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(54) RADIATION PANEL MODULE, RADIATION AIR CONDITIONING SYSTEM, AND AIR CONDITIONING METHOD

(57) A radiation panel module includes a radiation panel and a heat exchange flow path through which a heat medium passes. The heat exchange flow path is provided on a back surface side of the radiation panel. In a radiation air conditioning system using the radiation panel module, a bypass flow path that does not pass through the heat exchange flow path is provided, and the flow path of the heat medium is switched in accordance with the operating environment. In this manner, the occurrence of dew condensation is prevented.

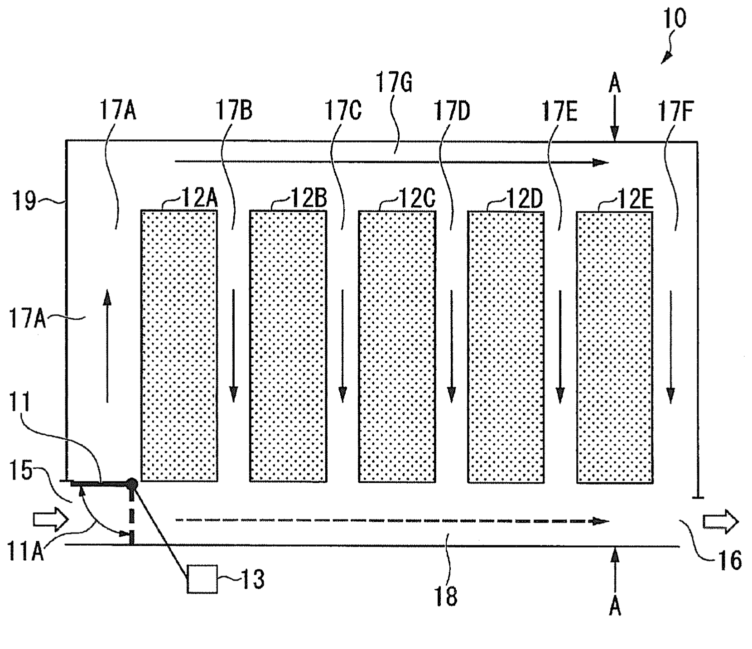

FIG. 2

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Description

Technical Field

[0001] The present invention relates to a radiation panel module, a radiation air conditioning system, and an air conditioning method.

[0002] This application claims priority based on JP 2016-241903 filed in Japan on December 14, 2016, of which the contents are incorporated herein by reference.

Background Art

[0003] There exists an indoor air conditioning system called radiation air conditioning. During radiation air conditioning, a radiation panel is provided on a ceiling or the like of an indoor space to be air-conditioned, and an indoor temperature is adjusted with radiation heat from the radiation panel. In many cases, the radiation air conditioning requires a countermeasure for dew condensation on the radiation panel caused by cooling.

[0004] For example, in Patent Document 1, description is made of a radiation air conditioning system including a damper for switching flow paths of air being heat medium between a duct for radiation and an air outlet port to an indoor space. In Patent Document 1, the following matter is described. That is, when dew condensation occurs on the radiation panel, a damper is switched so that air is discharged to the indoor space. A flow of the air is guided to a surface of the radiation panel on which dew condensation occurs, and is blown onto the surface of the radiation panel. In this manner, water droplets are evaporated to eliminate dew condensation.

Citation List

Patent Document

[0005] Patent Document 1: JP 09-96434 A

Summary of Invention

Problem to be Solved by the Invention

[0006] Incidentally, the related-art radiation air conditioning system has the following problems. Specifically, (1) dew condensation is caused by cooling. (2) A dehumidification system is required to deal with dew condensation, and accordingly, a building is subjected to engineering work. Thus, cost is increased. (3) It is difficult to achieve individual air conditioning.

[0007] The present invention provides a radiation panel module, a radiation air conditioning system, and an air conditioning method, which are capable of solving the above-mentioned problems.

Solution to Problem

[0008] According to a first aspect of the present invention, a radiation panel module includes a radiation panel and a heat exchange flow path through which a heat medium passes. The heat exchange flow path is provided on a back surface side of the radiation panel.

[0009] According to a second aspect of the present invention, the radiation panel module further includes an inlet part of the heat exchange flow path and an outlet part of the heat exchange flow path for the heat medium.

[0010] According to a third aspect of the present invention, the heat exchange flow path is formed to have a configuration of a heat exchanger.

[0011] According to a fourth aspect of the present invention, a part of the heat exchange flow path has a width smaller than a width of another part of the heat exchange flow path.

[0012] According to a fifth aspect of the present invention, the heat exchange flow path is formed of a resin or a foaming material, and forms a flow path of the heat medium in combination with the radiation panel.

[0013] According to a sixth aspect of the present invention, the radiation panel module further includes a bypass flow path, a damper, and a control unit. The bypass flow path is configured to bypass the heat exchange flow path. The damper is configured to adjust a flow rate of the heat medium flowing in the heat exchange flow path and a flow rate of the heat medium flowing in the bypass flow path, and is provided at a branch point of the heat exchange flow path and the bypass flow path. The control unit is configured to control the damper.

[0014] According to a seventh aspect of the present invention, the bypass flow path is formed to have a height larger than a height of the heat exchange flow path.

[0015] According to an eighth aspect of the present invention, at least a part of the heat exchange flow path has a width smaller than a width of the bypass flow path.

[0016] According to a ninth aspect of the present invention, a radiation air conditioning system includes an air conditioner, and one or a plurality of radiation panel modules of any one of the sixth aspect to the eighth aspect on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned. The radiation panel module includes the radiation panel arranged so as to be held in contact with the space.

[0017] According to a tenth aspect of the present invention, a radiation air conditioning system includes an air conditioner, one or a plurality of radiation panel modules of any one of the first aspect to the fifth aspect on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned, a bypass flow path, and a damper. The radiation panel module includes the radiation panel arranged so as to be held in contact with the space. The bypass flow path is configured to guide the heat medium sent out by the air conditioner to an air outlet port to the space. The damper is configured to switch a destination to which the air conditioner sends out the heat medium between the radiation panel module and the bypass flow path.

[0018] According to an eleventh aspect of the present invention, in an air conditioning method in the above-mentioned radiation air conditioning system, the heat medium is sent out to the bypass flow path under an environment where dew condensation is liable to occur, and the heat medium is sent out to the heat exchange flow path under an environment where dew condensation is less liable to occur.

Advantageous Effect of Invention

[0019] With the radiation panel module, the radiation air conditioning system, and the air conditioning method described above, low-cost and energy-saving individual radiation air conditioning can be achieved.

Brief Description of Drawings

[0020]

FIG. 1 is a view for illustrating an example of a schematic configuration of a radiation air conditioning system according to a first embodiment of the present invention.
FIG. 2 is a plan view for illustrating an example of a schematic configuration of a radiation panel module according to the first embodiment of the present invention.
FIG. 3 is a cross-sectional view for illustrating an example of a schematic configuration of the radiation panel module according to the first embodiment of the present invention.
FIG. 4 is a view for illustrating a working example of the radiation air conditioning system according to the first embodiment of the present invention.
FIG. 5 is a flowchart for illustrating an example of processes of the radiation air conditioning system according to the first embodiment of the present invention.
FIG. 6 is a plan view for illustrating an example of a schematic configuration of a radiation panel module according to a second embodiment of the present invention.
FIG. 7 is a view for illustrating a working example of a radiation air conditioning system according to the second embodiment of the present invention.
FIG. 8 is a plan view for illustrating an example of a schematic configuration of a radiation panel module according to a third embodiment of the present invention.

Description of Embodiments

First Embodiment

[0021] Now, with reference to FIG. 1 to FIG. 5, a radiation air conditioning system according to a first embodiment of the present invention is described.

[0022] FIG. 1 is a view for illustrating an example of a schematic configuration of the radiation air conditioning system according to the first embodiment of the present invention.

[0023] A radiation air conditioning system 1 includes an air conditioner 2, radiation panel modules 10A, 10B, ···, and 10N, and delivery hoses 8A, 8B, ···, and 8N.

[0024] The radiation air conditioning system 1 is provided on a back surface of a ceiling 9, under a floor, inside a wall surface of an indoor space 100 to be air-conditioned. For example, a radiation surface of a radiation panel 19A included in the radiation panel module 10A is provided so as to be held in contact with the space 100. The air conditioner 2 sucks an air of the space 100 through a suction port 3, and sends out a heat medium having been air-conditioned. The heat medium in the present embodiment is an air, and the air conditioner 2 sends out a cooled air or a heated air. The sent-out heat medium is supplied to the radiation panel module 10A through the delivery hose 8A. In the radiation panel module 10A, the heat medium having been air-conditioned cools or heats the radiation panel. Further, the heat medium passing through the radiation panel module 10A is supplied to the radiation panel module 10B through the delivery hose 8B, and similarly cools and heats a temperature of a radiation panel 19B. Similarly, from the radiation panel module 10B onward, the heat medium adjusts a temperature of a radiation panel 19n of a radiation panel module 10n ("n" may be any one of A to N) through which the heat medium passes, and is supplied to the radiation panel module 10N arranged at a farthest position from the air conditioner 2. The heat medium having cooled or heated a radiation panel 19N of the radiation panel module 10N is blown out to the space 100 through an air outlet port 4. As described above, in the radiation air conditioning system 1 according to the present embodiment, the heat medium having been air-conditioned, which is generated by the air conditioner 2, passes through the radiation panel module 10A and the like arranged on, for example, the ceiling. Accordingly, the radiation panel 19 of the radiation panel module 10 is cooled or heated, and a temperature of the space 100 is adjusted with radiation from the radiation panel 19. The number of radiation panel modules 10A and the like to be arranged may be plural or single. The radiation panel modules 10A, 10B, and the like are collectively referred to as the radiation panel module 10, the delivery hoses 8A, 8B, and the like are collectively referred to as the delivery hoses 8, and the radiation panels 19A, 19B, and the like are collectively referred to as the radiation panel 19.

[0025] FIG. 2 is a plan view for illustrating an example of a schematic configuration of the radiation panel module according to the first embodiment of the present invention.

[0026] As illustrated in FIG. 2, the radiation panel module 10 includes a damper 11, flow path-forming members 12A, 12B, 12C, 12D, and 12E, an open/close control unit 13, an inlet part 15, an outlet part 16, and the radiation panel 19 arranged on a bottom. The damper 11 opens and closes within a range indicated with an arrow 11A. The open/close control unit 13 controls opening and closing operations of the damper 11. When the damper 11 is at a position indicated with the solid line (open state), the heat medium flowing in through the inlet part 15 passes through a bypass flow path 18 in a direction indicated with a broken arrow, and is sent out through the outlet part 16. Meanwhile, when the damper 11 is at a position, which is indicated with the broken line, under control of the open/close control unit 13 (close state), the heat medium flowing in through the inlet part 15 passes through heat exchange flow paths 17A, 17B, 17C, 17D, 17E, 17F, and 17G in directions indicated with solid arrows, and is sent out through the outlet part 16.

[0027] Here, the heat exchange flow paths 17B, 17C, 17D, 17E, and 17F, which are defined by the flow path-forming members 12A, 12B, 12C, 12D, and 12E, are formed to have widths smaller than a width of the bypass flow path 18. The heat exchange flow paths 17A and 17G may be formed to have widths larger than those of the heat exchange flow paths 17B and the like. As illustrated, the heat exchange flow paths 17B to 17F are provided across the radiation panel 19 in a direction vertical to the heat exchange flow path 17G. With this configuration, the heat medium passes through the heat exchange flow paths 17B to 17F at a flow velocity V_{17} higher than a flow velocity V_{18} at which the heat medium passes through the bypass flow path 18. In the following description, in some cases, the flow path-forming members 12A and the like are collectively referred to as the flow path-forming member 12, and the heat exchange flow paths 17A and the like are collectively referred to as the heat exchange flow path 17.

[0028] The radiation panel module 10 is formed to have a size in conformity with, for example, a size of a ceiling board to be used for a system ceiling (for example, 600 mm × 600 mm or 600 mm × 1200 mm). Modularization of the radiation panel module in conformity with a standard size facilitates replacement with the ceiling board. As a result, the radiation air conditioning system 1 can efficiently be introduced.

[0029] FIG. 3 is a cross-sectional view for illustrating an example of a schematic configuration of the radiation panel module according to the first embodiment of the present invention.

[0030] FIG. 3 is a cross-sectional view of the radiation panel module 10 taken along the line A-A in FIG. 2. As illustrated in FIG. 3, the radiation panel module 10 has an L-shape cross section. As illustrated, the heat exchange flow path 17 and the bypass flow path 18 are formed on a back surface side (side opposite to the radiation surface) of the radiation panel 19. The bypass flow path 18 is formed to have a height HI larger than a height H2 of the heat exchange flow path 17G. A width L1 is equal to or larger than a width L2. Thus, a cross-sectional area of the bypass flow path 18 is relatively large, and a cross-section of the heat exchange flow path 17G is relatively small. With this configuration, the flow velocity V_{18} of the heat medium flowing through the bypass flow path 18 is low, and the flow velocity V_{17} of the heat medium passing through the heat exchange flow path 17G is high. Through the heat exchange flow paths 17B, 17C, 17D, 17E, and 17F formed to have the narrow flow-path widths, the heat medium flows also at a high velocity. When the heat medium flows at a high velocity, heat transmission from the heat medium to the radiation panel 19 is increased. Accordingly, a temperature of the radiation panel 19 is greatly influenced by a temperature of the heat medium. Therefore, the heat medium adjusted to a predetermined temperature by the air conditioner 2 passes through the heat exchange flow path 17. Accordingly, the temperature of the radiation panel 19 can be adjusted to a temperature suitable for a target temperature of the space 100. In order to increase heat transmission from the heat medium to the radiation panel 19, it is preferred that the flow path-forming members 12A and the like be formed of a material having a high coefficient of thermal conductivity. Alternatively, the flow path-forming members 12A and the like are formed of a resin, a foaming material, or the like, and are combined with the radiation panel 19. In this manner, the flow path may be formed with the foaming material or the like as side surfaces and the back surface of the radiation panel 19 as the bottom. With this configuration, the heat exchange flow path 17 can be formed of only two parts (the flow path-forming member 12 formed of the foaming material or the like and the radiation panel 19). With the flow path formed as described above, the temperature of the heat medium can be transmitted from the heat medium flowing at a relatively high velocity to the radiation panel 19 directly or via the flow path-forming members 12A and the like. As described later, a heat insulating material 14 may be arranged on a bottom portion of the bypass flow path 18.

[0031] As described above, the flow path of the heat medium is formed to have a configuration of a parallel flow type heat exchanger through use of the flow path-forming members 12A and the like. As a result, heat transmission can efficiently be performed from the heat medium to the radiation panel 19.

[0032] On the assumption of the configuration illustrated in FIG. 2 and FIG. 3, switching control of the damper 11 will be described. For example, when the radiation air conditioning system 1 performs a cooling operation, a large amount of water vapor is contained in the air in the space 100 for a certain time period from the time when the operation is started. When the radiation panel 19 is cooled under such state, dew condensation may occur on the surface of the radiation panel 19. Thus, in the present embodiment, under an environment where dew condensation is liable to occur, "radiation air conditioning" is not performed with the radiation panel module 10, and "convection air conditioning" is performed instead. Specifically, the open/close control unit 13 controls the damper 11 to be in the open state (at the position indicated with the solid line). Then, the cooled air generated by the air conditioner 2 is taken in through the inlet part 15, passes through the bypass flow path 18, and is sent out through the outlet part 16. As illustrated in FIG. 1, the cooled air passing through the bypass flow path 18 in the radiation panel module 10 is finally sent out to the space 100 through the air outlet port 6, is convected in the space 100, and returns to the air conditioner 2 through the suction port 3. Then, the heat medium cooled again by the heat exchanger included in the air conditioner 2 is supplied to the radiation panel module 10. As described with reference to FIG. 2 and FIG. 3, the relatively large cross-sectional area of the bypass flow path 18 is secured. Thus, the cooled heat medium passes through the bypass flow path 18 at a relatively low velocity. Accordingly, heat transmission from the heat medium to the radiation panel 19 is reduced while the heat medium passes through the bypass flow path 18, and the radiation panel 19 is not cooled very much by the heat medium. Thus, the temperature of the radiation panel 19 is maintained relatively high. As a result, dew condensation is less liable to occur on the surface of the radiation panel 19.

[0033] As illustrated in FIG. 3, the heat insulating material 14 covers the bottom portion of the bypass flow path 18 (upper side of the radiation panel 19), and hence the radiation panel 19 can be prevented from being cooled more reliably. With this, dew condensation can be prevented more effectively.

[0034] As described above, heat refrigerant, which passes through the bypass flow path 18 and is cooled by the air conditioner 2, is circulated in the space 100 during "convection air conditioning". When such operation is continued, an amount of water vapor contained in the air in the space 100 is reduced through a dehumidification function of the air conditioner 2. Under a state in which an amount of water vapor is small, even when the radiation panel 19 is cooled and then "radiation air conditioning" is performed, dew condensation is less liable to occur on the surface of the radiation panel 19. For example, under a state in which an operating environment with low liability of dew condensation can be confirmed based on measurement results of a humidity sensor included in the air conditioner 2 or the like, the open/close control unit 13 controls the damper 11 to be the close state (broken line). Then, heat transmission from the heat refrigerant to the radiation panel 19 is promoted, and the radiation panel 19 is cooled by the heat medium to have a low temperature. With this, radiation from the radiation panel 19 having a low temperature adjusts the temperature of the space 100. During "radiation air conditioning, dew condensation can be prevented because the water vapor in the air has already been eliminated during "convection air conditioning" performed by causing the heat medium to pass through the bypass flow path 18.

[0035] Next, description is made of a working example of the radiation air conditioning system 1 in which a plurality of radiation panel modules 10 according to the present embodiment are used.

[0036] FIG. 4 is a view for illustrating the working example of the radiation air conditioning system according to the first embodiment of the present invention.

[0037] As illustrated, the radiation air conditioning system 1 includes a plurality of radiation panel modules $10A_1$, $10B_1$, ···, $10N_1$, $10A_2$, $10B_2$, ···, $10N_2$, $10A_3$, $10B_3$, ···, and $10N_3$. The air conditioner 2 and the radiation panel module $10A_1$, $10A_2$, and $10A_3$ are connected through intermediation of the delivery hoses $8P_1$, $8P_2$, and the like. The radiation panel modules 10 are connected to each other through intermediation of the delivery hoses 8. For example, the radiation panel module $10A_1$ and $10B_1$ are connected through intermediation of the delivery hose $8B_1$. When a position close to the air conditioner 2 is referred to as upstream and a position far therefrom is referred to as downstream, the down-most stream radiation panel modules $10N_1$, $10N_2$, and $10N_3$ are respectively connected to the air outlet ports 4A, 4B, and 4C. A control device 30 is connected to the air conditioner 2 and the open/close control unit $13A_1$ and the like so as to communicate with each other, and the control device 30 controls the open/close control unit $13A_1$ and the like. The damper 11 included in the radiation panel module $10A_1$ is referred to as the damper $11A_1$. The same holds true in other configurations.

[0038] As illustrated in FIG. 4, the suction port 3 and the plurality of air outlet ports 4A, 4B, and 4C can be provided at positions away from each other on a ceiling of an office or the like, and the plurality of radiation panel modules 10 can be arrayed therebetween. In a case of such configuration, when the suction port 3 and the air outlet port 4A and the like are provided, for example, at positions close to both ends of a room to be air-conditioned, the entire room can be air-conditioned evenly with convection air conditioning. The radiation panel modules 10 obtained by modularization can be arranged in series or in parallel by being connected through intermediation of the delivery hoses 8 being joining members. With this characteristic, the radiation panel modules 10 can be arrayed and arranged on the entire ceiling. Accordingly, the entire room can be air-conditioned with radiation air conditioning.

[0039] For example, it is assumed that a user below the radiation panel module $10B_2$ feels cold while the air conditioner 2 performs a cooling operation with radiation air conditioning. In this case, the user inputs instruction information to the open/close control unit $13B_2$ so that the damper $11B_2$ can be controlled to be the open state.

[0040] Then, in the radiation panel module $10B_2$, the heat medium passes through the bypass flow path $18B_2$, and hence a cooled air of the heat medium is less transmitted to the radiation panel $19B_2$. Consequently, a temperature of the radiation panel $19B_2$ is increased, and the user does not feel cold any longer.

[0041] In general, when the same cooling temperature is set, as compared to "convection air conditioning", the user is more likely to feel a sense of cool with "radiation air conditioning". When this characteristic is utilized, for example, in a case where only the user below the radiation panel module $10B_2$ particularly feels hot, a cooling operation is performed without largely lowering a set temperature of the air conditioner 2. As for the radiation panel module $10A_1$ and the like other than the radiation panel module $10B_2$, the damper $11A_1$ and the like are controlled to be the open state, and only the damper $11B_2$ of the radiation panel module $10B_2$ is controlled to be the close state. Consequently, only in a space below the radiation panel module $10B_2$, the user is likely to feel a sense of cool with "radiation air conditioning". In other spaces, "convection air conditioning" with a set temperature, which is not very low, is performed, and hence the air can be conditioned to have a temperature, which is also comfortable for other users.

[0042] As described above, the radiation panel module 10 according to the present embodiment is formed as a module including the flow paths of the heat medium, and enables the flow paths of the heat medium to be switched between the bypass flow path 18 and the heat exchange flow path 17. With this, individual air conditioning for locally conditioning air only in the space below the radiation panel 19 can be achieved.

[0043] Switching of the damper 11 is not limited to the control for switching between the complete open state and the complete close state. For example, through use of a stepping motor, the control may be performed so as to switch in multi-steps between the open state and the close state. With this, a flow rate of the heat medium flowing in the heat exchange flow path 17 and a flow rate of the heat medium flowing in the bypass flow path 18 can be adjusted, and a temperature control can be performed more minutely. For example, in the above-mentioned example, in a case where the user below the radiation panel module $10B_2$ does not feel cold very much, the position of the damper $11B_2$ is controlled to be an intermediate position between the open state and the close state. With this, an amount of the heat medium, which is smaller than that in a case of the closing control, flows in the heat exchange flow path 17 side. Accordingly, the temperature of the radiation panel $19B_2$ is slightly increased, and coldness that the user feels can be relieved.

[0044] Next, with reference to FIG. 5, description is made of an example of a flow of the switching control of the damper 11 in the configuration of FIG. 4.

[0045] FIG. 5 is a flowchart for illustrating an example of processes of the radiation air conditioning system according to the first embodiment of the present invention.

[0046] It is assumed that the user starts the cooling operation. First, the control device 30 measures a state amount of the air in the space 100 (Step S11). For example, the control device 30 may acquire measurement values with a temperature sensor and a humidity sensor included in the air conditioner 2. The control device 30 determines whether the air of the space 100 has conditions that may cause dew condensation (Step S12). For example, from the air conditioner 2, the control device 30 acquires a set temperature (a temperature set by the user, which is, for example, 20°C to 25°C) and information on humidity of the air sucked through the suction port 3, and compares the information with a threshold value of humidity that does not cause dew condensation. The threshold value is set in advance for each set temperature. When current humidity is equal to or lower than the threshold value, the control device 30 determines that dew condensation will occur. When current humidity does not exceed the threshold value, the control device 30 determines that dew condensation will not occur. When it is determined that dew condensation is to occur (Yes in Step S12), the control device 30 determines that convection air conditioning is performed in order to reduce water vapor in the space 100. Consequently, the control device 30 switches the flow path of the heat medium to the bypass flow path 18 (Step S13). For example, the control device 30 transmits an instruction signal for causing the open/close control unit $13A_1$ to control the damper $11A_1$ to be the open state. The control device 30 transmits similar instruction signals also to other open/close control units such as the open/close control unit $13A_2$. The open/close control unit $13A_1$ controls the damper $11A_1$ to be the open state. The other open/close control units including the open/close control unit $13A_2$ perform the similar control. When the flow path is switched to the bypass flow path 18, the process returns to Step S11 again.

[0047] Meanwhile, when it is determined that dew condensation will not occur (No in Step S12), the control device 30 switches the flow path of the heat medium to the heat exchange flow path 17 (Step S14). For example, the control device 30 transmits an instruction signal for causing the open/close control unit $13A_1$ to control the damper $11A_1$ to be the close state. The control device 30 transmits similar instruction signals to the open/close control unit $13A_2$ and the like. The open/close control unit $13A_1$ controls the damper $11A_1$ to be the close state. The other open/close control units such as the open/close control unit $13A_2$ perform the similar control. As a damper switching method at the time of cooling, the following method is conceivable. That is, without measuring the state amount of the air, the damper is switched after a certain time period elapses from the time when the operation is started.

[0048] Next, the control device 30 determines whether to stop the cooling operation (Step S15). For example, in a case where the user inputs a stop instruction, the control device 30 determines to stop the cooling operation. When it is determined that the cooling operation is stopped (Yes in Step S15), the control device 30 stops the operation of the air conditioner 2. When it is determined that the cooling operation continues (No in Step S15), the process returns to Step S11.

[0049] In the related art, in many cases, the heat medium such as water (cooled water or heated water) and the like is supplied into a duct, and radiation air conditioning is performed with a radiation panel cooled or heated indirectly by the heat. With this method, a dehumidification system as a countermeasure to dew condensation at the time of cooling is required, and hence cost is liable to be increased. As compared to this, the radiation panel module 10 according to the present embodiment has means of switching the operations between a dehumidification operation and radiation air conditioning with the damper. Thus, the two operations can be performed by one air conditioner, and hence low cost can be achieved. According to the present embodiment, regardless of heating and cooling, radiation air cooling, which is energy-saving and efficient, can be performed by sending out the air having a temperature close to the indoor temperature by the presence of the radiation surface. Specifically, during cooling, the air conditioner 2 is only required to be operated at a higher set temperature. During heating, even when the air conditioner 2 is operated at a lower set temperature, the space 100 can be air-conditioned to have a desired temperature. With this, a low-cost and energy-saving air conditioning can be achieved.

[0050] In accordance with the temperature and the humidity in the room, the damper 11 is switched. In this manner, dew condensation on the radiation panel 19 can be prevented, and comfortable radiation air conditioning can be achieved.

[0051] The radiation panel module 10 is modularized and is provided with the inlet and the outlet of the heat medium. Thus, the radiation panels 19 can freely be arranged in conformity with an area and a shape of the room by connecting the radiation panels through use of the joining members such as the delivery hoses 8. In this manner, a desired area can be set to a space to be air-conditioned.

[0052] For example, the radiation panel modules 10 may not be arranged in the entire room, and may be arranged at particular positions so that a part of the space is air-conditioned.

[0053] The existing air conditioner, the existing suction port, and the existing air outlet port are utilized as they are, and the ceiling boards in the area to be air-conditioned are replaced with the radiation panel modules 10. In this simple manner, the radiation air conditioning system 1 according to the present embodiment can be introduced. Thus, introduction cost can be reduced, and influence on a construction can be reduced.

[0054] In the above-mentioned working example, cooling is exemplified, but the same effects can be obtained in a case of heating. In the case of heating, it is more effective to arrange the radiation panels 19 on a floor surface. When an air is used as the heat medium as described above, the radiation panel module 10 can be manufactured at low cost without water tightness provisions and the like, and can be used without a risk of water leak. However, the heat medium is not limited to the air, and water may be used.

Second Embodiment

[0055] Now, with reference to FIG. 6 to FIG. 7, a radiation air conditioning system according to a second embodiment of the present invention is described.

[0056] The radiation panel module 10 according to the first embodiment includes the damper 11. A radiation panel module 10' according to the second embodiment is different from the radiation panel module 10 of the first embodiment in that the damper 11 and the bypass flow path 18 are not included in the module.

[0057] FIG. 6 is a plan view for illustrating an example of a schematic configuration of the radiation panel module according to the second embodiment of the present invention.

[0058] As illustrated in FIG. 6, the radiation panel module 10' includes flow path-forming members 12A', 12B', 12C', 12D', and 12E', an inlet part 15', an outlet part 16', and a radiation panel 19' arranged on a bottom. The heat medium flowing in through the inlet part 15' passes through a heat exchange flow path 17A' in directions indicated with the solid arrows, is introduced to a heat exchange flow path 17G', and flows in heat exchange flow paths 17B', 17C', 17D', 17E', and 17F'. The heat medium passing through the heat exchange flow paths 17B' to 17F' passes through a heat exchange flow path 17H', and is sent out through the outlet part 16'.

[0059] Here, the heat exchange flow paths 17B', 17C', 17D', 17E', and 17F' may be formed to have widths, which are defined by the flow path-forming members 12A', 12B', 12C', 12D', and 12E', smaller than widths of the heat exchange flow paths 17A' and 17G'.

[0060] FIG. 7 is a view for illustrating a working example of a radiation air conditioning system according to the second embodiment of the present invention.

[0061] In FIG. 7, there is illustrated a working example in which the plurality of radiation panel modules 10' are used in the radiation air conditioning system 1'. As illustrated, the radiation air conditioning system 1' includes the radiation panel module $10A_1$', $10B_1$', ···, $10N_1$', $10A_2$', $10B_2$', ···, $10N_2$', $10A_3$', $10B_3$', ···, and $10N_3$'. The air conditioner 2 and the radiation panel module $10A_1$', $10A_2$', and $10A_3$' are connected through intermediation of delivery hoses $8P_1$' and the like. For example, the radiation panel module $10A_1$' and $10B_1$' are connected through intermediation of the delivery hose $8B_1$'. The down-most stream radiation panel module $10N_1$', $10N_2$', and $10N_3$' are connected respectively to the air outlet ports 4A, 4B, and 4C.

[0062] In addition to those configurations, in the present embodiment, a bypass flow path 18' corresponding to the bypass flow path 18 in the first embodiment is provided. One end thereof is connected to the air conditioner 2, and the other end thereof is connected to the air outlet ports 4A, 4B, and 4C. The bypass flow path 18' is for example, a duct. As the bypass flow path 18', there is used a duct having a cross-sectional area larger than cross-sectional areas of the flow paths of the heat medium passing through the radiation panel module 10'. At a branch point of the delivery hoses $8P_1$' connected to the radiation panel module 10' side and the bypass flow path 18', a damper 11' is provided. The control device 30 controls opening and closing operations of the damper 11'. The control device 30 controls the air conditioner 2 and the damper 11'.

[0063] With reference to the flowchart in FIG. 5, the operation of the radiation air conditioning system 1' according to the present embodiment will be described. First, the user starts the cooling operation. First, the control device 30 measures a state amount of the air in the space 100 (Step S11). The control device 30 determines whether the air of the space 100 have conditions that may cause dew condensation with high probability (Step S12). In a case where dew condensation is supposed to occur with high probability, the control device 30 switches the flow path of the heat medium to the bypass flow path 18' in order to reduce water vapor in the space 100 (Step S13). Specifically, the control device 30 controls the damper 11' to be the open state (position indicated with a solid line), and the heat medium (cooled air) is guided to the bypass flow path 18'. Consequently, in the present embodiment, the heat medium is not supplied to the radiation panel 19'. In this case, instead of radiation air conditioning, cooling is performed with convection air conditioning. After that, the process after Step S11 is repeated. Meanwhile, when the air of the space 100 has conditions that may cause dew condensation with low probability, the control device 30 switches the flow path of the heat medium in a case of the close state (position indicated with the broken line) (Step S14). Consequently, the heat medium flows to the radiation panel modules 10' side, and is supplied to the radiation panel modules 10'. Then, the radiation panel 19' is cooled, and the cooling operation with radiation air conditioning is performed. Next, the control device 30 determines whether to stop the cooling operation (Step S15). When it is determined that the cooling operation continues (No in Step S15), the process after Step S11 is repeated.

[0064] With the radiation air conditioning system 1' according to the present embodiment, in addition to the same effects in the first embodiment, the configuration in which the damper 11 and the open/close control unit 13 are eliminated from the radiation panel module 10 according to the first embodiment enables the system to be introduced at lower cost.

Third embodiment

[0065] Now, with reference to FIG. 8, a radiation air conditioning system according to a third embodiment of the present invention is described.

[0066] FIG. 8 is a plan view for illustrating an example of a schematic configuration of a radiation panel module according to the third embodiment of the present invention.

[0067] In the radiation panel module 10 according to the first embodiment, there is exemplified the heat exchange flow path 17 forming the configuration of the parallel flow type heat exchanger through use of the flow path-forming members 12. As another example, in the third embodiment, there is exemplified a radiation panel module 10" including a configuration of a serpentine type heat exchanger.

[0068] As illustrated in FIG. 8, the radiation panel module 10" includes a damper 11", flow path-forming members 12A", 12B", 12C", 12D", and 12E", an open/close control unit 13", an inlet part 15", an outlet part 16", and a radiation panel 19" arranged on a bottom. The open/close control unit 13" controls opening and closing operations of the damper 11". When the damper 11" is in the on state (position indicated with a solid line), the heat medium flowing in through the inlet part 15" passes through the bypass flow path 18" and is sent out through the outlet part 16". Meanwhile, when the damper 11" is in the off state (position indicated with a broken line), the heat medium flowing in through the inlet part 15" passes through the heat exchange flow path 17" in directions indicated with the solid arrows, and is sent out through the outlet part 16". A Width of the heat exchange flow path 17" is smaller than a width of the bypass flow path 18". As similar to the example illustrated in FIG. 3, a height of the bypass flow path 18" may be formed larger than a height of a region in which the heat exchange flow path 17" is formed. A flow velocity of the heat medium passing through the heat exchange flow path 17" is higher than a flow velocity of the heat medium passing through the bypass flow path 18", and a large amount of heat can be transmitted to the radiation panel 19". As for the flow path-forming member 12A", it is preferred that a material having a high coefficient of thermal conductivity be used. As for the wall surfaces of the bypass flow path 18", it is preferred that a material having a low coefficient of thermal conductivity be used.

[0069] With the radiation panel module 10" according to the present embodiment, the same effects as those in the first embodiment can be obtained. The structure of the heat exchange flow path 17" in the present embodiment may be applied to the radiation panel module 10' according to the second embodiment.

[0070] In addition, the constituent elements in the embodiments as described above can be replaced as appropriate with commonly known constituent elements, to the extent that it does not depart from the intention of the present invention. Also, the technical scope of the present invention is not limited to the above-mentioned embodiments, and various modifications may further be made without departing from the spirit of the present invention.

Industrial Applicability

[0071] With the radiation panel module, the radiation air conditioning system, and the air conditioning method described above, low-cost and energy-saving individual radiation air conditioning can be achieved.

Reference Signs List

[0072]

1, 1' Radiation air conditioning system
2 Air conditioner
3 Suction port
4 Air outlet port
8 Delivery hose
9 Ceiling
10, 10', 10" Radiation panel module
11, 11', 11" Damper
12, 12', 12" Flow path-forming member
13, 13', 13" Open/close control unit
14 Heat insulating material
15, 15', 15" Inlet part
16, 16', 16" Outlet part
17, 17', 17" Heat exchange flow path
18, 18', 18" Bypass flow path
19, 19', 19" Radiation panel
100 Space

Claims

1. A radiation panel module, comprising:

a radiation panel; and
a heat exchange flow path through which heat medium passes through, the heat exchange flow path being provided on a back surface side of the radiation panel.

2. The radiation panel module according to claim 1, further comprising: an inlet part of the heat exchange flow path and an outlet part of the heat exchange flow path for the heat medium.

3. The radiation panel module according to claim 1 or 2, wherein the heat exchange flow path is formed to have a configuration of a heat exchanger.

4. The radiation panel module according to any one of claims 1 to 3, wherein a part of the heat exchange flow path has a width smaller than a width of another part of the heat exchange flow path.

5. The radiation panel module according to any one of claims 1 to 4, wherein the heat exchange flow path is formed of a resin or a foaming material and forms a flow path of the heat medium in combination with the radiation panel.

6. The radiation panel module according to any one of claims 1 to 5, further comprising:

a bypass flow path configured to bypass the heat exchange flow path;
a damper configured to adjust a flow rate of the heat medium flowing in the heat exchange flow path and a flow rate of the heat medium flowing in the bypass flow path, the damper being provided at a branch point of the heat exchange flow path and the bypass flow path; and
a control unit configured to control the damper.

7. The radiation panel module according to claim 6, wherein the bypass flow path is formed to have a height larger than a height of the heat exchange flow path.

8. The radiation panel module according to claim 6 or 7, wherein at least a part of the heat exchange flow path has a width smaller than a width of the bypass flow path.

9. A radiation air conditioning system, comprising:

an air conditioner; and
one or a plurality of radiation panel modules of any one of claims 6 to 8 on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned, the radiation panel module including the radiation panel arranged so as to be held in contact with the space.

10. A radiation air conditioning system, comprising:

an air conditioner;
one or a plurality of radiation panel modules of any one of claims 1 to 5 on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned, the radiation panel module including the radiation panel arranged so as to be held in contact with the space;
a bypass flow path configured to guide the heat medium sent out by the air conditioner to a blow-out port to the space; and
a damper configured to switch a destination to which the air conditioner sends out the heat medium between the radiation panel module and the bypass flow path.

11. An air conditioning method in the radiation air conditioning system of claim 9 or 10, comprising:

sending out the heat medium to the bypass flow path under an environment where dew condensation is liable to occur; and sending out the heat medium to the heat exchange flow path under an environment where dew condensation is less liable to occur.

Amended claims under Art. 19.1 PCT

1. [Amended] A radiation panel module, comprising:

a radiation panel;
a heat exchange flow path through which heat medium passes through, the heat exchange flow path being provided on a back surface side of the radiation panel;
a damper configured to adjust a flow rate of the heat medium flowing in the heat exchange flow path and a flow rate of the heat medium flowing in the bypass flow path, the damper being provided at a branch point of the heat exchange flow path and the bypass flow path; and
a control unit configured to control the damper.

2. The radiation panel module according to claim 1, further comprising: an inlet part of the heat exchange flow path and an outlet part of the heat exchange flow path for the heat medium.

3. The radiation panel module according to claim 1 or 2, wherein the heat exchange flow path is formed to have a configuration of a heat exchanger.

4. The radiation panel module according to any one of claims 1 to 3, wherein a part of the heat exchange flow path has a width smaller than a width of another part of the heat exchange flow path.

5. The radiation panel module according to any one of claims 1 to 4, wherein the heat exchange flow path is formed of a resin or a foaming material, and forms a flow path of the heat medium in combination with the radiation panel.

6. [Deleted]

7. [Amended] The radiation panel module according to any one of claims 1 to 5, wherein the bypass flow path is formed to have a height larger than a height of the heat exchange flow path.

8. [Amended] The radiation panel module according to any one of claims 1 to 5 and 7, wherein at least a part of the heat exchange flow path has a width smaller than a width of the bypass flow path.

9. [Amended] A radiation panel module, comprising:

a radiation panel; and
a heat exchange flow path through which heat medium passes through, the heat exchange flow path being provided on a back surface side of the radiation panel, wherein
the heat exchange flow path formed into a serpentine shape.

10. [Amended] A radiation panel module, comprising:

a rectangular radiation panel;
a heat exchange flow path through which heat medium passes through, the heat exchange flow path being provided on a back surface side of the radiation panel; and
an inlet part of the heat exchange flow path and an outlet part of the heat exchange flow path for the heat medium, the inlet part and the outlet part being provided on opposing two sides of the rectangular radiation panel at positions facing each other and being close to a first side of rectangular radiation panel, the first side being one of the first side and a second side different from the opposing two sides,
wherein a plurality of rectangular flow path-forming members forming the heat exchange flow path are arranged in parallel with the opposing two sides,
wherein an end of one of the plurality of rectangular flow path-forming members is held in contact with the first side, and
wherein ends of the plurality of rectangular flow path-forming members are held in contact with the second side.

11. [Amended] A radiation air conditioning system, comprising:

an air conditioner; and
one or a plurality of radiation panel modules of any one of claims 1 to 5 and 7 to 9 on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned, the radiation panel module including the radiation panel arranged so as to be held in contact with the space.

12. [New] A radiation air conditioning system, comprising:

an air conditioner;
one or a plurality of radiation panel modules on at least one of a ceiling, a wall, and a floor of a space to be air-conditioned, the radiation panel module including:

a radiation panel arranged so as to be held in contact with the space; and
a heat exchange flow path through which heat medium passes through, the heat exchange flow path being provided on a back

surface side of the radiation panel;
a bypass flow path configured to guide the heat medium sent out by the air conditioner to a blow-out port to the space; and
a damper configured to switch a destination to which the air conditioner sends out the heat medium between the radiation panel module and the bypass flow path.

13. [New] An air conditioning method in the radiation air conditioning system of claim 11 or 12, comprising:

sending out the heat medium to the bypass flow path under an environment where dew condensation is liable to occur; and
sending out the heat medium to the heat exchange flow path under an environment where dew condensation is less liable to occur.

Statement under Art. 19.1 PCT

Claim 1 in Claims of this application was amended by adding the configuration of Claim 6. Claim 6 was deleted. Dependency of Claims 7 and 8 was amended. Claims 9 and 10 were added. Claim 9 was amended based on FIG. 8 and paragraph 0046. Claim 10 was amended based on FIG. 6 and paragraph 0040. Claims 11 to 13 correspond to Claims 9 to 11 before amendment, respectively, and dependency thereof was amended. Claim 12 was amended based on Claim 1.

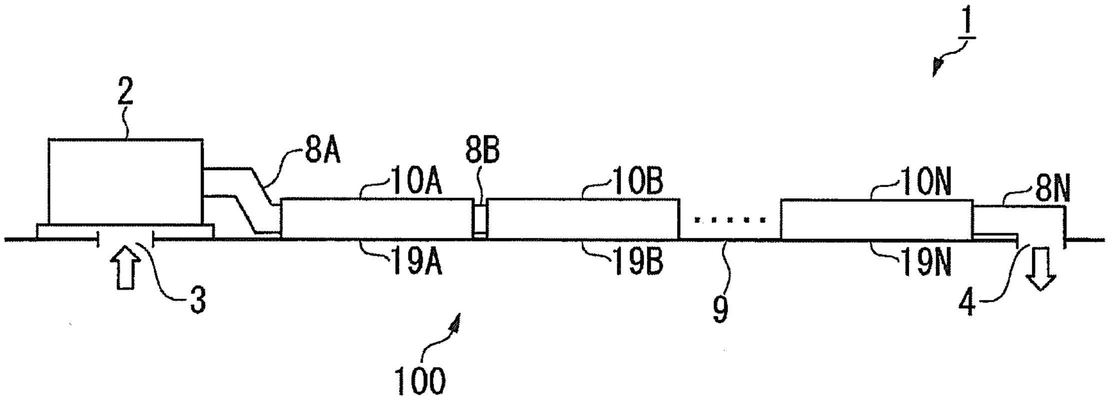
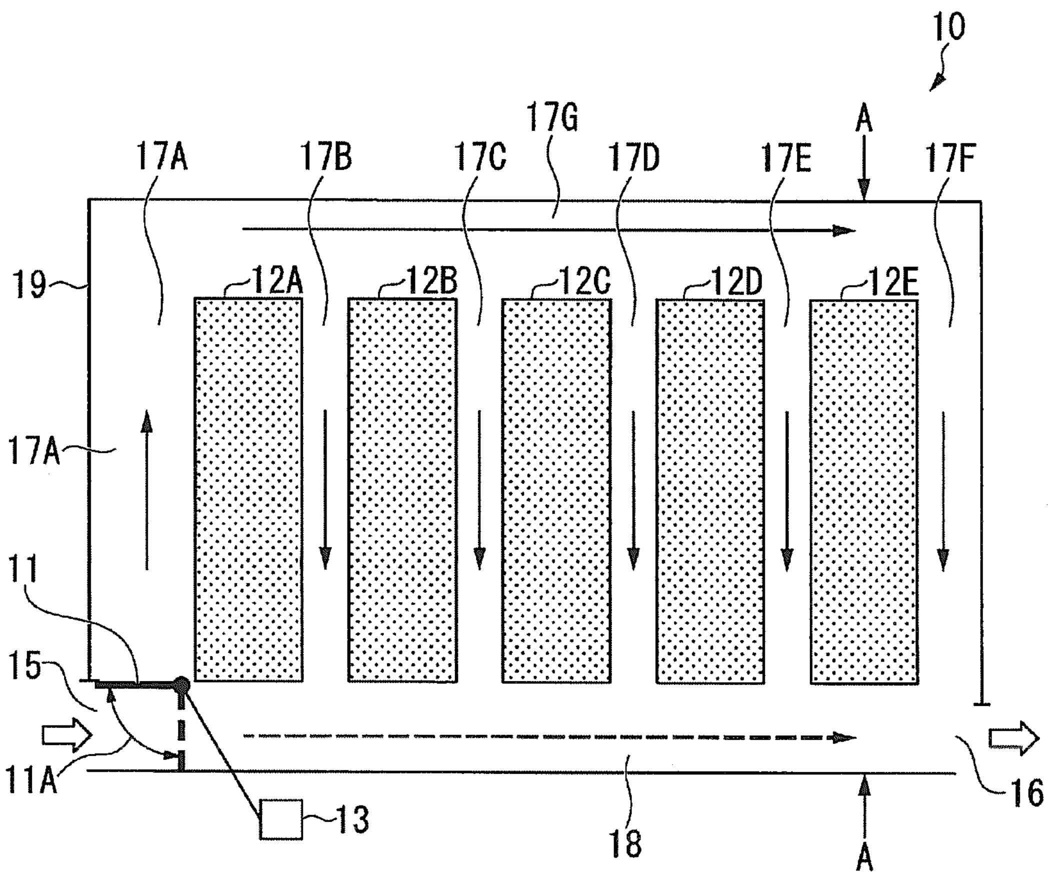

1
2
8A
8B
10A
10B
10N
8N
19A
19B
19N
3
9
4
100

FIG. 1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17G
A
17A
17B
17C
17D
17E
17F
19
12A
12B
12C
12D
12E
17A
11
15
11A
13
18
A
16

FIG. 2

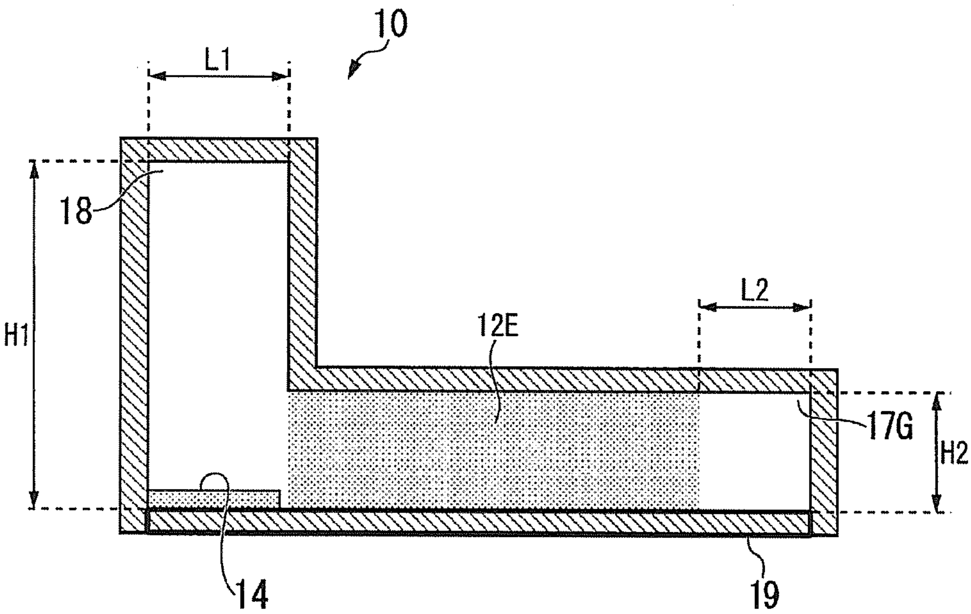
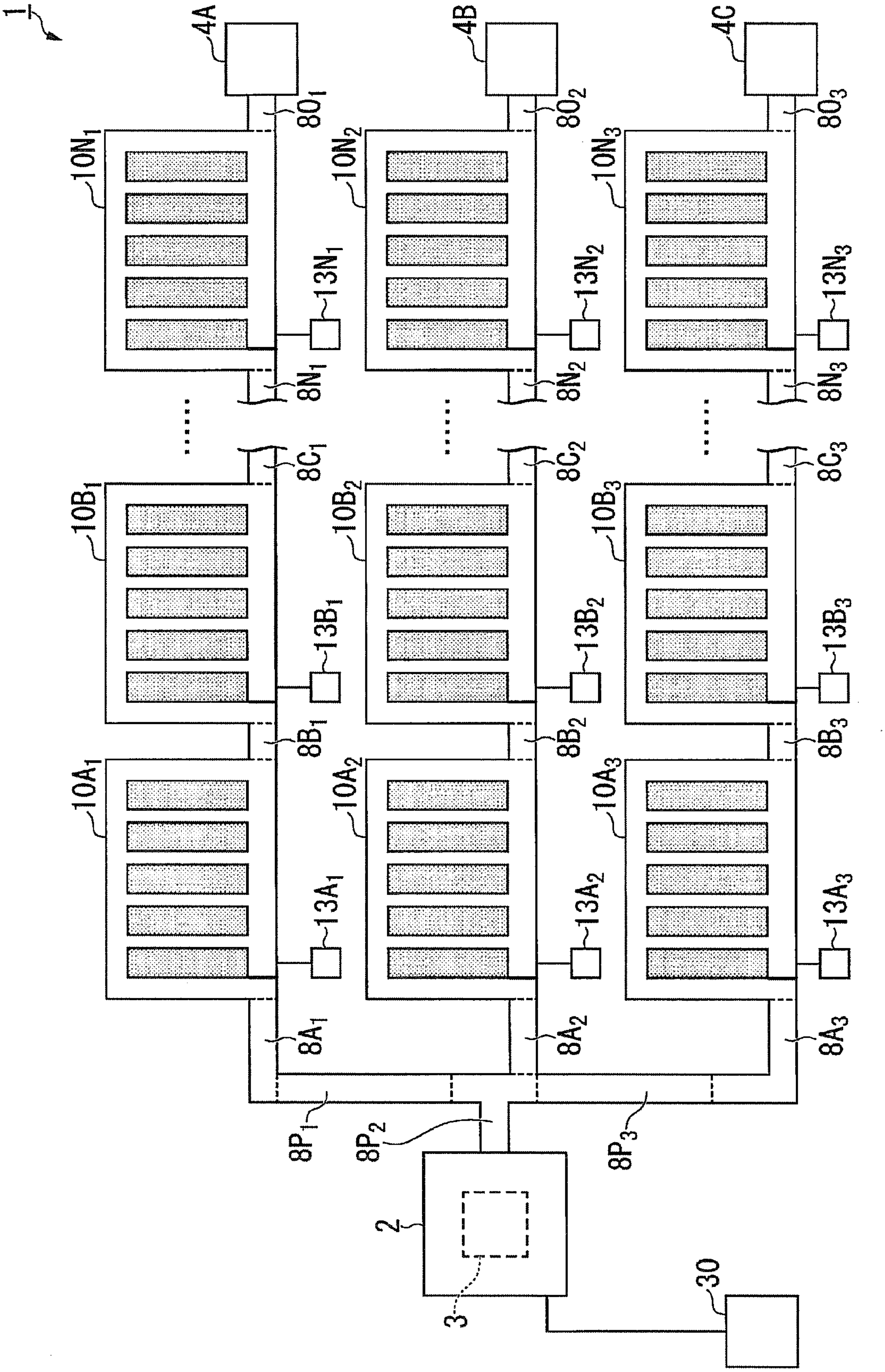


FIG. 3


1
4A
4B
4C
$8O_1$
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$8O_3$
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$8C_1$
$8C_2$
$8C_3$
$10B_1$
$10B_2$
$10B_3$
$13B_1$
$13B_2$
$13B_3$
$8B_1$
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$10A_1$
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$13A_1$
$13A_2$
$13A_3$
$8A_1$
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$8P_1$
$8P_2$
$8P_3$
2
3
30

FIG. 4

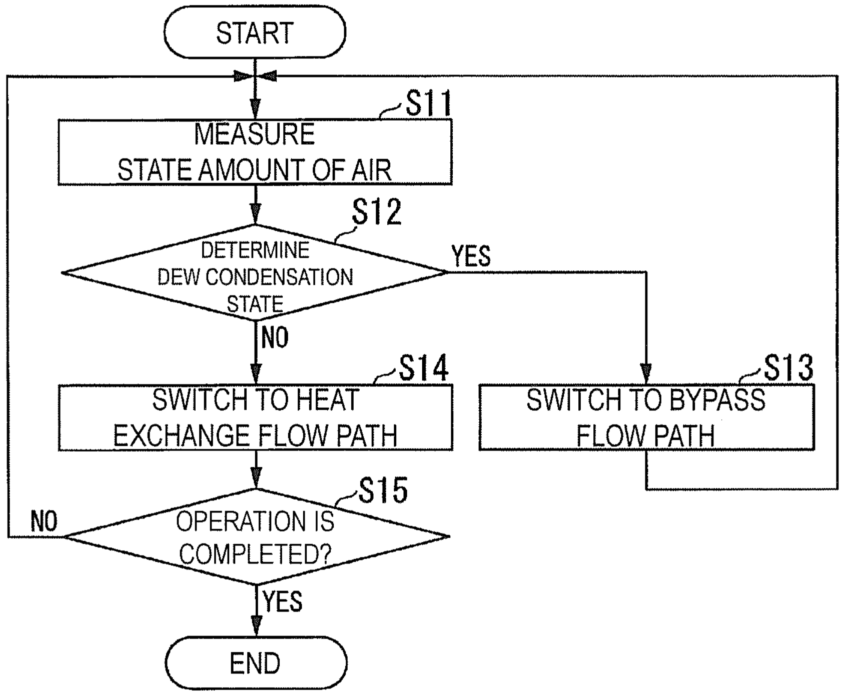

START
S11
MEASURE
STATE AMOUNT OF AIR
S12
DETERMINE
DEW CONDENSATION
STATE
YES
NO
S14
SWITCH TO HEAT
EXCHANGE FLOW PATH
S13
SWITCH TO BYPASS
FLOW PATH
S15
NO
OPERATION IS
COMPLETED?
YES
END

FIG. 5

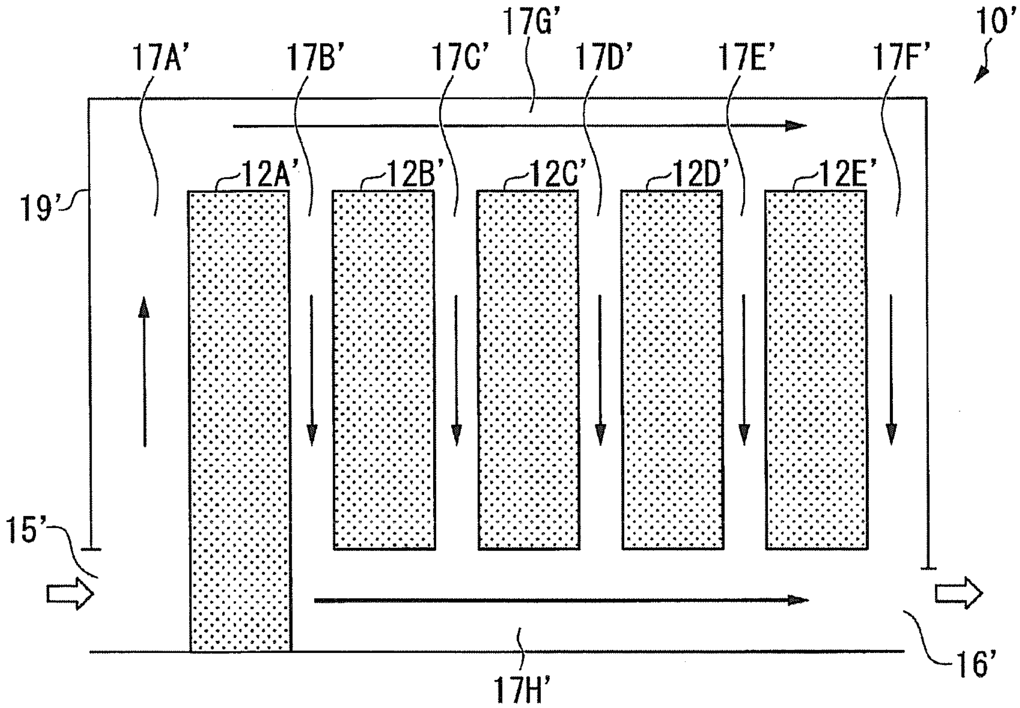
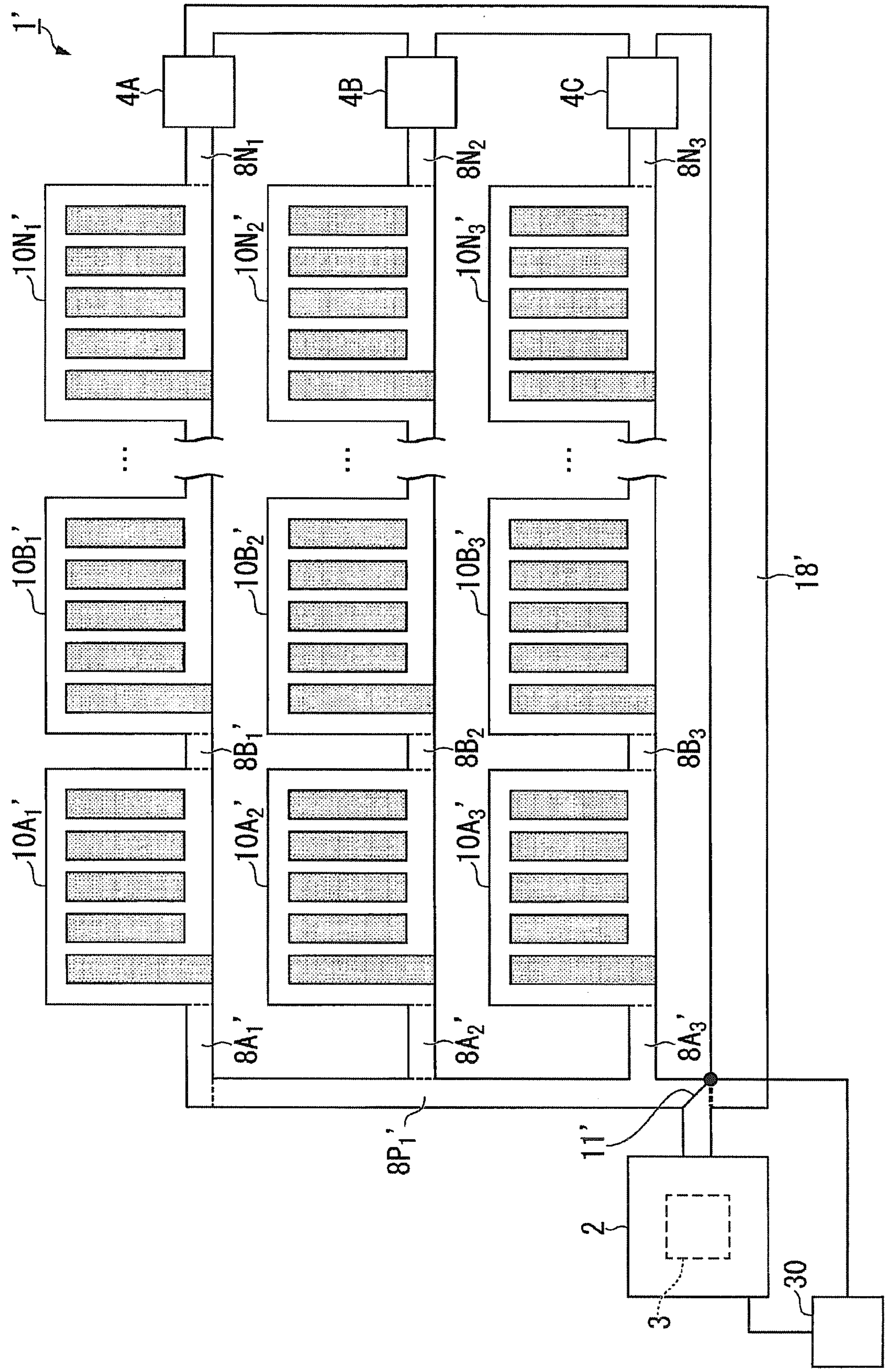

17G'
10'
17A'
17B'
17C'
17D'
17E'
17F'
19'
12A'
12B'
12C'
12D'
12E'
15'
16'
17H'

FIG. 6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4B
4C
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$10N_2'$
$10N_3'$
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$10B_2'$
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$8B_1'$
$8B_2$
$8B_3$
$10A_1'$
$10A_2'$
$10A_3'$
$8A_1'$
$8A_2'$
$8A_3'$
18'
$8P_1'$
11'
2
3
30

FIG. 7

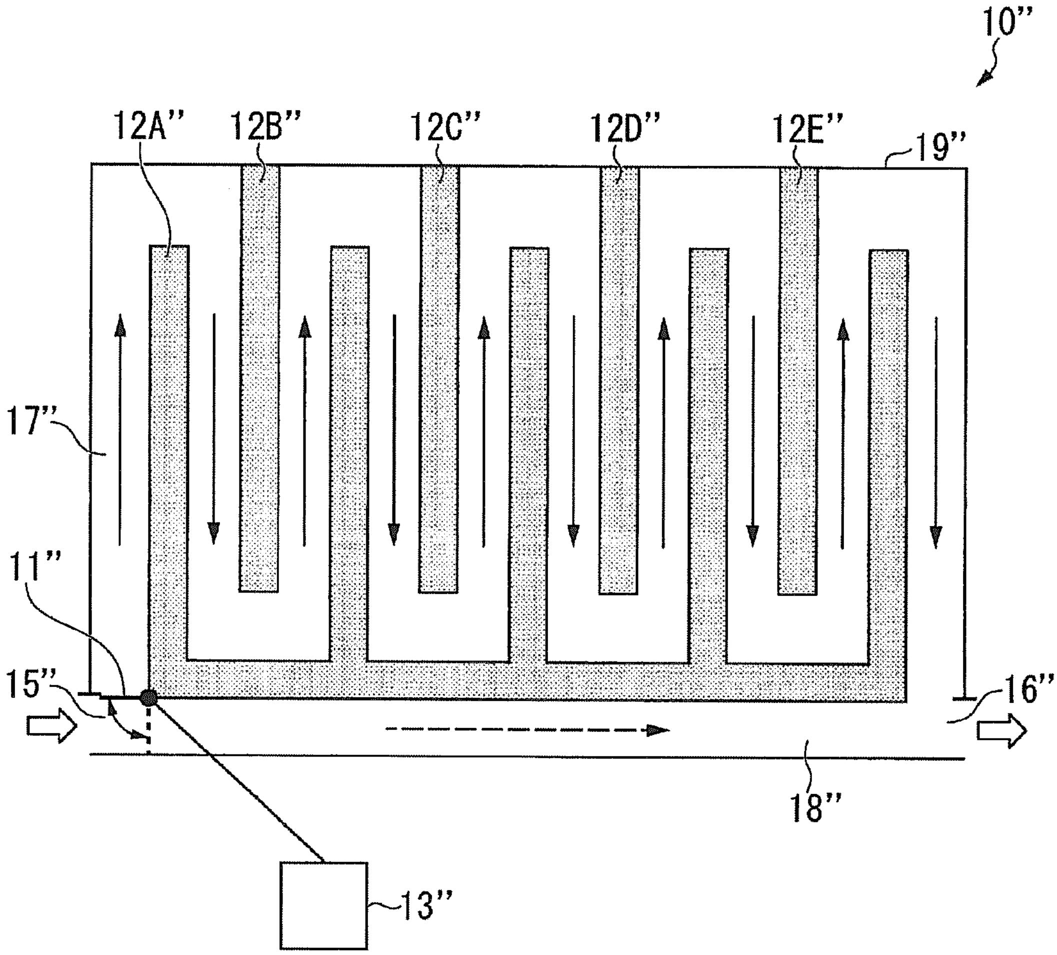

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/041712

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F24F1/00(2011.01)i, F24F5/00(2006.01)i, F24F11/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F24F1/00, F24F5/00, F24F11/02

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	1994-2017

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 A	JP 2014-153037 A (ECOPOWER CO., LTD.) 25 August 2014, paragraphs [0019]-[0024], [0039], [0046]-[0047], fig. 1-3, 8 (Family: none)	1-5 6-11
A	JP 9-96434 A (TOSHIBA CORP.) 08 April 1997, paragraphs [0014], [0025]-[0062], fig. 1-13 (Family: none)	1-11
A	JP 9-184642 A (DAIWA HOUSE INDUSTRY CO., LTD.) 15 July 1997, paragraph [0011], fig. 5 (Family: none)	1-11
A	JP 11-051445 A (TOSHIBA CORP.) 26 February 1999, paragraph [0026], fig. 9 (Family: none)	1-11

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

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"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
11 December 2017 (11.12.2017)

Date of mailing of the international search report
09 January 2018 (09.01.2018)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2016241903 A **[0002]**
- JP 9096434 A **[0005]**