inlet (23) are formed in a rear surface panel (13) of the casing (11). The outside-air inlet (24) is located at a lower portion of the rear surface panel (13). The room-air inlet (23) is located at an upper portion of the rear surface panel (13). The air supply opening (22) is formed in a first side surface panel (14) of the casing (11). The air supply opening (22) is located near the end of the first side surface panel (14) which is close to a front surface panel (12) of the casing (11). The exhaust opening (21) is formed in a second side surface panel (15) of the casing (11). The exhaust opening (21) is located near the end of the second side surface panel (15) which is close to the front surface panel (12).

[0052] In the internal space of the casing (11), an upstream-side partition (71), a downstream-side partition (72), and a center partition (73) are provided. Each of the partitions (71-73) is provided upright on a bottom plate of the casing (11) to partition the internal space of the casing (11) from the bottom plate to a top plate of the casing (11).

[0053] The upstream-side partition (71) and the downstream-side partition (72) are located in an orientation parallel to the front surface panel (12) and the rear surface panel (13), and are spaced a certain distance apart each other in a front-rear direction of the casing (11). The upstream-side partition (71) is located closer to the rear surface panel (13). The downstream-side partition (72) is located closer to the front surface panel (12). The location of the center partition (73) will be described later.

[0054] The internal space of the casing (11) between the upstream-side partition (71) and the rear surface panel (13) is partitioned into two spaces (i.e., upper and lower spaces). The upper space forms a room air-side passage (32), and the lower space forms an outside air-side passage (34). The room air-side passage (32) communicates with the indoor space via a duct connected to the room-air inlet (23). The outside air-side passage (34) communicates with the outdoor space via a duct connected to the outside-air inlet (24).

[0055] The room air-side passage (32) is provided with a room air-side filter (27), a room air temperature sensor (91), and a room air humidity sensor (92). The room air temperature sensor (91) measures temperature of the indoor air flowing in the room air-side passage (32). The room air humidity sensor (92) measures relative humidity of the indoor air flowing in the room air-side passage (32).

On the other hand, the outside air-side passage (34) is provided with an outside air-side filter (28), an outside air temperature sensor (93), and an outside air humidity sensor (94). The outside air temperature sensor (93) measures temperature of the outdoor air flowing in the outside air-side passage (34). The outside air humidity sensor (94) measures relative humidity of the outdoor air flowing in the outside air-side passage (34). In FIGS. 3-8, the room air temperature sensor (91), the room air humidity sensor (92), the outside air temperature sensor (93), and the outside air humidity sensor (94) are not shown.

[0056] The internal space of the casing (11) between the upstream-side partition (71) and the downstream-side partition (72) is partitioned into left and right spaces by the center partition (73). The space on the right side of the center partition (73) forms a first heat exchanger chamber (37), and the space on the left side of the center partition (73) forms a second heat exchanger chamber (38). The first adsorption heat exchanger (51) is accommodated in the first heat exchanger chamber (37). The second adsorption heat exchanger (52) is accommodated in the second heat exchanger chamber (38). Although not shown, the electric expansion valve (55) of the refrigerant circuit (50) is accommodated in the first heat exchanger chamber (37).

[0057] Each of the adsorption heat exchangers (51, 52) is a so-called cross-fin type fin-and-tube heat exchanger which carries an adsorbent on its surface. Each of the adsorption heat exchangers (51, 52) as a whole is formed in a thick rectangular plate shape or in a flat rectangular parallelepiped shape. The adsorption heat exchangers (51, 52) are provided upright in the corresponding heat exchanger chambers (37, 38) such that their front and rear surfaces are parallel to the upstream-side partition (71) and the downstream-side partition (72).

[0058] Part of the internal space of the casing (11) along the front surface of the downstream-side partition (72) is partitioned into upper and lower spaces. Of the upper and lower spaces, the upper space forms an air-supply-side passage (31) and the lower space forms an exhaust-side passage (33).

[0059] The upstream-side partition (71) is provided with four dampers (41-44) that can be opened/closed. Each of the dampers (41-44) is generally formed in a horizontally-oriented rectangular shape. Specifically, in a portion of the upstream-side partition (71) facing the room air-side passage (32) (an upper portion of the upstream-side partition (71)), a first room air-side damper (41) is attached on the right of the center partition (73), and a second room air-side damper (42) is attached on the left of the center partition (73). In a portion of the upstream-side partition (71) facing the outside air-side passage (34) (a lower portion of the upstream-side partition (71)), a first outside air-side damper (43) is attached on the right of the center partition (73), and a second outside air-side damper (44) is attached on the left of the center partition (73). The four dampers (41-44) provided on the upstream-side partition (71) form a switching

mechanism (40) configured to switch the flow path of the air.

[0060] The downstream-side partition (72) is provided with four dampers (45-48) which can be opened/closed. Each of the dampers (45-48) is generally formed in a horizontally-oriented rectangular shape. Specifically, in a portion of the downstream-side partition (72) facing the air-supply-side passage (31) (an upper portion of the downstream-side partition (72)), a first air supply-side damper (45) is attached on the right of the center partition (73), and a second air supply-side damper (46) is attached on the left of the center partition (73). Further, in a portion of the downstream-side partition (72) facing the exhaust-side passage (33) (a lower portion of the downstream-side partition (72)), a first exhaust-side damper (47) is attached on the right of the center partition (73), and a second exhaust-side damper (48) is attached on the left of the center partition (73). The four dampers (45-48) provided on the downstream-side partition (72) form a switching mechanism (40) configured to switch the flow path of the air.

[0061] In the casing (11), the space between the air-supply-side passage (31) and the exhaust-side passage (33), and the front surface panel (12), is partitioned by a partition (77) into left and right spaces. The space on the right of the partition (77) forms an air supply fan chamber (36), and the space on the left of the partition (77) forms an exhaust fan chamber (35).

[0062] An air supply fan (26) is accommodated in the air supply fan chamber (36). An exhaust fan (25) is accommodated in the exhaust fan chamber (35). Each of the air supply fan (26) and the exhaust fan (25) is a centrifugal multiblade fan (a so-called sirocco fan). The air supply fan (26) blows out the air taken from the downstream-side partition (72) side toward the air supply opening (22). The exhaust fan (25) blows out the air taken from the downstream-side partition (72) side toward the exhaust opening (21).

[0063] The compressor (53) of the refrigerant circuit (50) and the four-way valve (54) are accommodated in the air supply fan chamber (36). The compressor (53) and the four-way valve (54) are located in the air supply fan chamber (36) and between the air supply fan (26) and the partition (77).

<Configuration of Refrigerant Circuit>

[0064] As illustrated in FIG. 2, 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 valve (54), and the electric expansion valve (55). The refrigerant circuit (50) allows a refrigerant, filling the refrigerant circuit (50), to circulate therethrough to perform a vapor-compression refrigeration cycle. Although not shown, a plurality of temperature sensors and pressure sensors are attached to the refrigerant circuit (50).

[0065] In the refrigerant circuit (50), the compressor

(53) has its discharge side connected to a first port of the four-way valve (54), and its suction side connected to a second port of the four-way valve (54). In the refrigerant circuit (50), the first adsorption heat exchanger (51), the electric expansion valve (55), and the second adsorption heat exchanger (52) are sequentially arranged from the third port to the fourth port of the four-way valve (54).

[0066] The four-way valve (54) can switch between a first state (the state shown in FIG. 2(A)) in which the first port and the third port communicate with each other and the second port and the fourth port communicate with each other, and a second state (the state shown in FIG. 2(B)) in which the first port and the fourth port communicate with each other and the second port and the third port communicate with each other.

[0067] The compressor (53) is a hermetic compressor which accommodates, in a single casing, a compression mechanism and an electric motor configured to drive the compression mechanism. Alternating current is supplied to the electric motor of the compressor (53) via an inverter. When an output frequency of the inverter (i.e., an operation frequency of the compressor) is changed, the rotating speed of the electric motor and the compression mechanism driven by the electric motor is changed. As a result, the operation capacity of the compressor (53) changes.

<Configuration of Controller>

[0068] The humidity control apparatus (10) is provided with a controller (90) (see FIG. 2). Measurement values of the room air humidity sensor (92), the room air temperature sensor (91), the outside air humidity sensor (94), and the outside air temperature sensor (93) are input in the controller (90). Further, measurement values of the temperature sensors and the pressure sensors provided at the refrigerant circuit (50) are input in the controller (90). The controller (90) controls operation of the humidity control apparatus (10) based on the input measurement values.

[0069] The controller (90) switches the operation of the humidity control apparatus (10) among a dehumidifying operation, a low-performance operation, and a simple ventilation operation, which will be described later. The controller (90) controls operations of the dampers (41-48), the fans (25, 26), the compressor (53), the electric expansion valve (55), and the four-way valve (54) during the above operations.

-Operation-

[0070] The humidity control apparatus (10) of the present embodiment selectively performs the dehumidifying operation, the humidifying operation, the low-performance operation, and the simple ventilation operation. The dehumidifying operation and the humidifying operation are a first operation in which the compressor (53) is actuated and the switching mechanism (40) switches

the flow path of the air. The low-performance operation is a second operation in which the compressor (53) is stopped and the switching mechanism (40) switches the flow path of the air. The simple ventilation operation is an operation in which the compressor (53) and the switching mechanism (40) are both stopped.

[0071] The air supply fan (26) and the exhaust fan (25) are activated in each of the dehumidifying operation, the humidifying operation, the low-performance operation, and the simple ventilation operation. The humidity control apparatus (10) supplies the outdoor air (OA) taken therein into the indoor space as supply air (SA), and exhausts the indoor air (RA) taken therein to the outdoor space as exhaust air (EA).

<Dehumidifying operation>

[0072] In the dehumidifying operation, the humidity control apparatus (10) takes the outdoor air as first air into the casing (11) from the outside-air inlet (24), and takes the indoor air as second air into the casing (11) through the room-air inlet (23). Further, in the refrigerant circuit (50), the compressor (53) is actuated and a degree of opening of the electric expansion valve (55) is adjusted. The humidity control apparatus (10) in the dehumidifying operation performs a first batch operation and a second batch operation, which will be described below, alternately every three minutes.

[0073] The first batch operation of the dehumidifying operation will be described first.

[0074] As illustrated in FIG. 3, the switching mechanism (40) sets the flow path of the air to the second path in the first batch operation of the dehumidifying operation. Specifically, the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in an open state, and the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in a closed state. Further, in the first batch operation, the refrigerant circuit (50) performs the first refrigeration cycle operation. That is, in the refrigerant circuit (50), the four-way valve (54) is set to the first state (the state shown in FIG. 2(A)), wherein the first adsorption heat exchanger (51) serves as a condenser and the second adsorption heat exchanger (52) serves as an evaporator.

[0075] The first air having flowed into the outside air-side passage (34) and passed through the outside air-side filter (28), flows into the second heat exchanger chamber (38) through the second outside air-side damper (44) and thereafter passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture in the first air is adsorbed to the adsorbent, and adsorption heat generated at this time is absorbed by the refrigerant. The first air dehumidified by the second adsorption heat exchanger (52) passes through the second air supply-side damper (46) and flows

into the air-supply-side passage (31). After passing through the air supply fan chamber (36), the first air is supplied to the indoor space through the air supply opening (22).

[0076] On the other hand, the second air having flowed into the room air-side passage (32) and passed through the room air-side filter (27), flows into the first heat exchanger chamber (37) through the first room air-side damper (41) and passes through the first adsorption heat exchanger (51) thereafter. In the first adsorption heat exchanger (51), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air to which the moisture has been given in the first adsorption heat exchanger (51) flows into the exhaust-side passage (33) through the first exhaust-side damper (47). After passing through the exhaust fan chamber (35), the second air is exhausted to the outdoor space through the exhaust opening (21).

[0077] Now, the second batch operation of the dehumidifying operation will be described.

[0078] As illustrated in FIG. 4, the switching mechanism (40) sets the flow path of the air to the first path in the second batch operation of the dehumidifying operation. Specifically, the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in an open state, and the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in a closed state. Further, in the second batch operation, the refrigerant circuit (50) performs the second refrigeration cycle operation. That is, in the refrigerant circuit (50), the four-way valve (54) is set to the second state (the state shown in FIG. 2(B)), wherein the first adsorption heat exchanger (51) serves as an evaporator and the second adsorption heat exchanger (52) serves as a condenser.

[0079] The first air having flowed into the outside air-side passage (34) and passed through the outside air-side filter (28), flows into first heat exchanger chamber (37) through the first outside air-side damper (43) and thereafter passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air is adsorbed to the adsorbent, and adsorption heat generated at this time is absorbed by the refrigerant. The first air dehumidified by the first adsorption heat exchanger (51) passes through the first air supply-side damper (45) and flows into the air-supply-side passage (31). After passing through the air supply fan chamber (36), the first air is supplied to the indoor space through the air supply opening (22).

[0080] On the other hand, the second air having flowed into the room air-side passage (32) and passed through the room air-side filter (27), flows into the second heat exchanger chamber (38) through the second room air-side damper (42) and passes through the second adsorption heat exchanger (52) thereafter. In the second

adsorption heat exchanger (52), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air to which the moisture has been given in the second adsorption heat exchanger (52) flows into the exhaust-side passage (33) through the second exhaust-side damper (48). After passing through the exhaust fan chamber (35), the second air is exhausted to the outdoor space through the exhaust opening (21).

<Humidifying Operation>

[0081] In the humidifying operation, the humidity control apparatus (10) takes the outdoor air as second air into the casing (11) from the outside-air inlet (24), and takes the indoor air as first air in the casing (11) from the room-air inlet (23). Further, in the refrigerant circuit (50), the compressor (53) is actuated and a degree of opening of the electric expansion valve (55) is adjusted. The humidity control apparatus (10) in the humidifying operation performs a first batch operation and a second batch operation, which will be described below, alternately every four minutes.

[0082] The first batch operation of the humidifying operation will be described first.

[0083] As illustrated in FIG. 5, the switching mechanism (40) sets the flow path of the air to the first path in the first batch operation of the humidifying operation. Specifically, the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in an open state, and the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in a closed state. Further, in the first batch operation, the refrigerant circuit (50) performs the first refrigeration cycle operation. That is, in the refrigerant circuit (50), the four-way valve (54) is set to the first state (the state shown in FIG. 2(A)), wherein the first adsorption heat exchanger (51) serves as a condenser and the second adsorption heat exchanger (52) serves as an evaporator.

[0084] The first air having flowed into the room air-side passage (32) and passed through the room air-side filter (27), flows into the second heat exchanger chamber (38) through the second room air-side damper (42) and thereafter passes through the second adsorption heat exchanger (52). In the second adsorption heat exchanger (52), moisture in the first air is adsorbed to the adsorbent, and adsorption heat generated at this time is absorbed by the refrigerant. The first air of which the moisture is taken in the second adsorption heat exchanger (52) flows into the exhaust-side passage (33) through the second exhaust-side damper (48). After passing through the exhaust fan chamber (35), the first air is exhausted to the outdoor space through the exhaust opening (21).

[0085] On the other hand, the second air having flowed into the outside air-side passage (34) and passed

through the outside air-side filter (28), flows into the first heat exchanger chamber (37) through the first outside air-side damper (43) and passes through the first adsorption heat exchanger (51) thereafter. In the first adsorption heat exchanger (51), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air humidified by the first adsorption heat exchanger (51) flows into the air-supply-side passage (31) through the first air supply-side damper (45). After passing through the air supply fan chamber (36), the second air is supplied to the indoor space through the air supply opening (22).

[0086] Now, the second batch operation of the humidifying operation will be described.

[0087] As illustrated in FIG. 6, the switching mechanism (40) sets the flow path of the air to the second path in the second batch operation of the humidifying operation. Specifically, the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in an open state, and the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in a closed state. Further, in the second batch operation, the refrigerant circuit (50) performs the second refrigeration cycle operation. That is, in the refrigerant circuit (50), the four-way valve (54) is set to the second state (the state shown in FIG. 2(B)), wherein the first adsorption heat exchanger (51) serves as an evaporator and the second adsorption heat exchanger (52) serves as a condenser.

[0088] The first air having flowed into the room air-side passage (32) and passed through the room air-side filter (27), flows into the first heat exchanger chamber (37) through the first room air-side damper (41) and thereafter passes through the first adsorption heat exchanger (51). In the first adsorption heat exchanger (51), moisture in the first air is adsorbed to the adsorbent, and the adsorption heat generated at this time is absorbed by the refrigerant. The first air of which the moisture is taken in the first adsorption heat exchanger (51) flows into the exhaust-side passage (33) through the first exhaust-side damper (47). After passing through the exhaust fan chamber (35), the first air is exhausted to the outdoor space through the exhaust opening (21).

[0089] On the other hand, the second air having flowed into the outside air-side passage (34) and passes through the outside air-side filter (28), flows into the second heat exchanger chamber (38) through the second outside air-side damper (44) and passes through the second adsorption heat exchanger (52) thereafter. In the second adsorption heat exchanger (52), moisture is desorbed from the adsorbent heated by the refrigerant, and the desorbed moisture is given to the second air. The second air humidified by the second adsorption heat exchanger (52) flows into the air-supply-side passage (31) through the second air supply-side damper (46). After passing through the air supply fan chamber (36), the second air

is supplied to the indoor space through the air supply opening (22).

<Low-Performance Operation>

[0090] In the humidity control apparatus (10) in the low-performance operation, the compressor (53) of the refrigerant circuit (50) is stopped and the electric expansion valve (55) is maintained in a fully open state. Further, in the humidity control apparatus (10) in the low-performance operation, the switching mechanism (40) switches the flow path of the air. The switching mechanism (40) switches the flow path of the air between the first path and the second path alternately every three minutes. That is, the time interval between the switching operations of the switching mechanism (40) for switching the flow path of the air in the low-performance operation is the same as the time interval between the switching operations of the switching mechanism (40) for switching the flow path of the air in the dehumidifying operation. Since the compressor (53) is stopped, the four-way valve (54) may be in the first state or may be in the second state.

[0091] As illustrated in FIG. 7, in the state where the switching mechanism (40) sets the flow path of the air to the first path, the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in the open state, and the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in the closed state. The outdoor air passes through the first adsorption heat exchanger (51) and is thereafter supplied to the indoor space. The indoor air passes through the second adsorption heat exchanger (52) and is thereafter exhausted to the outdoor space.

[0092] On the other hand, as illustrated in FIG. 8, in the state where the switching mechanism (40) sets the flow path of the air to the second path, the first room air-side damper (41), the second outside air-side damper (44), the second air supply-side damper (46), and the first exhaust-side damper (47) are in the open state, and the second room air-side damper (42), the first outside air-side damper (43), the first air supply-side damper (45), and the second exhaust-side damper (48) are in the closed state. The outdoor air passes through the second adsorption heat exchanger (52) and is thereafter supplied to the indoor space. The indoor air passes through the first adsorption heat exchanger (51) and is thereafter exhausted to the outdoor space.

[0093] First, of the low-performance operation of the humidity control apparatus (10), an example in which the temperature and the absolute humidity of the outdoor air are slightly higher than those of the indoor air (e.g., a case in which the room is cooled in late spring or early autumn) will be described. In this case, the humidity control apparatus (10) in the low-performance operation cools and dehumidifies the outdoor air to be supplied to the indoor space. The mechanism will be described be-

low with reference to FIG. 9.

[0094] A state in which the flow path of the air is set to the first path will be described first. In this state, as illustrated in FIG. 9(A), the outdoor air passes through the first adsorption heat exchanger (51), and the indoor air passes through the second adsorption heat exchanger (52).

[0095] Even during a period when the compressor (53) is stopped, the liquid refrigerant remains in the first adsorption heat exchanger (51). When the outdoor air passes through the first adsorption heat exchanger (51), the liquid refrigerant in the first adsorption heat exchanger (51) absorbs the adsorption heat, which is generated when the moisture in the outdoor air is adsorbed to the adsorbent, and further absorbs heat from the outdoor air and evaporates.

[0096] On the other hand, the indoor air whose temperature is lower than the outdoor air flows in the second adsorption heat exchanger (52). Thus, the refrigerant evaporated in the first adsorption heat exchanger (51) passes through the electric expansion valve (55), and thereafter flows into the second adsorption heat exchanger (52) and is condensed. In the second adsorption heat exchanger (52), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent and is given to the indoor air. In the second adsorption heat exchanger (52), the heat transferred by the refrigerant from the first adsorption heat exchanger (51) is dissipated into the indoor air.

[0097] After that, in the humidity control apparatus (10) in the low-performance operation, the flow path of the air is switched from the first path to the second path. That is, as illustrated in FIG. 9(B), the air passing through the first adsorption heat exchanger (51) is changed from the outdoor air to the indoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the indoor air to the outdoor air.

[0098] As described above, in the state where the flow path of the air is set to the first path (the state of FIG. 9(A)), moisture is desorbed from the adsorbent in the second adsorption heat exchanger (52). Thus, after the flow path of the air is switched to the second path, the moisture contained in the outdoor air is adsorbed to the second adsorption heat exchanger (52). The refrigerant in the second adsorption heat exchanger (52) absorbs adsorption heat, which is generated when the moisture in the outdoor air is adsorbed to the adsorbent, and further absorbs heat from the outdoor air and evaporates. Thus, the temperature and the absolute humidity of the outdoor air passing through the second adsorption heat exchanger (52) are reduced. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of air in the indoor space.

[0099] On the other hand, the indoor air whose temperature is lower than the temperature of the outdoor air flows in the first adsorption heat exchanger (51). Thus,

the refrigerant which has evaporated in the second adsorption heat exchanger (52) passes through the electric expansion valve (55) and thereafter flows into the first adsorption heat exchanger (51) and is condensed. In the first adsorption heat exchanger (51), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent. That is, in the first adsorption heat exchanger (51), moisture in the outdoor air is adsorbed when the flow path of the air is set to the first path, and the moisture is released into the indoor air when the flow path of the air is set to the second path. Further, in the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) is dissipated into the indoor air.

[0100] After that, in the humidity control apparatus (10) in the low-performance operation, the flow path of the air is switched from the second path to the first path again. That is, as illustrated in FIG. 9(A), the air passing through the first adsorption heat exchanger (51) is changed from the indoor air to the outdoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the outdoor air to the indoor air.

[0101] As described above, in the state shown in FIG. 9(A), the outdoor air is cooled and dehumidified in the first adsorption heat exchanger (51). That is, the first adsorption heat exchanger (51) which releases moisture into the indoor air in the state shown in FIG. 9(B), adsorbs moisture in the outdoor air. Further, the refrigerant in the first adsorption heat exchanger (51) absorbs heat from the outdoor air. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of the indoor space.

[0102] Further, as described above, moisture and heat are released from the second adsorption heat exchanger (52) into the indoor air in the state shown in FIG. 9(A). That is, the second adsorption heat exchanger (52) releases heat transferred by the refrigerant from the first adsorption heat exchanger (51), and moisture adsorbed when the flow path of the air is set to the second path, into the indoor air.

[0103] Next, of the low-performance operation of the humidity control apparatus (10), an example in which the temperature and the absolute humidity of the outdoor air are slightly lower than those of the indoor air (e.g., a case in which the room is heated in early spring or late autumn) will be described. In this case, the humidity control apparatus (10) in the low-performance operation heats and humidifies the outdoor air to be supplied into the indoor space. The mechanism will be described below with reference to FIG. 10.

[0104] A state in which the flow path of the air is set to the first path will be described first. As illustrated in FIG. 10(A), in this state, the outdoor air passes through the first adsorption heat exchanger (51), and the indoor air passes through the second adsorption heat exchanger (52).

[0105] Even during a period when the compressor (53) is stopped, the liquid refrigerant remains in the second adsorption heat exchanger (52). When the indoor air passes through the second adsorption heat exchanger (52), the liquid refrigerant in the second adsorption heat exchanger (52) absorbs the adsorption heat, which is generated when the moisture in the indoor air is adsorbed to the adsorbent, and further absorbs heat from the indoor air and evaporates.

[0106] On the other hand, the outdoor air whose temperature is lower than the temperature of the indoor air flows in the first adsorption heat exchanger (51). Thus, the refrigerant evaporated in the second adsorption heat exchanger (52) flows into the first adsorption heat exchanger (51) and is condensed. In the first adsorption heat exchanger (51), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent and is given to the outdoor air. In the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) is dissipated into the outdoor air.

[0107] After that, in the humidity control apparatus (10) in the low-performance operation, the flow path of the air is switched from the first path to the second path. That is, as illustrated in FIG. 10(B), the air passing through the first adsorption heat exchanger (51) is changed from the outdoor air to the indoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the indoor air to the outdoor air.

[0108] As described above, in the state where the flow path of the air is set to the first path (the state of FIG. 10(A)), moisture is desorbed from the adsorbent in the first adsorption heat exchanger (51). Thus, after the flow path of the air is switched to the second path, the moisture contained in the indoor air is adsorbed to the first adsorption heat exchanger (51). The refrigerant in the first adsorption heat exchanger (51) absorbs adsorption heat, which is generated when the moisture in the indoor air is adsorbed to the adsorbent, and further absorbs heat from the indoor air and evaporates.

[0109] On the other hand, the outdoor air whose temperature is lower than the temperature of the indoor air flows in the second adsorption heat exchanger (52). Thus, the refrigerant which has evaporated in the first adsorption heat exchanger (51) passes through the electric expansion valve (55) and thereafter flows into the second adsorption heat exchanger (52) and is condensed. In the second adsorption heat exchanger (52), the adsorbent is heated by heat of condensation dissipated from the refrigerant, and moisture is desorbed from the adsorbent. That is, in the second adsorption heat exchanger (52), moisture in the indoor air is adsorbed when the flow path of the air is set to the first path, and the moisture is released into the outdoor air when the flow path of the air is set to the second path. Further, in the second adsorption heat exchanger (52), the heat transferred by the refrigerant from the first adsorption

heat exchanger (51) is dissipated into the outdoor air. Thus, the temperature and the absolute humidity of the outdoor air passing through the second adsorption heat exchanger (52) are increased. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of air in the indoor space.

[0110] After that, in the humidity control apparatus (10) in the low-performance operation, the flow path of the air is switched from the second path to the first path again. That is, as illustrated in FIG. 10(A), the air passing through the first adsorption heat exchanger (51) is changed from the indoor air to the outdoor air, and the air passing through the second adsorption heat exchanger (52) is changed from the outdoor air to the indoor air.

[0111] As described above, in the state shown in FIG. 10(A), the adsorbent adsorbs the moisture in the indoor air, and the refrigerant absorbs heat from the indoor air, in the second adsorption heat exchanger (52). That is, the second adsorption heat exchanger (52) takes moisture and heat from the indoor air.

[0112] Further, as described above, in the state shown in FIG. 10(A), the outdoor air is heated and humidified in the first adsorption heat exchanger (51). That is, the first adsorption heat exchanger (51) gives the moisture taken from the indoor air in the state shown in FIG. 10(B), to the outdoor air. Further, in the first adsorption heat exchanger (51), the heat transferred by the refrigerant from the second adsorption heat exchanger (52) is given to the outdoor air. As a result, the temperature and the absolute humidity of the outdoor air become close to the temperature and the absolute humidity of the indoor space.

[0113] As described above, even during the low-performance operation where the compressor (53) is stopped, the humidity control apparatus (10) controls the temperature and the absolute humidity of the outdoor air to be supplied to the indoor space. However, a flow rate of the refrigerant which moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) in the refrigerant circuit (50) in the low-performance operation is lower than a flow rate of the refrigerant which circulates in the refrigerant circuit (50) in the dehumidifying operation and the humidifying operation in which the compressor (53) is actuated. Thus, the dehumidification properties of the humidity control apparatus (10) in the low-performance operation are lower than the dehumidification properties of the humidity control apparatus (10) in the dehumidifying operation. Further, the humidification properties of the humidity control apparatus (10) in the low-performance operation are lower than the humidification properties of the humidity control apparatus (10) in the humidifying operation.

<Simple ventilation operation>

[0114] In the humidity control apparatus (10) in the simple ventilation operation, the compressor (53) of the re-

frigerant circuit (50) is stopped, and the electric expansion valve (55) is in a fully closed state, in general.

[0115] Further, in the humidity control apparatus (10) in the low-performance operation, the switching mechanism (40) is stopped, and the flow path of the air is fixed to either one of the first path or the second path. In the case where the flow path of the air is set to the first path, the outdoor air and the indoor air flow in the humidity control apparatus (10) as illustrated in FIG. 7. That is, the outdoor air is supplied to the indoor space after passing through the first adsorption heat exchanger (51), and the indoor air is exhausted to the outdoor space after passing through the second adsorption heat exchanger (52). On the other hand, in the case where the flow path of the air is set to the second path, the outdoor air and the indoor air flow in the humidity control apparatus (10) as illustrated in FIG. 8. That is, the outdoor air is supplied to the indoor space after passing through the second adsorption heat exchanger (52), and the indoor air is exhausted to the outdoor space after passing through the first adsorption heat exchanger (51).

[0116] In the low-performance operation, the switching mechanism (40) switches the flow path of the air every predetermined period or time, whereas in the simple ventilation operation, the switching mechanism (40) is stopped and the flow path of the air is fixed. Thus, in the simple ventilation operation, the adsorption heat exchangers (51, 52) do not exchange moisture or heat with the air passing through the adsorption heat exchangers (51, 52). As a result, the outdoor air is supplied to the indoor space without control of the temperature and the humidity. Further, the indoor air is exhausted to the outdoor space without control of the temperature and humidity.

-Control Operation of Controller-

[0117] Control operation of the controller (90) will be described. Here, the operation in which the controller (90) selects an operation mode of the humidity control apparatus (10) will be described with reference to the flow chart of FIG. 11. The controller (90) repeats the control operation of FIG. 11 every predetermined period of time (e.g., every two minutes).

[0118] In step ST1, the controller (90) calculates a target value of the absolute humidity of air (target absolute humidity: X_{tg}) to be supplied to the indoor space from the air supply opening (23). In the calculation, the controller (90) determines the target absolute humidity X_{tg} such that an absolute humidity X_{ra} of the indoor air will be a set value (X_{set}) of the absolute humidity, using a set value (X_{set}) of the absolute humidity of air in the indoor space, an absolute humidity X_{oa} of the outdoor air, and the absolute humidity X_{ra} of the indoor air. Further, the controller (90) calculates the absolute humidity X_{oa} of the outdoor air, using measurement values of the outside air temperature sensor (93) and the outside air humidity sensor (94), and calculates the absolute hu-

midity X_{ra} of the indoor air, using measurement values of the room air temperature sensor (91) and the room air humidity sensor (92).

[0119] In the next step ST2, the controller (90) calculates a necessary operation frequency F_n of the compressor (53). In the calculation, the controller (90) calculates an operation frequency of the compressor (53) such that the absolute humidity of air to be supplied to the indoor space from the air supply opening (23) will be the target absolute humidity X_{tg} , using the target absolute humidity X_{tg} calculated in step ST1, the absolute humidity X_{oa} of the outdoor air, and the absolute humidity X_{ra} of the indoor air. The obtained operation frequency is the necessary operation frequency F_n .

[0120] The higher the operation frequency of the compressor (53), the larger the operation capacity of the compressor (53). The lower the operation frequency of the compressor (53), the smaller the operation capacity of the compressor (53). When the compressor (53) has large operation capacity, the mass flow rate of the refrigerant circulating in the refrigerant circuit (50) is increased, and a heat absorption rate and a heat dissipation rate of the refrigerant in the adsorption heat exchangers (51, 52) per unit time are increased. As a result, the amount of moisture adsorbed to the adsorption heat exchanger (51, 52) serving as an evaporator is increased, and the amount of moisture desorbed from the adsorption heat exchanger (51, 52) serving as a radiator is increased. That is, the humidity control capability of the humidity control apparatus (10) is increased. On the other hand, when the compressor (53) has small operation capacity, the mass flow rate of the refrigerant circulating in the refrigerant circuit (50) is reduced, and the heat absorption rate and the heat dissipation rate of the refrigerant in the adsorption heat exchangers (51, 52) are reduced. As a result, the amount of moisture adsorbed to the adsorption heat exchanger (51, 52) serving as an evaporator is reduced, and the amount of moisture desorbed from the adsorption heat exchanger (51, 52) serving as a radiator is reduced. That is, the humidity control capability of the humidity control apparatus (10) is reduced. Thus, the controller (90) controls the operation frequency of the compressor (53) so that the absolute humidity of air to be supplied to the indoor space from the humidity control apparatus (10) will be the target absolute humidity X_{tg} .

[0121] In the next step ST3, the controller (90) calculates a minimum operation frequency F_{min} of the compressor (53). In the calculation, the controller (90) calculates a lower limit of the operation frequency of the compressor (53), using a temperature T_{oa} and the absolute humidity X_{oa} of the outdoor air, and a temperature T_{ra} and the absolute humidity X_{ra} of the indoor air. The obtained lower limit is the minimum operation frequency F_{min} . To ensure reliability of the compressor (53), operational conditions of the compressor (53), such as a difference between a suction pressure and a discharge pressure, need to fall within a predetermined range. Thus, the controller (90) determines the minimum oper-

ation frequency F_{min} of the compressor (53) so that the operational conditions of the compressor (53) can fall within the predetermined range.

[0122] In the next step ST4, the controller (90) determines whether the absolute humidity X_{oa} of the outdoor air is a value in a set humidity range or not (that is, whether a condition of $X_{set1} < X_{oa} < X_{set2}$ holds true or not). X_{set1} is a lower limit of a set range of the absolute humidity of air in the indoor space, and X_{set2} is an upper limit of the set range of the absolute humidity of air in the indoor space.

[0123] In the case where the condition of step ST4 holds true, the absolute humidity of the indoor air is maintained within the set range even if the outdoor air is supplied to the indoor space without control. Thus, the controller (90) performs operation in step ST5 in the case where the above condition holds true. In other words, in such a case, the controller (90) sets the operation of the humidity control apparatus (10) to the simple ventilation operation.

[0124] On the other hand, in the case where the condition of step ST4 does not hold true, the absolute humidity of air in the indoor space may deviate from the set range if the outdoor air is supplied to the indoor space without control. Thus, in the case where the above condition does not hold true, the controller (90) performs operation of step ST6.

[0125] In step ST6, the controller (90) compares the necessary operation frequency F_n of the compressor (53) obtained in step ST2 and the minimum operation frequency F_{min} of the compressor (53) obtained in step ST3. Specifically, the controller (90) determines whether a condition of $F_n \geq F_{min} \times A$ holds true or not. The letter "A" is a constant less than 1.0, and is set to 0.5, for example.

[0126] In the case where the condition of step ST6 holds true, the controller (90) performs operation of step ST7. When the above condition holds true, the absolute humidity X_{oa} of the outdoor air deviates from the set humidity range, and the necessary operation frequency F_n of the compressor (53) is relatively high. Therefore, it can be considered that the humidity control capability (i.e., a humidity control load) required of the humidity control apparatus (10) is relatively high. Thus, in step ST7, the controller (90) sets the operation of the humidity control apparatus (10) to either one of the dehumidifying operation or the humidifying operation. The controller (90) selects either the dehumidifying operation or the humidifying operation, based on setting information input in a remote, etc., by a user or on the absolute humidity of indoor and outdoor air.

[0127] In the case where the condition of step ST6 holds true during the low-performance operation, it can be assumed that the humidity control capability of the humidity control apparatus (10) is lower than the humidity control load. Thus, in the case where the condition of the step ST6 holds true during the low-performance operation, the controller (90) actuates the compressor (53) and

changes the operation of the humidity control apparatus (10) from the low-performance operation to the dehumidifying operation or the humidifying operation.

[0128] In the humidity control apparatus (10) in the dehumidifying operation and the humidifying operation, the controller (90) controls an operation frequency F of the compressor (53) as follows. That is, in the case where the necessary operation frequency F_n of the compressor (53) is more than or equal to the minimum operation frequency F_{min} ($F_{min} \leq F_n$), the controller (90) sets the operation frequency F of the compressor (53) to the necessary operation frequency F_n ($F=F_n$). On the other hand, in the case where the necessary operation frequency F_n of the compressor (53) is less than the minimum operation frequency F_{min} and higher than the $F_{min} \times A$ ($F_{min} \times A < F_n < F_{min}$), the controller (90) sets the operation frequency F of the compressor (53) to the minimum operation frequency F_{min} ($F=F_{min}$).

[0129] In the case where the condition of step ST6 does not hold true, the controller (90) performs operation of step ST8. When the above condition does not hold true, the absolute humidity X_{oa} of the outdoor air deviates from the set humidity range, and the necessary operation frequency F_n of the compressor (53) is relatively low. Therefore, it can be assumed that the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load. Thus, in step ST8, the controller (90) sets the operation of the humidity control apparatus (10) to the low-performance operation.

[0130] As described above, in the case where the relationship of $F_{min} \times A < F_n < F_{min}$ holds true in the dehumidifying operation and the humidifying operation, the controller (90) sets the operation frequency F of the compressor (53) to the minimum operation frequency F_{min} ($F=F_{min}$). If the condition of step ST6 does not hold true under the condition of $F=F_{min}$, it can be assumed that the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load even if the operation capacity of the compressor (53) is set to a minimum capacity. Thus, in this case, the controller (90) stops the compressor (53), and changes the operation of the humidity control apparatus (10) from the dehumidifying operation or the humidifying operation to the low-performance operation.

-Advantages of Embodiment-

[0131] The humidity control apparatus (10) of the present embodiment performs the dehumidifying operation and the humidifying operation in which both of the compressor (53) and the switching mechanism (40) are actuated, and the low-performance operation in which the compressor (53) is stopped and the switching mechanism (40) is actuated. As described above, the humidity control capability of the humidity control apparatus (10) in the low-performance operation is lower than the humidity control capability of the humidity control apparatus (10) in the dehumidifying operation and the humidifying

operation.

[0132] In the conventional humidity control apparatus (10) which does not perform the low-performance operation, the dehumidifying operation and the humidifying operation are stopped and the simple ventilation operation is performed when the humidity control capability in the dehumidifying operation and the humidifying operation is high relative to the humidity control load. However, even when the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load, there is a certain degree of difference in the temperature and the absolute humidity between the outdoor space air and the indoor space air, in general. Thus, if the dehumidifying operation and the humidifying operation are immediately stopped to perform the simple ventilation operation when the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load, the outdoor air may be supplied to the indoor space without control of the temperature and the absolute humidity, and that may cause people in the room discomfort.

[0133] In contrast, the humidity control apparatus (10) of the present embodiment can perform the low-performance operation. When the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load, the humidity control apparatus (10) stops the dehumidifying operation and the humidifying operation and performs the operation in the low-performance operation. The outdoor air is supplied to the indoor space without control in the simple ventilation operation, whereas in the low-performance operation, the outdoor air is supplied to the indoor space after the temperature and the absolute humidity of the outdoor air are controlled.

[0134] Thus, according to the humidity control apparatus (10) of the present embodiment, the temperature and the absolute humidity of the outdoor air to be supplied to the indoor space can be close to the temperature and the absolute humidity of the indoor space, even in such an operational condition in which the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load and therefore in which it is necessary to stop the dehumidifying operation and the humidifying operation. Thus, according to the present embodiment, a reduction in comfort caused by supplying the outdoor air to the indoor space without control can be prevented, and it is possible to ensure comfort of the indoor space even in the operational condition in which the dehumidifying operation and the humidifying operation need to be stopped.

[0135] Further, in the case where the difference between the humidity control load and the lower limit of the adjustable range of the humidity control capability of the humidity control apparatus (10) is small, the stop and restart of the compressor (53) may be frequently repeated. That is, when the compressor (53) is stopped and the humidity control capability of the humidity control apparatus (10) becomes zero, the outdoor air is supplied

to the indoor space without control, and therefore the humidity of the indoor air is changed, and as a result, the compressor (53) is restarted. When the compressor (53) restarts, the humidity of the indoor air reaches a target value in a relatively short time, and thus, the compressor (53) is stopped again. The frequent repetition of stop and restart of the compressor (53) increases the likelihood of damage of the compressor (53).

[0136] In contrast, in the humidity control apparatus (10) of the present embodiment, the outdoor air to be supplied to the indoor space is continuously dehumidified and humidified by the low-performance operation, even in such an operational condition in which the humidity control capability of the humidity control apparatus (10) is high relative to the humidity control load and therefore in which it is necessary to stop the dehumidifying operation and the humidifying operation. Thus, even after the stop of the compressor (53), it is possible to prevent an abrupt change in the humidity of the indoor air, and extend the time until the restart of the compressor (53) is necessary. According to the present embodiment, the frequent repetition of the stop and restart of the compressor (53) can be prevented. Therefore, reliability of the compressor (53) can be improved.

[0137] Further, in the humidity control apparatus (10) of the present embodiment, the electric expansion valve (55) of the refrigerant circuit (50) is maintained in the fully open state during the low-performance operation. Thus, sufficient flow rate of the refrigerant which moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52) during the low-performance operation can be maintained, thereby making it possible to increase the humidity control capability of the humidity control apparatus (10) in the low-performance operation.

-Variation of Embodiment-

[0138] In the humidity control apparatus (10) of the present embodiment, the time interval between the switching operations of the switching mechanism (40) for switching the flow path of the air in the low-performance operation may be shorter than the time interval between the switching operations of the switching mechanism (40) for switching the flow path of the air in the dehumidifying operation. That is, in the present embodiment, the time interval between the switching operations of the switching mechanism (40) for switching the flow path of the air in the low-performance operation may be less than three minutes.

[0139] The amount of moisture exchanged between the adsorption heat exchangers (51, 52) and the air passing therethrough abruptly increases in a short time after supply of the air into the adsorption heat exchangers (51, 52) starts, and gradually decreases thereafter. In the humidity control apparatus (10) of the present variation, the switching mechanism (40) switches the flow path of the air alternately between the first path and the second path,

more frequently in the low-performance operation than in the dehumidifying operation. Thus, in the present variation, the humidity control capability of the humidity control apparatus (10) in the low-performance operation can be improved.

[0140] Further, in the humidity control apparatus (10) of the present embodiment, the degree of opening of the electric expansion valve (55) of the refrigerant circuit (50) needs not to be the fully open state during the low-performance operation. That is, the degree of opening of the electric expansion valve (55) during the low-performance operation may be set to a degree of opening which can ensure sufficient flow rate of the refrigerant that moves between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52), and does not necessarily have to be maintained in the fully open state.

INDUSTRIAL APPLICABILITY

[0141] As described above, the present disclosure is useful as a humidity control apparatus which dehumidifies and humidifies air by using an adsorption heat exchanger carrying an adsorbent.

DESCRIPTION OF REFERENCE CHARACTERS

[0142]

10	humidity control apparatus
25	exhaust fan
26	air supply fan
40	switching mechanism
50	refrigerant circuit
51	first adsorption heat exchanger
52	second adsorption heat exchanger
53	compressor
55	electric expansion valve (expansion valve)
90	controller

Claims

1. A humidity control apparatus, comprising:

a refrigerant circuit (50) which includes a compressor (53), and a first adsorption heat exchanger (51) and a second adsorption heat exchanger (52) each carrying an adsorbent, and which performs a first refrigeration cycle operation in which the first adsorption heat exchanger (51) serves as a radiator and the second adsorption heat exchanger (52) serves as an evaporator, and a second refrigeration cycle operation in which the second adsorption heat exchanger (52) serves as a radiator and the first adsorption heat exchanger (51) serves as an evaporator; an air supply fan (26) configured to supply outdoor air to an indoor space;

an exhaust fan (25) configured to exhaust indoor air to an outdoor space; and

a switching mechanism (40) configured to switch a flow path of the air between a first path in which the outdoor air passes through the first adsorption heat exchanger (51) and thereafter flows into the indoor space, and the indoor air passes through the second adsorption heat exchanger (52) and is thereafter exhausted to the outdoor space, and a second path in which the outdoor air passes through the second adsorption heat exchanger (52) and thereafter flows into the indoor space, and the indoor air passes through the first adsorption heat exchanger (51) and is thereafter exhausted to the outdoor space, wherein

the humidity control apparatus performs

a first operation in which the air supply fan (26) and the exhaust fan (25) are actuated; the refrigerant circuit (50) alternately performs the first refrigeration cycle operation and the second refrigeration cycle operation every predetermined period of time; and the switching mechanism (40) alternately sets the flow path of the air to the first path and the second path in conjunction with the alternate change of the refrigeration cycle operation of the refrigerant circuit (50), thereby dehumidifying or humidifying the outdoor air to be supplied to the indoor space, and a second operation in which the air supply fan (26) and the exhaust fan (25) are actuated; the compressor (53) of the refrigerant circuit (50) is stopped; and the switching mechanism (40) alternately sets the flow path of the air to the first path and the second path every predetermined period of time.

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

a controller (90) which controls an operation capacity of the compressor (53) according to a humidity control load during the first operation, wherein

the controller (90) switches an operation of the humidity control apparatus (10) from the first operation to the second operation if it is considered that even if the operation capacity of the compressor (53) is set to a minimum capacity during the first operation, a humidity control capability is high relative to the humidity control load, and the controller (90) switches the operation of the humidity control apparatus (10) from the second operation to the first operation if it is considered that the humidity control capability is low relative to the humidity control load during the second

operation.

3. The humidity control apparatus of claim 1 or 2, wherein the refrigerant circuit (50) is provided with an expansion valve (55) whose degree of opening is variable, at a location between the first adsorption heat exchanger (51) and the second adsorption heat exchanger (52), and the expansion valve (55) is maintained in a fully open state during the second operation.
4. The humidity control apparatus of claim 1, wherein a time interval between switching operations of the switching mechanism (40) during the second operation, for alternately switching the flow path of the air between the first path and the second path, is less than or equal to a time interval between switching operations of the switching mechanism (40) during the first operation, for alternately switching the flow path of the air between the first path and the second path.

FIG.1

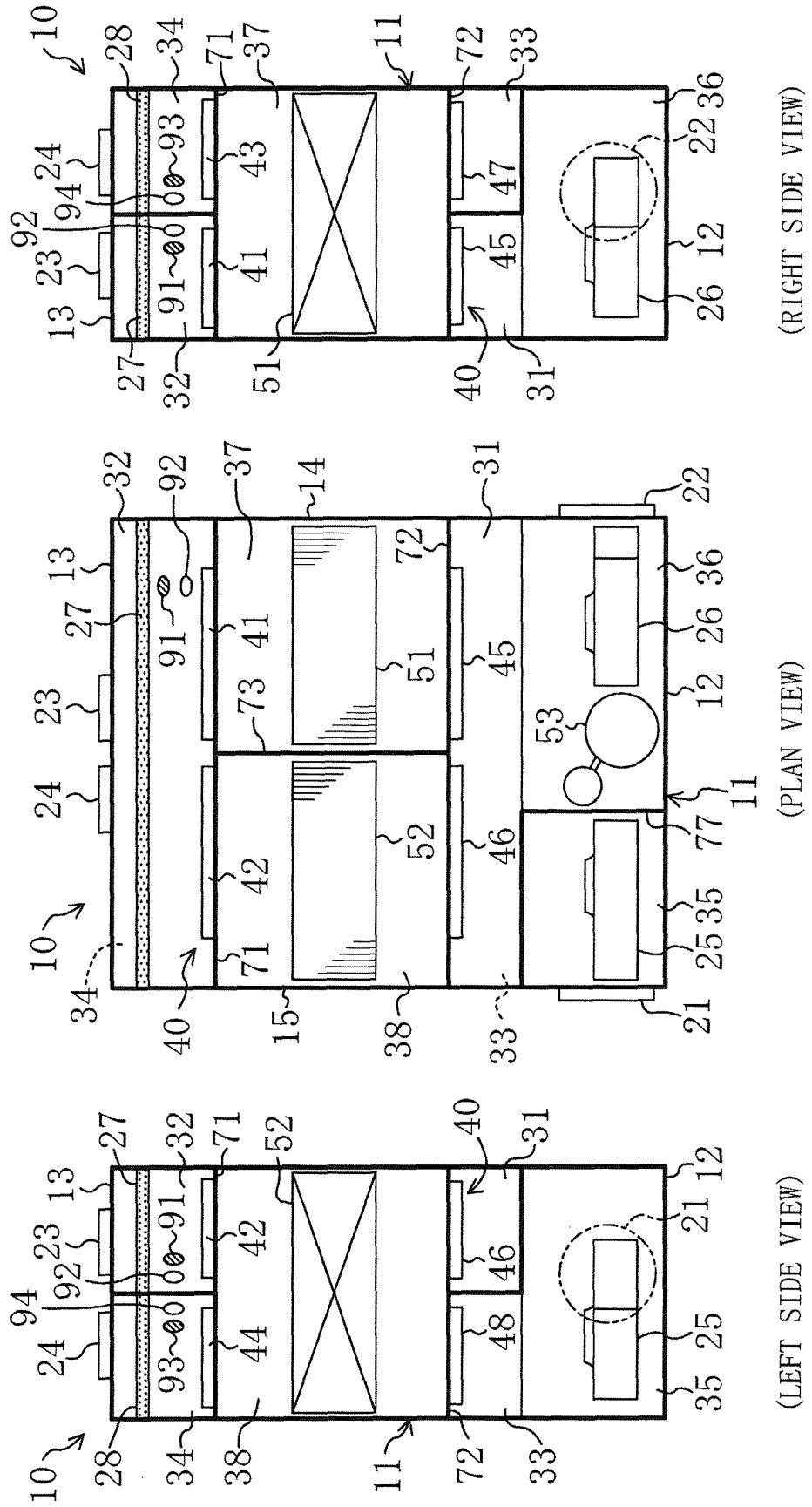


FIG.2

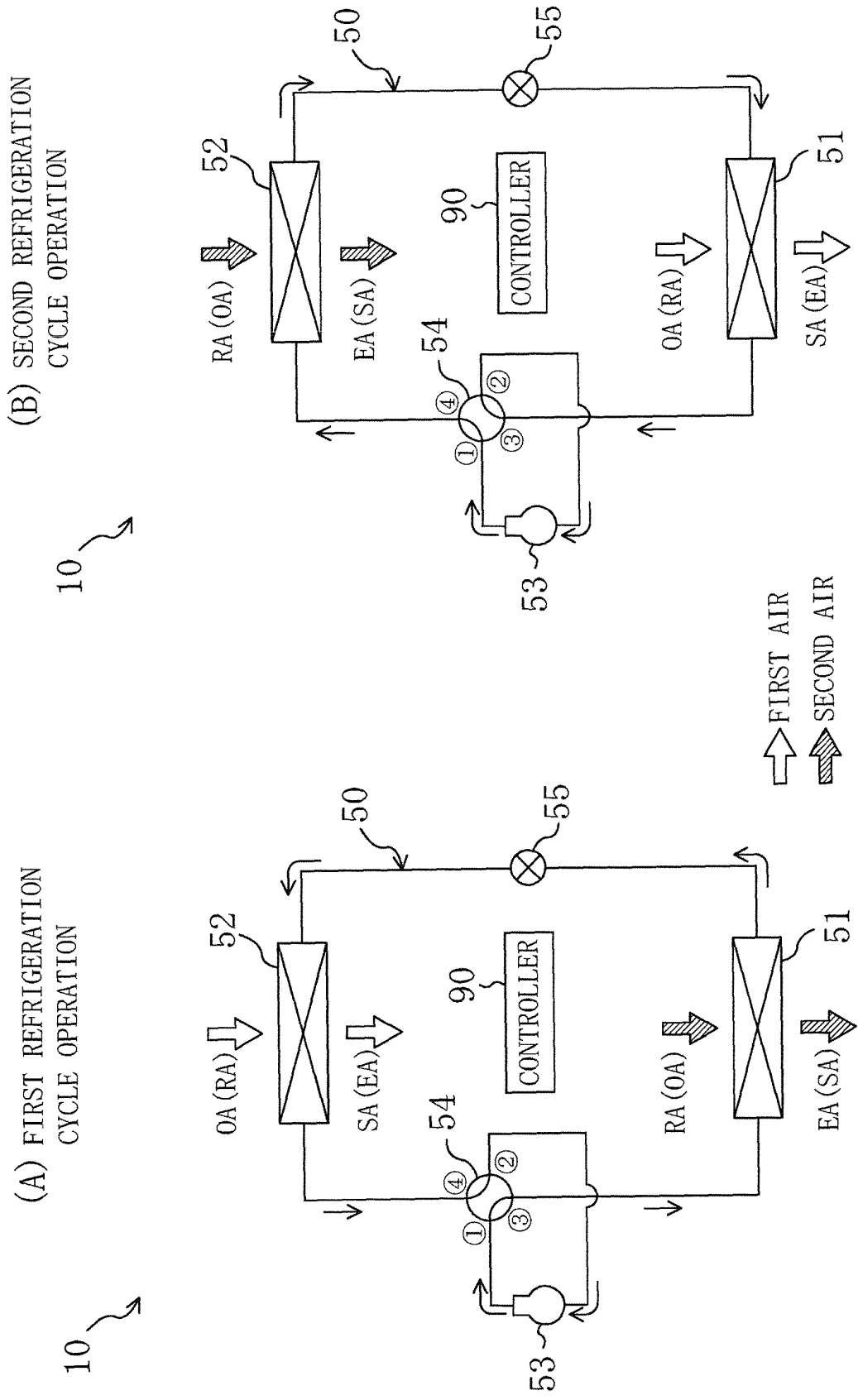


FIG.3

 FIRST AIR (OUTDOOR AIR)
 SECOND AIR (INDOOR AIR)

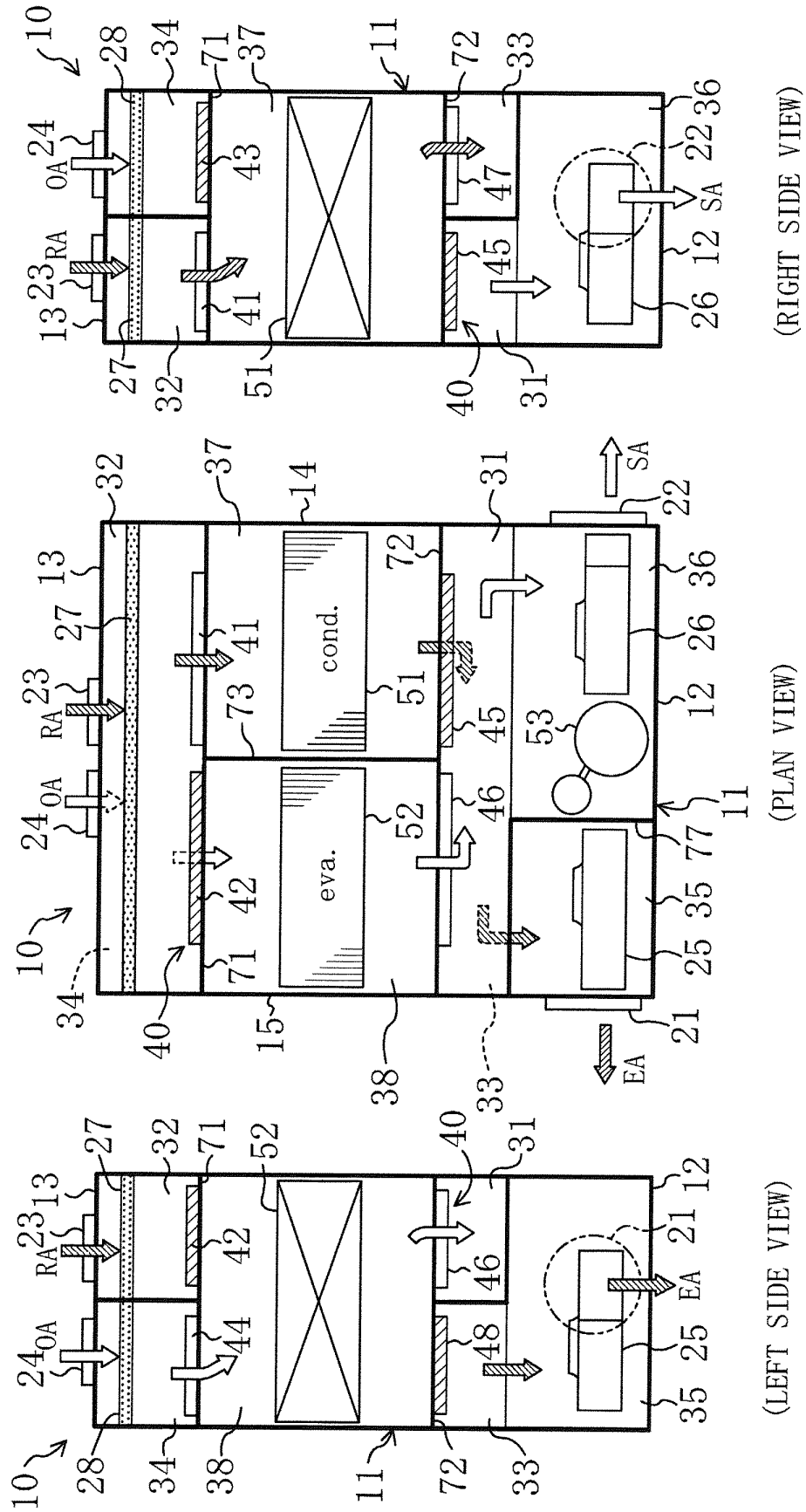


FIG. 4

⇐ FIRST AIR (OUTDOOR AIR)
⇐ SECOND AIR (INDOOR AIR)

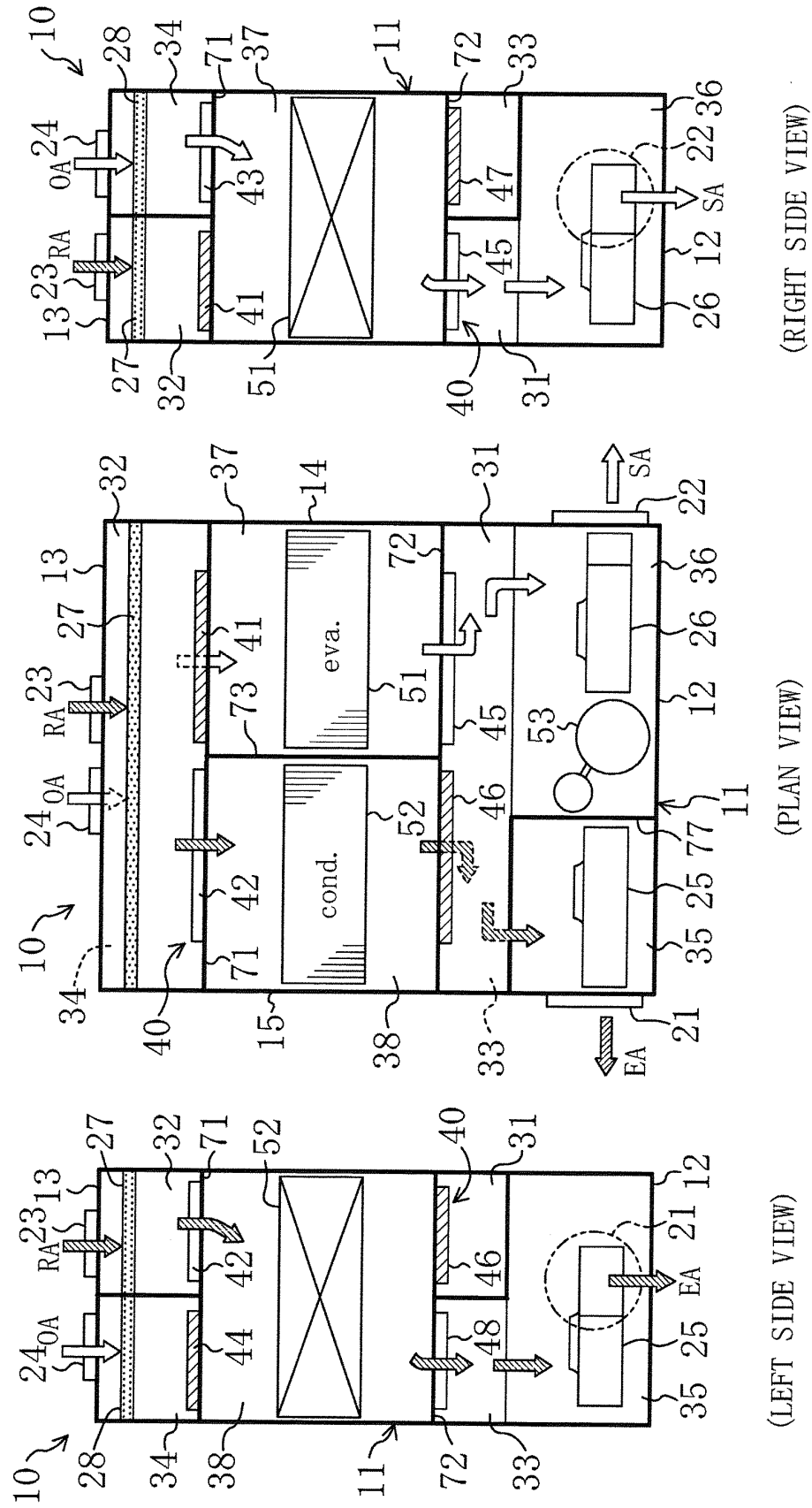


FIG.5

 FIRST AIR (INDOOR AIR)
 SECOND AIR (OUTDOOR AIR)

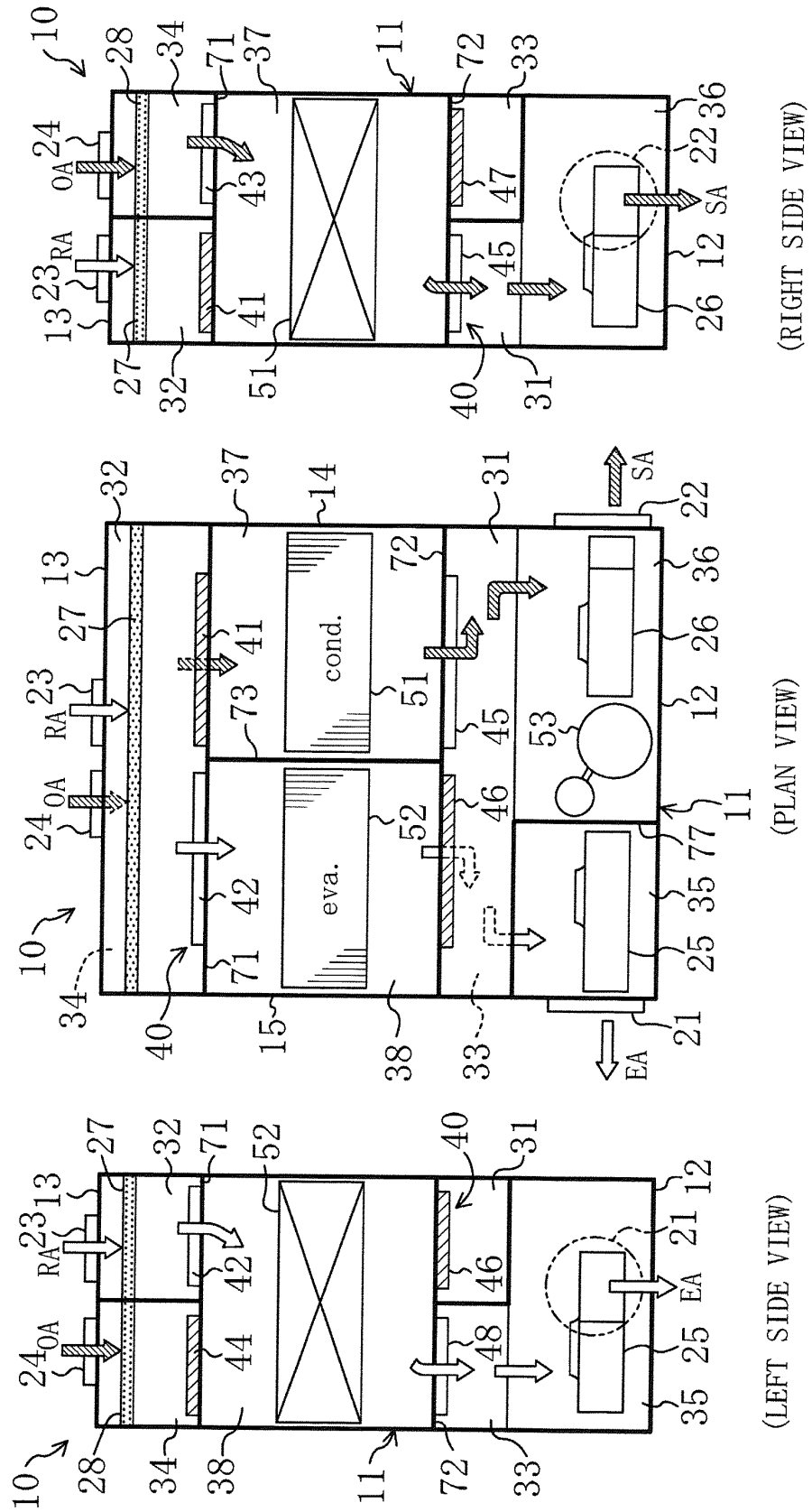


FIG.6

 FIRST AIR (INDOOR AIR)
 SECOND AIR (OUTDOOR AIR)

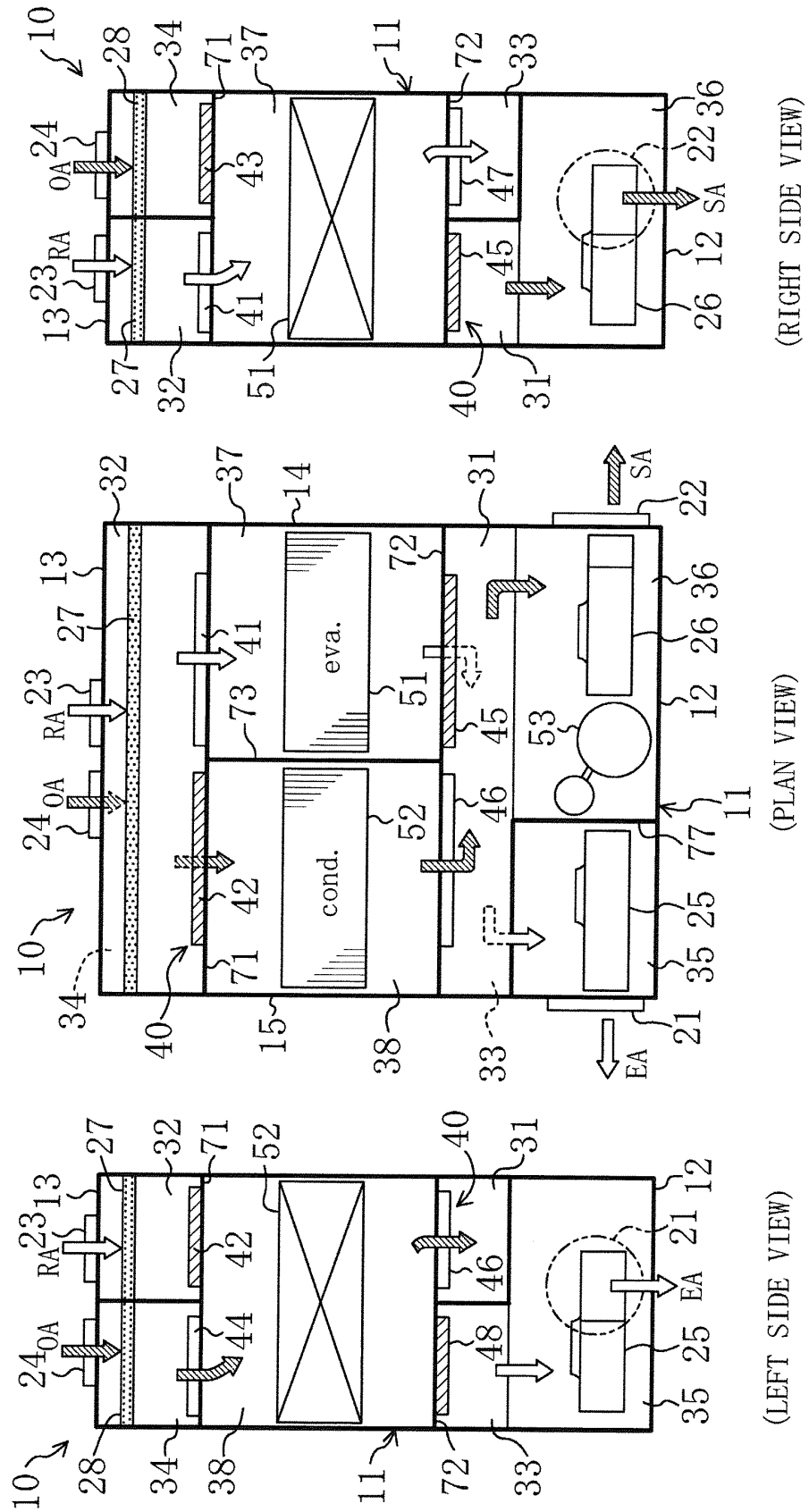


FIG.7

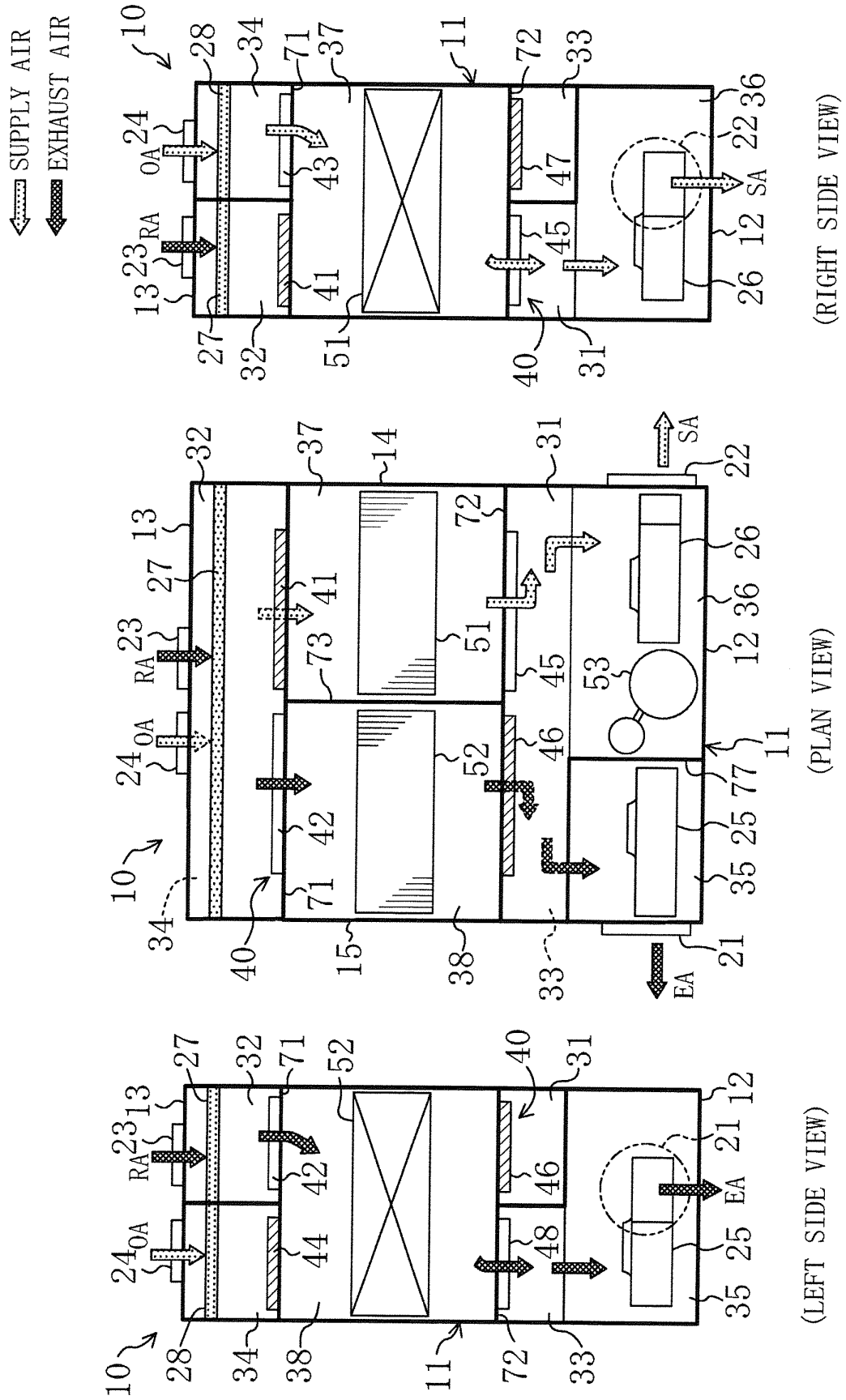


FIG. 8

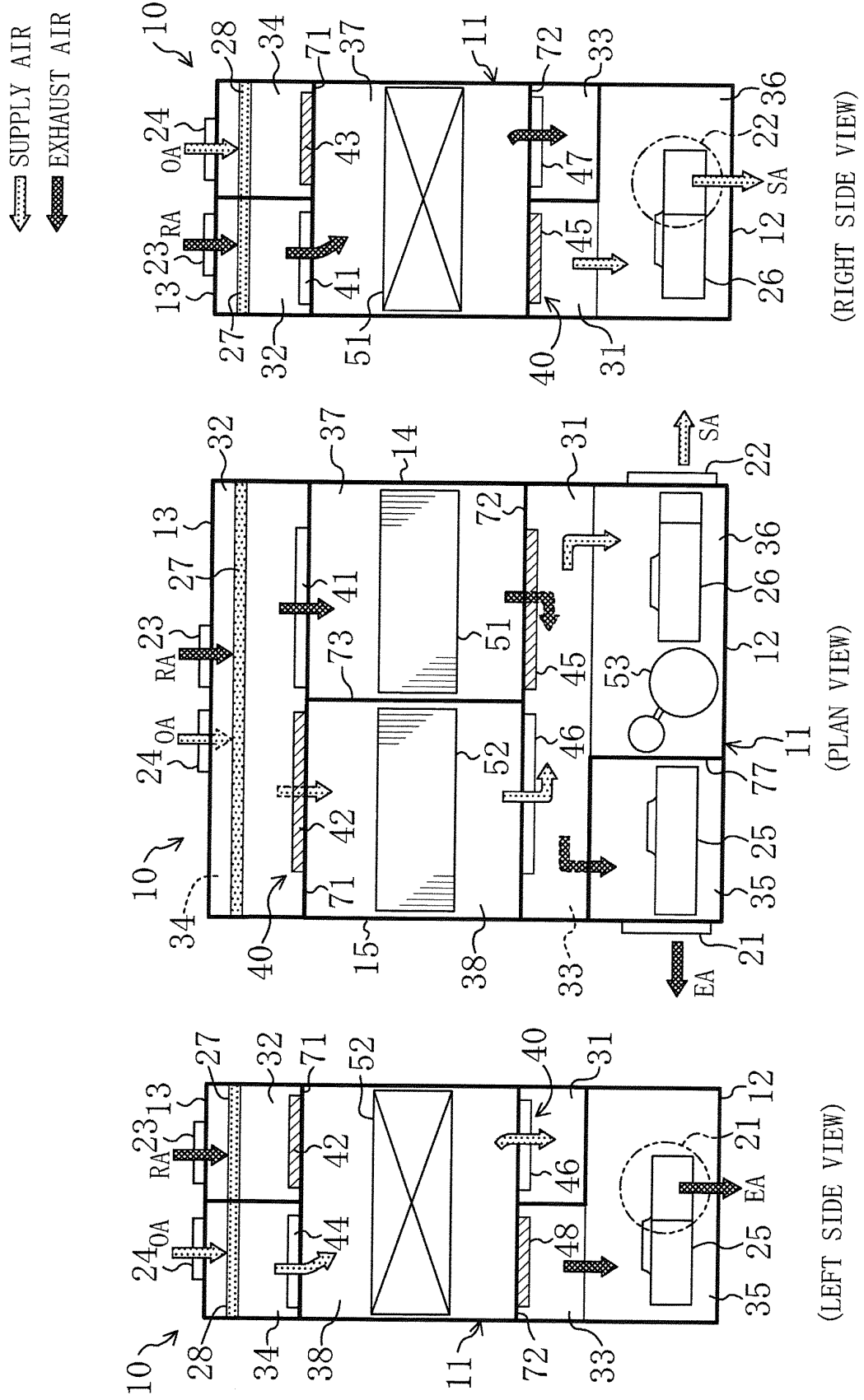


FIG.9

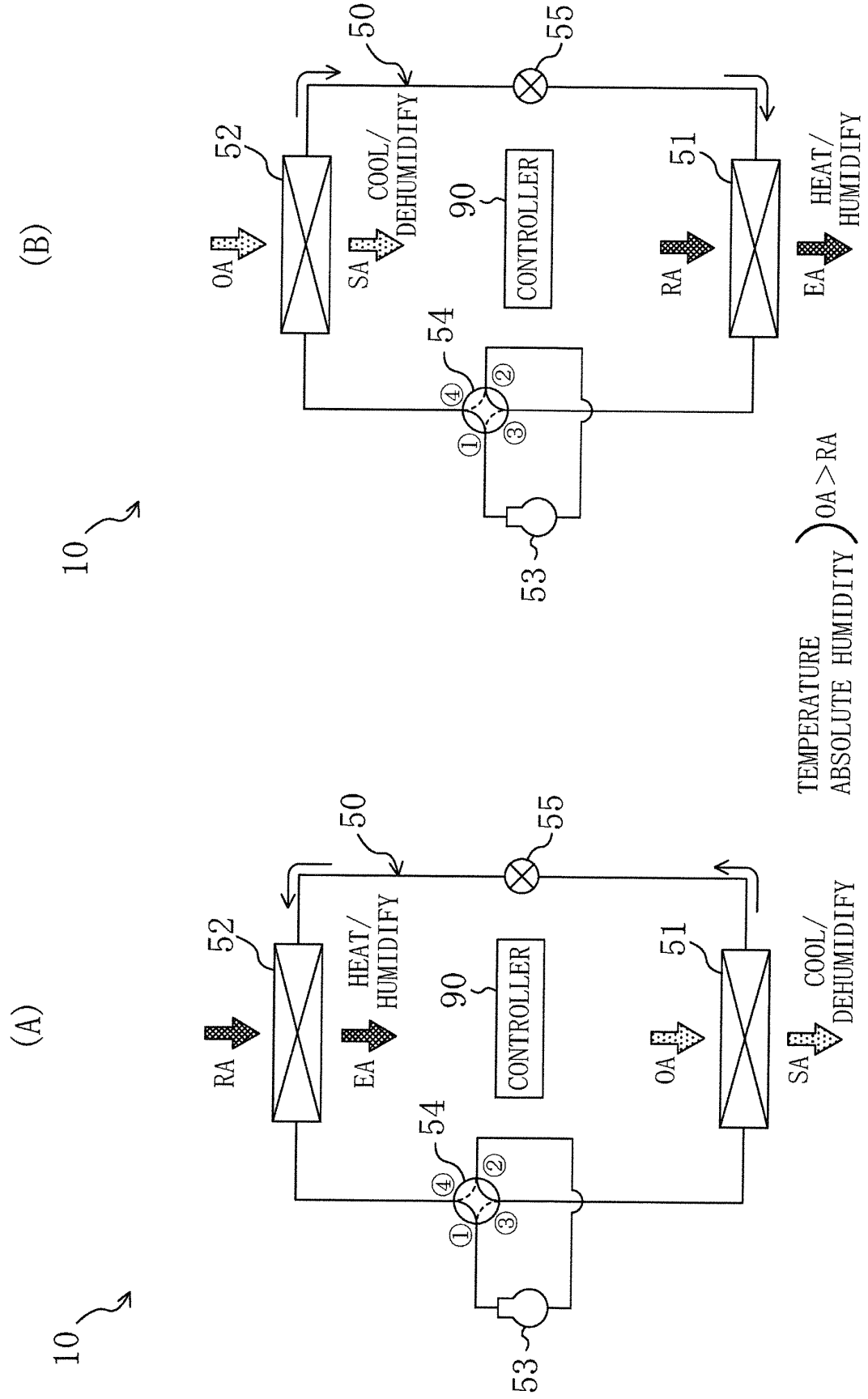


FIG.10

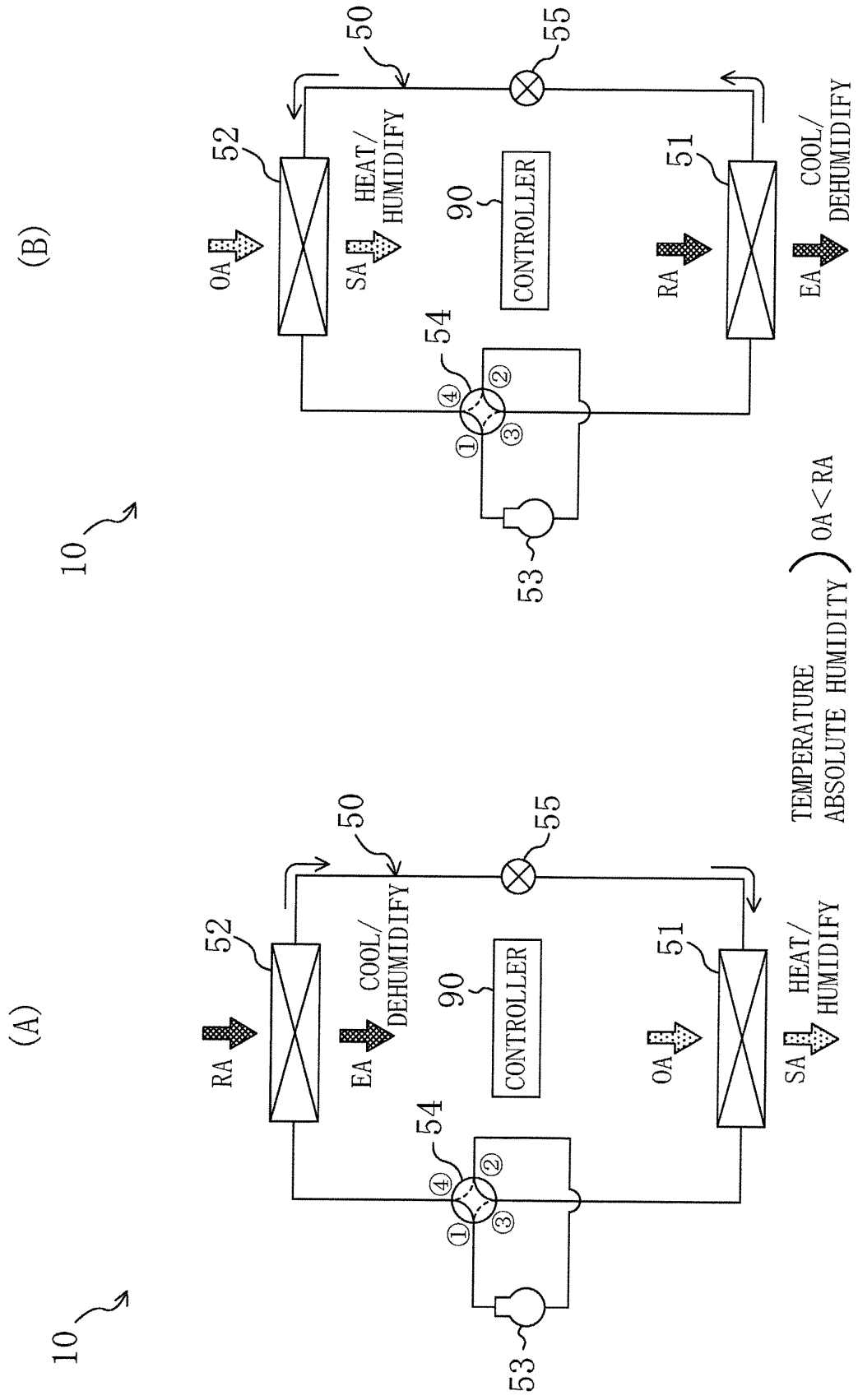
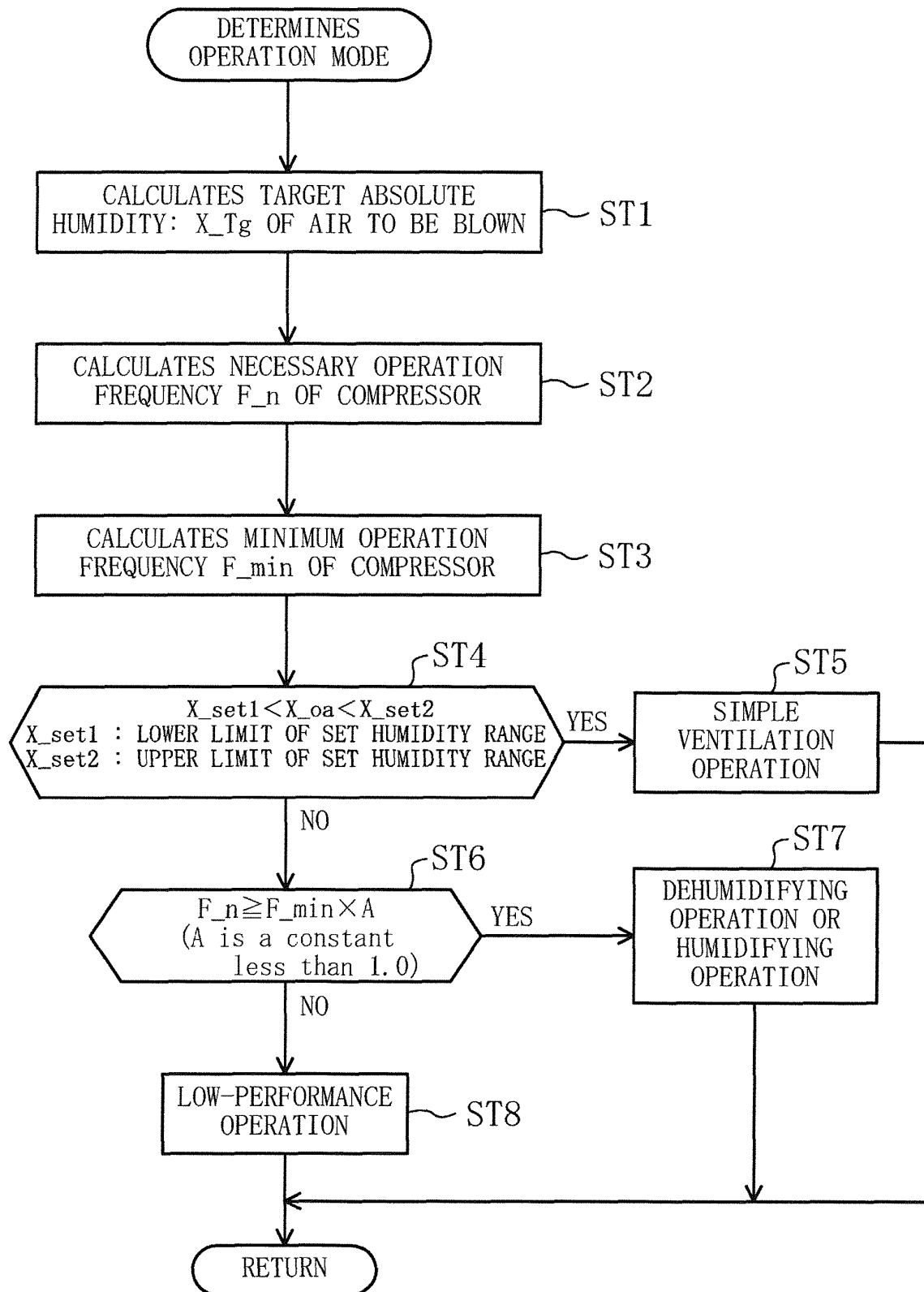


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/005988

A. CLASSIFICATION OF SUBJECT MATTER

F24F3/147(2006.01) i, F24F11/02(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F3/147, F24F11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012

Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2006-329469 A (Daikin Industries, Ltd.), 07 December 2006 (07.12.2006), entire text & US 2009/0118870 A1 & EP 1898161 A1 & WO 2006/126605 A1	1, 4 2-3
X Y	JP 2006-329593 A (Daikin Industries, Ltd.), 07 December 2006 (07.12.2006), entire text & US 2009/0038326 A1 & EP 1890090 A1 & WO 2006/129544 A1	1, 4 2-3
Y	JP 2004-353887 A (Daikin Industries, Ltd.), 16 December 2004 (16.12.2004), paragraphs [0127] to [0128] & US 2007/0028639 A1 & EP 1630482 A1 & WO 2004/106813 A1	2

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

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"&" document member of the same patent family

Date of the actual completion of the international search
22 November, 2012 (22.11.12)Date of mailing of the international search report
04 December, 2012 (04.12.12)Name and mailing address of the ISA/
Japanese Patent Office

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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 4-13051 A (Matsushita Electric Industrial Co., Ltd.), 17 January 1992 (17.01.1992), claim 1 (Family: none)	3
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 42790/1990 (Laid-open No. 1370/1992) (Sharp Corp.), 08 January 1992 (08.01.1992), claim 1 (Family: none)	3
Y	JP 1-219451 A (Matsushita Refrigeration Co.), 01 September 1989 (01.09.1989), claim 1 (Family: none)	3

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007010231 A [0006]