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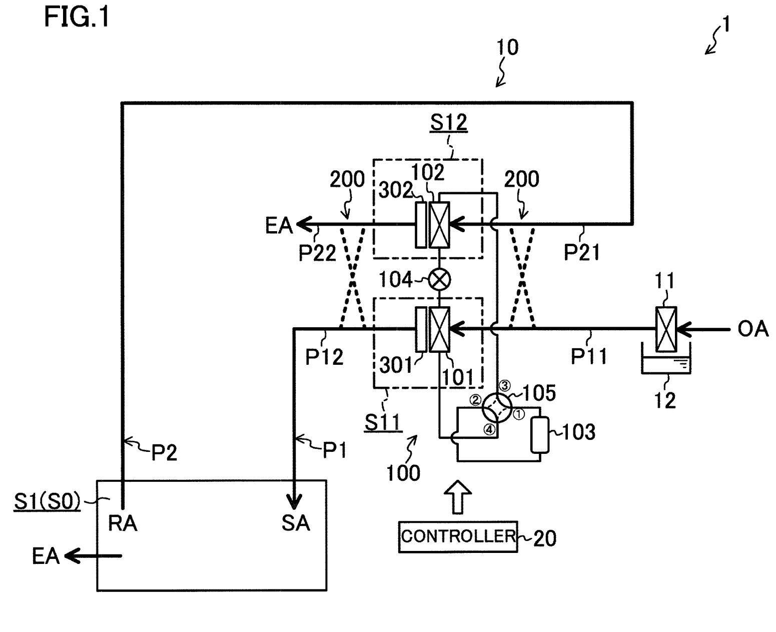
(54) **DEHUMIDIFICATION DEVICE AND DEHUMIDIFICATION SYSTEM**

(57) First and second adsorption heat exchangers (101, 102) are provided for first and second heat exchange chambers (S11, S12), respectively, and each interchangeably function as an evaporator or a condenser. If the first adsorption heat exchanger (101) functions as an evaporator in the first heat exchange chamber (S11), a first adsorption block (301) is arranged at a position downstream of the first adsorption heat exchanger (101). If the second adsorption heat exchanger (102) functions as an evaporator in the second heat exchange chamber (S12), a second adsorption block (302) is arranged at a position downstream of the second adsorption heat exchanger (102).

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a dehumidification device and dehumidification system configured to dehumidify air and supply the dehumidified air to a humidity-controlled space, and more particularly relates to a dehumidification device including an adsorption heat exchanger loaded with an adsorbent.

BACKGROUND ART

[0002] A dehumidification device has been known which dehumidifies air and supplies the dehumidified air to a humidity-controlled space (such as an indoor space). For example, Patent Document 1 discloses a humidity controller which includes a refrigerant circuit with two adsorption heat exchangers and which makes the adsorption heat exchangers control the humidity of the air. This humidity controller performs repeatedly and alternately one type of operation in which a first adsorption heat exchanger functions as a condenser and a second adsorption heat exchanger functions as an evaporator and the other type of operation in which the first adsorption heat exchanger functions as an evaporator and the second adsorption heat exchanger functions as a condenser. Specifically, this humidity controller performs dehumidification operation such that the air dehumidified by the adsorption heat exchanger functioning as an evaporator is supplied to a room and that the air humidified by the adsorption heat exchanger functioning as a condenser is exhausted out of the room.

CITATION LIST

PATENT DOCUMENT

[0003] PATENT DOCUMENT 1: Japanese Unexamined Patent Publication No. 2006-349294

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] A dehumidification device (humidity controller) such as the one disclosed in Patent Document 1 could have its dehumidification capacity improved by increasing the number of rotations of a compressor in its refrigerant circuit. If the number of rotations of the compressor in the refrigerant circuit is increased, however, the power consumption of the dehumidification device will increase, too.

[0005] In view of the foregoing background, it is therefore an object of the present invention to provide a dehumidification device with the ability to improve its dehumidification capacity with an increase in power consumption reduced.

SOLUTION TO THE PROBLEM

[0006] A first aspect of the invention is a dehumidification device including: a refrigerant circuit (100) including first and second adsorption heat exchangers (101, 102) loaded with an adsorbent and performing alternately a first operation in which the first adsorption heat exchanger (101) functions as an evaporator to dehumidify air and the second adsorption heat exchanger (102) functions as a condenser to regenerate the adsorbent and a second operation in *which the first adsorption heat exchanger (101) functions as a condenser to regenerate the adsorbent and the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air; first and second heat exchange chambers (S11, S12) provided with the first and second adsorption heat exchangers (101, 102), respectively; a switching mechanism (200) configured to change airflow paths such that air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to a humidity-controlled space (S0) and that air to regenerate the adsorbent flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser; a first adsorption block (301) loaded with the adsorbent, configured to bring air into contact with the adsorbent, and arranged at a position downstream of the first adsorption heat exchanger (101) if the first adsorption heat exchanger (101) functions as an evaporator in the first heat exchange chamber (S11); and a second adsorption block (302) loaded with the adsorbent, configured to bring air into contact with the adsorbent, and arranged at a position downstream of the second adsorption heat exchanger (102) if the second adsorption heat exchanger (102) functions as an evaporator in the second heat exchange chamber (S12).

[0007] According to the first aspect of the invention, by allowing air to be supplied to a humidity-controlled space (S0) to flow through one heat exchange chamber (S11, S12) provided with one adsorption heat exchanger (101, 102) functioning as an evaporator, the air may be dehumidified by having moisture in the air adsorbed into the adsorbent of the adsorption heat exchanger (101, 102) and adsorption block (301, 302). In addition, by allowing air to regenerate the adsorbent to flow through the other heat exchange chamber (S12, S11) provided with the other adsorption heat exchanger (102, 101) functioning as a condenser, the adsorbent of the adsorption heat exchanger (102, 101) and adsorption block (302, 301) may be regenerated by having moisture released into the air from the adsorbent of the adsorption heat exchanger (102, 101) and adsorption block (302, 301). Thus, by adding the first and second adsorption blocks (301, 302) to the first and second heat exchange chambers (S 11, S 12), respectively, the air may be dehumidified to an increased degree in each of the first and second heat exchange chambers (S11, S12).

[0008] In addition, according to the first aspect of the invention, when the adsorption heat exchanger (101, 102) functions as an evaporator in each of the first and second heat exchange chambers (S11, S12), an adsorption block (301, 302) is arranged at a position downstream of that adsorption heat exchanger (101, 102). Then, the air that has been dehumidified and cooled by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302). This thus allows for promoting the adsorption of moisture into the adsorbent of the adsorption block (301, 302).

[0009] A second aspect of the invention is an embodiment of the first aspect of the invention. In the second aspect, the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in an opposite direction when the adsorption heat exchanger (101, 102) functions as an evaporator from when the adsorption heat exchanger (101, 102) functions as a condenser.

[0010] According to the second aspect of the invention, if the adsorption heat exchanger (101, 102) functions as an evaporator in each of the first and second heat exchange chambers (S11, S12), the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102). On the other hand, if the adsorption heat exchanger (101, 102) functions as a condenser, the adsorption block (301, 302) is located upstream of the adsorption heat exchanger (101, 102). That is to say, in each of the first and second heat exchange chambers (S11, S12), the air supplied to that heat exchange chamber (S11, S12) passes through the adsorption block (301, 302) after having passed through the adsorption heat exchanger (101, 102) if the adsorption heat exchanger (101, 102) functions as an evaporator, but passes through the adsorption heat exchanger (101, 102) after having passed through the adsorption block (301, 302) if the adsorption heat exchanger (101, 102) functions as a condenser.

[0011] A third aspect of the invention is an embodiment of the first aspect of the invention. In the third aspect, the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in the same direction when the adsorption heat exchanger (101, 102) functions as an evaporator as when the adsorption heat exchanger (101, 102) functions as a condenser.

[0012] According to the third aspect of the invention, the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102) in each of the first and second heat exchange chambers (S11, S12), no matter whether the adsorption heat exchanger (101, 102) functions as an evaporator or a condenser. Thus, in each of the first and second heat exchange chambers (S11, S12), if the adsorption heat exchanger (101, 102) functions as an evaporator, the air dehumidified and cooled by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302). On the other hand, if the adsorption heat exchanger (101, 102) functions as a condenser, the air heated by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302).

[0013] A fourth aspect of the invention is an embodiment of any one of the first to third aspects of the invention. In the fourth aspect, the first and second adsorption blocks (301, 302) are arranged so as to be spaced apart from the first and second adsorption heat exchangers (101, 102), respectively.

[0014] According to the fourth aspect of the invention, the adsorption blocks (301, 302) are arranged so as to be spaced apart from the adsorption heat exchangers (101, 102), respectively, in each of the first and second heat exchange chambers (S11, S12), thus allowing for reducing the degree of non-uniformity in temperature distribution and airflow in the adsorption blocks (301, 302).

[0015] A fifth aspect of the invention is an embodiment of any one of the first to third aspects of the invention. In the fifth aspect, the first and second adsorption blocks (301, 302) are arranged so as to be in contact with the first and second adsorption heat exchangers (101, 102), respectively.

[0016] According to the fifth aspect of the invention, the adsorption blocks (301, 302) are arranged so as to be in contact with the adsorption heat exchangers (101, 102), respectively, in each of the first and second heat exchange chambers (S11, S12), thus allowing for promoting conduction of heat between the adsorption heat exchangers (101, 102) and the adsorption blocks (301, 302). Specifically, if the adsorption heat exchanger (101, 102) functions as an evaporator, the adsorption block (301, 302) may be cooled thanks to the heat absorption of a refrigerant flowing through the adsorption heat exchanger (101, 102). On the other hand, if the adsorption heat exchanger (101, 102) functions as a condenser, the adsorption block (301, 302) may be heated thanks to the heat dissipation of a refrigerant flowing through the adsorption heat exchanger (101, 102).

[0017] A sixth aspect of the invention is a dehumidification system including: the dehumidification device (10) according to the second aspect of the invention; and a heater (21) configured to heat air to regenerate the adsorbent. The switching mechanism (200) changes airflow paths such that air that has passed through the heater (21) flows in one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as a condenser.

[0018] According to the sixth aspect of the invention, in each of the first and second heat exchange chambers (S11, S12), if the adsorption heat exchanger (101, 102) functions as an evaporator, the air supplied to that heat exchange chamber (S11, S12) passes through the adsorption block (301, 302) after having passed through that adsorption heat exchanger (101, 102). On the other hand, if the adsorption heat exchanger (101, 102) functions as a condenser, the air supplied to that heat exchange chamber (S11, S12) passes through that adsorption heat exchanger (101, 102) after having passed through the adsorption block (301, 302). Thus, by allowing the air that has passed through the heater (21) to flow through the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as a condenser, the air heated by the heater (21) may be supplied to the adsorption block (301, 302) located upstream of the adsorption heat exchanger (101, 102) functioning as a condenser in the heat exchange chamber (S11, S12).

[0019] A seventh aspect of the invention is an embodiment of the sixth aspect of the invention. In the seventh aspect, the dehumidification system further includes an adsorption rotor (70) loaded with an adsorbent and including an adsorption portion (71) and a regeneration portion (72). The adsorption portion (71) dehumidifies air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator by bringing the air into contact with the adsorbent. The regeneration portion (72) regenerates the adsorbent by bringing the air that has passed through the heater (21) into contact with the adsorbent. The air that has passed through that one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) through the adsorption portion (71) of the adsorption rotor (70). The switching mechanism (200) changes the airflow paths such that air that has passed through the heater (21) and the regeneration portion (72) of the adsorption rotor (70) in this order flows in the other one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

[0020] According to the seventh aspect of the invention, the air to be supplied to the humidity-controlled space (S0) is dehumidified in the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator, and then further dehumidified by the adsorption portion (71) of the adsorption rotor (70). On the other hand, the air that has been heated by the heater (21) passes through the regeneration portion (72) of the adsorption rotor (70) and then passes through the heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser. That is to say, the air that has passed through the regeneration portion (72) of the adsorption rotor (70) may be used to regenerate the adsorbent of the adsorption heat exchanger (102, 101) and adsorption block (302, 301).

ADVANTAGES OF THE INVENTION

[0021] According to the first and second aspects of the invention, the air may be dehumidified to an increased degree in the first and second heat exchange chambers (S11, S12) and the adsorption of moisture into the adsorbent may be promoted in the adsorption block (301, 302). This thus allows the dehumidification device (10) to have improved dehumidification capacity. On top of that, there is no need to increase the number of rotations of the compressor (103) in the refrigerant circuit (100) to improve the dehumidification capacity of the dehumidification device (10), thus allowing for reducing an increase in the power consumption of the dehumidification device (10).

[0022] According to the third aspect of the invention, if the adsorption heat exchanger (101, 102) functions as a condenser, the air heated by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302), thus allowing for promoting the regeneration of the adsorbent of the adsorption block (301, 302).

[0023] According to the fourth aspect of the invention, the degree of non-uniformity in temperature distribution and airflow is reducible in the adsorption blocks (301, 302). This thus allows for preventing the adsorption and regeneration capabilities of the adsorption blocks (301, 302) from deteriorating significantly.

[0024] According to the fifth aspect of the invention, conduction of heat may be promoted between the adsorption heat exchangers (101, 102) and the adsorption blocks (301, 302), and therefore, the adsorption of moisture into the adsorbent of the adsorption blocks (301, 302) and the regeneration of the adsorbent may be promoted, too.

[0025] According to the sixth aspect of the invention, in each of the heat exchange chambers (S11, S12), the air heated by the heater (21) may be supplied to the adsorption block (301, 302) located upstream of the adsorption heat exchanger (101, 102) functioning as a condenser. Thus, the regeneration of the adsorbent of the adsorption block (301, 302) may be promoted, too.

[0026] According to the seventh aspect of the invention, the dehumidification system (1) may have its dehumidification capacity improved by adding the adsorption rotor (70). In addition, since the air that has passed through the regeneration portion (72) of the adsorption rotor (70) may be used to regenerate the adsorbent of the adsorption heat exchanger (102, 101) and adsorption block (301, 302), the air heated by the heater (21) is usable effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

[FIG. 1] FIG. 1 is a piping system diagram illustrating an exemplary configuration for a dehumidification system according to a first embodiment.

[FIG. 2] FIG. 2 generally illustrates the structure of a dehumidification device and an airflow direction during a first dehumidification operation according to the first embodiment.

[FIG. 3] FIG. 3 generally illustrates the structure of the dehumidification device and an airflow direction during a second dehumidification operation according to the first embodiment.

[FIG. 4] FIG. 4 is a piping system diagram illustrating a first variation of the dehumidification system according to the first embodiment.

[FIG. 5] FIG. 5 is a piping system diagram illustrating a second variation of the dehumidification system according to the first embodiment.

[FIG. 6] FIG. 6 is a piping system diagram illustrating a third variation of the dehumidification system according to the first embodiment.

[FIG. 7] FIG. 7 is a piping system diagram illustrating an exemplary configuration for a dehumidification system according to a second embodiment.

[FIG. 8] FIG. 8 generally illustrates the structure of a dehumidification device and an airflow direction during a first dehumidification operation according to the second embodiment.

[FIG. 9] FIG. 9 generally illustrates the structure of the dehumidification device and an airflow direction during a second dehumidification operation according to the second embodiment.

[FIG. 10] FIG. 10 is a piping system diagram illustrating a variation of the dehumidification system according to the second embodiment.

[FIG. 11] FIG. 11 is a piping system diagram illustrating an exemplary configuration for a dehumidification system according to a third embodiment.

[FIG. 12] FIG. 12 is a piping system diagram illustrating an exemplary configuration for a dehumidification system according to a fourth embodiment.

DESCRIPTION OF EMBODIMENTS

[0028] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings, wherein any pair of components illustrated in multiple drawings and having either an identical or substantially the same function are identified by the same reference numeral and will not be described all over again once described.

(First Embodiment)

[0029] FIG. 1 illustrates an exemplary configuration for a dehumidification system (1) according to a first embodiment. This dehumidification system (1) is configured to dehumidify air (e.g., outdoor air (OA) in this example) and supply the dehumidified air to a humidity-controlled space (S0). In this example, the humidity-controlled space (S0) is configured as an indoor space (S1), which is a space to be supplied with air with a low dew point temperature (e.g., air with a dew point temperature of approximately -30°C to -50°C) and which may be a dry clean room provided for a lithium ion battery manufacturing line, for example.

[0030] The dehumidification system (1) includes a dehumidification device (10) and a controller (20). The dehumidification device (10) is provided with an air supply passage (P1) and a regeneration passage (P2). The dehumidification device (10) includes first and second heat exchange chambers (S11, S12), a refrigerant circuit (100), a switching mechanism (200), and first and second adsorption blocks (301, 302).

<Air Supply Passage>

[0031] The air to be supplied to the humidity-controlled space (S0) (e.g., the air to be supplied to an indoor space (S1) in this example) flows through the air supply passage (P1). In this example, the air supply passage (P1) is configured to suck outdoor air (OA) from the outdoor space and provide supply air (RA) for the indoor space (S1). Specifically, the air supply passage (P1) includes a first air supply passage section (P11), of which the inflow end is connected to the outdoor space, and a second air supply passage section (P12), of which the outflow end is connected to the indoor space (S1). In addition, in this example, the first air supply passage section (P11) of the air supply passage (P1) is provided with a cooler (11), around which a drain pan (12) is provided.

<Regeneration Passage>

[0032] Air to regenerate the adsorbent flows through the regeneration passage (P2). In this example, the regeneration passage (P2) is configured to suck the room air (RA) from the indoor space (S1) and discharge exhaust air (EA) into the outdoor space. Specifically, the regeneration passage (P2) includes a first regeneration passage section (P21), of which the inflow end is connected to the indoor space (S1), and a second regeneration passage section (P22), of which the outflow end is connected to the outdoor space. In this example, part of the air in the indoor space (S1) is discharged as the exhaust air (EA) into the outdoor space without passing through the regeneration passage (P2).

<Heat Exchange Chambers>

[0033] The first and second heat exchange chambers (S11, S12) are configured such that one heat exchange chamber is incorporated into the air supply passage (P1) so as to form part of the air supply passage (P1) and the other heat exchange chamber is incorporated into the regeneration passage (P2) so as to form part of the regeneration passage (P2). Specifically, one (S11) of the first and second heat exchange chambers (S11, S12) is incorporated into the air supply passage (P1) by being connected between the outflow end of the first air supply passage section (P11) and the inflow end of the second air supply passage section (P12) and allows the air (i.e., the air to be supplied to the humidity-controlled space (S0)) to flow through itself. Meanwhile, the other (S12) of the first and second heat exchange chambers (S11, S12) is incorporated into the regeneration passage (P2) by being connected between the outflow end of the first regeneration passage section (P21) and the inflow end of the second regeneration passage section (P22) and allows the air (i.e., the air to regenerate the adsorbent) to flow through itself. In the following description, the first and second heat exchange chambers (S11, S12) will be collectively referred to herein as a "heat exchange chamber (S 11, S 12)."

<Cooler, Drain Pan>

[0034] The cooler (11) cools, and thereby dehumidifies, the outdoor air (OA). For example, the cooler (11) may be configured as a heat exchanger (specifically, a fin-and-tube heat exchanger) functioning as an evaporator for a refrigerant circuit (not shown). The drain pan (12) collects the water that has been condensed by the cooler (11). To receive the water that has been condensed by the cooler (11), the drain pan (12) may be configured as a container with an open top, for example, and may be arranged under the cooler (11). In this example, the cooler (11) is provided for the first air supply passage section (P11) of the air supply passage (P1).

<Refrigerant Circuit>

[0035] The refrigerant circuit (100) performs a refrigeration cycle operation by circulating a refrigerant through itself, and includes first and second adsorption heat exchangers (101, 102), a compressor (103), an expansion valve (104), and a four-way switching valve (105).

«Adsorption Heat Exchanger»

[0036] Each of the first and second adsorption heat exchangers (101, 102) is formed by loading an adsorbent on the surface of a heat exchanger (which may be a crossed-fin type fin-and-tube heat exchanger, for example). The first and second adsorption heat exchangers (101, 102) are provided for the first and second heat exchange chambers (S11, S12), respectively. As the adsorbent, zeolite, silica gel, active carbon or an organic polymer material with a hydrophilic functional group may be used. Alternatively, a material having not only the function of adsorbing moisture but also the function of absorbing moisture (i.e., a so-called "sorbent") may be used. In the following description, the first and second adsorption heat exchangers (101, 102) will be collectively simply referred to herein as an "adsorption heat exchanger (101, 102)."

<<Compressor>

[0037] The compressor (103) compresses and discharges the refrigerant. Also, the compressor (103) is configured to be able to change its number of rotations (i.e., its operating frequency) under the control of the controller (20). For example, the compressor (103) may be configured as a variable-capacitance compressor (such as a rotary compressor, a swing compressor or a scroll compressor), of which the number of rotations is adjustable by an inverter circuit (not shown).

«Expansion Valve»

[0038] The expansion valve (104) adjusts the pressure of the refrigerant. For example, the expansion valve (104) may be configured as an electronic expansion valve, of which the degree of opening is changeable in response to a control by the controller (20).

«Four-Way Switching Valve»

[0039] The four-way switching valve (105) has first to fourth ports. The first port is connected to the discharge side of the compressor (103). The second port is connected to the suction side of the compressor (103). The third port is connected to an end of the second adsorption heat exchanger (102). The fourth port is connected to an end of the first adsorption heat exchanger (101). This four-way switching valve (105) is configured to switch between a first connection state (i.e., the state indicated by the solid curves in FIG. 1) and a second connection state (i.e., the state indicated by the dotted curves in FIG. 1) in response to a control by the controller (20).

«Refrigeration Cycle Operation by Refrigerant Circuit»

[0040] If the four-way switching valve (105) is in the first connection state, the refrigerant circuit (100) performs a first refrigeration cycle operation (first operation) such that the first adsorption heat exchanger (101) functions as an evaporator to dehumidify the air and the second adsorption heat exchanger (102) functions as a condenser to humidify the air (i.e., to regenerate the adsorbent). On the other hand, if the four-way switching valve (105) is in the second connection state, the refrigerant circuit (100) performs a second refrigeration cycle operation (second operation) such that the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air and the first adsorption heat exchanger (101) functions as a condenser to humidify the air (i.e., to regenerate the adsorbent). Thus, this refrigerant circuit (100) is configured to selectively perform the first or second refrigeration cycle operation in response to the control by the controller (20). Specifically, this refrigerant circuit (100) is configured to perform the first and second refrigeration cycle operations alternately.

-- First Refrigeration Cycle Operation (First Operation) --

[0041] When the four-way switching valve (105) enters the first connection state, the first and third ports communicate with each other and the second and fourth ports communicate with each other. As a result, the refrigerant that has been compressed by the compressor (103) passes through the four-way switching valve (105) and flows into the second adsorption heat exchanger (102), which performs a regeneration operation by having the adsorbent heated by the refrigerant and releasing moisture from the adsorbent into the air. The refrigerant that has dissipated heat and condensed through the second adsorption heat exchanger (102) has its pressure reduced by the expansion valve (104) and then flows into the first adsorption heat exchanger (101), which performs an adsorption operation by having moisture in the air adsorbed into the adsorbent. The heat of adsorption generated during this operation is applied to the refrigerant. Then, the refrigerant that has absorbed heat and evaporated through the first adsorption heat exchanger (101) is sucked into, and compressed by, the compressor (103).

-- Second Refrigeration Cycle Operation (Second Operation) --

[0042] When the four-way switching valve (105) enters the second connection state, the first and fourth ports communicate with each other and the second and third ports communicate with each other. As a result, the refrigerant that has been compressed by the compressor (103) passes through the four-way switching valve (105) and flows into the first adsorption heat exchanger (101), which performs a regeneration operation by having the adsorbent heated by the refrigerant and releasing moisture from the adsorbent into the air. The refrigerant that has dissipated heat and condensed through the first adsorption heat exchanger (101) has its pressure reduced by the expansion valve (104) and then flows into the second adsorption heat exchanger (102), which performs an adsorption operation by having moisture in the air adsorbed into the adsorbent. The heat of adsorption generated during this operation is applied to the refrigerant. Then, the refrigerant that has absorbed heat and evaporated through the second adsorption heat exchanger (102) is sucked into, and compressed by, the compressor (103).

<Switching Mechanism>

[0043] The switching mechanism (200) is configured to set the connection state between the first and second heat exchange chambers (S11, S12) and the air supply passage (P1) and the regeneration passage (P2) to be either a first passage state (i.e., the state indicated by the solid lines in FIG. 1) or the second passage state (i.e., the state indicated by the dotted lines in FIG. 1) in response to the control by the controller (20).

«First Passage State»

[0044] When the connection state of the first and second heat exchange chambers (S11, S12) switches to the first passage state, the first heat exchange chamber (S11) is connected between the first and second air supply passage sections (P11, P12) and incorporated into the air supply passage (P1), and the second heat exchange chamber (S12) is connected between the first and second regeneration passage sections (P21, P22) and incorporated into the regeneration passage (P2).

«Second Passage State»

[0045] When the connection state of the first and second heat exchange chambers (S11, S12) switches to the second passage state, the first heat exchange chamber (S11) is connected between the first and second regeneration passage sections (P21, P22) and incorporated into the regeneration passage (P2), and the second heat exchange chamber (S12) is connected between the first and second air supply passage sections (P11, P12) and incorporated into the air supply passage (P1).

«Operation of Switching Connections between Heat Exchange Chambers»

[0046] If the four-way switching valve (105) is in the first connection state, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the first passage state. On the other hand, if the four-way switching valve (105) is in the second connection state, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the second passage state. Thus, this switching mechanism (200) is configured to switch the connection states between the first and second heat exchange chambers (S11, S12) and the air supply passage (P1) and the regeneration passage (P2) in parallel with a switch of modes of the refrigeration cycle operation by the refrigerant circuit (100) such that one of the first and second heat exchange chambers (S11, S12) that is provided with an adsorption heat exchanger functioning as an evaporator is incorporated into the air supply passage (P1) and that the other heat exchange chamber provided with an adsorption heat exchanger functioning as a condenser is incorporated into the regeneration passage (P2). That is to say, the switching mechanism (200) changes the airflow paths such that the air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with an adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) and that the air to regenerate the adsorbent flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

«Flow Direction of Air Passing through Adsorption Heat Exchanger»

[0047] In this example, the flow direction of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the air supply passage (P1)) is the same as that of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2)). That is to say, those two airflows form so-called "parallel flows." The same can be said about the flow direction of the air passing through the second adsorption heat exchanger (102). As can be seen, the flow direction of the air passing through each of the first and second adsorption heat exchangers (101, 102) does not change even if the adsorption heat exchanger has switched from an evaporator into a condenser (or vice versa). That is to say, the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in the same direction when the adsorption heat exchanger (101, 102) functions as an evaporator as when the adsorption heat exchanger (101, 102) functions as a condenser.

<Adsorption Block>

[0048] Each of the first and second adsorption blocks (301, 302) is configured to be loaded with an adsorbent and to bring the air into contact with the adsorbent. For example, each of the first and second adsorption blocks (301, 302) may be formed by loading an adsorbent on the surface of a structure (specifically, a structure with a honeycomb structure). Also, the first and second adsorption blocks (301, 302) are provided for the first and second heat exchange chambers (S11, S12), respectively. In the following description, the first and second adsorption blocks (301, 302) will be collectively simply referred to herein as an "adsorption block (301, 302)."

[0049] The first adsorption block (301) is arranged at a position downstream of (i.e., at a leeward position with respect to) the first adsorption heat exchanger (101) if the first adsorption heat exchanger (101) functions as an evaporator in the first heat exchange chamber (S11)(i.e., arranged at a position through which the air dehumidified by the first adsorption heat exchanger (101) passes if the first heat exchange chamber (S11) is incorporated into the air supply passage (P1)). In other words, the first adsorption block (301) is arranged at a position downstream of the first adsorption heat exchanger (101) if the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., the state indicated by the solid lines in FIG. 1) in the first heat exchange chamber (S11).

[0050] Likewise, the second adsorption block (302) is arranged at a position downstream of (i.e., at a leeward position with respect to) the second adsorption heat exchanger (102) if the second adsorption heat exchanger (102) functions as an evaporator in the second heat exchange chamber (S12)(i.e., arranged at a position through which the air dehumidified by the second adsorption heat exchanger (102) passes if the second heat exchange chamber (S12) is incorporated into the air supply passage (P1)). In other words, the second adsorption block (302) is arranged at a position downstream of the second adsorption heat exchanger (102) if the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., the state indicated by the dotted lines in FIG. 1) in the second heat exchange chamber (S12).

[0051] In this example, the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in the same direction when the adsorption heat exchanger (101, 102) functions as an evaporator as when the adsorption heat exchanger (101, 102) functions as a condenser. Thus, the position downstream of the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., the state indicated by the solid lines in FIG. 1) is the position downstream of the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., the state indicated by the dotted lines in FIG. 1). In the same way, the position downstream of the second adsorption heat exchanger (102) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., the state indicated by the dotted lines in FIG. 1) is the position downstream of the second adsorption heat exchanger (102) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., the state indicated by the solid lines in FIG. 1). That is to say, in each of the first and second heat exchange chambers (S11, S12), the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102), no matter whether the adsorption heat exchanger (101, 102) functions as an evaporator or a condenser.

<Controller>

[0052] The controller (20) controls the dehumidification device (10) based on detected values of various kinds of sensors (including a temperature sensor and a humidity sensor, for example). The controller (20) may be configured as a CPU and a memory, for example.

<Dehumidification Operation by Dehumidification Device>

[0053] Next, it will be described with reference to FIG. 1 how the dehumidification device (10) of the first embodiment performs dehumidification operation. This dehumidification device (10) alternately performs first and second dehumidification operations at regular time intervals (of 10 minutes, for example).

«First Dehumidification Operation»

[0054] During the first dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the first connection state (i.e., the state indicated by the solid curves in FIG. 1). As a result, the refrigerant circuit (100) performs a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the first passage state (i.e., the state indicated by the solid lines in FIG. 1).

-- Airflow through Air Supply Passage --

[0055] The air (e.g., the outdoor air (OA) in this example) introduced into the air supply passage (P1) is cooled and dehumidified by the cooler (11) and then supplied to the first heat exchange chamber (S11). The air supplied to the first heat exchange chamber (S11) passes through the first adsorption heat exchanger (101) functioning as an evaporator. In the meantime, moisture in the air passing through the first adsorption heat exchanger (101) is adsorbed into the adsorbent of the first adsorption heat exchanger (101). Also, the heat of adsorption generated during the adsorption is absorbed into the refrigerant flowing through the first adsorption heat exchanger (101). In this manner, the air passing through the first adsorption heat exchanger (101) functioning as an evaporator not only is deprived of its moisture by the adsorbent of the first adsorption heat exchanger (101) to have a decreased humidity but also is cooled due to the heat absorption action of the refrigerant flowing through the first adsorption heat exchanger (101) to have a decreased temperature as well. Next, the air that has been dehumidified and cooled by the first adsorption heat exchanger (101) passes through the first adsorption block (301). In the meantime, the moisture in the air is adsorbed into the adsorbent of the first adsorption block (301). As a result, the air that has been dehumidified by the first adsorption heat exchanger (101) is further dehumidified by the first adsorption block (301). Then, the air that has been dehumidified by passing through the first adsorption heat exchanger (101) and the first adsorption block (301) is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0056] The air (e.g., the room air (RA) in this example) introduced into the regeneration passage (P2) is supplied to the second heat exchange chamber (S12). The air supplied to the second heat exchange chamber (S12) passes through the second adsorption heat exchanger (102) functioning as a condenser. In the meantime, the air passing through the second adsorption heat exchanger (102) is heated by the refrigerant flowing through the second adsorption heat exchanger (102). In addition, the moisture in the adsorbent of the second adsorption heat exchanger (102) is released into the air passing through the second adsorption heat exchanger (102). As a result, the adsorbent of the second adsorption heat exchanger (102) is regenerated. In this manner, the air passing through the second adsorption heat exchanger (102) functioning as a condenser is not only given moisture by the adsorbent of the second adsorption heat exchanger (102) to have an increased humidity but also is heated due to the heat dissipation action of the refrigerant flowing through the second adsorption heat exchanger (102) to have an increased temperature as well. Next, the air that has been humidified and heated by the second adsorption heat exchanger (102) passes through the second adsorption block (302). In the meantime, the moisture in the adsorbent of the second adsorption block (302) is released into the air passing through the second adsorption block (302). As a result, the adsorbent of the second adsorption block (302) is regenerated. Then, the air that has passed through the second adsorption heat exchanger (102) and the second adsorption block (302) is discharged as exhaust air (EA) into the outdoor space.

«Second Dehumidification Operation»

[0057] During the second dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the second connection state (i.e., the state indicated by the dotted curves in FIG. 1). As a result, the refrigerant circuit (100) performs a second refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the second passage state (i.e., the state indicated by the dotted lines in FIG. 1).

-- Airflow through Air Supply Passage --

[0058] The air (e.g., the outdoor air (OA) in this example) introduced into the air supply passage (P1) is cooled and dehumidified by the cooler (11) and then supplied to the second heat exchange chamber (S12). The air supplied to the second heat exchange chamber (S12) passes through the second adsorption heat exchanger (102) functioning as an evaporator. In the meantime, the air passing through the second adsorption heat exchanger (102) functioning as an evaporator is not only deprived of its moisture by the adsorbent of the second adsorption heat exchanger (102) to have a decreased humidity but also is cooled due to the heat absorption action of the refrigerant flowing through the second adsorption heat exchanger (102) to have a decreased temperature as well. Next, the air that has been dehumidified and cooled by the second adsorption heat exchanger (102) passes through the second adsorption block (302). In the meantime, the moisture in the air is adsorbed into the adsorbent of the second adsorption block (302). As a result, the air that has been dehumidified by the second adsorption heat exchanger (102) is further dehumidified by the second adsorption block (302). Then, the air that has been dehumidified by passing through the second adsorption heat exchanger (102) and the second adsorption block (302) is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0059] The air (e.g., the room air (RA) in this example) introduced into the regeneration passage (P2) is supplied to the first heat exchange chamber (S11). The air supplied to the first heat exchange chamber (S11) passes through the first adsorption heat exchanger (101) functioning as a condenser. In the meantime, the air passing through the first adsorption heat exchanger (101) functioning as a condenser is not only given moisture by the adsorbent of the first adsorption heat exchanger (101) to have an increased humidity but also is heated due to the heat dissipation action of the refrigerant flowing through the first adsorption heat exchanger (101) to have an increased temperature as well. In this manner, the adsorbent of the first adsorption heat exchanger (101) is regenerated. Next, the air that has been humidified and heated by the first adsorption heat exchanger (101) passes through the first adsorption block (301). In the meantime, the moisture in the adsorbent of the first adsorption block (301) is released into the air passing through the first adsorption block (301). As a result, the adsorbent of the first adsorption block (301) is regenerated. Then, the air that has passed through the first adsorption heat exchanger (101) and the first adsorption block (301) is discharged as exhaust air (EA) into the outdoor space.

<Structure of Dehumidification Device>

[0060] Next, the structure of the dehumidification device (10) according to this first embodiment will be described with reference to FIG. 2. Note that "up," "down," "right," "left," "front," "back" and "rear" for use in the following description indicate various directions when the dehumidification device (10) is viewed from the front side. In FIG. 2, the view shown in the middle is a plan view of the dehumidification device (10), the view shown on the right side is a right side view of the dehumidification device (10), and the view shown on the left side is a left side view of the dehumidification device (10).

[0061] The dehumidification device (10) includes a casing (41) to house various components of the refrigerant circuit (100). The casing (41) is formed in a rather flat rectangular parallelepiped shape with a relatively short height, and includes a front panel (42), a rear panel (43), a left side panel (44) and a right side panel (45). In this example, the longitudinal direction of the casing (41) defines the forward/backward direction.

[0062] The casing (41) is provided with an adsorption side suction port (51), a regeneration side suction port (52), a supply port (53) and an exhaust port (54). The adsorption side suction port (51) is provided through an upper portion of the rear panel (43), while the regeneration side suction port (52) is provided through a lower portion of the rear panel (43). The supply port (53) is provided around an end of the right side panel (45) so as to be located closer to the front panel (42). Likewise, the exhaust port (54) is provided around an end of the left side panel (44) so as to be located closer to the front panel (42).

[0063] Also, the inner space of the casing (41) has a first partition plate (46), a second partition plate (47) and a middle partition plate (48). These partition plates (46, 47, 48) are provided so as to stand up on the bottom plate of the casing (41) and partition the inner space of the casing (41) from the bottom plate through the top plate thereof. The first and second partition plates (46, 47) are arranged parallel to the front and rear panels (42, 43) and at regular intervals in the forward/backward direction of the casing (41). Specifically, the first partition plate (46) is arranged closer to the rear panel (43), and the second partition plate (47) is arranged closer to the front panel (42). The arrangement of the middle partition plate (48) will be described later.

[0064] Inside the casing (41), the space between the first partition plate (46) and the rear panel (43) is vertically divided into two spaces, of which the lower one defines a first adsorption side internal passage (S21) and the upper one defines a first regeneration side internal passage (S22). The first adsorption side internal passage (S21) communicates with the outdoor space via a duct connected to the adsorption side suction port (51) (corresponding to the first air supply passage section (P11) shown in FIG. 1). The first regeneration side internal passage (S22) communicates with the indoor space (S1) via a duct connected to the regeneration side suction port (52) (corresponding to the first regeneration passage section (P21) shown in FIG. 1). In addition, an adsorption side filter (63) is arranged in the first adsorption side internal passage (S21) and a regeneration side filter (64) is arranged in the first regeneration side internal passage (S22).

[0065] Inside the casing (41), the space between the first and second partition plates (46, 47) is horizontally divided by the middle partition plate (48) into right and left spaces. The space on the left side of the middle partition plate (48) defines the first heat exchange chamber (S11), while the space on the right side of the middle partition plate (48) defines the second heat exchange chamber (S12). The first adsorption heat exchanger (101) is housed in the first heat exchange chamber (S11), and the second adsorption heat exchanger (102) is housed in the second heat exchange chamber (S12). Although not shown, the expansion valve (104) of the refrigerant circuit (100) is further housed in the second heat exchange chamber (S12).

[0066] Each of the first and second adsorption heat exchangers (101, 102) is formed in a rectangular thick plate shape or a flat rectangular parallelepiped shape as a whole, and the two principal surfaces thereof that face each other (i.e., their side surfaces with a broad width) function as air passage planes. The first adsorption heat exchanger (101) is arranged to stand up inside the first heat exchange chamber (S11) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47). Likewise, the second adsorption heat exchanger (102) is arranged to stand up inside the second heat exchange chamber (S12) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47).

[0067] Each of the first and second adsorption blocks (301, 302) is formed in a rectangular thick plate shape or a flat rectangular parallelepiped shape as a whole, and the two principal surfaces thereof that face each other (i.e., their side surfaces with a broad width) function as air passage planes. Each of the first and second adsorption blocks (301, 302) may be configured, for example, as a honeycomb structure with a lot of holes that penetrate from one of the two principal surfaces thereof through the other. The first adsorption block (301) is arranged to stand up inside the first heat exchange chamber (S11) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47). Likewise, the second adsorption block (302) is arranged to stand up inside the second heat exchange chamber (S12) such that the two principal surfaces thereof are parallel to the first and second partition plates (46,47).

[0068] Furthermore, in this example, the first adsorption block (301) is arranged in the first heat exchange chamber (S11) so as to be located between the first adsorption heat exchanger (101) and the second partition plate (47). On the other hand, the second adsorption block (302) is arranged in the second heat exchange chamber (S12) so as to be located between the second adsorption heat exchanger (102) and the second partition plate (47). Note that the first adsorption block (301) is spaced apart from the first adsorption heat exchanger (101) in the forward/backward direction and the second adsorption block (302) is spaced apart from the second adsorption heat exchanger (102) in the forward/backward direction.

[0069] Also, inside the casing (41), the space defined along the front side of the second partition plate (47) is vertically divided into two spaces, of which the upper one defines the second adsorption side internal passage (S23) and the lower one defines the second regeneration side internal passage (S24).

[0070] The first partition plate (46) is provided with first to fourth dampers (D1-D4), while the second partition plate (47) is provided with fifth to eighth dampers (D5-D8). Each of the first through eighth dampers (D1-D8) is configured to switch from an opened state to a closed state, and vice versa, in response to a control by the controller (20). These first through eighth dampers (D1-D8) constitute the switching mechanism (200).

[0071] The first damper (D1) is attached to the upper portion of the first partition plate (46) (i.e., the portion facing the first regeneration side internal passage (S22)) so as to be located on the right side of the middle partition plate (48). The second damper (D2) is attached to the upper portion of the first partition plate (46) so as to be located on the left side of the middle partition plate (48). The third damper (D3) is attached to the lower portion of the first partition plate (46) (i.e., the portion facing the first adsorption side internal passage (S21)) so as to be located on the right side of the middle partition plate (48). The fourth damper (D4) is attached to the lower portion of the first partition plate (46) so as to be located on the left side of the middle partition plate (48).

[0072] The fifth damper (D5) is attached to the upper portion of the second partition plate (47) (i.e., the portion facing the second adsorption side internal passage (S23)) so as to be located on the right side of the middle partition plate (48). The sixth damper (D6) is attached to the upper portion of the second partition plate (47) so as to be located on the left side of the middle partition plate (48). The seventh damper (D7) is attached to the lower portion of the second partition plate (47) (i.e., the portion facing the second regeneration side internal passage (S24)) so as to be located on the right side of the middle partition plate (48). The eighth damper (D8) is attached to the lower portion of the second partition plate (47) so as to be located on the left side of the middle partition plate (48).

[0073] Inside the casing (41), the space between the second adsorption side internal passage (S23) and the second regeneration side internal passage (S24) and the front panel (42) is horizontally divided by another partition plate (49) into two spaces. One of the two spaces located on the right side of the partition plate (49) defines a supply fan chamber (S25). The other space located on the left side of the partition plate (49) defines an exhaust fan chamber (S26). The supply fan chamber (S25) communicates with the indoor space (S1) via a duct connected to the supply port (53) (corresponding to the second air supply passage section (P12) shown in FIG. 1). On the other hand, the exhaust fan chamber (S26) communicates with the outdoor space via a duct connected to the exhaust port (54) (corresponding to the second regeneration passage section (P22) shown in FIG. 1). Also, a supply fan (61) is housed in the supply fan chamber (S25), and an exhaust fan (62) is housed in the exhaust fan chamber (S26). The supply fan (61) has its air outlet connected to the supply port (53) to blow out the air that has been sucked from the second partition plate (47) toward the supply port (53). The exhaust fan (62) has its air outlet connected to the exhaust port (54) to blow out the air that has been sucked from the second partition plate (47) toward the exhaust port (54). Each of the supply fan (61) and exhaust fan (62) may be configured as a centrifugal multi-blade fan (i.e., a so-called "sirocco fan.") Also, in the supply fan chamber (S25), further housed are the compressor (103) and four-way switching valve (105) (not shown) of the refrigerant circuit (100).

<<Airflow during First Dehumidification Operation>>

[0074] Next, the airflow while the dehumidification device (10) of the first embodiment is performing a first dehumidification operation will be described with reference to FIG. 2. During the first dehumidification operation, the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, as shown in FIG. 2, the first, fourth, sixth and seventh dampers (D1, D4, D6, D7) are opened, while the second, third, fifth and eighth dampers (D2, D3, D5, D8) are closed. As a result, the connection state of the first and second heat exchange chambers (S11, S12) is set to be the first passage state (i.e., the state indicated by the solid lines in FIG. 1), the first heat exchange chamber (S11) is incorporated into the air supply passage (P1), and the second heat exchange chamber (S12) is incorporated into the regeneration passage (P2).

-- Airflow through Air Supply Passage --

[0075] The air (e.g., the outdoor air (OA) in this example) that has been supplied to the first adsorption side internal passage (S21) through the adsorption side suction port (51) passes through the adsorption side filter (63) and the fourth damper (D4) and then is supplied to the first heat exchange chamber (S11).

[0076] The air supplied to the first heat exchange chamber (S11) is deprived of its moisture, and dehumidified, by the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) while passing through the first adsorption heat exchanger (101) and the first adsorption block (301) in this order.

[0077] The air that has been dehumidified by passing through the first adsorption heat exchanger (101) and the first adsorption block (301) flows into the second adsorption side internal passage (S23) through the sixth damper (D6), passes through the supply fan chamber (S25) and the supply port (53), and then is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0078] The air (e.g., the room air (RA) in this example) that has been supplied to the first regeneration side internal passage (S22) through the regeneration side suction port (52) passes through the regeneration side filter (64) and the first damper (D1) and then is supplied to the second heat exchange chamber (S12).

[0079] The air supplied to the second heat exchange chamber (S12) is given moisture by the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) while passing through the second adsorption heat exchanger (102) and the second adsorption block (302) in this order. As a result, the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) is regenerated.

[0080] The air that has passed through the second adsorption heat exchanger (102) and the second adsorption block (302) flows into the second regeneration side internal passage (S24) through the seventh damper (D7), passes through the exhaust fan chamber (S26) and the exhaust port (54), and then is exhausted into the outdoor space.

«Airflow during Second Dehumidification Operation»

[0081] Next, the airflow while the dehumidification device (10) of the first embodiment is performing a second dehumidification operation will be described with reference to FIG. 3. During the second dehumidification operation, the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, as shown in FIG. 3, the second, third, fifth and eighth dampers (D2, D3, D5, D8) are opened, while the first, fourth, sixth and seventh dampers (D1, D4, D6, D7) are closed. As a result, the connection state of the first and second heat exchange chambers (S11, S12) is set to be the second passage state (i.e., the state indicated by the solid lines in FIG. 1), the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2), and the second heat exchange chamber (S12) is incorporated into the air supply passage (P1).

-- Airflow through Air Supply Passage --

[0082] The air (e.g., the outdoor air (OA) in this example) that has been supplied to the first adsorption side internal passage (S21) through the adsorption side suction port (51) passes through the adsorption side filter (63) and the third damper (D3) and then is supplied to the second heat exchange chamber (S12).

[0083] The air supplied to the second heat exchange chamber (S12) is deprived of its moisture, and dehumidified, by the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) while passing through the second adsorption heat exchanger (102) and the second adsorption block (302) in this order.

[0084] The air that has been dehumidified by passing through the second adsorption heat exchanger (102) and the second adsorption block (302) flows into the second adsorption side internal passage (S23) through the fifth damper (D5), passes through the supply fan chamber (S25) and the supply port (53), and then is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0085] The air (e.g., the room air (RA) in this example) that has been supplied to the first regeneration side internal passage (S22) through the regeneration side suction port (52) passes through the regeneration side filter (64) and the second damper (D2) and then is supplied to the first heat exchange chamber (S11).

[0086] The air supplied to the first heat exchange chamber (S11) is given moisture by the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) while passing through the first adsorption heat exchanger (101) and the first adsorption block (301) in this order. As a result, the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) is regenerated.

[0087] The air that has passed through the first adsorption heat exchanger (101) and the first adsorption block (301) flows into the second regeneration side internal passage (S24) through the eighth damper (D8), passes through the exhaust fan chamber (S26) and the exhaust port (54), and then is exhausted into the outdoor space.

<Advantages of First Embodiment>

[0088] By adding first and second adsorption blocks (301, 302) to the first and second heat exchange chambers (S11, S12), respectively, the dehumidification device (10) of the first embodiment allows for dehumidifying the air to an increased degree using the first and second heat exchange chambers (S11, S12).

[0089] In addition, by arranging the first adsorption block (301) at such a position that the air dehumidified by the first adsorption heat exchanger (101) passes through if the first heat exchange chamber (S11) is incorporated into the air supply passage (P1), the air that has been dehumidified and cooled by the first adsorption heat exchanger (101) may be supplied to the first adsorption block (301). This thus allows for promoting the adsorption of moisture into the adsorbent of the first adsorption block (301). Likewise, if the second heat exchange chamber (S12) is incorporated into the air supply passage (P1), the air that has been dehumidified and cooled by the second adsorption heat exchanger (102) may be supplied to the second adsorption block (302). This thus allows for promoting the adsorption of moisture into the adsorbent of the second adsorption block (302). That is to say, if the adsorption heat exchanger (101, 102) functions as an evaporator in each of the first and second heat exchange chambers (S11, S12), an adsorption block (301, 302) is arranged at a position downstream of that adsorption heat exchanger (101, 102). Then, the air that has been dehumidified and cooled by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302). This thus allows for promoting the adsorption of moisture into the adsorbent of the adsorption block (301, 302).

[0090] As can be seen from the foregoing description, the first and second heat exchange chambers (S11, S12) are allowed to dehumidify the air to an increased degree, and the adsorption of moisture into the adsorbent of the adsorption block (301, 302) may be promoted, thus allowing for improving the dehumidification capacity of the dehumidification device (10).

[0091] On top of that, there is no need to increase the number of rotations of the compressor (103) in the refrigerant circuit (100) to improve the dehumidification capacity of the dehumidification device (10), thus allowing for reducing an increase in the power consumption of the dehumidification device (10).

[0092] Furthermore, according to the first embodiment, no matter whether the adsorption heat exchanger (101, 102) functions as an evaporator or a condenser, the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102) in each of the first and second heat exchange chambers (S11, S12). Therefore, if the first adsorption heat exchanger (101) functions as a condenser in the first heat exchange chamber (S11) (i.e., if the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2)), the air heated by the first adsorption heat exchanger (101) may be supplied to the first adsorption block (301), thus allowing for promoting the regeneration of the adsorbent of the first adsorption block (301). Likewise, if the second adsorption heat exchanger (102) functions as a condenser in the second heat exchange chamber (S12) (i.e., if the second heat exchange chamber (S12) is incorporated into the regeneration passage (P2)), the air heated by the second adsorption heat exchanger (102) may be supplied to the second adsorption block (302), thus allowing for promoting the regeneration of the adsorbent of the second adsorption block (302). As can be seen, since the regeneration of the adsorbent is promotable in each of the adsorption blocks (301, 302), the dehumidification capacity of the dehumidification device (10) may be further improved.

[0093] Furthermore, by spacing the first adsorption block (301) from the first adsorption heat exchanger (101), the degree of non-uniformity in temperature distribution and airflow is reducible in the first adsorption block (301). The same can be said about the second adsorption block (302). As can be seen, the degree of non-uniformity in temperature distribution and airflow is reducible in the first and second adsorption blocks (301, 302), thus allowing for preventing the adsorption and regeneration capabilities of the first and second adsorption blocks (301, 302) from deteriorating significantly.

(First Variation of First Embodiment)

[0094] Optionally, the regeneration passage (P2) may also be configured to suck the outdoor air (OA) and discharge the exhaust air (EA) into the outdoor space as shown in FIG. 4. In this example, the inflow end of the first regeneration passage section (P21) is connected to a midpoint of the first air supply passage section (P11) (specifically, to a point downstream of the cooler (11)). In the other respects, the configuration of this variation is the same as the one shown in FIG. 1.

[0095] In the dehumidification system (1) shown in FIG. 4, the room air (RA) is not allowed to go back from the indoor space (S1) toward the dehumidification device (10). That is why even if the indoor space (S1) is contaminated with any chemical substance, for example, the outdoor air (OA) that is cleaner than the room air (RA) may be dehumidified by the dehumidification device (10) and then supplied to the indoor space (S1). This thus allows for maintaining a sufficient degree of cleanness for the indoor space (S1).

(Second Variation of First Embodiment)

[0096] Alternatively, the air supply passage (P1) may also be configured to suck the room air (RA) and provide supply air (SA) for the indoor space (S1) as shown in FIG. 5. Also, the regeneration passage (P2) may also be configured to suck the outdoor air (OA) and discharge exhaust air (EA) into the outdoor space. In this example, the inflow end of the first air supply passage section (P11) is connected to the indoor space (S1), and the inflow end of the first regeneration passage section (P21) is connected to the outdoor space. Also, the cooler (11) is provided for the first regeneration passage section (P21). In the other respects, the configuration of this variation is the same as the one shown in FIG. 1.

[0097] The dehumidification system (1) shown in FIG. 5 is configured to have room air (RA) with a low dew point temperature further dehumidified by the dehumidification device (10) and supply the air thus dehumidified to the indoor space (S1). Thus, the indoor space (S1) may have an even lower dew point temperature.

(Third Variation of First Embodiment)

[0098] As shown in FIG. 6, the dehumidification system (1) may further include a pretreatment dehumidification device (30) in addition to the dehumidification device (10) and controller (20) shown in FIG. 1. In this example, the humidity-controlled space (S0) is comprised of an indoor space (S1) and a chamber (S2) provided for the indoor space (S1). The indoor space (S1) is a space that needs to be supplied with air with a low dew point temperature (e.g., air with a dew point temperature of about -30°C). The chamber (S2) is a space that needs to be supplied with air with a lower dew point temperature than the indoor space (S1) (e.g., air with a dew point temperature of about -50°C). Furthermore, in this example, the dehumidification system (1) is provided with a pretreatment passage (P3) and a post-treatment passage (P4). Also, in this dehumidification system (1), the air (e.g., the outdoor air (OA) in this example) dehumidified by the pretreatment dehumidification device (30) is supplied as supply air (SA0) to the indoor space (S1), and the air (e.g., the room air (RA) in this example) dehumidified by the dehumidification device (10) is supplied as supply air (SA) to the chamber (S2). The controller (20) controls the dehumidification device (10) and the pretreatment dehumidification device (30) based on the detected values of various kinds of sensors.

<Pretreatment Passage>

[0099] Air to be supplied to the humidity-controlled space (S0) (e.g., air to be supplied to the indoor space (S1) in this example) flows through the pretreatment passage (P3). In this example, the pretreatment passage (P3) is configured to suck the outdoor air (OA) from the outdoor space and provide supply air (SA0) for the indoor space (S1). Specifically, the pretreatment passage (P3) includes a first pretreatment passage section (P31), of which the inflow end is connected to the outdoor space, and a second pretreatment passage section (P32), of which the outflow end is connected to the indoor space (S1). In this example, the cooler (11) is provided for the first pretreatment passage section (P31).

<Post-Treatment Passage>

[0100] Air to regenerate the adsorbent (e.g., the air supplied from the regeneration passage (P2) in this example) flows through the post-treatment passage (P4). In this example, the post-treatment passage (P4) is configured to suck the air through the outflow end of the regeneration passage (P2) and discharge exhaust air (EA) into the outdoor space. Specifically, the post-treatment passage (P4) includes a first post-treatment passage section (P41), of which the inflow end is connected to the outflow end of the regeneration passage (P2), and a second post-treatment passage section (P42), of which the outflow end is connected to the outdoor space. Note that in this example, part of the air in the chamber (S2) is exhausted as exhaust air (EA) into the outdoor space without passing through the indoor space (S1) and part of the air in the indoor space (S1) is exhausted as exhaust air (EA) into the outdoor space without passing through the regeneration passage (P2) and the post-treatment passage (P4).

<Air Supply Passage, Regeneration Passage>

[0101] In this example, the air supply passage (P1) is configured to suck the room air (RA) from the indoor space (S1) and provide supply air (SA) for the chamber (S2). Specifically, the inflow end of the first air supply passage section (P11) is connected to the indoor space (S1), and the outflow end of the second air supply passage section (P12) is connected to the chamber (S2). Meanwhile, the regeneration passage (P2) is configured to suck the room air (RA) from the indoor space (S1) and discharge regenerate air (i.e., the air to regenerate the adsorbent) into the post-treatment passage (P4). Specifically, the inflow end of the first regeneration passage section (P21) is connected to a middle portion of the first air supply passage section (P11), and the outflow end of the second regeneration passage section (P22) is connected to the inflow end of the first post-treatment passage section (P41).

<Pretreatment Dehumidification Device>

[0102] The pretreatment dehumidification device (30) has the same configuration as the dehumidification device (10). Note that the structure of the pretreatment dehumidification device (30) may be the same as that of the dehumidification device (10) shown in FIG. 2.

<Refrigerant Circuit of Pretreatment Dehumidification Device>

[0103] Just like the refrigerant circuit (100) of the dehumidification device (10), the refrigerant circuit (100) of the pretreatment dehumidification device (30) is configured to perform alternately, in response to control by the controller (20), a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator to dehumidify the air and the second adsorption heat exchanger (102) functions as a condenser to regenerate the adsorbent and a second refrigeration cycle operation in which the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air and the first adsorption heat exchanger (101) functions as a condenser to regenerate the adsorbent.

<Switching Mechanism of Pretreatment Dehumidification Device>

[0104] The switching mechanism (200) of the pretreatment dehumidification device (30) is configured to set, in response to the control by the controller (20), the connection state between the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) and the pretreatment passage (P3) and the post-treatment passage (P4) to be either a third passage state (i.e., the state indicated by the solid lines in FIG. 6) or a fourth passage state (i.e., the state indicated by the dotted lines in FIG. 6).

<Third Passage State>

[0105] When the connection state of the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) switches to the third passage state, the first heat exchange chamber (S11) is connected between the first and second pretreatment passage sections (P31, P32) and incorporated into the pretreatment passage (P3), and the second heat exchange chamber (S12) is connected between the first and second post-treatment passage sections (P41, P42) and incorporated into the post-treatment passage (P4).

<Fourth Passage State>

[0106] When the connection state of the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) switches to the fourth passage state, the first heat exchange chamber (S11) is connected between the first and second post-treatment passage sections (P41, P42) and incorporated into the post-treatment passage (P4), and the second heat exchange chamber (S12) is connected between the first and second pretreatment passage sections (P31, P32) and incorporated into the pretreatment passage (P3).

<Operation of Switching Connections between Heat Exchange Chambers>

[0107] When the four-way switching valve (105) is in the first connection state, the switching mechanism (200) of the pretreatment dehumidification device (30) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the third passage state. On the other hand, when the four-way switching valve (105) is in the second connection state, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the fourth passage state. That is to say, just like the switching mechanism (200) of the dehumidification device (10), the switching mechanism (200) of the pretreatment dehumidification device (30) changes the airflow paths such that the air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) (e.g., the indoor space (S1) in this example) and that air to regenerate the adsorbent (e.g., the air that has passed through one of the first and second heat exchange chambers (S11, S12) of the dehumidification device (10) that is provided with the adsorption heat exchanger (101, 102) functioning as a condenser in this example) flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

«Flow Direction of Air Passing through Adsorption Heat Exchanger»

[0108] In this example, in the pretreatment dehumidification device (30), the flow direction of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the third passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the pretreatment passage (P3)) is the same as that of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the fourth passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the post-treatment passage (P4)). The same can be said about the flow direction of the air passing through the second adsorption heat exchanger (102). That is to say, just like the switching mechanism (200) of the dehumidification device (10), the switching mechanism (200) of the pretreatment dehumidification device (30) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in the same direction when the adsorption heat exchanger (101, 102) functions as an evaporator as when the adsorption heat exchanger (101, 102) functions as a condenser.

<Dehumidification Operation by Pretreatment Dehumidification Device>

[0109] Next, it will be described with reference to FIG. 6 how the pretreatment dehumidification device (30) performs dehumidification operation. This pretreatment dehumidification device (30) alternately performs third and fourth dehumidification operations at regular time intervals (of 10 minutes, for example).

«Third Dehumidification Operation»

[0110] During the third dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the first connection state (i.e., the state indicated by the solid curves in FIG. 6). As a result, the refrigerant circuit (100) performs a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the third passage state (i.e., the state indicated by the solid lines in FIG. 6).

[0111] The air (e.g., the outdoor air (OA) in this example) introduced into the pretreatment passage (P3) is cooled and dehumidified by the cooler (11) and then supplied to the first heat exchange chamber (S11). While passing through the first adsorption heat exchanger (101) and the first adsorption block (301) in this order, the air supplied to the first heat exchange chamber (S11) is deprived of its moisture, and dehumidified, by the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301). The air that has been dehumidified in the first heat exchange chamber (S11) is supplied as supply air (SA0) to the indoor space (S1).

[0112] The air introduced into the post-treatment passage (P4) (e.g., the air supplied from the regeneration passage (P2) in this example) is supplied to the second heat exchange chamber (S12). While passing through the second adsorption heat exchanger (102) and the second adsorption block (302) in this order, the air supplied to the second heat exchange chamber (S12) is given moisture by the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302). As a result, the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) is regenerated. The air that has passed through the second heat exchange chamber (S12) is exhausted as exhaust air (EA) into the outdoor space.

<<Fourth Dehumidification Operation>>

[0113] During the fourth dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the second connection state (i.e., the state indicated by the dotted curves in FIG. 6). As a result, the refrigerant circuit (100) performs a second refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the fourth passage state (i.e., the state indicated by the dotted lines in FIG. 6).

[0114] The air (e.g., the outdoor air (OA) in this example) introduced into the pretreatment passage (P3) is cooled and dehumidified by the cooler (11) and then supplied to the second heat exchange chamber (S12). While passing through the second adsorption heat exchanger (102) and the second adsorption block (302) in this order, the air supplied to the second heat exchange chamber (S12) is deprived of its moisture, and dehumidified, by the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302). The air that has been dehumidified in the second heat exchange chamber (S12) is supplied as supply air (SA0) to the indoor space (S1).

[0115] The air introduced into the post-treatment passage (P4) (e.g., the air supplied from the regeneration passage (P2) in this example) is supplied to the first heat exchange chamber (S11). While passing through the first adsorption heat exchanger (101) and the first adsorption block (301) in this order, the air supplied to the first heat exchange chamber (S11) is given moisture by the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301). As a result, the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) is regenerated. The air that has passed through the first heat exchange chamber (S11) is exhausted as exhaust air (EA) into the outdoor space.

<Advantages of Third Variation of First Embodiment>

[0116] As can be seen from the foregoing description, the air (e.g., the outdoor air (OA) in this example) to be supplied to the indoor space (S1) is dehumidified by the pretreatment dehumidification device (30) and supplied as supply air (SA0) to the indoor space (S1), and the room air (RA) supplied from the indoor space (S1) is dehumidified by the dehumidification device (10) and supplied as supply air (SA) to the chamber (S2). This thus allows for making the dew point temperature of the air in the chamber (S2) lower than that of the air in the indoor space (S1). In this manner, by supplying heavily the supply air (SA) with such a low dew point temperature to the chamber (S2), the power to be consumed to operate the dehumidification system (1) may be cut down compared to a situation where the dew point temperature is lowered in the entire indoor space (S1).

(Second Embodiment)

[0117] FIG. 7 illustrates an exemplary configuration for a dehumidification system (1) according to a second embodiment. This dehumidification system (1) includes a dehumidification device (10), a controller (20) and a heater (21). Note that the dehumidification device (10) of this second embodiment has a different structure from the dehumidification device (10) of the first embodiment (see FIG. 2). Specifically, the flow directions of the air passing through the first and second adsorption heat exchangers (101, 102) and the arrangements of the first and second adsorption blocks (301, 302) are different from those of the first embodiment described above. In the other respects, this second embodiment has the same configuration as the first embodiment described above.

<Heater>

[0118] The heater (21) is provided for the regeneration passage (P2) and arranged upstream of (i.e., at a windward position with respect to) one of the first and second heat exchange chambers (S11, S12) that is provided with an adsorption heat exchanger functioning as a condenser. That is to say, the heater (21) is configured to heat the air that is going to regenerate the adsorbent. In this example, the heater (21) is arranged on the first regeneration passage section (P21). For example, the heater (21) may be implemented either as a sensible heat exchanger which exchanges heat between air flowing through the first regeneration passage section (P21) and air flowing through the second regeneration passage section (P22) or as a heat exchanger functioning as a condenser of a refrigerant circuit (not shown) (specifically, as a fin-and-tube heat exchanger).

<Refrigerant Circuit>

[0119] As in the first embodiment described above, the refrigerant circuit (100) is also configured to perform alternately, in response to control by the controller (20), a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator to dehumidify the air and the second adsorption heat exchanger (102) functions as a condenser to regenerate the adsorbent and a second refrigeration cycle operation in which the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air and the first adsorption heat exchanger (101) functions as a condenser to regenerate the adsorbent.

<Switching Mechanism>

[0120] The switching mechanism (200) is configured to set the connection state of the first and second heat exchange chambers (S11, S12) to be either a first passage state (i.e., the state indicated by the solid lines in FIG. 7) or a second passage state (i.e., the state indicated by the dotted lines in FIG. 7) in response to the control by the controller (20). If the four-way switching valve (105) is in the first connection state (i.e., the state indicated by the solid curves in FIG. 7), the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the first passage state. On the other hand, if the four-way switching valve (105) is in the second connection state (i.e., the state indicated by the dotted curves in FIG. 7), the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the second passage state. That is to say, the switching mechanism (200) changes the airflow paths such that the air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with an adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) and that the air to regenerate the adsorbent (i.e., the air that has passed through the heater (21) in this example) flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

[0121] In this example, the flow direction of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the air supply passage (P1)) is opposite from that of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2)). That is to say, those two airflows form so-called "parallel flows." The same can be said about the flow direction of the air passing through the second adsorption heat exchanger (102). As can be seen, the flow direction of the air passing through each of the first and second adsorption heat exchangers (101,

102) inverts when the adsorption heat exchanger switches from an evaporator to a condenser (or vice versa). That is to say, the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in an opposite direction when the adsorption heat exchanger (101, 102) functions as an evaporator from when the adsorption heat exchanger (101, 102) functions as a condenser.

<Adsorption Block>

[0122] The first adsorption block (301) is arranged at a position downstream of (i.e., at a leeward position with respect to) the first adsorption heat exchanger (101) if the first adsorption heat exchanger (101) functions as an evaporator in the first heat exchange chamber (S11)(i.e., arranged at a position through which the air dehumidified by the first adsorption heat exchanger (101) passes if the first heat exchange chamber (S11) is incorporated into the air supply passage (P1)).

[0123] Likewise, the second adsorption block (302) is arranged at a position downstream of (i.e., at a leeward position with respect to) the second adsorption heat exchanger (102) if the second adsorption heat exchanger (102) functions as an evaporator in the second heat exchange chamber (S12)(i.e., arranged at a position through which the air dehumidified by the second adsorption heat exchanger (102) passes if the second heat exchange chamber (S12) is incorporated into the air supply passage (P1)).

[0124] In this example, the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in an opposite direction when the adsorption heat exchanger (101, 102) functions as an evaporator from when the adsorption heat exchanger (101, 102) functions as a condenser. Thus, the position downstream of the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., the state indicated by the solid lines in FIG. 7) is the position upstream of the first adsorption heat exchanger (101) (e.g., a position between the heater (21) and the first adsorption heat exchanger (101) in this example) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., the state indicated by the dotted lines in FIG. 7). In the same way, the position downstream of the second adsorption heat exchanger (102) when the connection state of the first and second heat exchange chambers (S11, S12) is the second passage state (i.e., the state indicated by the dotted lines in FIG. 7) is the position upstream of the second adsorption heat exchanger (102) (e.g., a position between the heater (21) and the second adsorption heat exchanger (102) in this example) when the connection state of the first and second heat exchange chambers (S11, S12) is the first passage state (i.e., the state indicated by the solid lines in FIG. 7). That is to say, in each of the first and second heat exchange chambers (S11, S12), the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102) when the adsorption heat exchanger (101, 102) functions as an evaporator and located upstream of the adsorption heat exchanger (101, 102) when the adsorption heat exchanger (101, 102) functions as a condenser.

<Dehumidification Operation by Dehumidification Device>

[0125] Next, it will be described with reference to FIG. 7 how the dehumidification device (10) of the second embodiment performs dehumidification operation. Just like the dehumidification device (10) of the first embodiment, the dehumidification device (10) of the second embodiment also alternately performs first and second dehumidification operations at regular time intervals (of 10 minutes, for example).

«First Dehumidification Operation»

[0126] During the first dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the first connection state (i.e., the state indicated by the solid curves in FIG. 7). As a result, the refrigerant circuit (100) performs a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the first passage state (i.e., the state indicated by the solid lines in FIG. 7).

-- Airflow through Air Supply Passage --

[0127] The air (e.g., the outdoor air (OA) in this example) introduced into the air supply passage (P1) is cooled and dehumidified by the cooler (11) and then supplied to the first heat exchange chamber (S11). The air supplied to the first heat exchange chamber (S11) passes through the first adsorption heat exchanger (101) functioning as an evaporator. In the meantime, the air passing through the first adsorption heat exchanger (101) functioning as an evaporator not only is deprived of its moisture by the adsorbent of the first adsorption heat exchanger (101) to have a decreased humidity but also is cooled due to the heat absorption action of the refrigerant flowing through the first adsorption heat exchanger (101) to have a decreased temperature as well. Next, the air that has been dehumidified and cooled by the first adsorption heat exchanger (101) passes through the first adsorption block (301). In the meantime, the moisture in the air is adsorbed into the adsorbent of the first adsorption block (301). As a result, the air that has been dehumidified by the first adsorption heat exchanger (101) is further dehumidified by the first adsorption block (301). Then, the air that has been dehumidified by passing through the first adsorption heat exchanger (101) and the first adsorption block (301) is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0128] The air (e.g., the room air (RA) in this example) introduced into the regeneration passage (P2) is heated by the heater (21) and then supplied to the second heat exchange chamber (S12). The air supplied to the second heat exchange chamber (S12) passes through the second adsorption block (302). In the meantime, the moisture in the adsorbent of the second adsorption block (302) is released into the air passing through the second adsorption block (302). As a result, the adsorbent of the second adsorption block (302) is regenerated. Next, the air that has been humidified by the second adsorption block (302) passes through the second adsorption heat exchanger (102) functioning as a condenser. The air passing through the second adsorption heat exchanger (102) functioning as a condenser is not only given moisture by the adsorbent of the second adsorption heat exchanger (102) to have an increased humidity but also is heated due to the heat dissipation action of the refrigerant flowing through the second adsorption heat exchanger (102) to have an increased temperature as well. As a result, the adsorbent of the second adsorption heat exchanger (102) is regenerated. Then, the air that has passed through the second adsorption heat exchanger (102) and the second adsorption block (302) is discharged as exhaust air (EA) into the outdoor space.

«Second Dehumidification Operation»

[0129] During the second dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the second connection state (i.e., the state indicated by the dotted curves in FIG. 7). As a result, the refrigerant circuit (100) performs a second refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the second passage state (i.e., the state indicated by the dotted lines in FIG. 7).

-- Airflow through Air Supply Passage --

[0130] The air (e.g., the outdoor air (OA) in this example) introduced into the air supply passage (P1) is cooled and dehumidified by the cooler (11) and then supplied to the second heat exchange chamber (S12). The air supplied to the second heat exchange chamber (S12) passes through the second adsorption heat exchanger (102) functioning as an evaporator. In the meantime, the air passing through the second adsorption heat exchanger (102) functioning as an evaporator not only is deprived of its moisture by the adsorbent of the second adsorption heat exchanger (102) to have a decreased humidity but also is cooled due to the heat absorption action of the refrigerant flowing through the second adsorption heat exchanger (102) to have a decreased temperature as well. Next, the air that has been dehumidified and cooled by the second adsorption heat exchanger (102) passes through the second adsorption block (302). In the meantime, the moisture in the air is adsorbed into the adsorbent of the second adsorption block (302). As a result, the air that has been dehumidified by the second adsorption heat exchanger (102) is further dehumidified by the second adsorption block (302). Then, the air that has been dehumidified by passing through the second adsorption heat exchanger (102) and the second adsorption block (302) is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0131] The air (e.g., the room air (RA) in this example) introduced into the regeneration passage (P2) is heated by the heater (21) and then supplied to the first heat exchange chamber (S11). The air supplied to the first heat exchange chamber (S11) passes through the first adsorption block (301). In the meantime, the moisture in the adsorbent of the first adsorption block (301) is released into the air passing through the first adsorption block (301). As a result, the adsorbent of the first adsorption block (301) is regenerated. Next, the air that has been humidified by the first adsorption block (301) passes through the first adsorption heat exchanger (101) functioning as a condenser. In the meantime, the air passing through the first adsorption heat exchanger (101) functioning as a condenser is not only given moisture by the adsorbent of the first adsorption heat exchanger (101) to have an increased humidity but also is heated due to the heat dissipation action of the refrigerant flowing through the first adsorption heat exchanger (101) to have an increased temperature as well. As a result, the adsorbent of the first adsorption heat exchanger (101) is regenerated. Then, the air that has passed through the first adsorption heat exchanger (101) and the first adsorption block (301) is discharged as exhaust air (EA) into the outdoor space.

<Structure of Dehumidification Device>

[0132] Next, the structure of the dehumidification device (10) according to this second embodiment will be described with reference to FIG. 8. Note that "up," "down," "right," "left," "front," "back" and "rear" for use in the following description indicate various directions when the dehumidification device (10) is viewed from the front side. In FIG. 8, the view shown in the middle is a plan view of the dehumidification device (10), the view shown at the top is a rear view of the dehumidification device (10), and the view shown at the bottom is a front view of the dehumidification device (10).

[0133] The dehumidification device (10) includes a casing (41) to house various components of the refrigerant circuit (100). The casing (41) is formed in a rather flat rectangular parallelepiped shape with a relatively short height, and includes a front panel (42), a rear panel (43), a left side panel (44) and a right side panel (45). In this example, the longitudinal direction of the casing (41) defines the rightward/leftward direction.

[0134] The casing (41) is provided with an adsorption side suction port (51), a regeneration side suction port (52), a supply port (53) and an exhaust port (54). The adsorption side suction port (51) is provided through a portion of the rear panel (43) close to the right end, while the regeneration side suction port (52) is provided through a portion of the rear panel (43) close to the left end. The supply port (53) is provided through a portion of the front panel (42) close to the left end. The exhaust port (54) is provided through a portion of the front panel (42) close to the right end.

[0135] Also, the inner space of the casing (41) has a first partition plate (46), a second partition plate (47) and a middle partition plate (48). These partition plates (46, 47, 48) are provided so as to stand up on the bottom plate of the casing (41) and partition the inner space of the casing (41) from the bottom plate through the top plate thereof. The first and second partition plates (46, 47) are arranged parallel to the left and right side panels (44, 45) and at regular intervals in the rightward/leftward direction of the casing (41). Specifically, the first partition plate (46) is arranged closer to the left side panel (44), and the second partition plate (47) is arranged closer to the right side panel (45). The space on the left side of the first partition plate (46) defines a left side space (S31), the space between the first and second partition plates (46, 47) defines a middle space (S32), and the space on the right side of the second partition plate (47) defines a right side space (S33). The arrangement of the middle partition plate (48) will be described later.

[0136] The left side space (S31) is partitioned into a portion closer to the left side panel (44) and a portion closer to the first partition plate (46). The former portion of the left side space (S31) closer to the left side surface of the casing (41) is partitioned into two spaces in the forward/backward direction. The front space defines a supply fan chamber (S25), while the rear space defines a regeneration side suction chamber (S28). The latter portion of the left side space (S31) closer to the first partition plate (46) is vertically partitioned into two spaces, of which the upper one defines a second adsorption side internal passage (S23) and the lower one defines a first regeneration side internal passage (S22).

[0137] The supply fan chamber (S25) communicates with the indoor space (S1) via a duct connected to the supply port (53) (corresponding to the second air supply passage section (P12) shown in FIG. 7). A supply fan (61) is housed in the supply fan chamber (S25). The supply fan (61) has its air outlet connected to the supply port (53). In the supply fan chamber (S25), further housed are the compressor (103) and four-way switching valve (105) (not shown) of the refrigerant circuit (100). On the other hand, the regeneration side suction chamber (S28) communicates with the indoor space (S1) via a duct connected to the regeneration side suction port (52) (corresponding to the first regeneration passage section (P21) shown in FIG. 7).

[0138] The second adsorption side internal passage (S23) is separated from the regeneration side suction chamber (S28) by a partition plate extending in the forward/backward direction, and communicates with the supply fan chamber (S25). The first regeneration side internal passage (S22) communicates with the regeneration side suction chamber (S28).

[0139] The right side space (S33) is partitioned into a portion closer to the right side surface of the casing (41) and a portion closer to the second partition plate (47). The former portion of the right side space (S33) closer to the right side surface of the casing (41) is partitioned into two spaces in the forward/backward direction. The front space defines an exhaust fan chamber (S26), while the rear space is further vertically divided into two spaces. The lower one of the two spaces defines an adsorption side suction chamber (S27) separated from the exhaust fan chamber (S26), while the upper space communicates with the exhaust fan chamber (S26). The portion of the right side space (S33) closer to the second partition plate (47) is further vertically divided into two spaces. The upper one of the two spaces defines a second regeneration side internal passage (S24), while the lower space defines a first adsorption side internal passage (S21).

[0140] The exhaust fan chamber (S26) communicates with the outdoor space via a duct connected to the exhaust port (54) (corresponding to the second regeneration passage section (P22) shown in FIG. 7). An exhaust fan (62) is housed in the exhaust fan chamber (S26). The air outlet of the exhaust fan (62) is connected to the exhaust port (54). The adsorption side suction chamber (S27) communicates with the outdoor space via a duct connected to the adsorption side suction port (51) (corresponding to the first air supply passage section (P11) shown in FIG. 7).

[0141] The second regeneration side internal passage (S24) communicates with the exhaust fan chamber (S26). The first adsorption side internal passage (S21) communicates with the adsorption side suction chamber (S27).

[0142] The middle space (S32) is partitioned by the middle partition plate (48) in the forward/backward direction. The space on the backside of the middle partition plate (48) defines the first heat exchange chamber (S11), while the space on the front side of the middle partition plate (48) defines the second heat exchange chamber

(S12). The first adsorption heat exchanger (101) is housed in the first heat exchange chamber (S11), and the second adsorption heat exchanger (102) is housed in the second heat exchange chamber (S12). Although not shown, the expansion valve (104) of the refrigerant circuit (100) is further housed in the second heat exchange chamber (S12).

[0143] Each of the first and second adsorption heat exchangers (101, 102) is formed in a rectangular thick plate shape or a flat rectangular parallelepiped shape as a whole, and the two principal surfaces thereof that face each other (i.e., their side surfaces with a broad width) function as air passage planes. The first adsorption heat exchanger (101) is arranged to stand up inside the first heat exchange chamber (S11) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47). Likewise, the second adsorption heat exchanger (102) is also arranged to stand up inside the second heat exchange chamber (S12) such that the two principal surfaces thereof are parallel to the first and second partition plates (46,47).

[0144] Each of the first and second adsorption blocks (301, 302) is formed in a rectangular thick plate shape or a flat rectangular parallelepiped shape as a whole, and the two principal surfaces thereof that face each other (i.e., their side surfaces with a broad width) function as air passage planes. Each of the first and second adsorption blocks (301, 302) is configured as a honeycomb structure with a lot of holes that penetrate from one of the two principal surfaces thereof through the other. The first adsorption block (301) is arranged to stand up inside the first heat exchange chamber (S11) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47). Likewise, the second adsorption block (302) is also arranged to stand up inside the second heat exchange chamber (S12) such that the two principal surfaces thereof are parallel to the first and second partition plates (46, 47). Furthermore, in this example, the first adsorption block (301) is arranged in the first heat exchange chamber (S11) so as to be located between the first adsorption heat exchanger (101) and the first partition plate (46). On the other hand, the second adsorption block (302) is arranged in the second heat exchange chamber (S12) so as to be located between the second adsorption heat exchanger (102) and the first partition plate (46). Note that the first adsorption block (301) is spaced apart from the first adsorption heat exchanger (101) in the rightward/leftward direction and the second adsorption block (302) is spaced apart from the second adsorption heat exchanger (102) in the rightward/leftward direction.

[0145] The first partition plate (46) is provided with first to fourth dampers (D1-D4), while the second partition plate (47) is provided with fifth to eighth dampers (D5-D8). Each of the first through eighth dampers (D1-D8) is configured to switch from an opened state to a closed state, and vice versa, in response to control by the controller (20). These first through eighth dampers (D1-D8) constitute the switching mechanism (200).

[0146] The first damper (D1) is attached to the upper portion of the first partition plate (46) (i.e., the portion facing the second adsorption side internal passage (S23)) so as to be located closer to the front end than the middle partition plate (48) is. The second damper (D2) is attached to the upper portion of the first partition plate (46) so as to be located closer to the rear end than the middle partition plate (48) is. The third damper (D3) is attached to the lower portion of the first partition plate (46) (i.e., the portion facing the first regeneration side internal passage (S22)) so as to be located closer to the front end than the middle partition plate (48) is. The fourth damper (D4) is attached to the lower portion of the first partition plate (46) so as to be located closer to the rear end than the middle partition plate (48) is.

[0147] If the first damper (D1) is opened, the second adsorption side internal passage (S23) communicates with the second heat exchange chamber (S12). If the second damper (D2) is opened, the second adsorption side internal passage (S23) communicates with the first heat exchange chamber (S11). If the third damper (D3) is opened, the first regeneration side internal passage (S22) communicates with the second heat exchange chamber (S12). If the fourth damper (D4) is opened, the first regeneration side internal passage (S22) communicates with the first heat exchange chamber (S11).

[0148] The fifth damper (D5) is attached to the upper portion of the second partition plate (47) (i.e., the portion facing the second regeneration side internal passage (S24)) so as to be located closer to the front end than the middle partition plate (48) is. The sixth damper (D6) is attached to the upper portion of the second partition plate (47) so as to be located closer to the rear end than the middle partition plate (48) is. The seventh damper (D7) is attached to the lower portion of the second partition plate (47) (i.e., the portion facing the first adsorption side internal passage (S21)) so as to be located closer to the front end than the middle partition plate (48) is. The eighth damper (D8) is attached to the lower portion of the second partition plate (47) so as to be located closer to the rear end than the middle partition plate (48) is.

[0149] If the fifth damper (D5) is opened, the second regeneration side internal passage (S24) communicates with the second heat exchange chamber (S12). If the sixth damper (D6) is opened, the second regeneration side internal passage (S24) communicates with the first heat exchange chamber (S11). If the seventh damper (D7) is opened, the first adsorption side internal passage (S21) communicates with the second heat exchange chamber (S12). If the eighth damper (D8) is opened, the first adsorption side internal passage (S21) communicates with the first heat exchange chamber (S11).

«Airflow during First Dehumidification Operation»

[0150] Next, the airflow while the dehumidification device (10) of the second embodiment is performing a first dehumidification operation will be described with reference to FIG. 8. During the first dehumidification operation, the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, as shown in FIG. 8, the second, third, fifth and eighth dampers (D2, D3, D5, D8) are opened, while the first, fourth, sixth and seventh dampers (D1, D4, D6, D7) are closed. As a result, the connection state of the first and second heat exchange chambers (S11, S12) is set to be the first passage state (i.e., the state indicated by the solid lines in FIG. 7), the first heat exchange chamber (S11) is incorporated into the air supply passage (P1), and the second heat exchange chamber (S12) is incorporated into the regeneration passage (P2).

-- Airflow through Air Supply Passage --

[0151] The air (e.g., the outdoor air (OA) in this example) that has been supplied to the first adsorption side internal passage (S21) through the adsorption side suction port (51) and the adsorption side suction chamber (S27) passes through the eighth damper (D8) and then is supplied to the first heat exchange chamber (S11).

[0152] The air supplied to the first heat exchange chamber (S11) is deprived of its moisture, and dehumidified, by the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) while passing through the first adsorption heat exchanger (101) and the first adsorption block (301) in this order.

[0153] The air that has been dehumidified by passing through the first adsorption heat exchanger (101) and the first adsorption block (301) flows into the second adsorption side internal passage (S23) through the second damper (D2), passes through the supply fan chamber (S25) and the supply port (53), and then is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0154] The air (e.g., the room air (RA) in this example) that has been supplied to the first regeneration side internal passage (S22) through the regeneration side suction port (52) and the regeneration side suction chamber (S28) passes through the third damper (D3) and then is supplied to the second heat exchange chamber (S12).

[0155] The air supplied to the second heat exchange chamber (S12) is given moisture by the adsorbent of the second adsorption block (302) and second adsorption heat exchanger (102) while passing through the second adsorption block (302) and second adsorption heat exchanger (102) in this order. As a result, the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) is regenerated.

[0156] The air that has passed through the second adsorption block (302) and the second adsorption heat exchanger (102) flows into the second regeneration side internal passage (S24) through the fifth damper (D5), passes through the exhaust fan chamber (S26) and the exhaust port (54), and then is exhausted into the outdoor space.

«Airflow during Second Dehumidification Operation»

[0157] Next, the airflow while the dehumidification device (10) of the second embodiment is performing a second dehumidification operation will be described with reference to FIG. 9. During the second dehumidification operation, the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, as shown in FIG. 9, the first, fourth, sixth and seventh dampers (D1, D4, D6, D7) are opened, while the second, third, fifth and eighth dampers (D2, D3, D5, D8) are closed. As a result, the connection state of the first and second heat exchange chambers (S11, S12) is set to be the second passage state (i.e., the state indicated by the dotted lines in FIG. 7), the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2), and the second heat exchange chamber (S12) is incorporated into the air supply passage (P1).

-- Airflow through Air Supply Passage --

[0158] The air (e.g., the outdoor air (OA) in this example) that has been supplied to the first adsorption side internal passage (S21) through the adsorption side suction port (51) and the adsorption side suction chamber (S27) passes through the seventh damper (D7) and then is supplied to the second heat exchange chamber (S12).

[0159] The air supplied to the second heat exchange chamber (S12) is deprived of its moisture, and dehumidified, by the adsorbent of the second adsorption heat exchanger (102) and second adsorption block (302) while passing through the second adsorption heat exchanger (102) and the second adsorption block (302) in this order.

[0160] The air that has been dehumidified by passing through the second adsorption heat exchanger (102) and the second adsorption block (302) flows into the second adsorption side internal passage (S23) through the first damper (D1), passes through the supply fan chamber (S25) and the supply port (53), and then is supplied as supply air (SA) to the indoor space (S1).

-- Airflow through Regeneration Passage --

[0161] The air (e.g., the room air (RA) in this example) that has been supplied to the first regeneration side internal passage (S22) through the regeneration side suction port (52) and the regeneration side suction chamber (S28) passes through the fourth damper (D4) and then is supplied to the first heat exchange chamber (S11).

[0162] The air supplied to the first heat exchange chamber (S11) is given moisture by the adsorbent of the first adsorption block (301) and first adsorption heat exchanger (101) while passing through the first adsorption block (301) and the first adsorption heat exchanger (101) in this order. As a result, the adsorbent of the first adsorption heat exchanger (101) and first adsorption block (301) is regenerated.

[0163] The air that has passed through the first adsorption block (301) and the first adsorption heat exchanger (101) flows into the second regeneration side internal passage (S24) through the sixth damper (D6), passes through the exhaust fan chamber (S26) and the exhaust port (54), and then is exhausted into the outdoor space.

<Advantages of Second Embodiment>

[0164] By adding first and second adsorption blocks (301, 302) to the first and second heat exchange chambers (S11, S12), respectively, the dehumidification device (10) of the second embodiment allows for dehumidifying the air to an increased degree using the first and second heat exchange chambers (S11, S12).

[0165] In addition, by arranging the first adsorption block (301) at such a position that the air dehumidified by the first adsorption heat exchanger (101) passes through if the first heat exchange chamber (S11) is incorporated into the air supply passage (P1), the air that has been dehumidified and cooled by the first adsorption heat exchanger (101) may be supplied to the first adsorption block (301). This thus allows for promoting the adsorption of moisture into the adsorbent of the first adsorption block (301). Likewise, if the second heat exchange chamber (S12) is incorporated into the air supply passage (P1), the air that has been dehumidified and cooled by the second adsorption heat exchanger (102) may be supplied to the second adsorption block (302). This thus allows for promoting the adsorption of moisture into the adsorbent of the second adsorption block (302). That is to say, in each of the first and second heat exchange chambers (S11, S12), an adsorption block (301, 302) is arranged at a position downstream of the adsorption heat exchanger (101, 102) if the adsorption heat exchanger (101, 102) functions as an evaporator. Then, the air that has been dehumidified and cooled by the adsorption heat exchanger (101, 102) may be supplied to the adsorption block (301, 302). This thus allows for promoting the adsorption of moisture into the adsorbent of the adsorption block (301, 302).

[0166] As can be seen from the foregoing description, the first and second heat exchange chambers (S11, S12) are allowed to dehumidify the air to an increased degree, and the adsorption of moisture into the adsorbent of the adsorption block (301, 302) may be promoted, thus allowing for improving the dehumidification capacity of the dehumidification device (10).

[0167] On top of that, there is no need to increase the number of rotations of the compressor (103) in the refrigerant circuit (100) to improve the dehumidification capacity of the dehumidification device (10), thus allowing for reducing an increase in the power consumption of the dehumidification device (10).

[0168] Furthermore, according to the second embodiment, in each of the first and second heat exchange chambers (S11, S12), if the adsorption heat exchanger (101, 102) functions as an evaporator, the adsorption block (301, 302) is located downstream of the adsorption heat exchanger (101, 102). On the other hand, in each of the first and second heat exchange chambers (S11, S12), if the adsorption heat exchanger (101, 102) functions as a condenser, the adsorption block (301, 302) is located upstream of the adsorption heat exchanger (101, 102). Therefore, if the air that has passed through the heater (21) is allowed to flow through one of the first and second heat exchange chambers (S11, S12) that is provided with an adsorption heat exchanger (101, 102) functioning as a condenser, the air heated by the heater (21) may be supplied to the adsorption block (301, 302) which is located upstream of the adsorption heat exchanger (101, 102) in that heat exchange chamber (S11, S12). This thus allows for promoting the regeneration of the adsorbent of the adsorption block (301, 302).

[0169] According to the first embodiment described above, if the first adsorption heat exchanger (101) functions as a condenser, the first adsorption block (301) is located downstream of the first adsorption heat exchanger (101) in the first heat exchange chamber (S11), and therefore, the air that has passed through the first adsorption heat exchanger (101) is supplied to the first adsorption block (301). In this case, the air supplied to the first adsorption block (301) after having passed through the first adsorption heat exchanger (101) is not only heated, but also humidified, by the first adsorption heat exchanger (101). The same can be said about the second adsorption block (302).

[0170] On the other hand, according to the second embodiment, if the first adsorption heat exchanger (101) functions as a condenser, the first adsorption block (301) is located upstream of the first adsorption heat exchanger (101) in the first heat exchange chamber (S11), and the air that has been heated by the heater (21) is supplied to the first adsorption block (301). In this case, the air to be supplied to the first adsorption block (301) after having passed through the heater (21) is heated, but not humidified, by the heater (21). That is why the adsorption of the adsorbent of the first adsorption block (301) may be further promoted, and the adsorption capability of the first adsorption block (301) may be further improved, compared to the first embodiment. The same can be said about the second adsorption block (302).

[0171] Furthermore, by spacing the first adsorption block (301) from the first adsorption heat exchanger (101), the degree of non-uniformity in temperature distribution and airflow is reducible in the first adsorption block (301). The same can be said about the second adsorption block (302). As can be seen, the degree of non-uniformity in temperature distribution and airflow is reducible in the first and second adsorption blocks (301, 302), thus allowing for preventing the adsorption and regeneration capabilities of the first and second adsorption blocks

(301, 302) from deteriorating significantly.

(Variation of Second Embodiment)

[0172] As shown in FIG. 10, the dehumidification system (1) may further include a pretreatment dehumidification device (30) in addition to the dehumidification device (10), controller (20) and heater (21) shown in FIG. 7. In this example, the humidity-controlled space (S0) is comprised of an indoor space (S1) and a chamber (S2) provided for the indoor space (S1). The dehumidification system (1) is further provided with a pretreatment passage (P3) and a post-treatment passage (P4). Also, in this dehumidification system (1), the air (e.g., the outdoor air (OA) in this example) dehumidified by the pretreatment dehumidification device (30) is supplied as supply air to the indoor space (S1), and the air (e.g., the room air (RA) in this example) dehumidified by the dehumidification device (10) is supplied as supply air (SA) to the chamber (S2). The controller (20) controls the dehumidification device (10) and the pretreatment dehumidification device (30) based on the detected values of various kinds of sensors.

<Pretreatment Passage, Post-Treatment Passage>

[0173] The pretreatment passage (P3) is configured to suck outdoor air (OA) from the outdoor space and provide supply air (SA0) for the indoor space (S1). The post-treatment passage (P4) is configured to suck air through the outflow end of the regeneration passage (P2) and discharge exhaust air (EA) into the outdoor space.

<Air Supply Passage, Regeneration Passage>

[0174] In this example, the air supply passage (P1) is configured to suck the room air (RA) from the indoor space (S1) and provide supply air (SA) for the chamber (S2). Specifically, the inflow end of the first air supply passage section (P11) is connected to the indoor space (S1), and the outflow end of the second air supply passage section (P12) is connected to the chamber (S2). Meanwhile, the regeneration passage (P2) is configured to suck the room air (RA) from the indoor space (S1) and discharge the treated air into the post-treatment passage (P4). Specifically, the inflow end of the first regeneration passage section (P21) is connected to a middle portion of the first air supply passage section (P11), and the outflow end of the second regeneration passage section (P22) is connected to the inflow end of the first post-treatment passage section (P41).

<Pretreatment Dehumidification Device>

[0175] The pretreatment dehumidification device (30) has the same configuration as the dehumidification device (10). Note that the structure of the pretreatment dehumidification device (30) may be the same as that of the dehumidification device (10) shown in FIG. 8.

<Refrigerant Circuit of Pretreatment Dehumidification Device>

[0176] Just like the refrigerant circuit (100) of the dehumidification device (10), the refrigerant circuit (100) of the pretreatment dehumidification device (30) is configured to perform alternately, in response to control by the controller (20), a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator to dehumidify the air and the second adsorption heat exchanger (102) functions as a condenser to regenerate the adsorbent and a second refrigeration cycle operation in which the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air and the first adsorption heat exchanger (101) functions as a condenser to regenerate the adsorbent.

<Switching Mechanism of Pretreatment Dehumidification Device>

[0177] The switching mechanism (200) of the pretreatment dehumidification device (30) is configured to set, in response to the control by the controller (20), the connection state between the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) and the pretreatment passage (P3) and the post-treatment passage (P4) to be either a third passage state (i.e., the state indicated by the solid lines in FIG. 10) or a fourth passage state (i.e., the state indicated by the dotted lines in FIG. 10).

<Third Passage State>

[0178] When the connection state of the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) switches to the third passage state, the first heat exchange chamber (S11) is connected between the first and second pretreatment passage sections (P31, P32) and incorporated into the pretreatment passage (P3), and the second heat exchange chamber (S12) is connected between the first and second post-treatment passage sections (P41, P42) and incorporated into the post-treatment passage (P4).

<Fourth Passage State>

[0179] When the connection state of the first and second heat exchange chambers (S11, S12) of the pretreatment dehumidification device (30) switches to the fourth passage state, the first heat exchange chamber (S11) is connected between the first and second post-treatment passage sections (P41, P42) and incorporated into the post-treatment passage (P4), and the second heat exchange chamber (S12) is connected between the first and second pretreatment passage sections (P31, P32) and incorporated into the pretreatment passage (P3).

<Operation of Switching Connections between Heat Exchange Chambers>

[0180] When the four-way switching valve (105) is in the first connection state, the switching mechanism (200) of the pretreatment dehumidification device (30) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the third passage state. On the other hand, when the four-way switching valve (105) is in the second connection state, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the fourth passage state. That is to say, just like the switching mechanism (200) of the dehumidification device (10), the switching mechanism (200) of the pretreatment dehumidification device (30) changes the airflow paths such that the air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) and that air to regenerate the adsorbent (e.g., the air that has passed through one of the first and second heat exchange chambers (S11, S12) of the dehumidification device (10) that is provided with the adsorption heat exchanger (101, 102) functioning as a condenser in this example) flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

<<Flow Direction of Air Passing through Adsorption Heat Exchanger>>

[0181] In this example, in the pretreatment dehumidification device (30), the flow direction of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the third passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the pretreatment passage (P3)) is opposite from that of the air passing through the first adsorption heat exchanger (101) when the connection state of the first and second heat exchange chambers (S11, S12) is the fourth passage state (i.e., when the first heat exchange chamber (S11) is incorporated into the post-treatment passage (P4)). The same can be said about the flow direction of the air passing through the second adsorption heat exchanger (102). That is to say, just like the switching mechanism (200) of the dehumidification device (10), the switching mechanism (200) of the pretreatment dehumidification device (30) also changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in an opposite direction when the adsorption heat exchanger (101, 102) functions as an evaporator from when the adsorption heat exchanger (101, 102) functions as a condenser.

<Dehumidification Operation by Pretreatment Dehumidification Device>

[0182] Next, it will be described with reference to FIG. 10 how the pretreatment dehumidification device (30) performs dehumidification operation. Just like the pretreatment dehumidification device (30) according to the third variation of the first embodiment, the pretreatment dehumidification device (30) according to this variation of the second embodiment also alternately performs third and fourth dehumidification operations at regular time intervals (of 10 minutes, for example).

«Third Dehumidification Operation»

[0183] During the third dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the first connection state (i.e., the state indicated by the solid curves in FIG. 10). As a result, the refrigerant circuit (100) performs a first refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as an evaporator and the second adsorption heat exchanger (102) functions as a condenser. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the third passage state (i.e., the state indicated by the solid lines in FIG. 10).

<<Fourth Dehumidification Operation>>

[0184] During the fourth dehumidification operation, the compressor (103) is driven, the degree of opening of the expansion valve (104) is adjusted, and the four-way switching valve (105) is turned to the second connection state (i.e., the state indicated by the dotted curves in FIG. 10). As a result, the refrigerant circuit (100) performs a second refrigeration cycle operation in which the first adsorption heat exchanger (101) functions as a condenser and the second adsorption heat exchanger (102) functions as an evaporator. Also, the switching mechanism (200) sets the connection state of the first and second heat exchange chambers (S11, S12) to be the fourth passage state (i.e., the state indicated by the dotted lines in FIG. 10).

<Advantages of Variation of Second Embodiment>

[0185] As can be seen from the foregoing description, the air (e.g., the outdoor air (OA) in this example) to be supplied to the indoor space (S1) is dehumidified by the pretreatment dehumidification device (30) and supplied as supply air (SA0) to the indoor space (S1), and the room air (RA) supplied from the indoor space (S1) is dehumidified by the dehumidification device (10) and supplied as supply air (SA) to the chamber (S2). This thus allows for making the dew point temperature of the air in the chamber (S2) lower than that of the air in the indoor space (S1). In this manner, by supplying heavily the supply air (SA) with such a low dew point temperature to the chamber (S2), the power to be consumed to operate the dehumidification system (1) may be cut down compared to a situation where the dew point temperature is lowered in the entire indoor space (S1).

(Third Embodiment)

[0186] FIG. 11 illustrates an exemplary configuration for a dehumidification system (1) according to a third embodiment. This dehumidification system (1) includes the pretreatment dehumidification device (30) shown in FIG. 10 in place of the pretreatment dehumidification device (30) shown in FIG. 6. In the other respects, the system shown in FIG. 11 is the same as the counterpart shown in FIG. 6. Even when such a configuration is adopted, the same effects as the ones achieved by the third variation of the first embodiment (see FIG. 6) and by the variation of the second embodiment (see FIG. 10) are also achievable.

(Fourth Embodiment)

[0187] FIG. 12 illustrates an exemplary configuration for a dehumidification system (1) according to a fourth embodiment. This dehumidification system (1) includes not only the dehumidification device (10) and controller (20) shown in FIG. 1 but also a heater (21), an adsorption rotor (70) and an auxiliary cooler (80) as well. This dehumidification system (1) is further provided with a rotor air supply passage (P71), a rotor regeneration passage (P72), a purging passage (P73) and a cooling air passage (P80).

<Rotor Air Supply Passage>

[0188] The air to be supplied to the humidity-controlled space (S0) (e.g., the air to be supplied to the indoor space (S1) in this example) flows through the rotor air supply passage (P71). In this example, the rotor air supply passage (P71) is configured to suck the air through the outflow end of the air supply passage (P1) and provide supply air (SA) for the indoor space (S1). Specifically, the rotor air supply passage (P71) has its inflow end connected to the outflow end of the air supply passage (P1) and its outflow end connected to the indoor space (S1), respectively.

<Rotor Regeneration Passage>

[0189] The air to regenerate the adsorbent (e.g., the air supplied from the purging passage (P73) in this example) flows through the rotor regeneration passage (P72). In this example, the rotor regeneration passage (P72) is configured to suck the air through the outflow end of the purging passage (P73) and supply regenerate air (i.e., air to regenerate the adsorbent) to the regeneration passage (P2). Specifically, the rotor regeneration passage (P72) has its inflow end connected to the outflow end of the purging passage (P73) and its outflow end connected to the inflow end of the regeneration passage (P2), respectively.

<Purging Passage>

[0190] The air to be supplied to the rotor regeneration passage (P72) (e.g., the air supplied from the air supply passage (P1) in this example) flows through the purging passage (P73). In this example, the purging passage (P73) is configured to suck the air through the outflow end of the air supply passage (P1) and supply regenerate air to the rotor regeneration passage (P72). Specifically, the purging passage (P73) has its inflow end connected to the outflow end of the air supply passage (P1) and its outflow end connected to the inflow end of the rotor regeneration passage (P72), respectively.

<Cooling Air Passage>

[0191] The cooled and dehumidified air flows through the cooling air passage (P80). In this example, the cooling air passage (P80) is configured to suck the room air (RA) from the indoor space (S1) and supply the air to a halfway point of the air supply passage (P1) (more specifically, to a point through which the air that has passed through the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator passes). Specifically, the cooling air passage (P80) has its inflow end connected to the indoor space (S1) and its outflow end connected to the halfway point of the air supply passage (P1), respectively.

<Heater>

[0192] The heater (21) is provided for the rotor regeneration passage (P72) and is configured to heat the air to regenerate the adsorbent (e.g., the air supplied from the purging passage (P73) to the rotor regeneration passage (P72) in this example). Note that the heating temperature of the heater (21) is set to be a temperature (of 60°C, for example) which is lower than the upper limit of the condensation temperature of the adsorption heat exchanger (101, 102).

<Adsorption Rotor>

[0193] The adsorption rotor (70) is formed by loading an adsorbent on the surface of a disklike porous substrate, and is arranged to cross the rotor air supply passage (P71), rotor regeneration passage (P72) and purging passage (P73). The adsorption rotor (70) is driven by a drive mechanism (not shown) and is configured to rotate on a shaft center provided between the rotor air supply passage (P1), rotor regeneration passage (P72) and purging passage (P73). Specifically, the adsorption rotor

(70) includes an adsorption portion (71) arranged on the rotor air supply passage (P71), a regeneration portion (72) arranged on the rotor regeneration passage (P72), and a purging portion (73) arranged on the purging passage (P73). The adsorbent loaded on the adsorption rotor (70) goes through the adsorption portion (71), regeneration portion (72) and purging portion (73) in this order as the adsorption rotor (70) rotates. More specifically, the adsorption rotor (70) rotates such that its part located in the adsorption portion (71) moves to the regeneration portion (72), its part located in the regeneration portion (72) moves to the purging portion (73), and its part located in the purging portion (73) moves to the adsorption portion (71).

<Adsorption Portion>

[0194] The adsorption portion (71) is provided to bring the air flowing through the rotor air supply passage (P71) (e.g., mixture of the air that has passed through one of the first and second heat exchange chambers (S11, S12) of the dehumidification device (10) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator and the air that has passed through the cooling air passage (P80) in this example) into contact with the adsorbent and to dehumidify the air. The air that has been dehumidified by passing through the adsorption portion (71) is supplied as supply air (SA) to the indoor space (S1).

<Regeneration Portion>

[0195] The regeneration portion (72) is arranged at a position downstream of the heater (21) on the rotor regeneration passage (P72) and is provided to regenerate the adsorbent by bringing the air flowing through the rotor regeneration passage (P72) (e.g., the air that has passed through the heater (21) in this example) into contact with the adsorbent. The air that has passed through the regeneration portion (72) is supplied to the regeneration passage (P2).

<Purging Portion>

[0196] The purging portion (73) is provided to preheat the air to be supplied to the regeneration portion (72) by utilizing the waste heat of the regeneration portion (72) (more specifically, the waste heat that has not been used by the regeneration portion (72) to regenerate the adsorbent). More specifically, in the purging portion (73), the air flowing through the purging passage (P73) is brought into contact with, and dehumidified by, the adsorbent. Also, the part located in the regeneration portion (72) (i.e., the part heated by the air that has passed through the heater (21)) moves to the purging portion (73) as the adsorption rotor (70) rotates. Thus, the air flowing through the purging passage (P73) is given heat (i.e., the waste heat of the regeneration portion (72)), and preheated, by the purging portion (73). Meanwhile, the part located in the purging portion (73) is cooled by giving heat to the air passing through the purging passage (P73), and then moves to the adsorption portion (71) as the adsorption rotor (70) rotates.

<Auxiliary Cooler>

[0197] The auxiliary cooler (80) is provided on the cooling air passage (P80) to cool the air (e.g., the room air (RA) in this example) flowing through the cooling air passage (P80). For example, the auxiliary cooler (80) may be configured as a heat exchanger (more specifically, a fin-and-tube heat exchanger) functioning as an evaporator for a refrigerant circuit (not shown). The air that has been cooled by passing through the cooling air passage (P80) merges with the air flowing through the air supply passage (P1) (e.g., the air that has passed through one of the first and second heat exchange chambers (S11, S12) of the dehumidification device (10) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator in this example).

<Dehumidification Device>

[0198] In this example, the air that has passed through the air supply passage (P1) passes through the rotor air supply passage (P71) and then is supplied to the indoor space (S1). That is to say, the air that has passed through one of the first and second heat exchange chambers (S11, S12) of the dehumidification device (10) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the indoor space (S1) after having passed through the adsorption portion (71) of the adsorption rotor (70).

[0199] Also, in this example, the air that has passed through the rotor regeneration passage (P72) passes through the regeneration passage (P2) and then is exhausted into the outdoor space. That is to say, the switching mechanism (200) of the dehumidification device (10) changes the airflow paths such that the air that has passed through the heater (21) and the regeneration portion (72) of the adsorption rotor (70) in this order flows through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

<Advantages of Fourth Embodiment>

[0200] As can be seen from the foregoing description, the air to be supplied to the humidity-controlled space (S0) (e.g., the air to be supplied to the indoor space (S1) in this example) is dehumidified in the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator, and then further dehumidified by the adsorption portion (71) of the adsorption rotor (70). Thus, the dehumidification capacity of the dehumidification system (1) is improvable by adding the adsorption rotor (70).

[0201] On the other hand, the air that has been heated by the heater (21) passes through the regeneration portion (72) of the adsorption rotor (70) and then passes through the heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser. That is to say, the air that has passed through the regeneration portion (72) of the adsorption rotor (70) may be used to regenerate the adsorbent of the adsorption heat exchanger (102, 101) and adsorption block (302, 301). This thus allows for using effectively the air that has been heated by the heater (21).

[0202] In addition, by supplying the air flowing through the cooling air passage (P80) to a halfway point of the air supply passage (P1), the temperature of the air that has passed through the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator may be lowered with the air that has been cooled by the cooling air passage (P80). That is to say, the temperature of the air that has risen due to the waste heat remaining in the adsorption block (301, 302) during the regeneration or the heat of adsorption of the adsorption block (301, 302) maybe lowered.

[0203] Furthermore, part of the air supplied from the air supply passage (P1) passes through the purging passage (P73), rotor regeneration passage (P72) and regeneration passage (P2) in this order. Thus, part of the air that has passed through the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator (i.e., the air dehumidified by the dehumidification device (10)) may be used to regenerate the adsorbent of the adsorption rotor (70) and the adsorbent of the adsorption heat exchanger (102, 101) functioning as a condenser. This thus allows for promoting the regeneration of the adsorbents.

(Other Embodiments)

[0204] In the foregoing description, the first adsorption block (301) is arranged to be spaced from the first adsorption heat exchanger (101) and the second adsorption block (302) is arranged to be spaced from the second adsorption heat exchanger (102). However, this is only an example. Alternatively, the first adsorption block (301) may also be arranged in contact with the first adsorption heat exchanger (101), and the second adsorption block (301) may also be arranged in contact with the second adsorption heat exchanger (102). Such a configuration allows for promoting the conduction of heat not only between the first adsorption heat exchanger (101) and the first adsorption block (301) but also between the second adsorption heat exchanger (102) and the second adsorption block (302) as well. For example, if the first heat exchange chamber (S11) is incorporated into the air supply passage (P1), the first adsorption block (301) may be cooled with the heat absorption action of the refrigerant flowing through the first adsorption heat exchanger (101). On the other hand, if the first heat exchange chamber (S11) is incorporated into the regeneration passage (P2), the first adsorption block (301) may be heated with the heat dissipation action of the refrigerant flowing through the first adsorption heat exchanger (101). This thus allows for promoting the adsorption of moisture into the adsorbent and the regeneration of the adsorbent in the first and second adsorption blocks (301, 302).

[0205] Optionally, a single dehumidification unit may be formed by connecting a plurality of dehumidification devices (10) in parallel with each other. For example, a single dehumidification unit may be formed by vertically stacking a number of dehumidification devices (10), each having the configuration shown in FIG. 2 (or FIG. 7), one upon the other and by connecting together each group of ports of the same type of the dehumidification devices (10) (more specifically, the adsorption side suction ports (51), the regeneration side suction ports (52), the supply ports (53) and the exhaust ports (54)).

[0206] Alternatively, the dehumidification capacity of the dehumidification device (10) could be improved by increasing the size of the first and second adsorption heat exchangers (101, 102) without adding the first and second adsorption blocks (301, 302) to the dehumidification device (10). That is to say, the heat absorption action of the refrigerant may be increased in an adsorption heat exchanger functioning as an evaporator by increasing the size of the adsorption heat exchanger. This thus allows for lowering the temperature of the air in the adsorption heat exchanger and reducing a rise in the temperature of the air due to the heat of adsorption of the adsorbent. Also, the lower the temperature of the air in the adsorption heat exchanger, the smaller the amount of saturated water vapor of the air, and the more easily the moisture in the air tends to be adsorbed into the adsorbent. This thus allows for promoting the adsorption of moisture from the air into the adsorbent thanks to the heat absorption action of the refrigerant.

[0207] Inside the adsorption heat exchanger functioning as an evaporator, the temperature of the air and the quantity of moisture in the air both decrease from an upstream point toward a downstream point. That is to say, inside the adsorption heat exchanger, the air that has been dehumidified and cooled at an upstream point is supplied to a downstream point. Thus, at a downstream point in the adsorption heat exchanger, even if the temperature of the air has fallen, and the amount of saturated water vapor in the air has decreased, due to the heat absorption action of the refrigerant, the adsorption of moisture from the air into the adsorbent is hardly promoted, since the amount of moisture in the air has decreased. Also, the smaller the amount of moisture in the air, the smaller the quantity of the heat of adsorption generated by the adsorbent. Thus, at a downstream point of the adsorption heat exchanger, the adsorbent is cooled excessively due to the heat absorption action of the refrigerant.

[0208] As can be seen, even if the size of the adsorption heat exchanger is increased, the effects caused by the heat absorption action of the refrigerant (namely, the effect of promoting the adsorption of moisture into the adsorbent and the effect of removing the heat of adsorption) diminish from an upstream point toward a downstream point inside the adsorption heat exchanger. Thus, it is difficult to improve the dehumidification capacity of the dehumidification device (10) effectively.

[0209] Also, another means for promoting the adsorption of moisture from the air into the adsorbent may be increasing the area of contact between the air and the adsorbent. That is to say, the larger the area of contact between the air and the adsorbent, the more easily the moisture in the air is adsorbed into the adsorbent. Particularly when there is a decreased amount of moisture in the air, the adsorption of moisture from the air into the adsorbent is promoted more easily by increasing the area of contact between the air and the adsorbent rather than by lowering the temperature of the air due to the heat absorption action of the refrigerant. In addition, since there is no need to provide a refrigerant pipe or any other part for the adsorption block, it is structurally easier to increase the surface area (i.e., the area in contact with the air) of the adsorption block than in the adsorption heat exchanger. Thus, by arranging the adsorption block at a point downstream of the adsorption heat exchanger functioning as an evaporator (i.e., a point through which the air that has been dehumidified and cooled by the adsorption heat exchanger passes), the area of contact between the air and the adsorbent may be increased downstream of the adsorption heat exchanger. As a result, the dehumidification capacity of the dehumidification device (10) is improvable more effectively than in a situation where the size of the adsorption heat exchanger is increased.

[0210] Note that the operation of regenerating an adsorbent (i.e., releasing moisture from the adsorbent into the air) generally results in a higher reaction kinetic than the adsorption operation by the adsorbent (i.e., adsorbing moisture from the air into the adsorbent). Thus, the flow rate of the air passing through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator may be higher than, or comparable with, that of the air passing through the heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

[0211] Furthermore, in the second embodiment (see FIG. 7) and the variation of the second embodiment (see FIG. 10), the regeneration passage (P2) is provided with a heater (21). However, this is only an example, and the dehumidification system (1) does not have to include the heater (21). The heater (21) may be omitted, for example, if the temperature of the air to be supplied to the regeneration passage (P2) (i.e., the air to be supplied to the heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser) is higher than that of the air to be supplied to the air supply passage (P1) (i.e., the air to be supplied to the heat exchange chamber (S11, S12) provided with the adsorption heat exchanger (101, 102) functioning as an evaporator) and if the difference in temperature between these two airflows is greater than a predetermined temperature difference (more specifically, a temperature difference that is large enough to regenerate the adsorbent).

[0212] Optionally, the embodiments described above may be carried out in any appropriate combination. The embodiments described above are merely preferred examples in nature and not intended to limit the scope of the present invention, its applications, or its use.

INDUSTRIAL APPLICABILITY

[0213] As can be seen from the foregoing description, the dehumidification device described above is useful as a dehumidification device to dehumidify a humidity-controlled space such as a dry clean room.

DESCRIPTION OF REFERENCE CHARACTERS

[0214]

1	Dehumidification System
10	Dehumidification Device
100	Refrigerant Circuit
101	First Adsorption Heat Exchanger
102	Second Adsorption Heat Exchanger
103	Compressor
104	Expansion Valve
105	Four-Way Switching Valve
200	Switching Mechanism
301	First Adsorption Block
302	Second Adsorption Block
S0	Humidity-Controlled Space
S1	Indoor Space
S2	Chamber
S11	First Heat Exchange Chamber
S12	Second Heat Exchange Chamber
P1	Air Supply Passage
P2	Regeneration Passage
20	Controller
30	Pretreatment Dehumidification Device
P3	Pretreatment Passage
P4	Post-Treatment Passage
70	Adsorption Rotor
71	Adsorption Portion
72	Regeneration Portion
73	Purging Portion

Claims

1. A dehumidification device comprising:

a refrigerant circuit (100) including first and sec-

ond adsorption heat exchangers (101, 102) loaded with an adsorbent and performing alternately a first operation in which the first adsorption heat exchanger (101) functions as an evaporator to dehumidify air and the second adsorption heat exchanger (102) functions as a condenser to regenerate the adsorbent and a second operation in which the first adsorption heat exchanger (101) functions as a condenser to regenerate the adsorbent and the second adsorption heat exchanger (102) functions as an evaporator to dehumidify the air;
first and second heat exchange chambers (S11, S12) provided with the first and second adsorption heat exchangers (101, 102), respectively;
a switching mechanism (200) configured to change airflow paths such that air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to a humidity-controlled space (S0) and that air to regenerate the adsorbent flows through the other heat exchange chamber (S12, S11) provided with the adsorption heat exchanger (102, 101) functioning as a condenser;
a first adsorption block (301) loaded with the adsorbent, configured to bring air into contact with the adsorbent, and arranged at a position downstream of the first adsorption heat exchanger (101) if the first adsorption heat exchanger (101) functions as an evaporator in the first heat exchange chamber (S11); and
a second adsorption block (302) loaded with the adsorbent, configured to bring air into contact with the adsorbent, and arranged at a position downstream of the second adsorption heat exchanger (102) if the second adsorption heat exchanger (102) functions as an evaporator in the second heat exchange chamber (S12).

2. The dehumidification device of claim 1, wherein the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in an opposite direction when the adsorption heat exchanger (101, 102) functions as an evaporator from when the adsorption heat exchanger (101, 102) functions as a condenser.

3. The dehumidification device of claim 1, wherein the switching mechanism (200) changes the airflow paths such that the air passing through each of the first and second adsorption heat exchangers (101, 102) flows in the same direction when the adsorption heat exchanger (101, 102) functions as an evaporator as when the adsorption heat exchanger (101, 102) functions as a condenser.

4. The dehumidification device of any one of claims 1-3, wherein
the first and second adsorption blocks (301, 302) are arranged so as to be spaced apart from the first and second adsorption heat exchangers (101, 102), respectively.

5. The dehumidification device of any one of claims 1-3, wherein
the first and second adsorption blocks (301, 302) are arranged so as to be in contact with the first and second adsorption heat exchangers (101, 102), respectively.

6. A dehumidification system comprising:

the dehumidification device (10) of claim 2; and
a heater (21) configured to heat air to regenerate the adsorbent, wherein
the switching mechanism (200) changes airflow paths such that air that has passed through the heater (21) flows in one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as a condenser.

7. The dehumidification system of claim 6, further comprising
an adsorption rotor (70) loaded with an adsorbent and including an adsorption portion (71) and a regeneration portion (72), the adsorption portion (71) dehumidifying air that has passed through one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator by bringing the air into contact with the adsorbent, the regeneration portion (72) regenerating the adsorbent by bringing the air that has passed through the heater (21) into contact with the adsorbent, wherein the air that has passed through that one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (101, 102) functioning as an evaporator is supplied to the humidity-controlled space (S0) through the adsorption portion (71) of the adsorption rotor (70), and the switching mechanism (200) changes the airflow paths such that air that has passed through the heater (21) and the regeneration portion (72) of the adsorption rotor (70) in this order flows in the other one of the first and second heat exchange chambers (S11, S12) that is provided with the adsorption heat exchanger (102, 101) functioning as a condenser.

FIG.1

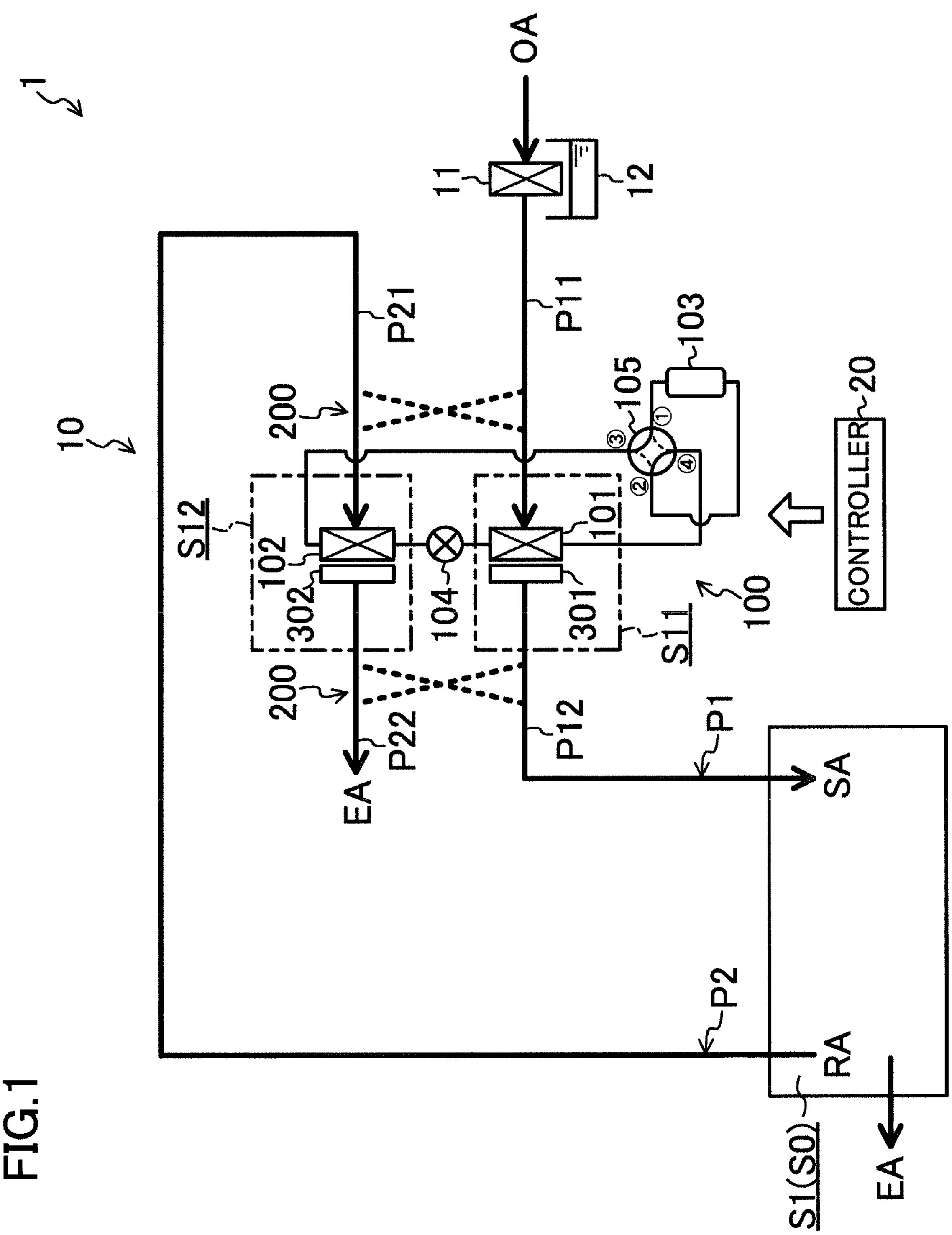
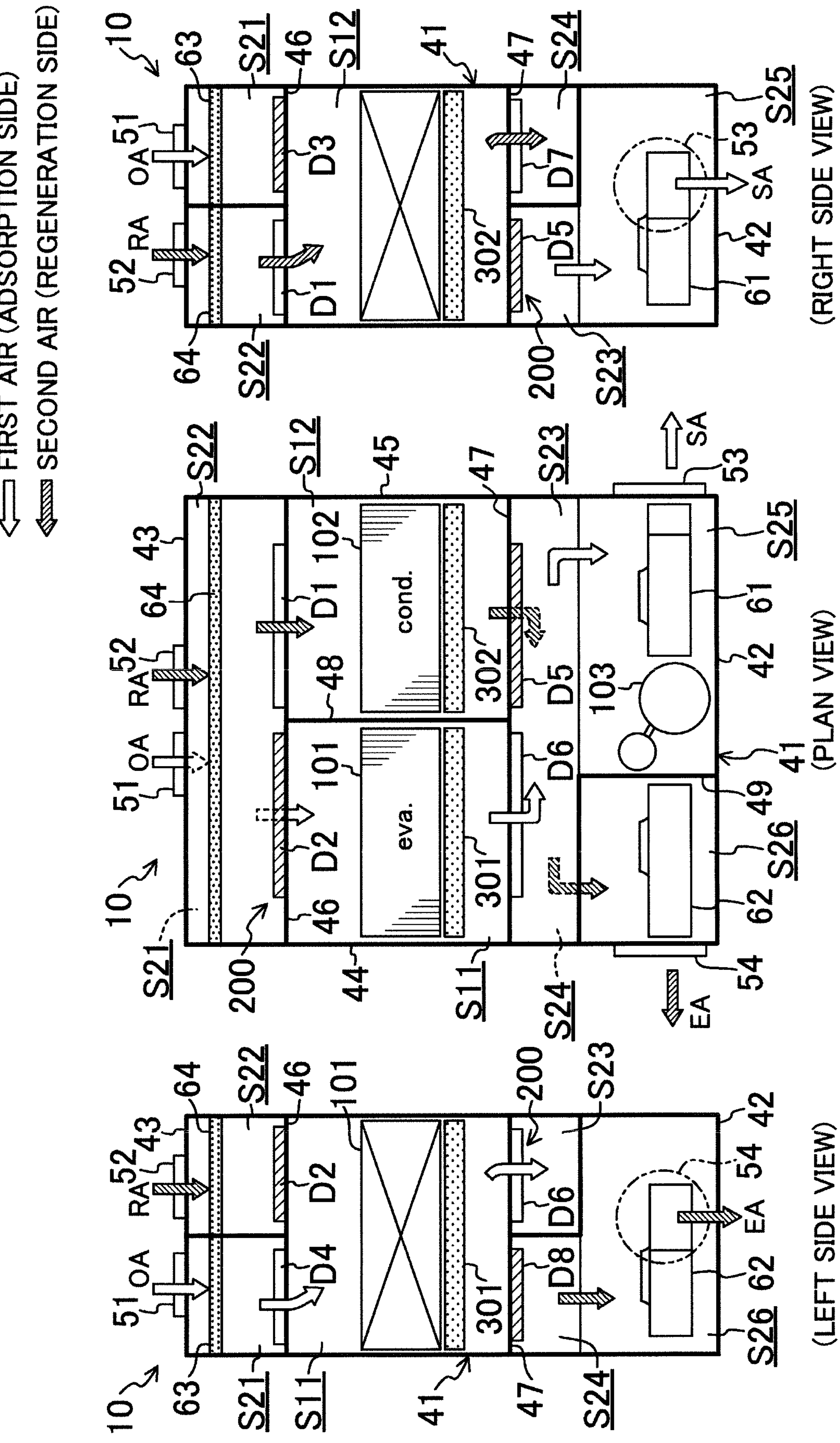

1
10
OA
11
12
P11
P21
103
105
200
CONTROLLER
20
S12
102
101
104
302
301
S11
100
P12
P22
P1
EA
SA
P2
RA
S1(S0)
EA

FIG.2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(PLAN VIEW)
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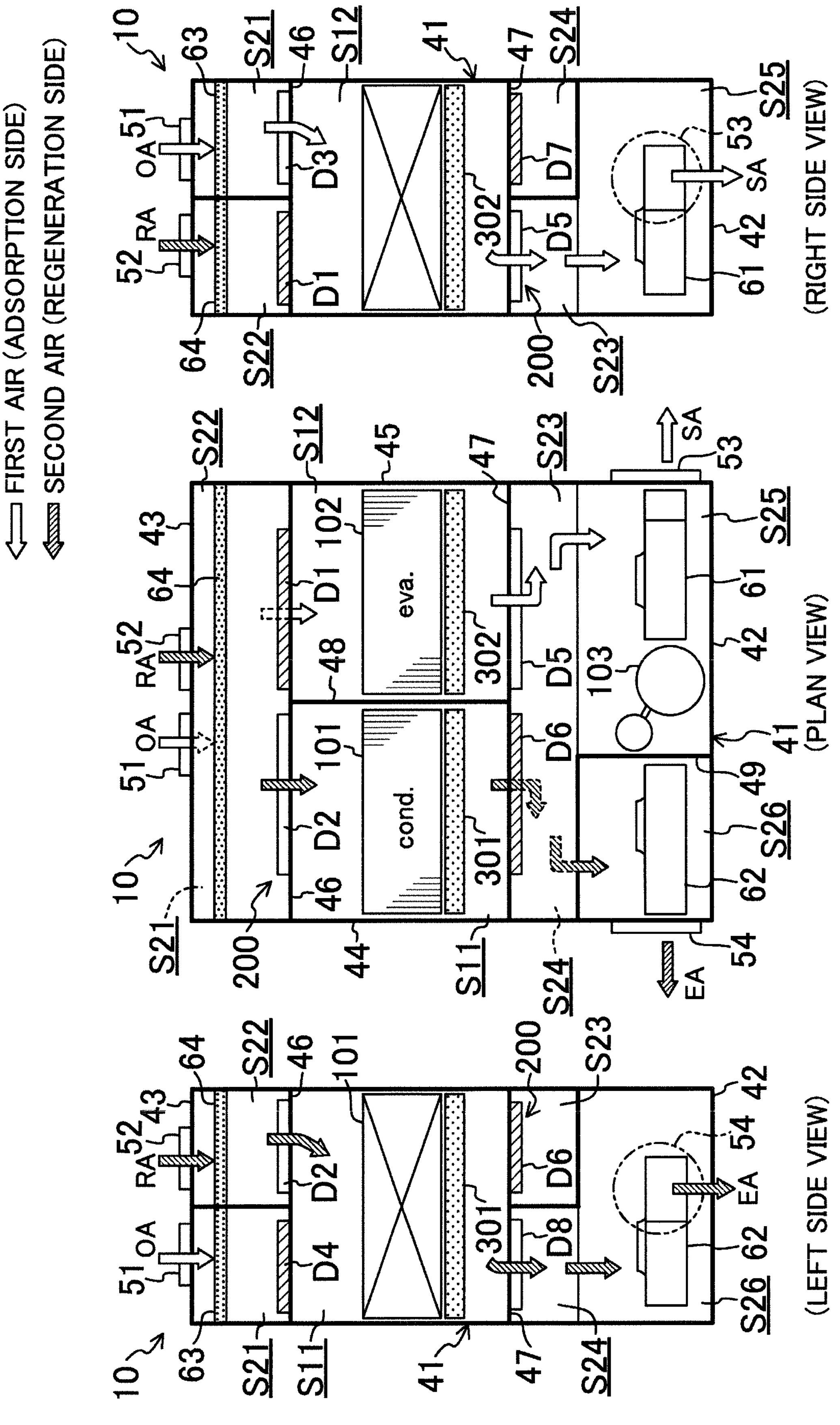
FIG.3


FIRST AIR (ADSORPTION SIDE)
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102
103
200
301
302
D1
D2
D3
D4
D5
D6
D7
D8
S11
S12
S21
S22
S23
S24
S25
S26

FIG.4

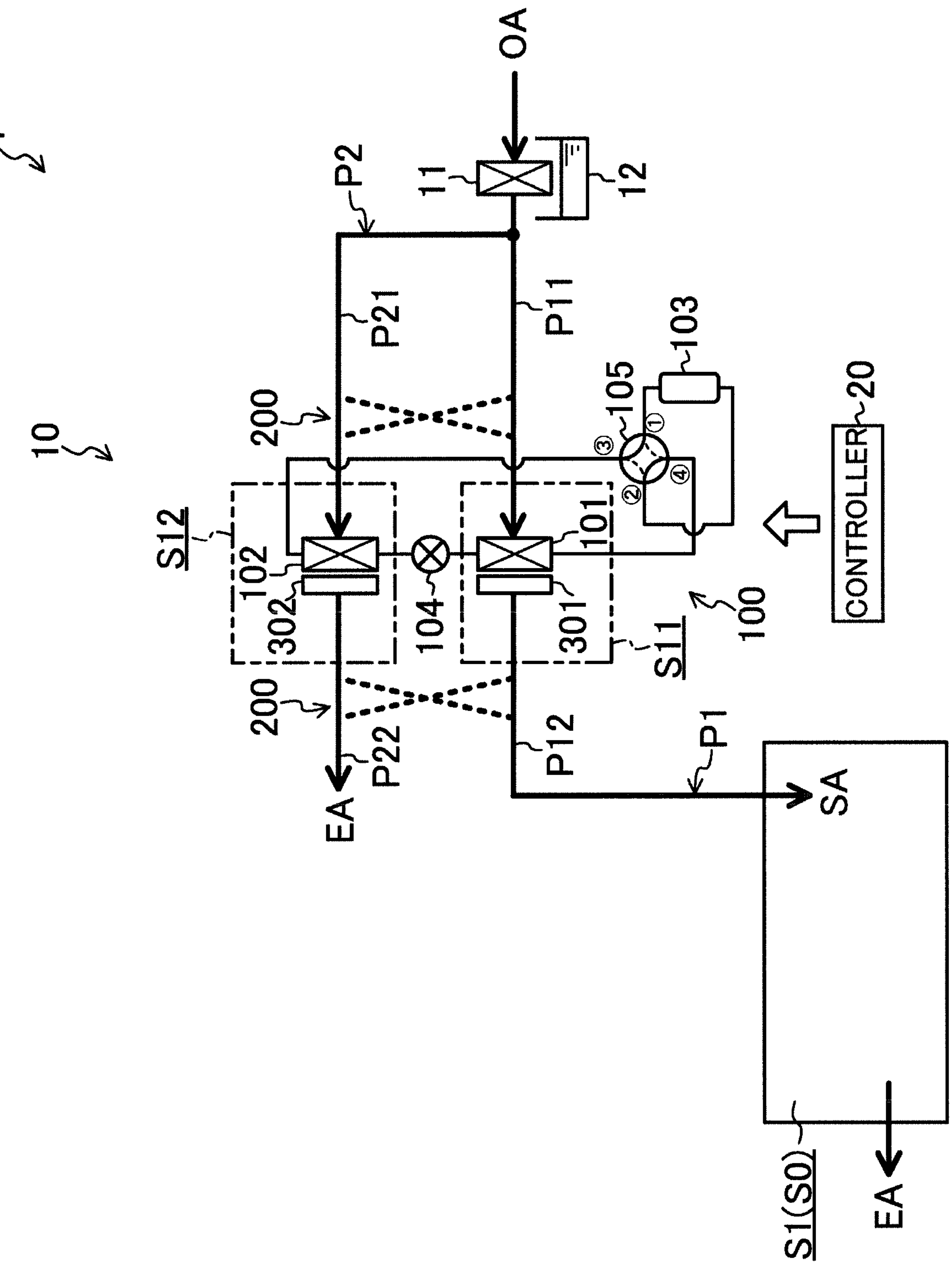
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FIG.5

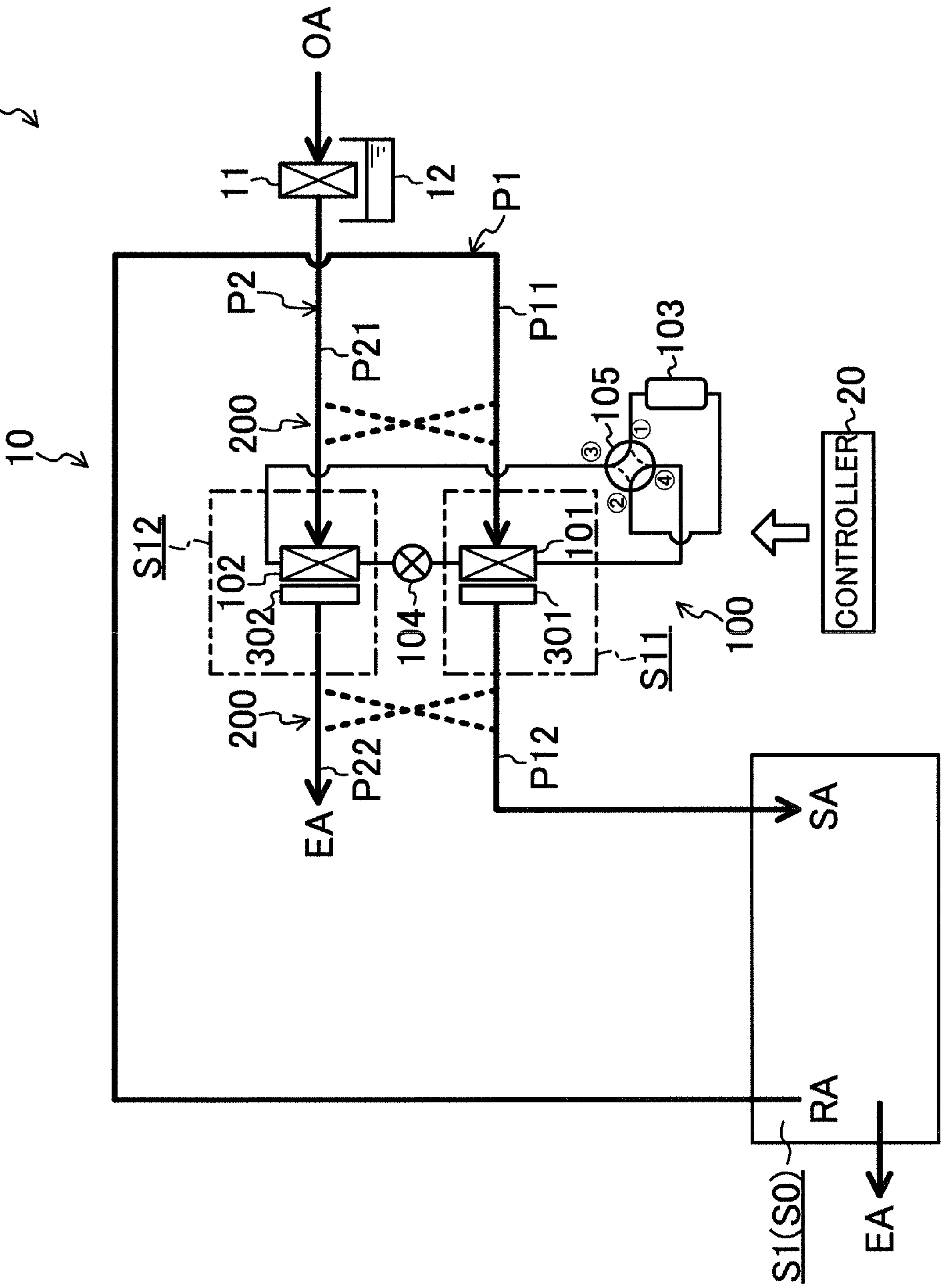
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FIG.6

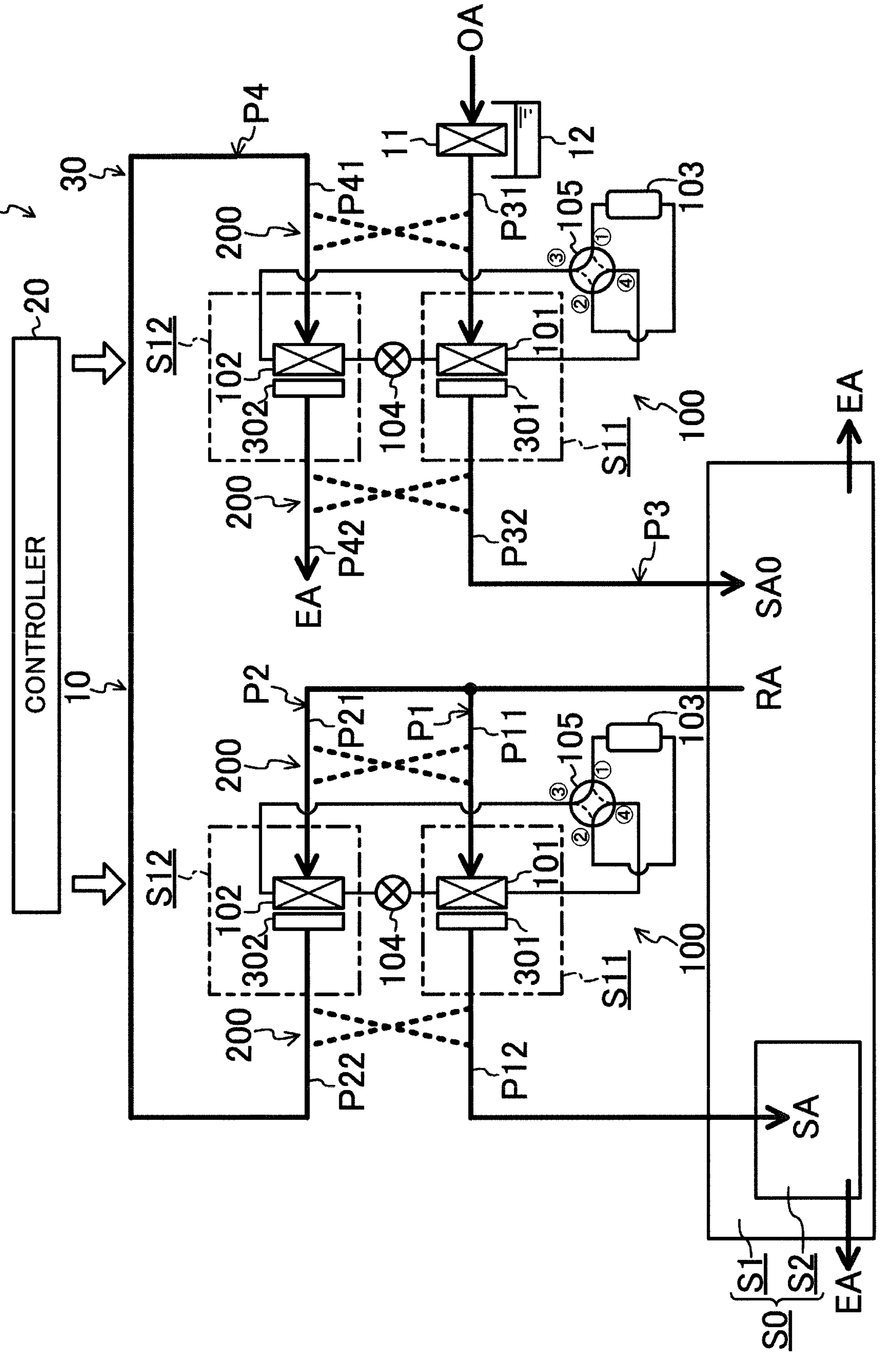
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FIG.7

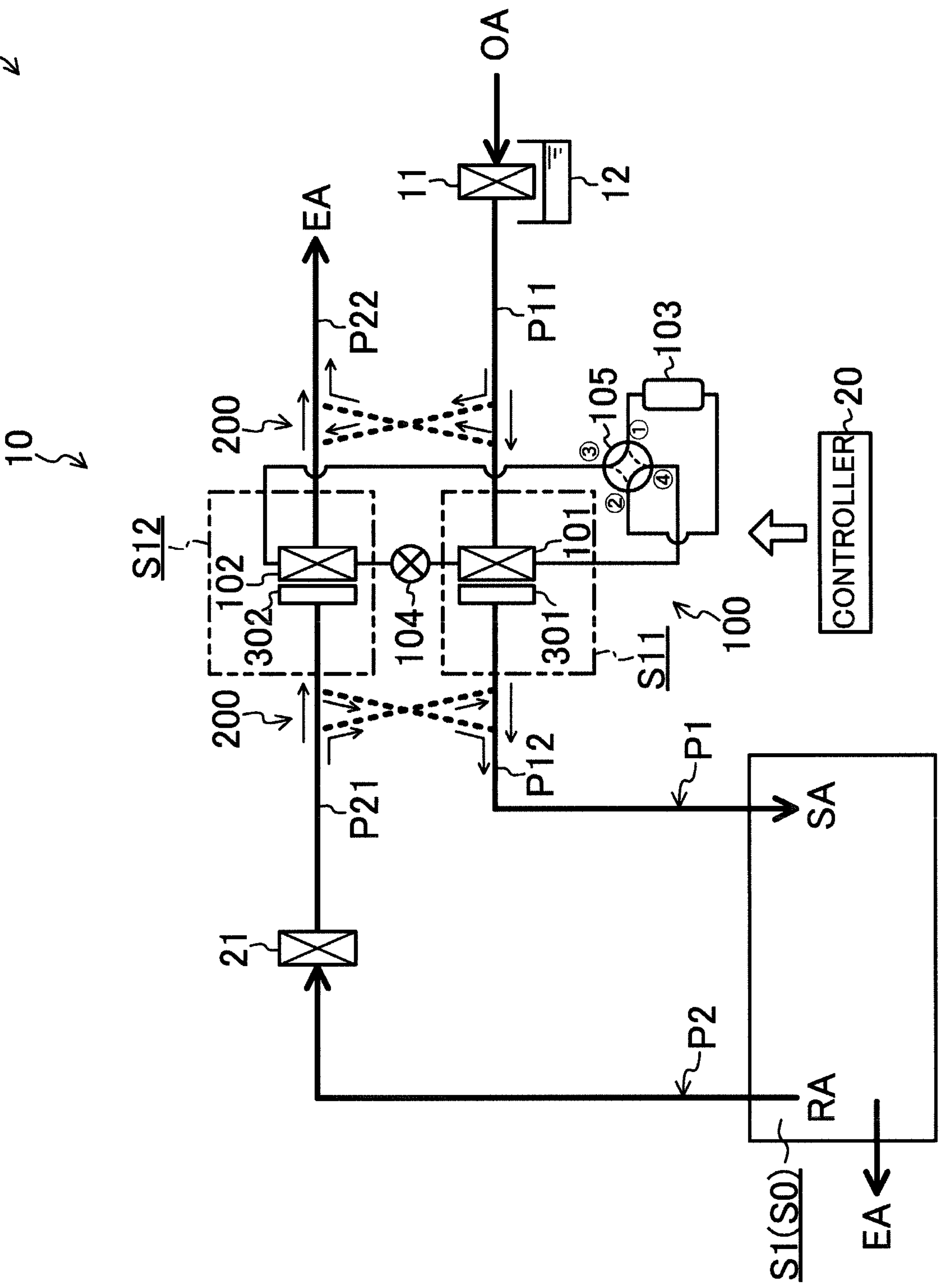
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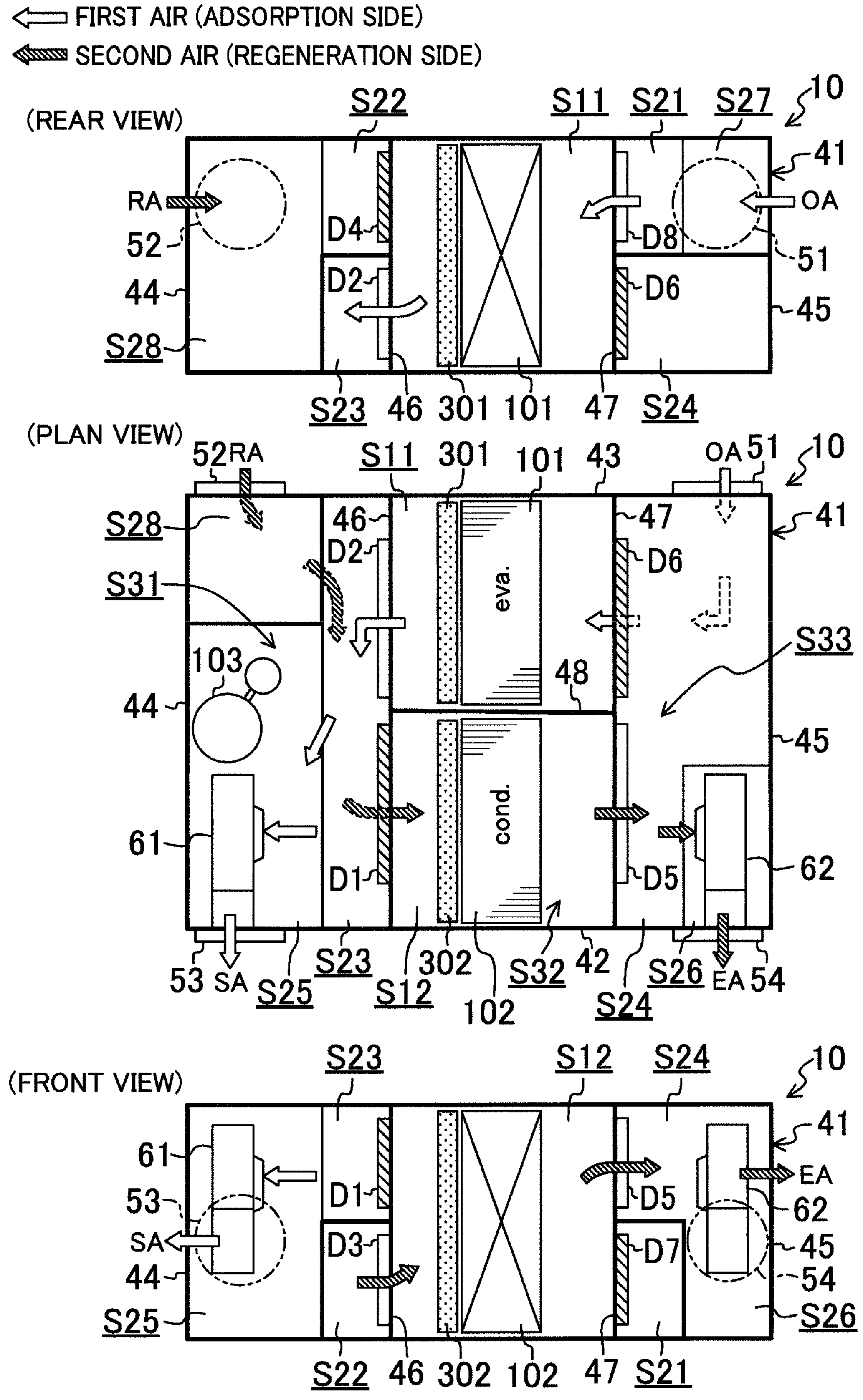
FIG.8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(REAR VIEW)
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(PLAN VIEW)
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D2
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S31
eva.
S33
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cond.
61
62
D1
D5
53
SA
S25
S23
S12
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102
S32
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S24
S26
EA
54
(FRONT VIEW)
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S21

FIG.9

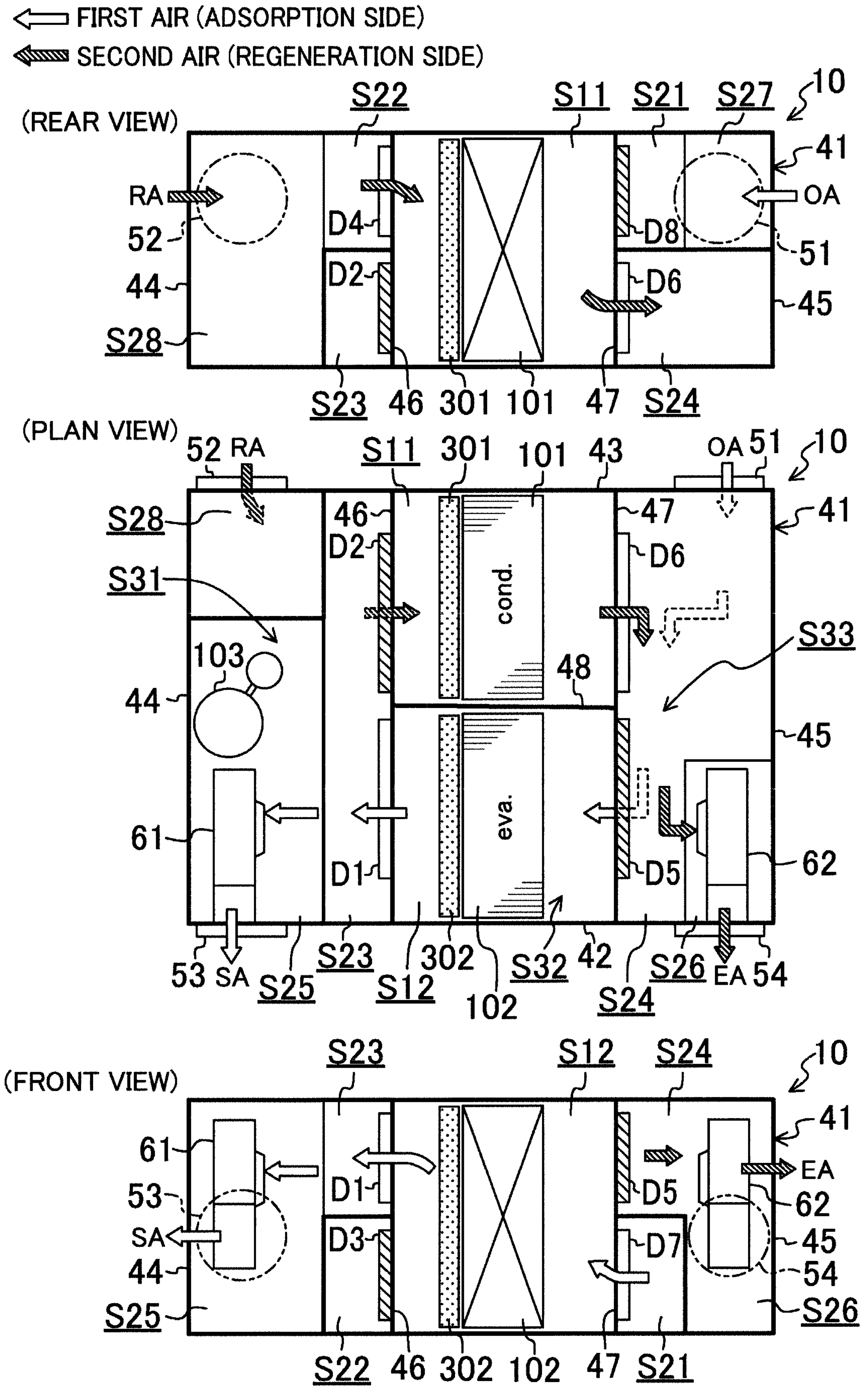
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FIG.10

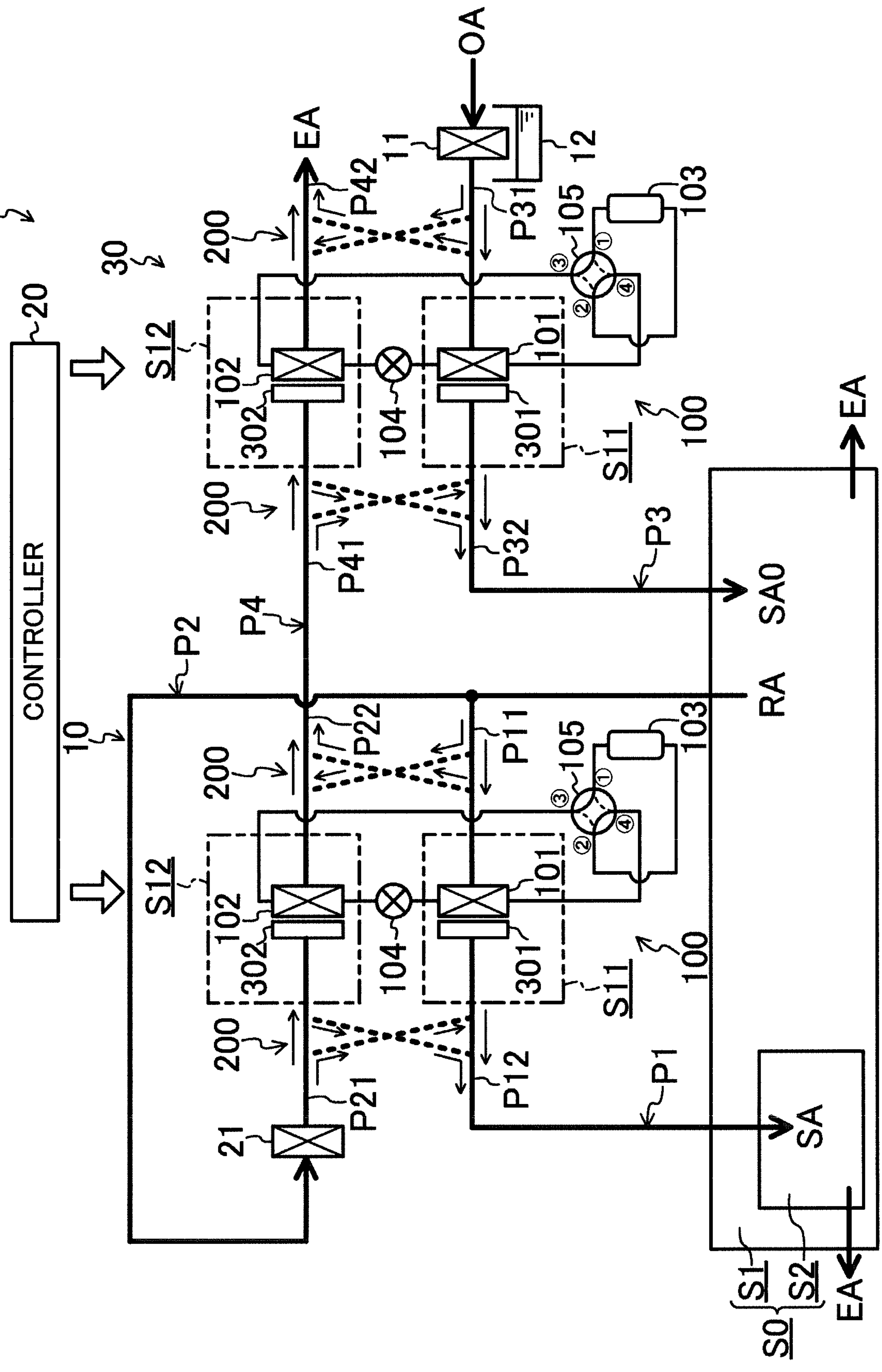
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FIG.11

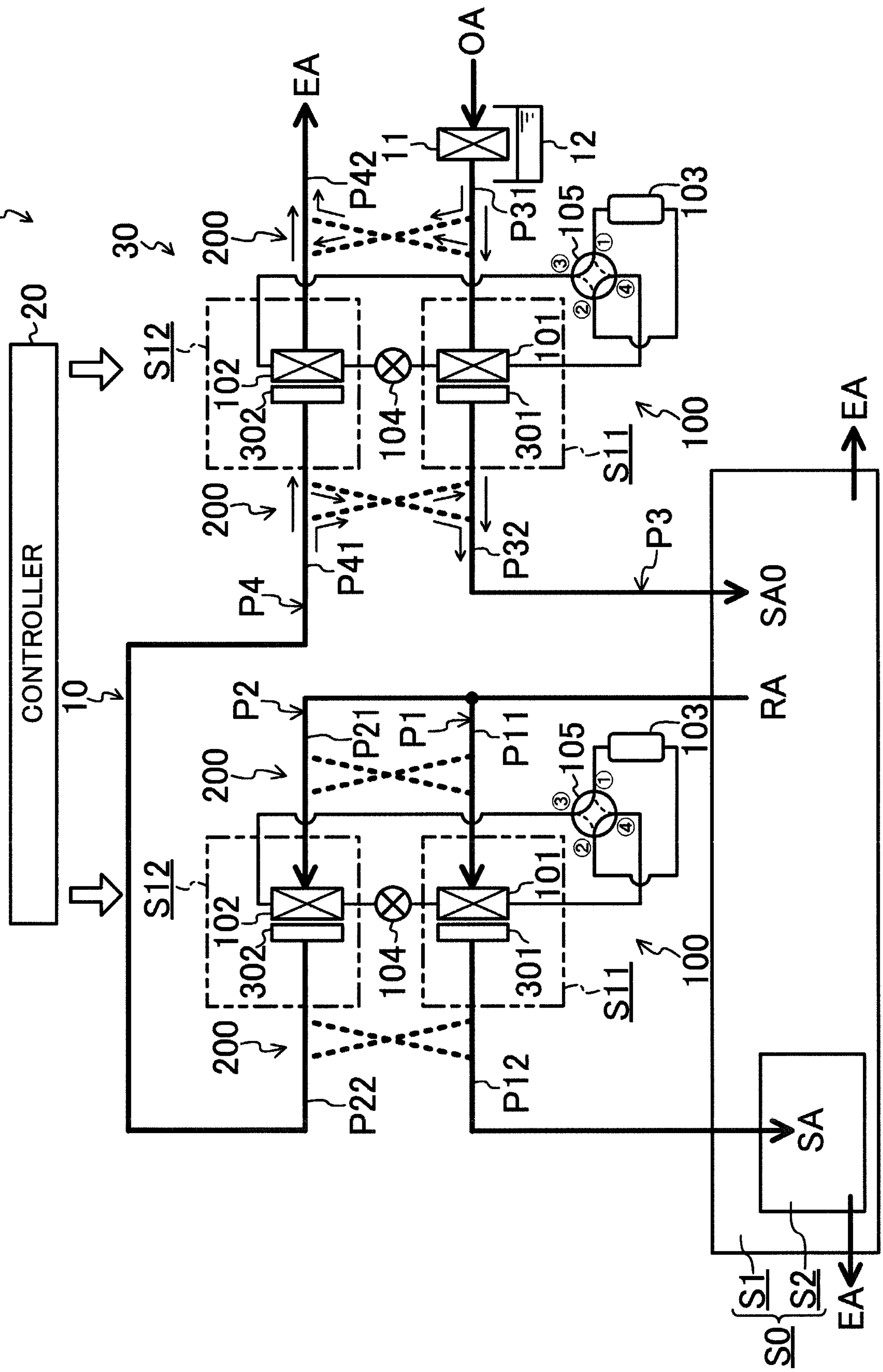
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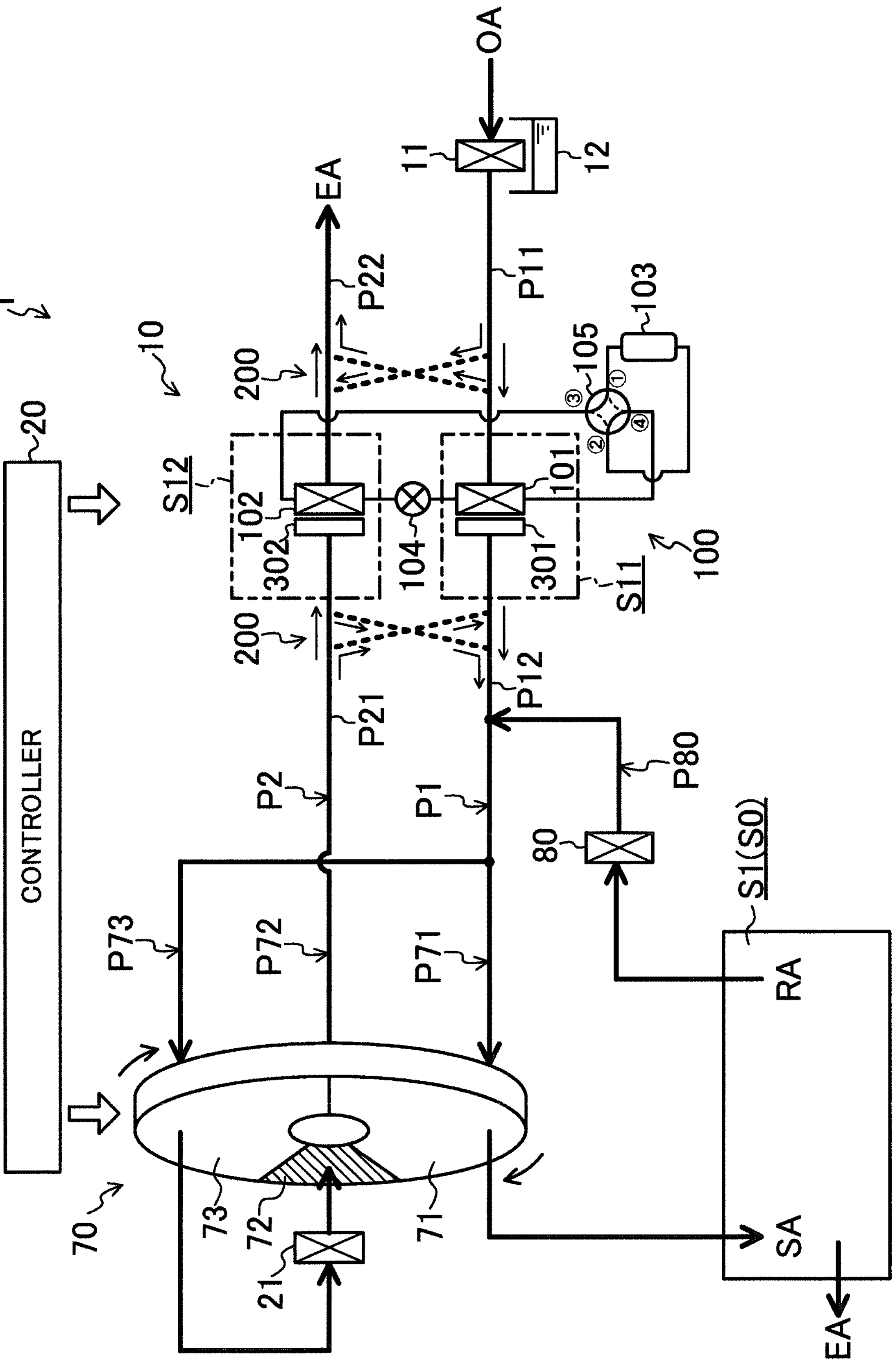
FIG.12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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/003387

A. CLASSIFICATION OF SUBJECT MATTER
F24F3/14(2006.01)i, *B60H3/00*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24F3/14, B60H3/00

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	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-190495 A (Daikin Industries, Ltd.), 02 September 2010 (02.09.2010), paragraphs [0031] to [0062]; fig. 1 to 3 (Family: none)	1-7
Y	JP 7-275642 A (Matsushita Electric Industrial Co., Ltd.), 24 October 1995 (24.10.1995), paragraphs [0016] to [0020]; fig. 2 to 3 (Family: none)	1-7
Y	JP 2013-92290 A (Daikin Industries, Ltd.), 16 May 2013 (16.05.2013), paragraphs [0036] to [0040], [0059] to [0065], [0069] to [0072]; fig. 1 to 2 & WO 2013/061564 A & WO 2013/061564 A1	7

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Date of the actual completion of the international search 22 September, 2014 (22.09.14)	Date of mailing of the international search report 30 September, 2014 (30.09.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/003387

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-264490 A (Mazda Motor Corp.), 05 October 2006 (05.10.2006), paragraphs [0019] to [0023]; fig. 3 to 4 (Family: none)	1-7
A	JP 2000-146220 A (Nissan Motor Co., Ltd.), 26 May 2000 (26.05.2000), paragraphs [0016] to [0034]; fig. 1 to 2 (Family: none)	1-7
A	JP 2008-247305 A (Mitsubishi Chemical Corp.), 16 October 2008 (16.10.2008), paragraphs [0059] to [0074], [0090] to [0094]; fig. 2 to 3, 7 & US 2010/0107673 A1 & EP 2143574 A1 & WO 2008/120733 A1 & CN 101646577 A & KR 10-2009-0127368 A & AU 2008233653 A & AT 544622 T	2-3
A	US 4398927 A (Exxon Research and Engineering Co.), 16 August 1983 (16.08.1983), entire text; all drawings & US 4398927 A & EP 45210 A1 & DE 3173766 D & AU 555137 B & AU 7353781 A & CA 1171799 A & AU 3381484 A & AU 549605 B	1-7
A	US 5826434 A (NovelAire Technologies, L.L.C.), 27 October 1998 (27.10.1998), column 3, line 26 to column 5, line 23; fig. 1 to 2 (Family: none)	7

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Patent documents cited in the description

- JP 2006349294 A **[0003]**