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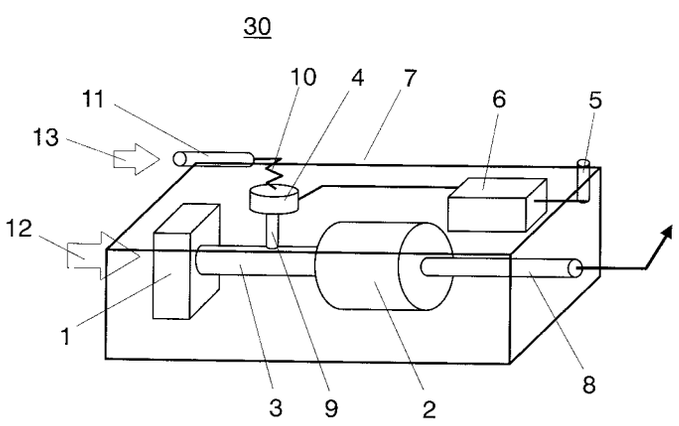
(54) GAS ENRICHMENT DEVICE, DIFFERENTIAL PRESSURE GENERATING DEVCIE USED THEREFOR, AND AIR CONDITIONER

(57) A gas enrichment apparatus in which a gas enrichment unit and differential pressure generation means are coupled. Which gas enrichment apparatus performs purging of high humidity air coming through the gas enrichment unit, and the anti-icing. It includes at least gas enrichment means, differential pressure generation means for generating a differential pressure with the gas enrichment means, a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through the gas enrichment means, and flow channel gate means for supplying a third gas whose relative humidity is lower than that of said second gas into the gas flow channel.

FIG.1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a gas enrichment apparatus for increasing the concentration of a certain specific gas in relation to the other gas components in the air and a differential pressure generating equipment for use in the gas enrichment apparatus. The invention also includes an air conditioner which contains the above items.

BACKGROUND OF THE INVENTION

[0002] Oxygen enrichment apparatus, nitrogen enrichment apparatus, etc. which increase relative concentration of a certain specific gas component of the air, for example oxygen, nitrogen, in these apparatus, by means of selective permeable membrane, absorbent used in the PSA process or the like, have been in use in the field of medical gas enrichment apparatus, air conditioners, air purifiers and other such appliances.

[0003] Japanese Patent Laid-Open Application No. H5-113227 and Japanese Patent Laid-Open Application No. 2002-39569 disclose examples of the oxygen enrichment in a separate type air conditioner. Outdoor unit of the air conditioner is provided with oxygen enrichment means, which enrichment means increases the concentration of oxygen and delivers the oxygen-enriched air via a tube into a room space which is the target of air conditioning in order to improve the amenity of people in the space.

[0004] In the oxygen enrichment process by means of oxygen enrichment membrane, which is one of the selective gas permeable membranes, nitrogen gas which occupies a major part of the air component is separated from oxygen, and oxygen is allowed with priority to pass through the membrane. However, the moisture contained in the air is also allowed to go through the membrane, in the above process.

[0005] As the result, the secondary air after the oxygen enrichment membrane has a higher relative humidity than that of the primary air before passing through the membrane, reflecting the nitrogen gas component separated from it. The secondary air has a higher dew point as compared with that of the primary air, which often brings about dew drops due to dew condensation residing in the secondary delivery tube.

[0006] The dew drop is sometimes dispersed by the room unit of an air conditioner; which water wets the room, or even drops from above the people to the deterioration of amenity. In order to prevent this to happen, a conventional room unit is provided with a cooling unit in the flow channel of oxygen-enriched air so that the water content in the air is forcedly condensed there, it is further provided with a water separator so that the water is prevented from entering to the room space.

[0007] As described in the above, in the gas enrichment process by means of selective gas permeable membrane, absorbent used in the PSA process or the like, the secondary gas, not only oxygen gas, after gas enrichment apparatus inevitably has a higher relative humidity, and the dew point rises. Thus the dew drop readily occurs.

[0008] Above-described conventional technologies contain the following problems.

[0009] At the secondary side after gas enrichment apparatus, in a case where the gas delivery tube is disposed exposed in the outside air and the air temperature is low, the dew drop of gas-enriched gas in the delivery channel may get iced, which ice blocks transportation of the enriched gas. Besides, if there is dew drop in the delivery channel, it causes a pulse motion with the travelling gas flow; which leads to generation of abnormal sounds, even exploding sounds due to burst of dripping water. Such annoying sounds are carried into the room space to the discomfort of the people there. Furthermore, when the dew drop stream into decompression pump or other components used for driving the air, etc. into gas enrichment apparatus, it may ill-affect the operating life of such components, or seriously damage the total system, if the dew drop is taken into the system and compressed.

[0010] The present invention addresses the above-described problems, and aims to offer a gas enrichment apparatus and a differential pressure generating equipment for use in the apparatus. Where, the dew drop with the enriched gas travelling in the delivery channel is suppressed to a minimum and the icing is prevented, even if the outdoor temperature is low. In this way, the flow volume is assured to be sufficient through the delivery channel, and pump and other members of the apparatus can be operating in a stable manner. An air conditioner containing these items is also disclosed in the present invention.

SUMMARY OF THE INVENTION

[0011] A gas enrichment apparatus in the present invention includes at least gas enrichment means, differential pressure generation means for generating a differential pressure with the gas enrichment means, a gas delivery channel for delivering a second gas which gas has been enriched with respect to a certain specific gas component of a first gas by having the first gas to go through the gas enrichment means, and flow channel gating means for supplying a third gas whose relative humidity is lower than that of the second gas to the delivery channel.

[0012] With the above-described structure, dew drop in the delivery channel can be pushed out or re-evaporated; thereby, staying of dew drop in the delivery channel and generation of the annoying sounds are prevented, and a stable operation of gas enrichment apparatus is implemented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 shows a perspective view of a gas enrichment apparatus in accordance with a first exemplary embodiment of the present invention.

FIG. 2 shows a control specification of a flow channel gate valve used in the gas enrichment apparatus.

FIG. 3 is a time chart showing the operation of flow channel gate valve and decompression pump in the gas enrichment apparatus.

FIG. 4 shows a perspective view of a gas enrichment apparatus in accordance with a second exemplary embodiment of the present invention.

FIG. 5 shows a perspective view of a gas enrichment apparatus in accordance with a third exemplary embodiment of the present invention.

FIG. 6 is a time chart showing the operation of flow channel gate valve and decompression pump in a fourth exemplary embodiment of the present invention.

FIG. 7 shows a control specification of a flow channel gate valve in a fifth exemplary embodiment of the present invention.

FIG. 8 is a time chart showing the operation of flow channel gate valve and a decompression pump in the fifth embodiment.

FIG. 9 is a perspective view used to describe the structure of an air conditioner in accordance with a sixth exemplary embodiment of the present invention.

FIG. 10 is a perspective view used to describe the structure of an air conditioner in a seventh exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Description is made below on exemplary embodiments of the present invention, referring to the drawings. Where, the gas enrichment apparatus is an oxygen enrichment apparatus built in a separate type air conditioner for harmonizing the air in a living space.

(FIRST EMBODIMENT)

[0015] First embodiment of the present invention is described with reference to FIG. 1, FIG. 2 and FIG. 3. FIG. 1 is a perspective view showing a gas enrichment apparatus in accordance with a first exemplary embodiment of the present invention. The differential pressure generation means in the present embodiment 1 for generating a differential pressure with gas enrichment means is a decompression pump.

[0016] Gas enrichment apparatus 30 includes gas enrichment means, or oxygen enrichment unit 1, differential pressure generation means, or decompression pump 2, delivery tube 3, flow channel gate means, or flow channel gate valve 4, temperature detection means, or temperature sensor 5, control means 6, etc. The entire structure is housed in case 7. Decompression pump 2 is connected at the outlet side to main outlet tube 8 for delivering the enriched gas to the point of use. Gate valve 4 is connected with delivery tube 3 via branch tube 9 coming from delivery tube 3. The valve is connected also with flow resistance member 10 and intake tube 11. Oxygen enrichment unit 1 can be either a selective permeable membrane which selectively allows a certain specific gas component to go through, or a selective absorption membrane which absorbs a certain specific gas component.

[0017] In the above-configured gas enrichment apparatus 30, outdoor air 12 which is the source gas for enrichment, or first gas, is sucked into oxygen enrichment unit 1 by the effect of decompression pump 2 disposed at the exit side of oxygen enrichment unit 1. Oxygen is selectively allowed to go through a selective permeable membrane or other membrane of same function disposed in oxygen enrichment unit 1, and second gas of higher oxygen concentration is provided. The second gas proceeds to delivery tube 3 to be discharged to main outlet tube 8 via decompression pump 2.

[0018] A fan (not shown) may be provided at the intake side, viz. the side facing the outdoor air of oxygen enrichment unit 1, in order to blow the resultant nitrogen-rich air staying in the neighborhood of oxygen enrichment unit 1 away. Operation of the fan can be coupled with operation of gas enrichment apparatus 30. In an exemplary case where gas enrichment apparatus 30 is applied to an air conditioner, oxygen enrichment unit 1 may be disposed in the outdoor unit's blown air circuit so that the fan of the outdoor unit serves also for the above-described purpose.

[0019] As to gate valve 4 connected to branch tube 9, a electro-magnetic two-way valve, or the like gate valve may be used. For flow resistance member 10, a capillary tube or the like item may be used. Opening-and-closing operation of flow channel valve 4 is controlled by the signal delivered from control means 6, which signal is generated based on temperature detected by temperature detection means, or temperature sensor 5. In a case where gas enrichment apparatus 30 is coupled with other appliances, the opening-and-closing operation of valve 4 may be controlled under the control of external signals delivered from the appliance. Gate valve 4 may be operated in either a simple ON-OFF action, or variable opening-and-closing degrees so that volume of gas flow running through it is controlled accordingly. The sensing point of temperature sensor 5 may be determined at option in any places; for example, the outdoor air temperature where gas enrichment apparatus 30 is installed, temperature in the neighborhood of oxygen enrichment unit 1, tube temperature of delivery tube 3, main outlet tube 8, etc.

[0020] Now in the following, the oxygen enrichment operation is described using the above-canfigured gas enrichment apparatus 30 installed in the outdoor air, with reference to FIG. 1, FIG. 2 and FIG. 3.

[0021] When decompression pump 2 is put into operation, first gas, or outdoor air 12, is sucked into oxygen enrichment unit 1. The air of higher oxygen concentration created as the result of passing through oxygen enrichment unit 1 proceeds to delivery tube 3 to be sucked into decompression pump 2, and sent out via main outlet tube 8.

[0022] Next, the operation of gate valve 4 disposed on branch tube 9 of delivery tube 3 is described referring to FIG. 2 and FIG. 3. FIG. 2 shows a control specification of a flow channel gate valve in a gas enrichment apparatus in accordance with embodiment 1. FIG. 3 is a time chart showing the operation of flow channel gate valve and decompression pump under the above control specification.

[0023] At the operation start, gate valve 4 is in closed state. When decompression pump 2 is put into operation for the oxygen enrichment process, control means 6 starts to control the opening-and-closing operation of flow channel gate valve 4 in accordance with the outdoor air temperature detected by temperature sensor 5.

[0024] In FIG. 2, the upper area represents the higher outdoor air temperature detected, while the lower area the lower temperature. Reference is made to FIG. 2 and FIG. 3, when the detected outdoor air temperature T is at point a, which is higher than certain specified temperature T1, flow channel gate valve 4 stays in the closed state. When the outdoor air temperature T goes lower to be reaching at point b, which is lower than specified temperature T1, relative humidity of the outdoor air rises, and the relative humidity of the oxygen-enriched second gas goes to be still higher; as the result, the dew condensation readily takes place in delivery tube 3 and main outlet tube 8. The tubes can be blocked by iced condensation water, etc.

[0025] Then, if flow channel gate valve 4 is opened, outdoor air 13, which is third gas whose relative humidity is lower than at least that of the enriched gas flowing through delivery tube 3, is introduced into delivery tube 3 via intake tube 11. The gas coming to main outlet tube 8 has been mixed with the outdoor air of lower relative humidity; which means that the condition of dew condensation is eased.

[0026] It has been designed so that the flow resistance is lower with the route of intake tube 11 than with the route of oxygen enrichment unit 1. Therefore, when flow channel gate valve 4 is turned to open state, the outdoor air is introduced with priority on the route of intake tube 11, not on the route of oxygen enrichment unit 1. Thus, by making the overall flow resistance of intake tube 11, flow resistance member 10, flow channel gate valve 4 and branch tube 9 to be smaller than that of oxygen enrichment unit 1, the outdoor air can be introduced for a higher flow volume. Therefore, by increasing the flow velocity in the tube, dew drop staying in main outlet tube 8, etc. can be discharged to outside. The increased flow velocity also expedites evaporation of the dew drop. Even if the dew drop is iced in main outlet tube 8, etc., it can be purged by taking advantage of the high speed air flow.

[0027] In the present embodiment 1, the flow volume can be optimized by means of flow resistance member 10 provided for controlling the flow volume to be introduced through intake tube 11. Evaporation of dew drop and anti-icing of the water can be effected in more reliable manner by introducing a third gas whose temperature is higher than that of first gas sucked into oxygen enrichment unit 1.

[0028] A certain specific temperature for performing the opening-and-closing operation with flow channel gate valve 4 in re-ascending stage of outdoor temperature T is provided with a hysteresis, as shown in FIG. 3. Namely, the outdoor air temperature T at which flow channel gate valve 4 is made to open in the outdoor air temperature descending stage does not bring the valve back to closed state even at point c in the ascending stage; the valve is closed only when the outdoor air temperature T reached point d. It may of course be set to be T1 = T2, but the hysteresis eliminates chattering of flow channel gate valve 4 at the vicinity of T1, and ill-affect to the valve reliability is prevented. Also the users are relieved from the chattering noise.

[0029] The detected outdoor air temperature may be compared to a plurality of certain specific temperatures, and an open time of gate valve 4 may be increased to be longer for the lower outdoor temperatures in order to make sure of anti-icing of the dew drop in the flow channel.

[0030] As shown in FIG. 1, intake tube 11 in the present embodiment 1 is provided with flow resistance member 10. If no flow resistance member 10 is provided, a sudden change in the sucking pressure arises at decompression pump 2 when valve is opened, which brings about big abnormal sounds. Flow resistance member 10 contributes to reduce the sudden change in the pressure, which is effective to reduce the abnormal sounds. Furthermore, flow resistance member 10 can be used to control the flow volume, as described earlier. When the flow resistance member 10 is structured to have a smaller flow resistance than that of oxygen enrichment unit 1, it is advantageous in purging the dew drop.

[0031] Although temperature sensor 5 in the above descriptions is provided to detect the outdoor air temperature, it may detect temperatures of delivery tube 3, main outlet tube 8, etc., or the outdoor air temperatures at the vicinity of the tubes. By so doing, dew condensation and the icing in these flow channels can be avoided at a higher reliability level.

[0032] Furthermore, flow channel gate valve 4 can be controlled to make an intermittent opening-and-closing operation based on a certain time schedule, being irrel-

evant to the outdoor air temperature. Under such a control scheme, an air conditioner containing a gas enrichment apparatus, for example, can switch its operation mode from introduction of the fresh outdoor air into the room, to supply of the oxygen-enriched air, from time to time. Thus the air conditioner can be provided with a ventilation function.

[0033] Still further, when the above-configured gas enrichment apparatus is coupled with an air conditioner, the air conditioner's temperature sensor may be used in common to perform the function of temperature sensor 5, or control means 6 may be built within the air conditioner's control gear in the outdoor unit.

(SECOND EMBODIMENT)

[0034] Second embodiment is described referring to FIG. 4. FIG. 4 is a perspective view showing a gas enrichment apparatus in accordance with a second exemplary embodiment of the present invention.

[0035] In embodiment 1, branch tube 9 is provided to delivery tube 3. However, branch tube 20, or gas introduction portion, in the present embodiment is connected direct with the sucking side of decompression pump 2, as shown in FIG. 4. Flow channel gate valve 4, etc. are connected to branch tube 20. Other structures remain the same as those in embodiment 1.

[0036] Branch tube 20 in the present embodiment may be provided beforehand on decompression pump 2. In this structure, it is not necessary for delivery tube 3 between oxygen enrichment unit 1 and decompression pump 2 to have a branch. A unit of flow channel gate valve 4, branch tube 20, etc. may be assembled to decompression pump 2 during manufacturing stage of the pump; then, decompression pump 2 is completed as a decompression pump containing built-in dew condensation suppression function.

[0037] Although the opening-and-closing operation of flow channel gate valve 4 in embodiment 1 is controlled based on the detected outdoor air temperature, it may be controlled instead based on, for example, load current of decompression pump 2. In this setup, the flow channel gate valve 4 operates based on a judgement as to whether main outlet tube 8 is troubled with dew condensation or the icing.

[0038] Branch tube 9 in embodiment 1 is provided to delivery tube 3, while branch tube 20 in embodiment 2 is connected direct to the sucking side of decompression pump 2. There can be another structure of connecting the branch tube 9 direct to oxygen enrichment unit 1.

(THIRD EMBODIMENT)

[0039] Third embodiment is described referring to FIG. 5. FIG. 5 is a perspective view showing a gas enrichment apparatus in accordance with a third exemplary embodiment of the present invention.

[0040] In embodiments 1 and 2, a decompression pump has been used as the differential pressure generation means for generating a differential pressure with gas enrichment means, or oxygen enrichment unit 1. In the present embodiment 3, however, a pressurizing facility, not a decompression facility, is used for the same purpose. Namely, as shown in FIG. 5, outdoor air 12, or first gas, is pressurized by turbo fan 40, or a pressurizing facility, to be supplied via flow channel 41 to gas enrichment means, viz. oxygen enrichment unit 42. Second gas coming out of oxygen enrichment unit 42, which is the oxygen-enriched gas, proceeds to delivery tube 43. As for oxygen enrichment unit 42, a selective gas permeable membrane, the PSA process or the like absorbent, etc. may be used, as described earlier in embodiments 1 and 2. The structure in accordance with the present embodiment 3, where a pressurizing pump or an air blower is used for the differential pressure generation means, is advantageous in such cases where a hollow fiber membrane is used for oxygen enrichment unit 42.

[0041] Flow channel gate valve 44 is provided in parallel with oxygen enrichment unit 42, forming bypass channel 45 which couples flow channel 41 with delivery tube 43. A heater (not shown) may be provided in bypass channel 45 for heating the gas going through the bypass channel 45. Likewise in embodiments 1 and 2, the opening-and-closing operation of flow channel gate valve 44 is controlled by control means 6 in accordance with the temperature detected by temperature sensor 5.

[0042] Thus, even in a case where a pressurizing facility is used for the differential pressure generation means, purging of dew drop generated from the gas after oxygen enrichment unit 42, as well as the anti-icing, can be performed through the opening-and-closing operation of flow channel gate valve 44.

[0043] Furthermore, in the present embodiment 3, it is not necessary to suck as much gas volume as done by the decompression pump's sucking side in embodiments 1 and 2. So, abnormal sounds due to the sucking are suppressed. And differential pressure can be provided without being influenced by the condition of outdoor air, or the atmospheric pressure.

[0044] Method of introducing the second gas to delivery tube and main outlet tube is not limited to the above-described. An example of alternative methods is; providing an ejector in the delivery tube or main outlet tube, and sucking and introducing the second gas by taking advantage of the ejector effect.

[0045] The opening-and-closing operation of flow channel gate valves in embodiments 1 through 3 has been based on electrical control. Instead, the operation may be done by, for example, a valve whose valve blade is made with a shape memory alloy; where, the gate action is controlled by deformation of the shape memory alloy exhibited at a certain specific temperature.

(FOURTH EMBODIMENT)

[0046] The opening-and-closing operation of a flow channel gate valve in accordance with a fourth exemplary embodiment is described referring to FIG. 2 and FIG. 6. FIG. 6 is a time chart used to describe the operation of flow channel gate valve and decompression pump in embodiment 4. The structure of gas enrichment apparatus remains the same as that in embodiment 1; so, description on which is eliminated here.

[0047] In the present embodiment 4, when temperature sensor 5 detects a certain specific outdoor air temperature T1, flow channel gate valve 4 is put into an intermittent opening-and-closing operation in order to introduce dry outdoor air of low relative humidity for a large volume before the air from oxygen enrichment unit 1, whose relative humidity is high, makes dew drop. The icing phenomenon is thus prevented.

[0048] Outdoor air in this context means the atmospheric air; it may be either the outdoor air or the ambient air of decompression pump.

[0049] The intermittent operation of flow channel gate valve 4 means a cyclical mode of open and close operation; where, when outdoor temperature goes to be lower than T1 it opens (ON operation) for a duration of time ta, and then closes (OFF operation) for a duration of time tb. As soon as the outdoor air temperature goes to be higher than T2, flow channel gate valve 4 is closed and the intermittent opening-and-closing operation is terminated.

[0050] Furthermore, anti-icing effects on the dew drop in flow channel can be enhanced, by comparing a detected outdoor air temperature with a plurality of specified temperatures and increasing a ratio of opening-and-closing operation for the lower outdoor air temperature. The ratio of opening-and-closing operation in this context means proportion of the open time during the intermittent opening-and-closing operation.

(FIFTH EMBODIMENT)

[0051] The opening-and-closing operation of flow channel gate valve in accordance with a fifth exemplary embodiment is described referring to FIG. 7 and FIG. 8. The structure of gas enrichment apparatus remains the same as that in embodiment 1; so, description on which is eliminated here.

[0052] FIG. 7 shows a control specification of flow channel gate valve 4, which valve is controlled based on results of comparison of the outdoor air temperature as detected by temperature sensor 5 with certain specified temperatures. FIG. 8 is a time chart of flow channel gate valve 4 and decompression pump 2, which are operating in accordance with the outdoor air temperature as detected by temperature sensor 5.

[0053] As described earlier in embodiment 4, when the outdoor air temperature goes low, the gas of high relative humidity coming from oxygen enrichment unit 1 produces dew drop and the water is iced, which leads to a blocked air channel. So, as soon as a low outdoor air temperature is detected by temperature sensor 5, flow channel gate valve 4 starts an intermittent opening-and-closing operation in order to introduce the dry outdoor air abundantly, before the high relative humidity air makes dew drop. Depending on status of the outdoor air temperature, if the temperature is getting further lower, operation ratio of flow channel gate valve 4's intermittent opening-and-closing operation is increased for preventing the icing in the flow channel.

[0054] Reference is made to FIG. 7 and FIG. 8, when the outdoor air temperature goes lower than T3, flow channel gate valve 4 in the present embodiment 5 is put into opening-and-closing operation mode A; where, flow channel gate valve 4 opens (ON operation) for a duration of time ta, and then closes (OFF operation) for a duration of time tb. When outdoor air temperature goes higher than T4, flow channel gate valve 4 is closed and the intermittent operation is terminated. When outdoor air temperature is going still lower reaching T1 and lower, flow channel gate valve 4 is put into opening-and-closing operation mode B; where, flow channel gate valve 4 opens (ON operation) for a duration of time tc, and then closes (OFF operation) for a duration of time td. Mutual relationship between the open times ta and tc, is : $ta < tc$, and $tc > td$.

[0055] By so doing, the dew drop residing in flow channel and main outlet tube can be surely purged even when the outdoor air temperature is low. As the result, the gas enrichment apparatus does not generate abnormal sounds and keeps on operating in a stable manner.

(SIXTH EMBODIMENT)

[0056] A separate type air conditioner consisting of room unit and outdoor unit, which contains a gas enrichment apparatus in accordance with one of embodiments 1 through 5, is described below as a sixth exemplary embodiment of the present invention.

[0057] FIG. 9 is a perspective view used to describe the structure of an air conditioner provided with gas enrichment apparatus in accordance with a sixth embodiment of the present invention. Referring to FIG. 9, the air conditioner consists of room unit 50 and outdoor unit 51, which are coupled together by means of connecting tube (not shown) through which a refrigerant gas circulates. Room unit 50 is provided with room fan 52. Outdoor unit 51 is provided with compressor 53, outdoor heat exchanger 54 and outdoor fan 55, and oxygen enrichment apparatus 56, or a gas enrichment apparatus, is provided thereon housed in a separate chamber.

[0058] Oxygen enrichment apparatus 56 corresponds to gas enrichment apparatus 30 of embodiment 1. Oxygen enrichment apparatus 56 is provided with outlet mouth 57, which discharges the gas-enriched second gas having a high oxygen concentration within, or in the neighborhood of, room unit 50's cabinet via main outlet

tube 8. Outlet mouth 57 is means for discharging the gas-enriched second gas in a room space, which space being the target of air conditioning. If outlet mouth 57 is disposed facing to the blown air circuit inside the cabinet of room unit 50, the air blown by room fan 52 to be sent out into the room space is added with the oxygen-rich air provided through outlet mouth 57. The mixed air goes out through guide wing 58. Thus, room fan 52 functions also as diffusion means for diffusing the second gas.

[0059] The structure and the operating principle of refrigeration cycle of the air conditioner are irrelevant to the present invention; so, no detailed description here.

[0060] In an air conditioner in accordance with the present embodiment, which having the above-described configuration, oxygen enrichment apparatus 56 can make use of the gas enrichment apparatus, differential pressure generation means and the methods of controlling the flow channel gate valve described in one of embodiments 1 through 5. Therefore, the air conditioner delivers oxygen gas, besides performing the basic functions, into a room space, viz. the target of air conditioning, to an improved amenity of people staying there.

[0061] When the oxygen-rich air from oxygen enrichment apparatus 56 is delivered to a room space, dew condensation readily occurs in main outlet tube 8 in summer season, for example, when the relative humidity of outdoor air is high, and in winter season when the temperature of outdoor air is low. Especially during cold season, the dew drop easily get iced. In the present embodiment, however, the dew condensation and its icing are prevented by introducing the low relative humidity outdoor air into the oxygen-rich air having a high relative humidity, in an intermittent mode or for a big volume. Therefore, the room space can receive the oxygen-rich air in a stable and reliable manner.

[0062] In order not to let the dew drop, or the ice, residing in main outlet tube 8 discharged as they are into a room space through outlet mouth 57, an expanded portion may be provided just before outlet mouth 57 so that the water or ice is melted and evaporated at the expanded portion.

(SEVENTH EMBODIMENT)

[0063] Another example of air conditioner containing gas enrichment apparatus is described below. FIG. 10 is a perspective view showing the structure of an air conditioner with built-in gas enrichment apparatus in accordance with a seventh exemplary embodiment of the present invention.

[0064] Reference is made to FIG. 10, basic structure of the air conditioner remains the same as that in embodiment 6, and the key corresponding items of the air conditioners bear the same numerical symbols.

[0065] In FIG. 10, outdoor unit 51 includes compressor chamber 60 which houses compressor 53, four-way valve (not shown), etc., an oxygen enrichment apparatus consisting of oxygen enrichment unit 61, decompression pump 62, etc., and electrical components chamber 64 which houses control unit 63, etc. for controlling the air conditioner. All these items form a machine chamber. It also includes heat exchanger chamber 65 which houses outdoor fan 55 and outdoor heat exchanger 54.

[0066] Room unit 50 is provided with room fan 52, as well as outlet mouth 57 of oxygen enrichment apparatus 56.

[0067] The oxygen enrichment apparatus includes a selective gas permeable membrane, or oxygen enrichment unit 61, decompression pump 62 for decompressing the secondary side of oxygen enrichment unit 61, main oxygen supply tube 66 which couples the former two items to be air-through, three way valve 68 having air intake tube 67 disposed in the middle of main oxygen supply tube 66, and main outlet tube 69 connected with decompression pump 62 at the outlet side. The other end of air intake tube 67 is extended so that air intake mouth 70 is disposed within inside of compressor chamber 60.

[0068] Air tube 71 is a connection tube for coupling main outlet tube 69 with outlet mouth 57. The air tube 71 comes out of outdoor unit 51 and goes into room unit 50.

[0069] It is preferred to provide a fan (not shown) at the primary side (the side of atmospheric air) of oxygen enrichment unit 61 for sweeping the nitrogen-rich air staying in the neighborhood away. Operation of the fan may be linked with operation of the oxygen enrichment apparatus. In the present exemplary case, the primary side of oxygen enrichment apparatus 61 is disposed within the blown air circuit in heat exchanger chamber 65 having outdoor fan 55, in order that the nitrogen-rich air at the primary side of oxygen enrichment unit 61 is swept away by the blown air generated by outdoor fan 55.

[0070] In the above-described setup, when decompression pump 62 is put into operation, the air in the inside of heat exchanger chamber 65, or first gas, is sucked and goes through oxygen enrichment unit 61. The oxygen-enriched gas, or second gas, proceeds main oxygen supply tube 66 and three-way valve 68, and then sucked into decompression pump 62. The second gas goes through main outlet tube 69 and air tube 71, and reaches inside of room unit 50 to be discharged there via outlet mouth 57.

[0071] The flow resistance in a state where three-way valve 68 is in open state (air intake tube 67 and main oxygen supply tube 66 of decompression pump 62 are connected through) is lower than that in a state where the three-way valve 68 is in closed state (main oxygen supply tube 66 at the oxygen enrichment unit 61 side and the tube 66 at the decompression pump 62 side are connected through). As the result, when three-way valve 68 is in open state, the outdoor air is introduced with priority on the route of air intake mouth 70 of air

intake tube 67, not on the route of oxygen enrichment unit 61. Furthermore, since the air is introduced for more volume than via oxygen enrichment unit 61 route, reflecting the reduced flow resistance, the wind velocity in the tube increases, and dew drop residing in main outlet tube 69, etc. can be easily pushed forward to outlet mouth 57. The increased wind velocity expedites the evaporation of dew drop either. These contributes to reduce volume of the dew drop. Even if it get iced within flow channel, the increased wind velocity can easily push the ice towards outlet mouth 57.

[0072] Air intake mouth 70 in the present embodiment 7 is disposed in the inside of compressor chamber 60. Since the inside temperature of compressor chamber 60 is higher than outer environmental temperature of outdoor unit 51 because of heat radiation from compressor 53 and other items, the air introduced from there has an advantage in expediting evaporation of dew drop and making main outlet tube 69 and air tube 71 dry. If three-way valve 68 is controlled to operate in an appropriate intermittent mode, a cycle of dew condensation and evaporation is repeated and storage of dew drop in volume is prevented. Furthermore, an optimized control may implement a state of no dew condensation.

[0073] Air intake mouth 70 may be disposed instead in the inside of electrical components chamber 64. Heats generated from control unit 63, etc. provide the same advantage also in this setup. Thus, air intake mouth 70 disposed in the inside of machine chamber of outdoor unit 51 has advantages over the case in which the air is introduced direct from the outside; in that the possibility of sucking dusts or particles is less and influence due to rough weather is small.

[0074] It is preferred to dispose air intake mouth 70 somewhere in the inside of room space. Because the air in the inside of a room space has stable temperature, humidity and other properties, the air introduced from there brings about less influence on the room environment, as compared to the air introduced from the outdoor. This concept can be implemented easily by the use of a double tube for air tube 71; coupling air intake tube 67 with the outer part of the double tube, while leaving the other end of the outer part open somewhere at a point where air tube 71 comes into the room space.

[0075] Air intake mouth 70 may be disposed instead in the inside of heat exchanger chamber 65.

[0076] Although the present embodiment used an example where a gas enrichment apparatus is applied to a separate type air conditioner for harmonizing the room air of a house, it can be applied likewise to, for example, air conditioners for vehicles, unitized type air conditioners.

[0077] A gas enrichment apparatus described in the present embodiment can be applied also to air purifiers, medical-use oxygen enrichment apparatuses, portable oxygen enrichment equipment, oxygen enrichment equipment for combustion facilities, etc. to implement the same advantages.

[0078] It can be applied to the nitrogen enrichment apparatus for keeping foodstuffs fresh, to the implementation of the same advantages.

INDUSTRIAL APPLICABILITY

[0079] As described in the above, in a gas enrichment apparatus in accordance with the present invention, the enriched gas having a high relative humidity is prevented from making dew condensation in the flow channel, dew drop is discharged or re-evaporated. Thus, staying of the dew drop in the flow channel and generation of abnormal sounds due to the water are suppressed, and the gas enrichment apparatus is assured of a stable operation.

Claims

1. A gas enrichment apparatus comprising at least

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through said gas enrichment means, and
flow channel gating means for introducing a third gas whose relative humidity is lower than that of said second gas into said gas flow channel.

2. A gas enrichment apparatus comprising at least

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through said gas enrichment means, and
flow channel gating means for introducing a third gas into said gas flow channel for a higher flow volume than that delivered through said gas enrichment means.

3. A gas enrichment apparatus comprising at least

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go

through said gas enrichment means, and
flow channel gating means for introducing a third gas whose temperature is higher than that of said first gas into said gas flow channel.

4. The gas enrichment apparatus recited in one of claims 1 through 3, wherein

said differential pressure generation means is decompression means which decompresses said gas enrichment means at one end for sucking said first gas, and
said flow channel gating means introduces a third gas to said decompression means at the sucking side.

5. The gas enrichment apparatus recited in one of claims 1 through 3, wherein

said differential pressure generation means is compression means which compresses said gas enrichment means at one end for pushing said first gas in, and
said flow channel gating means is disposed in parallel with said gas enrichment means.

6. The gas enrichment apparatus recited in one of claims 1 through 3, wherein

operation of said flow channel gating means is controlled by control signal delivered from another control apparatus.

7. The gas enrichment apparatus recited in one of claims 1 through 3, wherein

said flow channel gating means changes its opening for controlling flow volume of a third gas going through the present flow channel gate means.

8. The gas enrichment apparatus recited in one of claims 1 through 3, wherein

said third gas flow channel is provided with a flow resistance member.

9. The gas enrichment apparatus recited in one of claims 1 through 3 comprising temperature detection means for detecting temperature of the air in the anbient of said gas enrichment means, wherein

operation of said flow channel gate means is controlled in accordance with the air temperature detected by said temperature detection means.

10. The gas enrichment apparatus of claim 9, wherein

said flow channel gating means is controlled to make an intermittent opening-and-closing operation.

11. The gas enrichment apparatus of claim 9, wherein

said flow channel gating means is an gate valve whose open degree is variable, and controlled in terms of opening of said gate valve.

12. The gas enrichment apparatus of claim 10, wherein said flow channel gating means is controlled in terms of operation ratio of intermittent opening-and-closing operation.

13. The gas enrichment apparatus recited in one of claims 1 through 3 comprising temperature detection means for detecting temperature of said flow channel or ambient air temperature of said flow channel, wherein

operation of said flow channel gating means is controlled in accordance with the flow channel temperature or the air temperature detected by said temperature detection means.

14. The gas enrichment apparatus of claim 13, wherein

said flow channel gating means is operated to make an intermittent gate action.

15. The gas enrichment apparatus of claim 13, wherein

said flow channel gating means is an gate valve whose opening is variable, and controlled in terms of opening of said gate valve.

16. The gas enrichment apparatus of claim 14, wherein said flow channel gating means is controlled in terms of operation ratio of intermittent opening-and-closing operation.

17. A decompression apparatus for generating a differential pressure with gas enrichment means in gas enrichment apparatus comprising

a gas introduction portion provided by having a branch channel at the sucking side of said decompression apparatus, and said gas introduction portion is provided with flow channel gate means.

18. The decompression apparatus in gas enrichment apparatus recited in claim 17 comprising temperature detection means for detecting ambient air temperature of gas enrichment means, wherein

operation of said flow channel gating means is

controlled in accordance with the air temperature detected by said temperature detection means.

19. The decompression apparatus in gas enrichment apparatus recited in claim 17, wherein

operation of said flow channel gate means is controlled by control signal delivered from outside.

20. The decompression apparatus in gas enrichment apparatus recited in claim 17, wherein

said flow channel gating means changes its opening for controlling flow volume of gas going through the present flow channel gate means.

21. The decompression apparatus in gas enrichment apparatus recited in claim 17, wherein

said gate means is further provided with a flow resistance member.

22. A compression apparatus for generating a differential pressure with gas enrichment means in gas enrichment apparatus comprising

a gas introduction portion provided by having a branch channel at the outlet side of said compression apparatus, and said gas introduction portion is provided with flow channel gating means.

23. The compression apparatus in gas enrichment apparatus recited in claim 22 comprising temperature detection means for detecting ambient air temperature of gas enrichment means, wherein

operation of said flow channel gating means is controlled in accordance with the air temperature detected by said temperature detection means.

24. The compression apparatus in gas enrichment apparatus recited in claim 22, wherein

operation of said flow channel gating means is controlled by control signal delivered from another control apparatus.

25. The compression apparatus in gas enrichment apparatus recited in claim 22, wherein

said flow channel gating means changes its opening for controlling flow volume of gas going through the present flow channel gating means.

26. The compression apparatus in gas enrichment apparatus recited in claim 22, wherein

said flow channel gating means is further provided with a flow resistance member.

27. An air conditioner comprising

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through said gas enrichment means,
flow channel gating means for introducing a third gas whose relative humidity is lower than that of said second gas into said gas flow channel, and
discharge means for discharging said second gas into a room space, which being the target of air conditioning.

28. An air conditioner comprising

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through said gas enrichment means,
flow channel gate means for introducing a third gas into said gas flow channel for a higher flow volume than that delivered through said gas enrichment means, and
discharge means for discharging said second gas into a room space, which being the target of air harmonization.

29. An air conditioner comprising

gas enrichment means,
differential pressure generation means for generating a differential pressure with said gas enrichment means,
a gas flow channel for delivering a second gas which has been enriched with a certain kind of gas component by having a first gas to go through said gas enrichment means,
flow channel gating means for introducing a third gas having a higher temperature than said first gas into said gas flow channel, and
discharge means for discharging said second gas into a room space, which being the target of air harmonization.

30. The air conditioner recited in one of claims 27 through 29, wherein

said differential pressure generation means is decompression means which decompresses said gas enrichment means at one side for sucking said first gas, and said flow channel gating means introduces a third gas into flow channel at the sucking side of said decompression means.

31. The air conditioner recited in one of claims 27 through 29, wherein

said differential pressure generation means is compression means which compresses said gas enrichment means at one side for pushing said first gas in, and said flow channel gating means is disposed in parallel with said gas enrichment means.

32. The air conditioner recited in one of claims 27 through 29, wherein

operation of said flow channel gating means is controlled by control signal delivered from outside.

33. The air conditioner recited in one of claims 27 through 29, wherein

said flow channel gating means changes its opening for controlling flow volume of a third gas going through the present flow channel gating means.

34. The air conditioner recited in one of claims 27 through 29, wherein

said third gas flow channel is provided with a flow resistance member.

35. The air conditioner recited in one of claims 27 through 29 comprising temperature detection means for detecting ambient air temperature of said gas enrichment means, wherein

operation of said flow channel gating means is controlled in accordance with the air temperature detected by said temperature detection means.

36. The air conditioner recited in one of claims 27 through 29 comprising temperature detection means for detecting temperature of said flow channel or temperature of the air in the neighborhood of said flow channel, wherein

operation of said flow channel gate means is controlled in accordance with the flow channel temperature or the air temperature detected by said temperature detection means.

37. The air conditioner recited in one of claims 27 through 29, comprising

diffusion means for diffusing said second gas into a room space, which being the target of air harmonization.

38. The air conditioner of claim 37, wherein

said diffusion means is air blowing means provided in a room space, which space being the target of air harmonization.

39. The air conditioner, consisting of room unit and outdoor unit, recited in one of claims 27 through 29, wherein

at least said gas enrichment means is mounted in said outdoor unit, and said first gas is the air in the neighborhood of said outdoor unit.

40. The air conditioner, consisting of room unit and outdoor unit, recited in one of claims 27 through 29, wherein

said outdoor unit forms a machine chamber in which a compressor is housed, and said third gas is the air in said machine chamber.

41. The air conditioner, consisting of room unit and outdoor unit, recited in one of claims 27 through 29, wherein

said outdoor unit forms an electrical components chamber in which electrical components are housed, and said third gas is the air in said electrical components chamber.

42. The air conditioner, consisting of room unit and outdoor unit, recited in one of claims 27 through 29, wherein

said third gas is the air of a room space in which said room unit is installed.

FIG.1

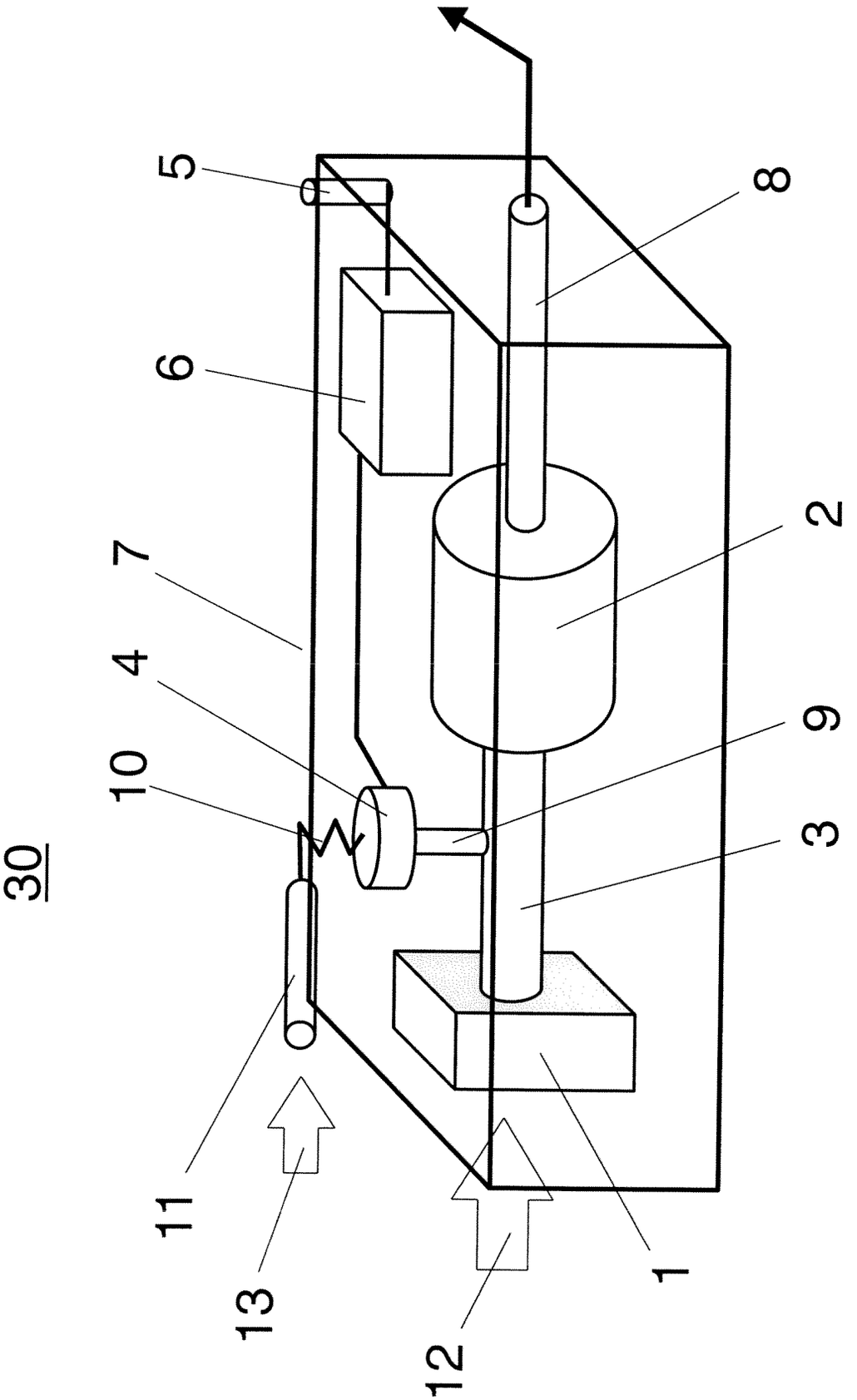


FIG.2

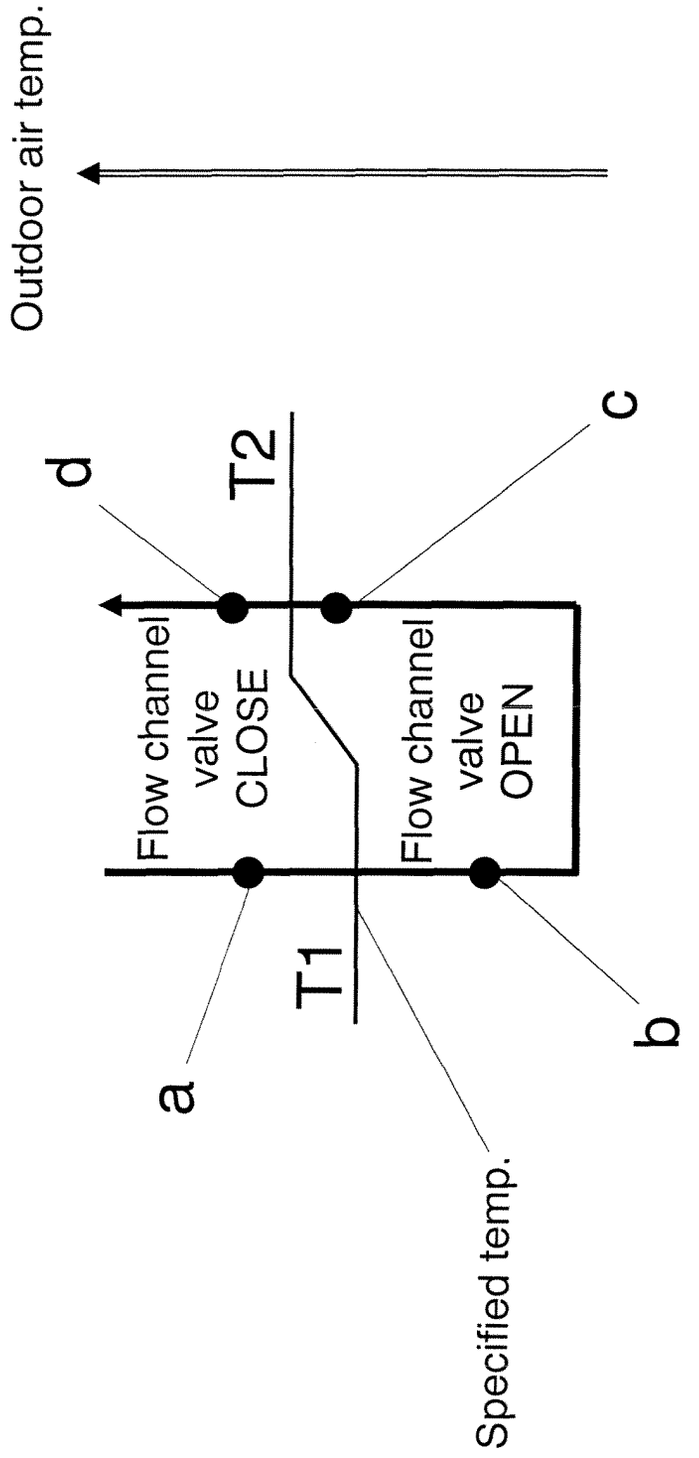

Outdoor air temp.
d
T2
c
Flow channel valve CLOSE
Flow channel valve OPEN
T1
a
b
Specified temp.

FIG.3

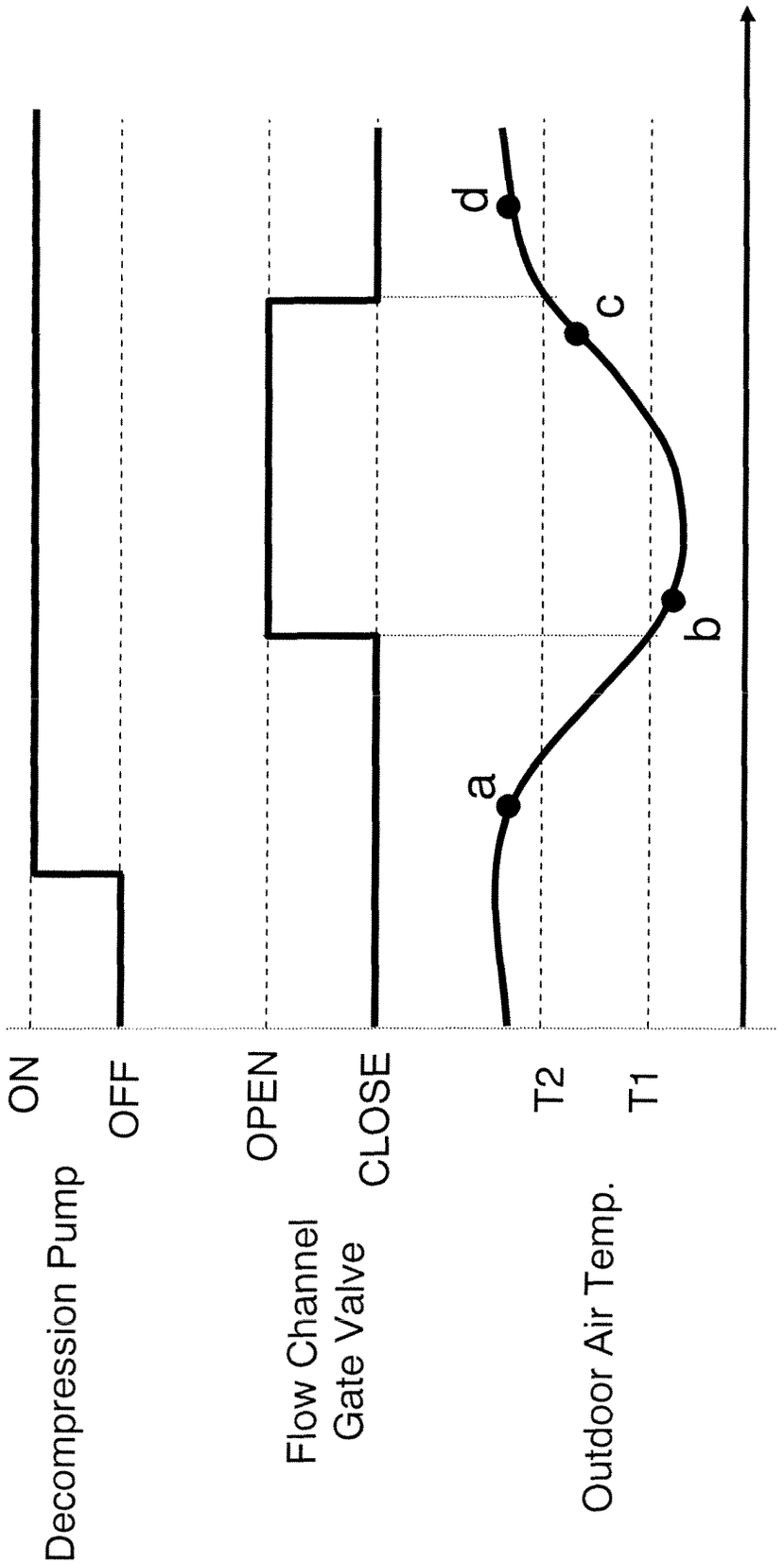

ON
OFF
Decompression Pump
OPEN
CLOSE
Flow Channel Gate Valve
T2
T1
Outdoor Air Temp.
a
b
c
d

FIG.4

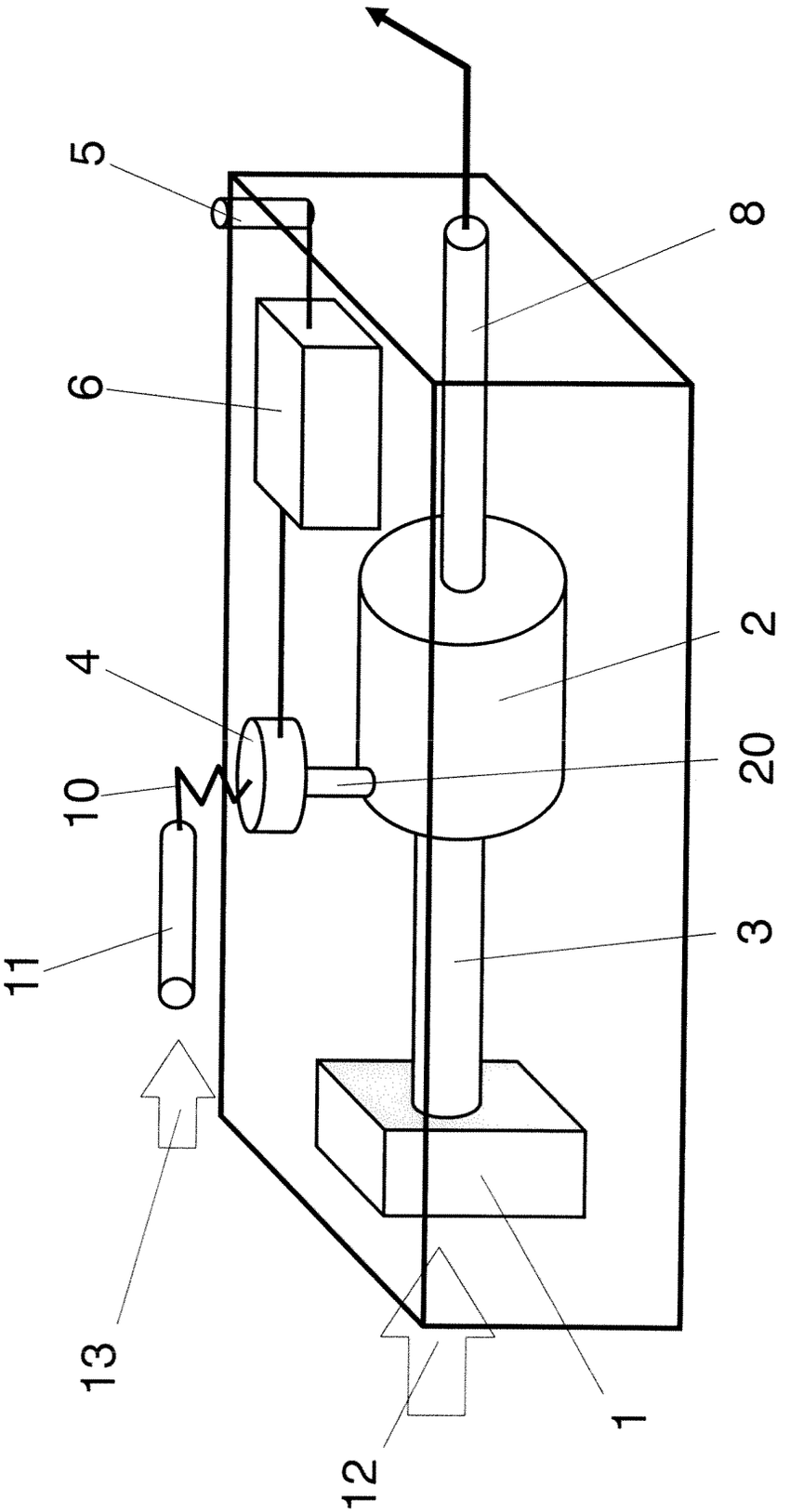


FIG.5

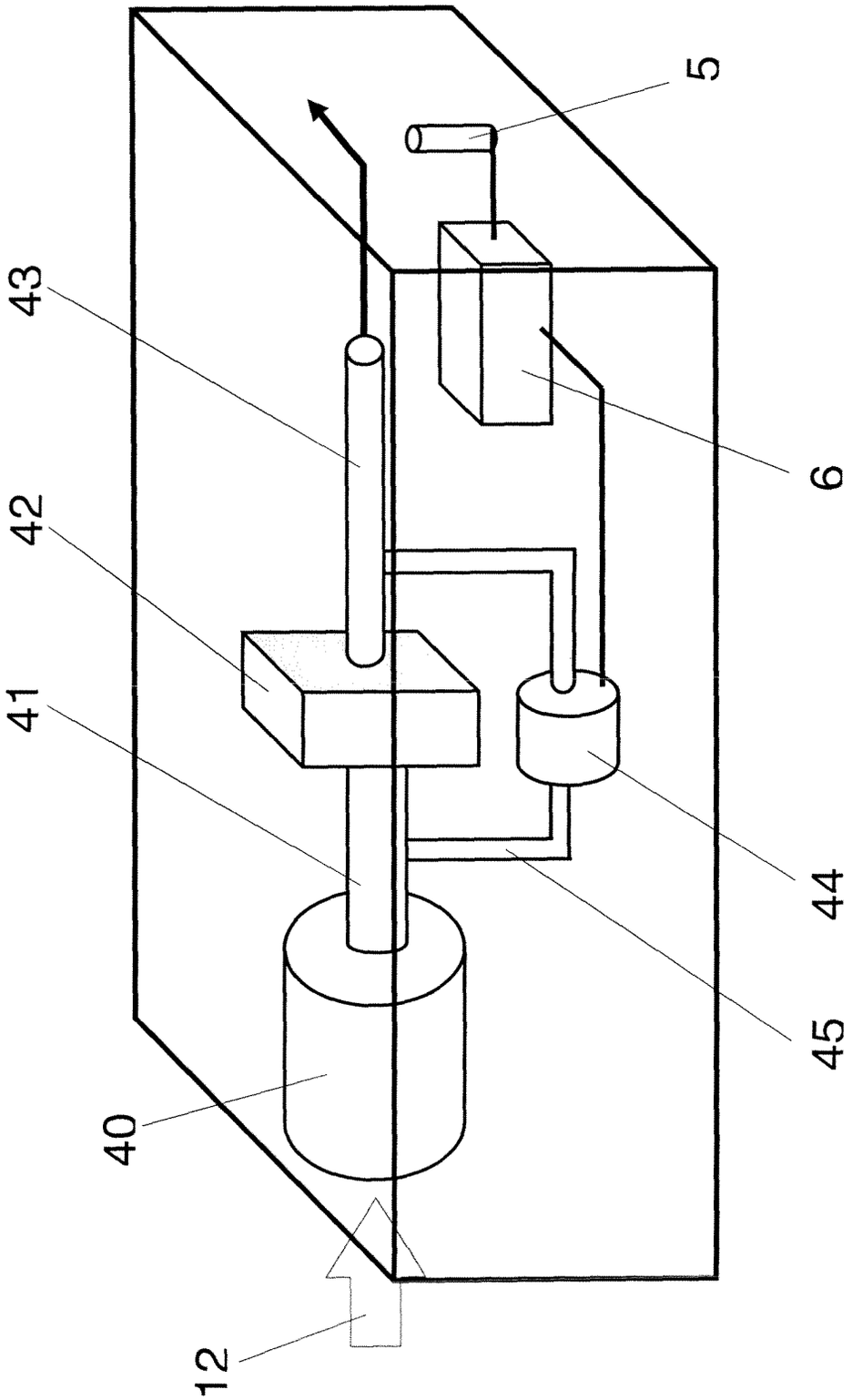


FIG.6

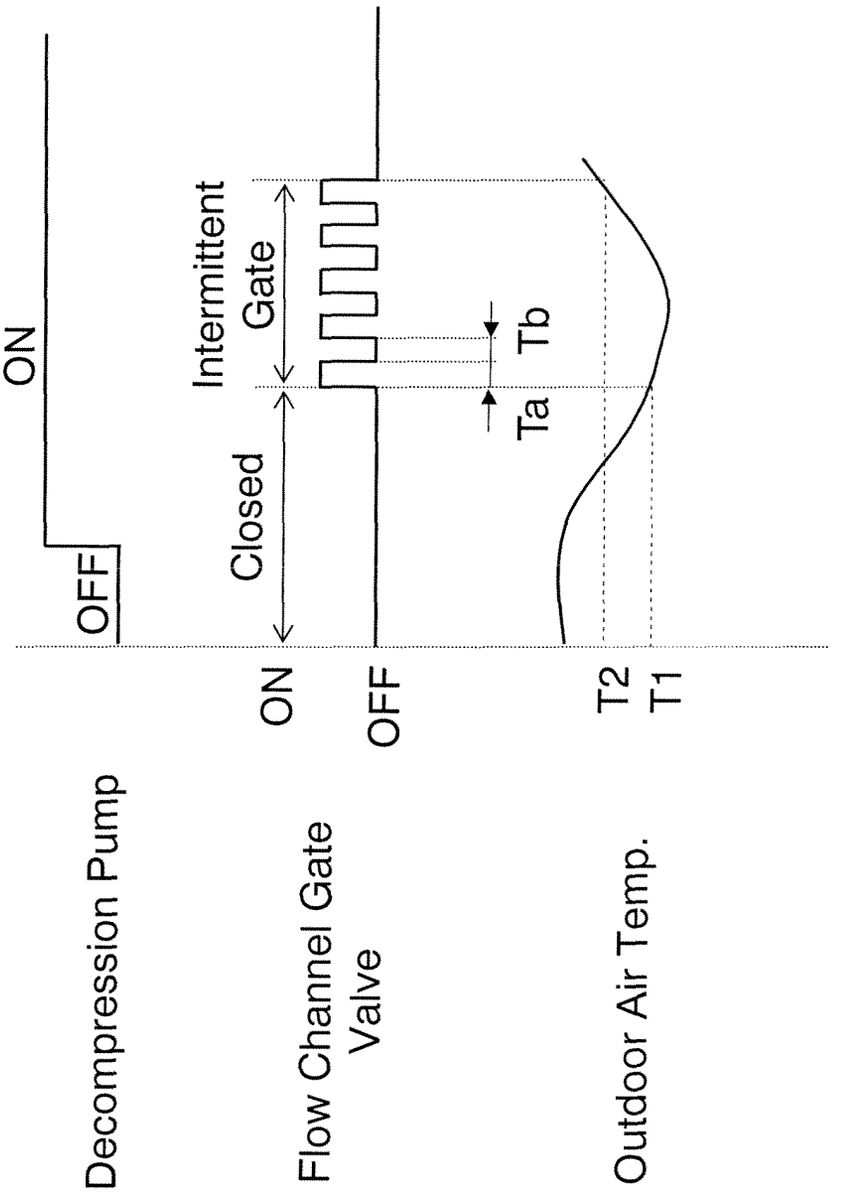

ON
OFF
Decompression Pump
Intermittent
Gate
Closed
Tb
Ta
ON
OFF
Flow Channel Gate
Valve
T2
T1
Outdoor Air Temp.

FIG.7

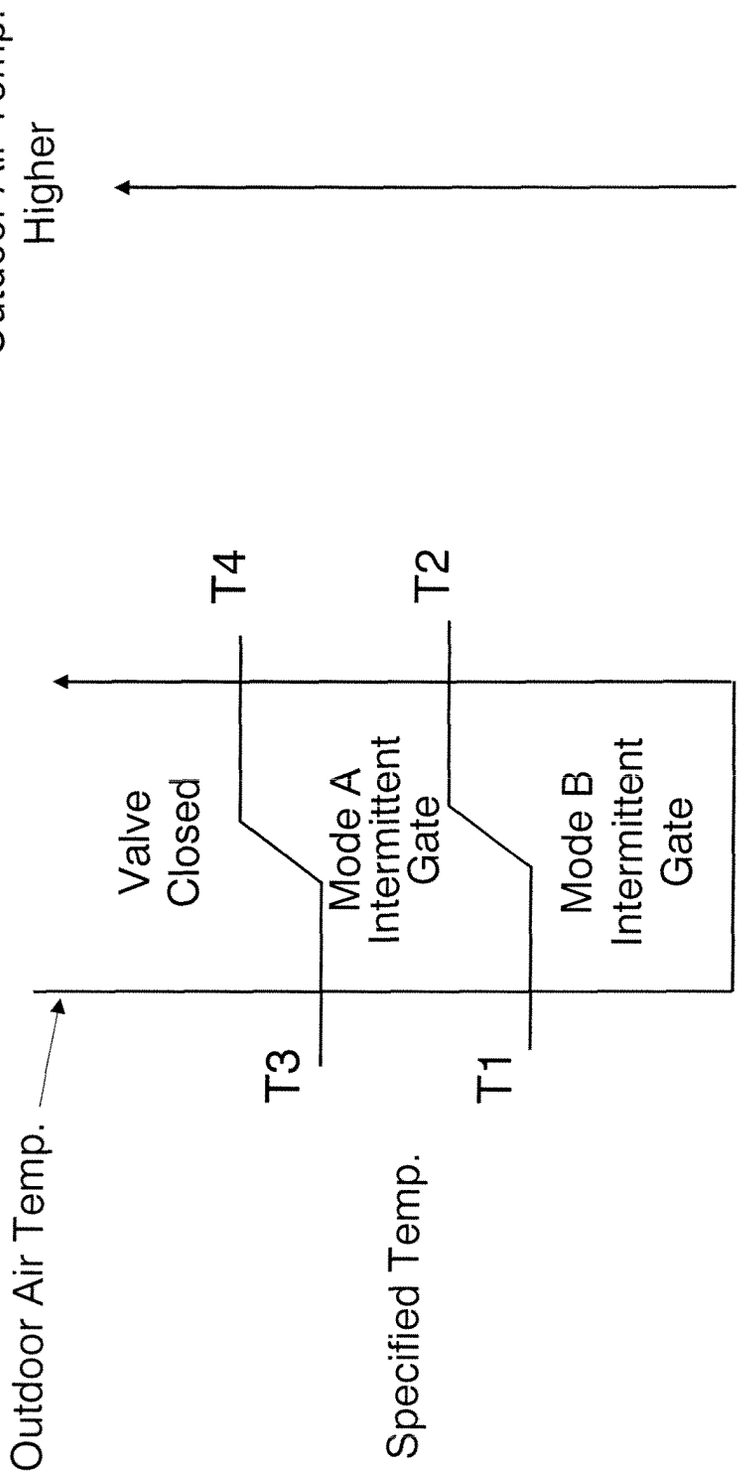

Outdoor Air Temp.
Higher
T4
T2
Valve
Closed
Mode A
Intermittent
Gate
Mode B
Intermittent
Gate
T3
T1
Outdoor Air Temp.
Specified Temp.

FIG.8

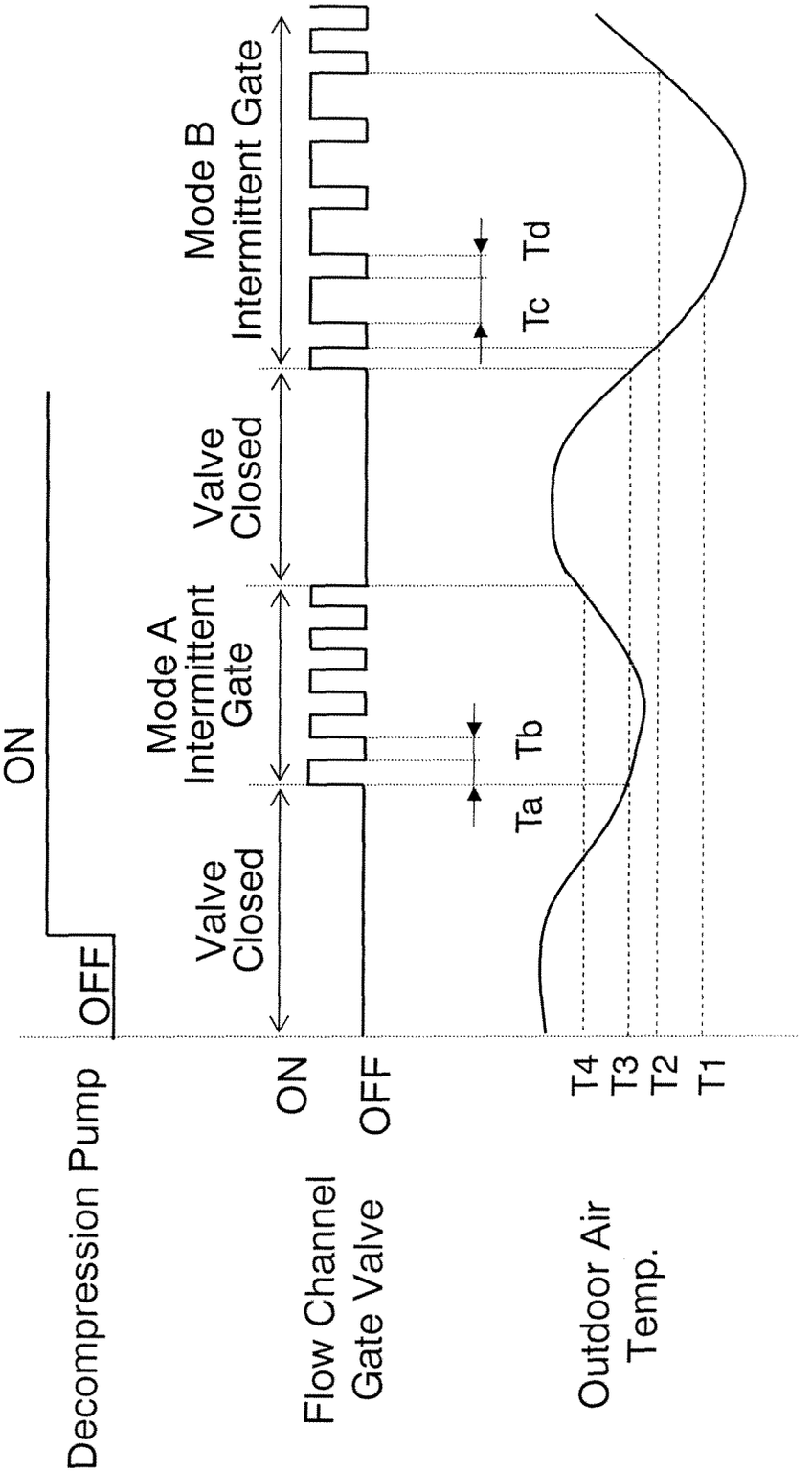

Decompression Pump
ON
OFF
Flow Channel Gate Valve
ON
OFF
Valve Closed
Mode A Intermittent Gate
Valve Closed
Mode B Intermittent Gate
Ta
Tb
Tc
Td
Outdoor Air Temp.
T4
T3
T2
T1

FIG.9

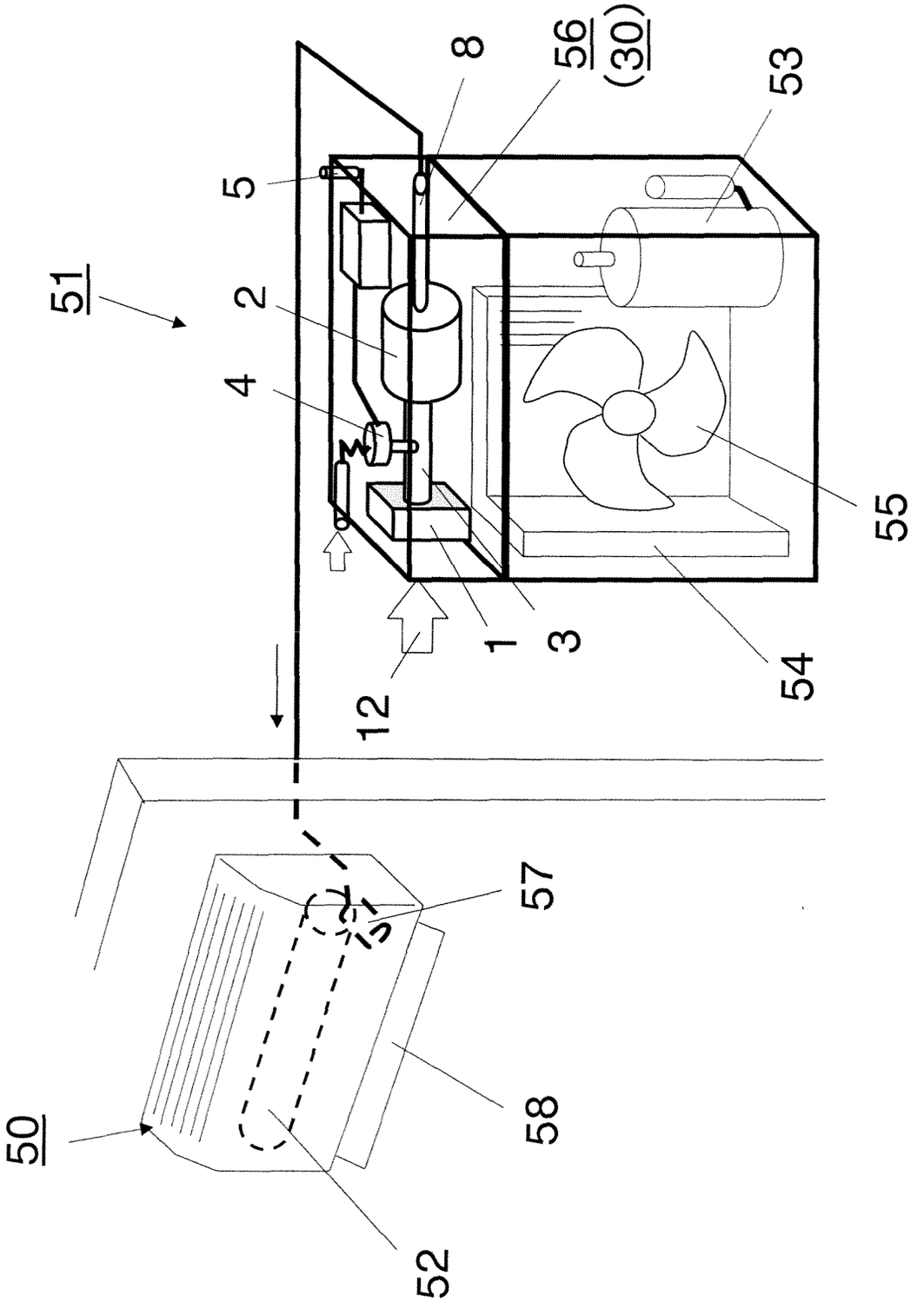
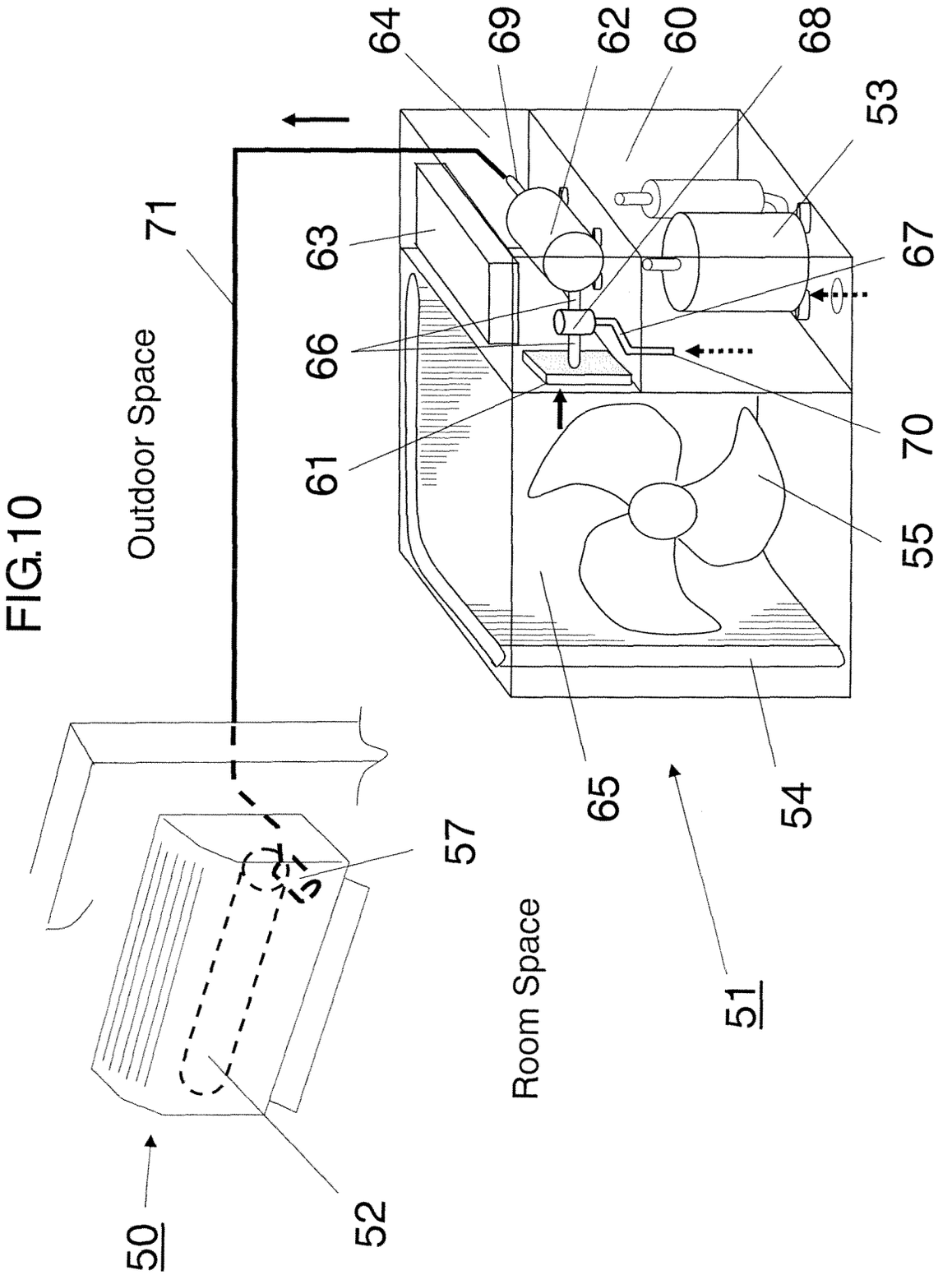


FIG.10


64
69
62
60
68
53
71
63
67
66
61
70
55
Outdoor Space
57
65
54
Room Space
51
50
52

Reference numerals in the drawings

1, 42, 61 oxygen enrichment unit
2, 62 decompression pump
3, 43 delivery tube
4, 44 flow channel gate valve
5 temperature sensor
6 control unit
7 case
8, 69 main outlet tube
9, 20 branch tube
10 flow resistance member
11 intake tube
12, 13 outdoor air
30 gas enrichment apparatus
40 turbo fan
41 flow channel
43 delivery tube
45 bypass channel
50 room unit
51 outdoor unit
52 room fan
53 commpressor
54 outdoor heat exchanger
55 outdoor fan
56 oxygen enrichment apparatus
57 outlet mouth
58 guide wing
60 compressor chamber
63 control unit
64 electrical components chamber
65 heat exchenger chamber
66 main oxygen supply tube
67 air intake tube
68 three-way valve
70 air intake mouth

71 air tube

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/11238

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F24F1/00, B01D53/22

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)
Int.Cl[7] F24F1/00, B01D53/22

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	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 63-218232 A (Cubic Engineering Kabushiki Kaisha), 12 September, 1988 (12.09.88), Page 201, lower left column, line 2 to lower right column, line 1 (Family: none)	1-42
A	US 5129921 A (MENBRANE TECHNOLOGY & RESEARCH, INC.), 14 July, 1992 (14.07.92), Full text; all drawings (Family: none)	1-42

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 October 2003 (03.10.03)	21 October, 2003 (21.10.03)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)