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(54) AIR CONDITIONING SYSTEM AND CONTROL METHOD FOR SAME

(57) An air conditioning system and a control method of the same, wherein the air conditioning system can provide a sufficiently dehumidified and heated fluid to a room in an energy conserving way and furthermore has a hot water supply function. The air conditioning system of this invention includes an outdoor unit, an indoor dehumidification and heating unit, and a refrigerant-water heat exchange unit that are coupled to each other via a first coupling pipe, a second coupling pipe, and a third coupling pipe; one end of the third coupling pipe is coupled to a discharge pipe coupled to a discharge side of a compressor; a second indoor-side pipe is provided in the indoor dehumidification and heating unit; a second indoor-side refrigerating regulating device and a second heat exchanger are provided in the second indoor-side pipe; another end of the third coupling pipe is coupled to another end of the second indoor-side pipe; a refrigerant pipe, a water circuit, and a refrigerant-water heat exchanger are provided in the refrigerant-water heat exchange unit; and one end of the refrigerant pipe is coupled to the first coupling pipe and another end of the refrigerant pipe is coupled to the third coupling pipe.

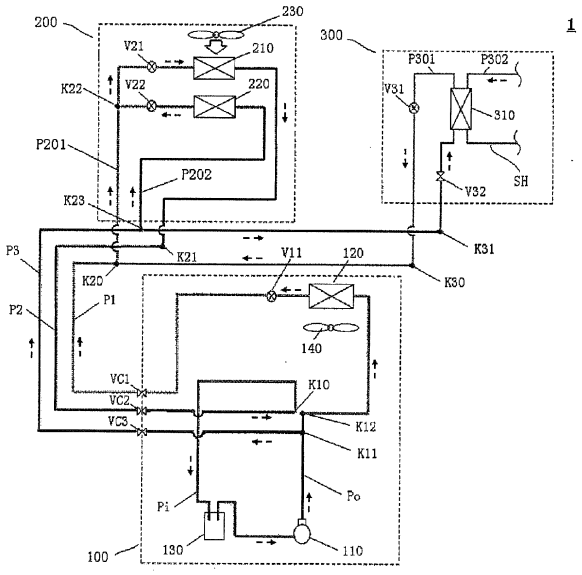

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioning system and a control method of the same, and particularly an air conditioning system including an outdoor unit and an indoor dehumidification and heating unit and a control method of the same.

BACKGROUND ART

[0002] As people's living standards improve, people's needs with respect to controlling their living environment become more pronounced by the day, so air conditioning system functions are also gradually expanding from being just for regulating temperature to being diverse. Air conditioning systems equipped with a humidity control function have been created because in rainy and humid regions and in rainy seasons the humidity in the air becomes higher and is also uncomfortably felt by the human body.

[0003] Air conditioning systems generally dehumidify air using the following principle. Moisture in the air is removed by causing the air to flow through a heat exchanger whose surface temperature is lower than the dewpoint of the air to thereby condense the air, and because of this dehumidification principle it is understood that the dehumidifying effect is better the lower the surface temperature of the heat exchanger is. However, although the humidity can be lowered when dehumidification is performed at a low temperature, the temperature of the air also concomitantly drops, so in an environment requiring both a dehumidifying effect and temperature, such as a bathroom, for example, it becomes necessary to maintain the comfort experienced by the human body by heating the air again after dehumidifying the air.

[0004] In order to realize heating and dehumidification, ordinarily a structure has been used where, as shown in FIG. 10, an electric heating unit 29X is added downstream of an airflow path of a dehumidification heat exchanger 21 X. However, an electric heating unit ordinarily utilizes a heating element (e.g., a heating wire) to convert electrical energy to thermal energy and raises the blowing air temperature by causing the air to absorb a heat quantity when the air flows through it, so this ends up increasing energy consumption. In addition to this, the airflow that has exchanged heat in the electrical heating unit is unevenly heated, so the temperature distribution of the airflow also becomes uneven and comfort ends up dropping.

[0005] In order to realize heating and dehumidification, it is also conceivable to use the structure disclosed in patent document CN1590890A, where, as shown in FIG. 11, a dehumidification heat exchanger 21X1 and a heating heat exchanger 22X are connected in series to an indoor refrigerant circuit, the dehumidification heat exchanger 21X1 and the heating heat exchanger 22X are sequentially provided in an airflow path, and a throttling device 25X is provided in a pipe between them. However, when this structure is utilized to perform heating and dehumidification, the heat quantity of the refrigerant in the same section is first used for heating and is then used for cooling after being carried away by the airflow, so both the dehumidification heat exchanger 21X1 and the heating heat exchanger 22X do not exhibit sufficient roles, dehumidification is no longer sufficient, and the heating quantity also becomes deficient.

[0006] In addition to this, it is also desired that air conditioning systems have a hot water supply function.

SUMMARY OF INVENTION

<Technical Problem>

[0007] The present invention has been completed in view of the problems described above, and it is an object thereof to provide an air conditioning system including an outdoor unit and an indoor dehumidification and heating unit and a control method of the same. The air conditioning system can provide a sufficiently dehumidified and heated fluid in an energy conserving way to a room and furthermore has a hot water supply function.

<Solution to Problem>

[0008] In order to realize this object, the present invention provides an air conditioning system including an outdoor unit and an indoor dehumidification and heating unit that are coupled to each other via coupling pipes. In the outdoor unit a discharge side of a compressor is coupled to one end of a discharge pipe, another end of the discharge pipe is coupled to one end of a first coupling pipe of the coupling pipes, a suction side of the compressor is coupled to one end of a suction pipe, another end of the suction pipe is coupled to one end of a second coupling pipe of the coupling pipes, and an outdoor-side heat exchanger is provided in a section of the first coupling pipe positioned inside the outdoor unit. In the indoor dehumidification and heating unit a first indoor-side refrigerant regulating device and a first heat exchanger are provided in a first indoor-side pipe sequentially from one end of the first indoor-side pipe, the one end of the first

indoor-side pipe is coupled to a section of the first coupling pipe positioned outside the outdoor unit, and another end of the first indoor-side pipe is coupled to a section of the second coupling pipe positioned outside the outdoor unit. In the indoor dehumidification and heating unit a heat cycle device for delivering a heat quantity or a cold quantity of the indoor dehumidification and heating unit to a room is also provided. The coupling pipes further include a third coupling pipe having one end coupled to the discharge pipe. In the indoor dehumidification and heating unit a second indoor-side refrigerant regulating device and a second heat exchanger are provided in a second indoor-side pipe sequentially from one end of the second indoor-side pipe, the one end of the second indoor-side pipe is coupled to the first indoor-side pipe and is positioned between the first indoor-side refrigerant regulating device and the one end of the first indoor-side pipe, and another end of the second indoor-side pipe is coupled to a section of the third coupling pipe positioned outside the outdoor unit. The air conditioning system further includes a refrigerant-water heat exchange unit including a refrigerant pipe, a water circuit configured by a water pipe, and a refrigerant-water heat exchanger that exchanges heat between refrigerant flowing in the refrigerant pipe and water flowing in the water pipe, with one end of the refrigerant pipe being coupled to the section of the first coupling pipe positioned outside the outdoor unit and with another end of the refrigerant pipe being coupled to the section of the third coupling pipe positioned outside the outdoor unit.

[0009] According to the air conditioning system of the present invention, the air conditioning system can operate in a hot water supply/dehumidification/heating mode or a dehumidification/heating-only mode, and in these two modes the first heat exchanger of the indoor dehumidification and heating unit can be utilized to dehumidify the fluid delivered from the heat cycle device and the second heat exchanger of the indoor dehumidification and heating unit can be utilized to heat the fluid delivered from the heat cycle device. Consequently, compared to a structure where an electric heating unit is added downstream of the dehumidification heat exchanger in the flow path formed by the heat cycle device, the air conditioning system of the present invention can reduce energy consumption and can enhance the comfort experienced by persons in the room by ensuring that the temperature distribution of the fluid that the indoor dehumidification and heating unit supplies to the room does not become uneven. Furthermore, compared to a structure where the dehumidification heat exchanger and the heating heat exchanger connected in series in an indoor refrigerant circuit are sequentially provided in the flow path formed by the heat cycle device, the air conditioning system of the present invention can ensure that the dehumidification does not become insufficient and the heating quantity is not deficient because both the dehumidification heat exchanger (i.e., the first heat exchanger) and the heating heat exchanger (i.e., the second heat exchanger) can fulfill sufficient roles. Furthermore, waste heat utilization can be realized by using in the second heat exchanger some of the waste heat that is discharged from the outdoor unit to the atmosphere anyway, so the energy consumption rate can be improved to realize energy conservation and environmental protection.

[0010] Furthermore, according to the air conditioning system of the present invention, even when the system efficiency has dropped because of frosting of the outdoor unit, the air conditioning system can perform a constant-temperature defrost operation in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, which is to say that because the heating heat exchanger fulfills a heating action in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, cold air does not blow to the room even if an indoor blower device continues to be operated, so constant-temperature defrosting can be realized.

[0011] Furthermore, according to the air conditioning system of the present invention, the air conditioning system includes the refrigerant-water heat exchange unit including the refrigerant pipe, the water circuit configured by the water pipe, and the refrigerant-water heat exchanger that exchanges heat between the refrigerant flowing in the refrigerant pipe and the water flowing in the water pipe, so by utilizing the refrigerant carried from the outdoor unit and flowing in the refrigerant pipe to heat the water flowing in the water pipe of the water circuit, the water circuit can be utilized to provide hot water.

[0012] In the air conditioning system of the present invention, preferably the outdoor unit further includes a first switching device that can switch between a first switching state and a second switching state. In the first switching state of the first switching device the first coupling pipe and the discharge pipe communicate with each other and the second coupling pipe and the suction pipe communicate with each other, and in the second switching state of the first switching device the first coupling pipe and the suction pipe communicate with each other and the second coupling pipe and the discharge pipe communicate with each other.

[0013] By using this structure, the air conditioning system can operate in a hot water supply/dehumidification/heating mode, a dehumidification/heating-only mode, a heating/hot water supply mode, and a hot water supply-only mode.

[0014] Furthermore, by using this structure, the first switching state of the outdoor unit can be switched to the second switching state to thereby cause both the first heat exchanger and the second heat exchanger to fulfill roles as condensers to heat the fluid delivered from the heat cycle device. For this reason, overall efficiency can be enhanced.

[0015] In the air conditioning system of the present invention, preferably the outdoor unit is further provided with a first outdoor-side branching pipe having one end coupled to the suction pipe, the third coupling pipe has a first section and a second section, with the first section being coupled to the discharge pipe and with the second section being coupled to the second indoor-side pipe, and the air conditioning system further includes a second switching device that can switch between a first switching state and a second switching state. In the first switching state of the second switching

device the second section of the third coupling pipe and the first section of the third coupling pipe communicate with each other, and in the second switching state of the second switching device the second section of the third coupling pipe and another end of the first outdoor-side branching pipe communicate with each other.

[0016] By using this structure, the air conditioning system can operate in a hot water supply/dehumidification/heating mode, a dehumidification/heating-only mode, a heating/hot water supply mode, a hot water supply-only mode, and a cooling-only mode.

[0017] Furthermore, by using this structure, the first switching device can be switched to the first switching state and the second switching device can be switched to the second switching state to thereby cause both the first heat exchanger and the second heat exchanger to fulfill roles as evaporators to cool the room air. For this reason, overall efficiency can be enhanced.

[0018] Furthermore, by using this structure, even when the system efficiency has dropped because of frosting of the outdoor unit, the air conditioning system can perform a routine defrost operation in the cooling-only mode. At this time, preferably the operation of the heat cycle device is stopped to ensure that the drop in the room temperature does not affect the comfort experienced by persons in the room, but the heat cycle device is not limited to this and can also be operated at a low speed to provide a weak airflow to the room. In this connection, compared to the constant-temperature defrost operation, the defrost speed of the routine defrost operation performed in the cooling-only mode is faster.

[0019] In the air conditioning system of the present invention, preferably the first switching device is a four-port valve.

[0020] By using this structure, a simple structure can be utilized to realize the switching of the first switching device between the first switching state and the second switching state.

[0021] In the air conditioning system of the present invention, preferably the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are motor-operated valves or electromagnetic valves.

[0022] By using this structure, simple structures can be utilized to regulate the state of the refrigerant flowing in the first indoor-side pipe and the second indoor-side pipe.

[0023] In the air conditioning system of the present invention, preferably the heat cycle device is an indoor blower device, and the first heat exchanger and the second heat exchanger are provided in a flow path of an airflow formed by the indoor blower device.

[0024] In the air conditioning system of the present invention, preferably the first heat exchanger is provided on an upstream side or a downstream side of the second heat exchanger in the flow path or the first heat exchanger and the second heat exchanger are provided side by side in the flow path.

[0025] By using this structure, it can be made easier to deliver the necessary heat quantity or cold quantity to the room.

[0026] In the air conditioning system of the present invention, preferably a reservoir device is provided in the suction pipe.

[0027] By using this structure, the reservoir device can be utilized to absorb the liquid component in the refrigerant returned to the compressor, so that the compressor does not suck in liquid refrigerant and sustain damage.

[0028] In the air conditioning system of the present invention, preferably the air conditioning system further includes a floor heating water circuit connected to the water circuit.

[0029] By using this structure, the refrigerant-water heat exchange unit can be utilized to heat floorboards or the like.

[0030] In the air conditioning system of the present invention, preferably the air conditioning system further includes a water tank provided with a domestic water pipe connected to a terminal end of domestic water, and the water pipe configuring the water circuit runs through the water tank.

[0031] By using this structure, the refrigerant-water heat exchange unit can be utilized to heat floorboards or the like and provide hot water to the terminal end of domestic water.

[0032] In the air conditioning system of the present invention, preferably there is an electric heating device in the water tank.

[0033] By using this structure, even when the heat quantity of the water supplied to the water tank of the water flowing in the water pipe in the water circuit is deficient, the electric heating device can be utilized to heat the water in the water tank and thereby provide water with the necessary temperature to the terminal end of domestic water.

[0034] In the air conditioning system of the present invention, preferably the air conditioning system further includes a fan coil unit connected to the water circuit.

[0035] By using this structure, the refrigerant-water heat exchange unit can be utilized to heat or cool the water flowing in the water circuit to thereby provide the heat quantity or cold quantity of the water in the water circuit to the fan coil unit, and the fan coil unit can be utilized to heat or cool.

[0036] In the air conditioning system of the present invention, preferably the outdoor unit further includes a sub-cooling pipe, a refrigerant regulating device, and a sub-cooler, one end of the sub-cooling pipe is coupled to the first coupling pipe in a position located on the side of the outdoor heat exchanger corresponding to another end of the first coupling pipe, and another end of the sub-cooling pipe is coupled to the suction pipe, the refrigerant regulating device is provided in the sub-cooling pipe, and the sub-cooler exchanges heat between refrigerant flowing in the first coupling pipe and refrigerant that has flowed through the refrigerant regulating device in the sub-cooling pipe.

[0037] By using this structure, the sub-cooler can be utilized to cool the refrigerant flowing in the first outdoor-side

pipe, whereby the capacity to dehumidify the fluid delivered from the heat cycle device utilizing the first heat exchanger of the indoor dehumidification and heating unit can be enhanced.

[0038] In the air conditioning system of the present invention, preferably the air conditioning system further includes at least one indoor unit, the indoor unit includes an indoor unit-side refrigerant pipe, one end of the indoor unit-side refrigerant pipe is coupled to the section of the first coupling pipe positioned outside the outdoor unit, another end of the indoor unit-side refrigerant pipe is coupled to the section of the second coupling pipe positioned outside the outdoor unit, and an indoor unit-side refrigerant regulating device and an indoor unit-side heat exchanger are provided in the indoor unit-side refrigerant pipe sequentially from the one end of the indoor unit-side refrigerant pipe.

[0039] By using this structure, not only can the indoor dehumidification and heating unit be utilized to perform dehumidification and heating, but the refrigerant-water heat exchange unit can be utilized to provide hot water, and cooling by the indoor unit can also be done.

[0040] In the air conditioning system of the present invention, preferably the air conditioning system includes a plurality of the outdoor units, outdoor unit coupling pipe spans of the first coupling pipe that are coupled to the plural outdoor units merge with a total coupling pipe span of the first coupling pipe outside the outdoor units, the one end of the first indoor-side pipe and the one end of the refrigerant pipe of the refrigerant-water heat exchange unit are coupled to the total coupling pipe span of the first coupling pipe, outdoor unit coupling pipe spans of the second coupling pipe that are coupled to the plural outdoor units merge with a total coupling pipe span of the second coupling pipe outside the outdoor units, the other end of the first indoor-side pipe is coupled to the total coupling pipe span of the second coupling pipe, and outdoor unit coupling pipe spans of the third coupling pipe that are coupled to the plural outdoor units merge with a total coupling pipe span of the third coupling pipe outside the outdoor units, and the other end of the second indoor-side pipe and the other end of the refrigerant pipe are coupled to the total coupling pipe span of the third coupling pipe.

[0041] By using this structure, even when the capacity of one outdoor unit is deficient, refrigerant with the proper temperature, proper quantity, and proper pressure can be provided to the indoor dehumidification and heating unit and the refrigerant-water heat exchange unit by starting up the plural outdoor units.

[0042] In the air conditioning system of the present invention, preferably a refrigerant-water heat exchange unit-side refrigerant regulating device is provided between the one end of the refrigerant pipe and the refrigerant-water heat exchanger.

[0043] By using this structure, the flow rate and state of the refrigerant flowing in the refrigerant pipe can be controlled.

[0044] In the air conditioning system of the present invention, preferably the refrigerant-water heat exchange unit-side refrigerant regulating device is a motor-operated valve or an electromagnetic valve.

[0045] By using this structure, a simple structure can be utilized to control the flow rate and state of the refrigerant flowing in the refrigerant pipe.

[0046] In the air conditioning system of the present invention, preferably an electromagnetic valve is provided between the other end of the refrigerant pipe and the refrigerant-water heat exchanger.

[0047] By using this structure, the electromagnetic valve is provided between the other end of the refrigerant pipe and the refrigerant-water heat exchanger, so even when the temperature of the refrigerant flowing from the third coupling pipe to the refrigerant-water heat exchange unit is too low, the electromagnetic valve can be closed to ensure that freezing does not occur as a result of the temperature of the refrigerant in the refrigerant pipe being too low.

[0048] In the air conditioning system of the present invention, preferably a refrigerant control valve is provided in the second coupling pipe.

[0049] By using this structure, when the first switching device is switched to the second switching state, and the refrigerant-water heat exchange unit-side refrigerant regulating device is opened, and the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are partially opened to switch to the hot water supply-only mode, the refrigerant accumulating in the indoor dehumidification and heating unit can be effectively reduced, whereby the refrigerant flowing in the refrigerant-water heat exchange unit can be increased, so that the heating capacity of the refrigerant in the refrigerant-water heat exchange unit with respect to the water can be enhanced.

[0050] In this connection, "partially open" mentioned in this specification is not intended to carry a meaning such as "open" or "completely open" nor is it intended to convey the meaning of "completely closed"; rather, it means to open the valve just a little so that the valve itself does not sustain damage (that is to say, to open the valve just a little and balance out the pressure at both ends of the valve to ensure that the liquid pressure at both ends of the valve does not become imbalanced resulting in the valve sustaining damage), and this substantially corresponds to "closed." Furthermore, "open" mentioned in this specification does not at all mean completely opening the valve, and the specific opening degree of the valve can be controlled according to the requirements of the operating circumstances.

[0051] In the air conditioning system of the present invention, preferably the refrigerant control valve is any one type among a motor-operated valve, an electromagnetic valve, or a pilot valve.

[0052] By using this structure, the refrigerant control valve can be inexpensively configured.

[0053] In the air conditioning system of the present invention, preferably the second switching device is provided in the outdoor unit.

[0054] By using this structure, the second switching device is integrated into the outdoor unit, which is useful for making compact and downsizing the structure of the air conditioning system.

[0055] In order to realize the above-described object, the present invention provides an air conditioning system control method that is used to control the above-described air conditioning system, wherein a refrigerant-water heat exchange unit-side refrigerant regulating device is provided between the one end of the refrigerant pipe and the refrigerant-water heat exchanger. The air conditioning system control method utilizes a control unit to cause the air conditioning system to switch operation between a first mode, a second mode, and a third mode, in the first mode the first switching device is switched to the second switching state and the second switching device is switched to the first switching state, in the second mode the first switching device is switched to the first switching state, the second switching device is switched to the first switching state, and the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are opened, and in the third mode the first switching device is switched to the first switching state and the second switching device is switched to the second switching state.

[0056] In the air conditioning system control method pertaining to the present invention, preferably in the second mode the air conditioning system performs a defrost operation.

[0057] In the air conditioning system control method pertaining to the present invention, preferably in the third mode the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are opened and operation of the heat cycle device is stopped or the heat cycle device is operated at a low speed to thereby perform a defrost operation.

[0058] In the air conditioning system control method pertaining to the present invention, preferably in the first mode or the third mode the first indoor-side refrigerant regulating device, the second indoor-side refrigerant regulating device, and the refrigerant-water heat exchange unit-side refrigerant regulating device are opened.

[0059] In the air conditioning system control method pertaining to the present invention, preferably in the first mode or the third mode the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are partially opened and the refrigerant-water heat exchange unit-side refrigerant regulating device is opened.

[0060] In the air conditioning system control method pertaining to the present invention, preferably in the first mode or the third mode the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are opened and the refrigerant-water heat exchange unit-side refrigerant regulating device is closed.

[0061] In the air conditioning system control method pertaining to the present invention, preferably a refrigerant control valve is provided in the second coupling pipe, and in the first mode the refrigerant control valve is closed, the first indoor-side refrigerant regulating device and the second indoor-side refrigerant regulating device are partially opened, and the refrigerant-water heat exchange unit-side refrigerant regulating device is opened.

[0062] In the air conditioning system control method pertaining to the present invention, preferably the refrigerant control valve is any one type among a motor-operated valve, an electromagnetic valve, or a pilot valve.

<Advantageous Effects of Invention>

[0063] According to the air conditioning system and the control method of the same of the present invention, the air conditioning system can operate in a hot water supply/dehumidification/heating mode or a dehumidification/heating-only mode, and in these two modes the first heat exchanger of the indoor dehumidification and heating unit can be utilized to dehumidify the fluid delivered from the heat cycle device and the second heat exchanger of the indoor dehumidification and heating unit can be utilized to heat the fluid delivered from the heat cycle device. Consequently, compared to a structure where an electric heating unit is added downstream of the first heat exchanger in the flow path formed by the heat cycle device, the air conditioning system of the present invention can reduce energy consumption and can enhance the comfort experienced by persons in the room by ensuring that the temperature distribution of the fluid that the indoor dehumidification and heating unit supplies to the room does not become uneven. Furthermore, compared to a structure where the first heat exchanger and the second heat exchanger connected in series in the indoor refrigerant circuit are sequentially provided in the flow path formed by the heat cycle device, the air conditioning system of the present invention can ensure that the dehumidification does not become insufficient and the heating quantity is not deficient because both the first heat exchanger and the second heat exchanger can fulfill sufficient roles. Furthermore, waste heat utilization can be realized by using in the second heat exchanger some of the waste heat that is discharged from the outdoor unit to the atmosphere anyway, so the energy consumption rate can be improved to realize energy conservation and environmental protection.

[0064] Furthermore, according to the air conditioning system and the control method of the same of the present invention, even when a system efficiency decreases by frosting of the outdoor unit, the air conditioning system can perform a constant-temperature defrost operation in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, which is to say that because the heating heat exchanger effects a heating action in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, cold air does not blow to the room even when an indoor blower device continues to be operated, so constant-temperature defrosting can be

realized.

[0065] Furthermore, according to the air conditioning system and the control method of the same of the present invention, by utilizing the refrigerant carried from the outdoor unit and flowing in the refrigerant pipe to heat the water flowing in the water pipe of the water circuit, the water circuit can be utilized to provide hot water.

BRIEF DESCRIPTION OF DRAWINGS

[0066]

FIG. 1 is a schematic drawing showing a circuit structure of an air conditioning system of embodiment 1 of the present invention, and shows the direction in which refrigerant flows when the air conditioning system is operated in a hot water supply/dehumidification/heating mode.

FIG. 2 is a schematic drawing showing a circuit structure of an air conditioning system of embodiment 2 of the present invention, and shows the direction in which refrigerant flows when the air conditioning system is operated in a heating/hot water supply mode.

FIG. 3 is a schematic drawing showing a circuit structure of an air conditioning system of embodiment 3 of the present invention, and shows the direction in which refrigerant flows when the air conditioning system is operated in a cooling/cold water supply mode.

FIG. 4 is a schematic drawing showing a circuit structure of an air conditioning system of embodiment 4 of the present invention.

FIG. 5 is a schematic drawing showing a circuit structure of an air conditioning system of embodiment 5 of the present invention.

FIG. 6 is a schematic drawing showing a modification of the air conditioning system pertaining to the present invention, and shows the direction in which refrigerant flows when the air conditioning system is operated in the hot water supply/dehumidification/heating mode.

FIG. 7 is a schematic drawing showing another modification of the air conditioning system pertaining to the present invention, and shows the direction in which refrigerant flows when the air conditioning system is operated in a hot water supply-only mode.

FIG. 8 is a schematic drawing showing still another example modification of the air conditioning system pertaining to the present invention.

FIG. 9 is a schematic drawing showing part of a refrigerant-water heat exchange unit included in the air conditioning system pertaining to the present invention, and shows an example where a floor heating water circuit, a water tank, and a fan coil unit are connected to a water circuit of the refrigerant-water heat exchange unit.

FIG. 10 is a schematic diagram showing a conventional dehumidification and heating circuit structure.

FIG. 11 is a schematic diagram showing another conventional dehumidification and heating circuit structure.

DESCRIPTION OF EMBODIMENTS

[0067] Next, embodiments of the air conditioning system pertaining to the present invention will be described with reference to the drawings.

<Embodiment 1>

[0068] First, a circuit structure of an air conditioning system 1 of embodiment 1 of the present invention will be described in detail with reference to FIG. 1.

[0069] As shown in FIG. 1, the air conditioning system 1 of the present embodiment includes an outdoor unit 100, an indoor dehumidification and heating unit 200, and a refrigerant-water heat exchange unit 300, and the outdoor unit 100, the indoor dehumidification and heating unit 200, and the refrigerant-water heat exchange unit 300 are coupled to each other via plural coupling pipes including a first coupling pipe P1, a second coupling pipe P2, and a third coupling pipe P3.

[0070] Here, cutoff valves VC1 to VC3 are provided in the middle of the first coupling pipe P1, the second coupling pipe P2, and the third coupling pipe P3 (below, the cutoff valves VC1 to VC3 also serve as a boundary in defining the range of the outdoor unit), and ordinarily the cutoff valves VC1 to VC3 are all in a normally open state. Furthermore, in certain cases one, plurality, or even all of the cutoff valves VC1 to VC3 may also be omitted.

(Outdoor Unit 100)

[0071] The outdoor unit 100 is provided with a compressor 110, an outdoor heat exchanger 120, a valve V11, and a reserve tank 130 (which corresponds to a reservoir device of the present invention).

[0072] Specifically, a discharge side of the compressor 110 is coupled to one end of a discharge pipe Po, another end of the discharge pipe Po (the end portion positioned in the place of point K12 in FIG. 1) is coupled to one end of the first coupling pipe P1, a suction side of the compressor 110 is coupled to one end of a suction pipe Pi, another end of the suction pipe Pi (the end portion positioned in the place of point K10 in FIG. 1) is coupled to one end of the second coupling pipe P2, the valve V11 and the outdoor heat exchanger 120 are provided in the middle of a section of the first coupling pipe P1 positioned inside the outdoor unit 100 (the section from point K12 to the cutoff valve VC1 in FIG. 1), and the reserve tank 130 is provided in the middle of the suction pipe Pi. Furthermore, one end of the third coupling pipe P3 (the end portion positioned in the place of point K11 in FIG. 1) branches from the discharge pipe Po.

[0073] Here, the outdoor unit 100 is also provided with an outdoor blower device 140 for delivering air to the outdoor heat exchanger 120.

[0074] Furthermore, the valve V 11 may be a motor-operated valve or an electromagnetic valve.

(Indoor Dehumidification and Heating Unit 200)

[0075] The indoor dehumidification and heating unit 200 is provided with a valve 21 (which corresponds to a first indoor-side refrigerant regulating device of the invention), a dehumidification heat exchanger 210 (which corresponds to a first heat exchanger of the invention), a valve V22 (which corresponds to a second indoor-side refrigerant regulating device of the invention), and a heating heat exchanger 220 (which corresponds to a second heat exchanger of the invention).

[0076] Specifically, the valve V21 and the dehumidification heat exchanger 210 are provided in the middle of a first indoor-side pipe P201 sequentially from one end (the end portion positioned in the place of point K20 in FIG. 1) of the first indoor-side pipe P201, the one end of the first indoor-side pipe P201 is coupled to a section of the first coupling pipe P1 positioned outside the outdoor unit 100, and another end (the end portion positioned in the place of point K21 in FIG. 1) of the first indoor-side pipe P201 is coupled to a section of the second coupling pipe P2 positioned outside the outdoor unit 100. Moreover, the valve V22 and the heating heat exchanger 220 are provided in the middle of a second indoor-side pipe P202 sequentially from one end (the end portion positioned in the place of point K22 in FIG. 1) of the second indoor-side pipe P202, the one end of the second indoor-side pipe P202 is coupled to the first indoor-side pipe P201 and is positioned between the valve V21 and the one end of the first indoor-side pipe P201, and another end (the end portion positioned in the place of point K23 in FIG. 1) of the second indoor-side pipe P202 is coupled to a section of the third coupling pipe P3 positioned outside the outdoor unit 100.

[0077] Furthermore, the indoor dehumidification and heating unit 200 is also provided with an indoor blower device 230 (which corresponds to a heat cycle device of the invention) for delivering the heat quantity or cold quantity of the indoor dehumidification and heating unit 200 to the room, and the dehumidification heat exchanger 210 and the heating heat exchanger 220 are provided in a flow path of an airflow formed by the indoor blower device 230. Here, the dehumidification heat exchanger 210 is provided on the upstream side of the heating heat exchanger 220 in the flow path of the airflow formed by the indoor blower device 230.

[0078] Furthermore, the valve V21 and the valve V22 may be motor-operated valves or electromagnetic valves.

(Refrigerant-Water Heat Exchange Unit 300)

[0079] The refrigerant-water heat exchange unit 300 is provided with a refrigerant pipe P301, a water circuit SH, and a refrigerant-water heat exchanger 310.

[0080] Specifically, one end (the end portion positioned in the place of point K30 in FIG. 1) of the refrigerant pipe P301 is coupled to the section of the first coupling pipe P1 positioned outside the outdoor unit 100, another end (the end portion positioned in the place of point K31 in FIG. 1) of the refrigerant pipe P301 is coupled to the section of the third coupling pipe P3 positioned outside the outdoor unit 100, the water circuit SH is configured by a water pipe P302, and the refrigerant-water heat exchanger 310 exchanges heat between refrigerant flowing in the refrigerant pipe P301 and water flowing in the water pipe P302.

[0081] Here, a valve V31 and a valve V32 can also be provided in the middle of the refrigerant pipe P301. The valve V31 (which corresponds to a refrigerant-water heat exchange unit-side refrigerant regulating device of the present invention) is provided between the one end (the end portion positioned in the place of point K30 in FIG. 1) of the refrigerant pipe P301 and the refrigerant-water heat exchanger 310, and the valve V32 is provided between the other end (the end portion positioned in the place of point K31 in FIG. 1) of the refrigerant pipe P301 and the refrigerant-water heat exchanger 310.

[0082] Furthermore, a motor-operated valve or an electromagnetic valve can be used for the valve 31 and an electromagnetic valve can be used for the valve V32, but the valve V31 and the valve V32 are not limited to this.

[0083] Furthermore, the air conditioning system of the present embodiment further includes a control unit (not shown in the drawings) for controlling the actions of parts such as the compressor 110, the outdoor blower device 140, the

indoor blower device 230, the valve V11, the valve V21, the valve V22, the valve V31, and the valve V32 of the air conditioning system 1.

[0084] Next, the operation of the air conditioning system 1 of the present embodiment will be described with reference to FIG. 1.

[0085] The air conditioning system 1 of the present embodiment can operate alternately between a hot water supply/dehumidification/heating mode and a dehumidification/heating-only mode.

(Hot Water Supply/Dehumidification/Heating Mode)

[0086] In the hot water supply/dehumidification/heating mode, the valve V11, the valve V21, the valve V22, the valve V31, and the valve V32 are opened by the control unit of the air conditioning system 1. At this time, in the refrigerant-water heat exchange unit 300, preferably it is ensured that the water in the water pipe P302 of the water circuit SH flows in the direction of the arrow in FIG. 1.

[0087] In this state, the refrigerant is compressed by the compressor 110 of the outdoor unit 100, and the refrigerant compressed in the compressor 110 and discharged to the discharge pipe Po branches at the place of point K11, with some of the refrigerant flowing into the first coupling pipe P1 and being carried to the outdoor heat exchanger 120 and with the rest of the refrigerant flowing into the third coupling pipe P3. The refrigerant that has flowed into the third coupling pipe P3 flows via the cutoff valve VC3 out from the outdoor unit 100 and further branches at the place of point K23, with some of the refrigerant flowing into the second indoor-side pipe P202 and being carried to the heating heat exchanger 220 of the indoor dehumidification and heating unit 200 and with the rest of the refrigerant flowing into the refrigerant pipe P301 at the place of point K31.

[0088] The refrigerant that has been carried to the outdoor heat exchanger 120 exchanges heat in the outdoor heat exchanger 120 with outdoor air delivered from the outdoor blower device 140 and then flows through the valve V 11. The refrigerant that has flowed through the valve V11 flows via the cutoff valve VC1 out from the outdoor unit 100.

[0089] The refrigerant that has flowed into the refrigerant pipe P301 flows through the valve V32, flows into the refrigerant-water heat exchanger 310, and exchanges heat in the refrigerant-water heat exchanger 310 with the water flowing in the water pipe P302 to thereby heat the water flowing in the water pipe P302 and provide hot water. The refrigerant that has exchanged heat in the refrigerant-water heat exchanger 310 with the water flowing in the water pipe P302 flows through the valve V31, then flows into the first coupling pipe P1 at the place of point K30, and merges at the place of point K20 with the refrigerant flowing out via the cutoff valve VC1 from the outdoor unit 100, and the merged flows of refrigerant together flow into the first indoor-side pipe P201.

[0090] In addition, the refrigerant that has been carried to the heating heat exchanger 220 of the indoor dehumidification and heating unit 200 exchanges heat in the heating heat exchanger 220 with room air delivered from the indoor blower device 230 to thereby heat the room air. The refrigerant that has exchanged heat in the heating heat exchanger 220 with the room air flows through the valve V22 and then merges at the place of point K22 with the flows of refrigerant that merged at the place of point K20 and flowed into the first indoor-side pipe P201.

[0091] The merged refrigerant flows through the valve V21 of the indoor dehumidification and heating unit 200 and is then carried to the dehumidification heat exchanger 210. The refrigerant that has been carried to the dehumidification heat exchanger 210 exchanges heat in the dehumidification heat exchanger 210 with room air delivered from the indoor blower device 230 to thereby dehumidify the room air. The refrigerant that has exchanged heat in the dehumidification heat exchanger 210 with the room air flows into the second coupling pipe P2 at the place of point K21, flows via the cutoff valve VC2 into the outdoor unit 100, then flows into the suction pipe Pi, and returns via the reserve tank 130 to the compressor 110.

(Dehumidification/Heating-Only Mode)

[0092] In the dehumidification/heating-only mode, the valve V11, the valve V21, and the valve V22 are opened and either one of or both the valve V31 and the valve V32 are closed by the control unit of the air conditioning system 1. At this time, in the refrigerant-water heat exchange unit 300, it is alright not to ensure that the water in the water circuit SH flows.

[0093] Here, other than the fact that the refrigerant does not flow in the refrigerant-water heat exchange unit 300, the way the refrigerant flows is identical to the way the refrigerant flows in the hot water supply/dehumidification/heating mode, so it will not be described in detail again here.

[0094] According to the air conditioning system 1 of the present embodiment, the air conditioning system 1 can operate in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, and in these two modes the dehumidification heat exchanger 210 of the indoor dehumidification and heating unit 200 can be utilized to dehumidify the room air delivered from the indoor blower device 230 and the heating heat exchanger 220 of the indoor dehumidification and heating unit 200 can be utilized to heat the room air delivered from the indoor blower device 230.

Consequently, compared to a structure where an electric heating unit is added downstream of the dehumidification heat exchanger in the airflow path formed by the indoor blower device, the air conditioning system 1 of the present embodiment can reduce energy consumption and can enhance the comfort experienced by persons in the room by ensuring that the temperature distribution of the air that the indoor dehumidification and heating unit supplies to the room does not become uneven. Furthermore, compared to a structure where the dehumidification heat exchanger and the heating heat exchanger that are connected to each other in series in the indoor refrigerant circuit are sequentially provided in the airflow path formed by the indoor blower device, the air conditioning system 1 of the present embodiment can, by causing both the dehumidification heat exchanger and the heating heat exchanger to fulfill sufficient roles, ensure that the dehumidification does not become insufficient and the heating quantity is not deficient.

[0095] Furthermore, waste heat utilization can be realized by using in the heating heat exchanger some of the waste heat that is discharged from the outdoor unit to the atmosphere anyway, so the energy consumption rate can be improved to realize energy conservation and environmental protection.

[0096] Furthermore, according to the air conditioning system 1 of the present embodiment, even when the system efficiency has dropped because of frosting of the outdoor unit 100, the air conditioning system 1 can perform a constant-temperature defrost operation in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, which is to say that because the heating heat exchanger 220 fulfills a heating action in the hot water supply/dehumidification/heating mode or the dehumidification/heating-only mode, cold air does not blow to the room even if the indoor blower device 230 continues to be operated, so constant-temperature defrosting can be realized.

[0097] Furthermore, according to the air conditioning system 1 of the present embodiment, the air conditioning system 1 includes the refrigerant-water heat exchange unit 300 including the refrigerant pipe P301, the water circuit SH configured by the water pipe P302, and the refrigerant-water heat exchanger 310 that exchanges heat between the refrigerant flowing in the refrigerant pipe P301 and the water flowing in the water pipe P302, so by utilizing the refrigerant carried from the outdoor unit 100 and flowing in the refrigerant pipe P301 to heat the water flowing in the water pipe P302 of the water circuit SH, the water circuit SH can be utilized to provide hot water.

[0098] Furthermore, according to the air conditioning system 1 of the present embodiment, the valve V32 is provided in the refrigerant pipe P301 of the refrigerant-water heat exchange unit 300, so even when the temperature of the refrigerant flowing from the third coupling pipe P3 to the refrigerant-water heat exchange unit 300 is too low, the control unit of the air conditioning system 1 can close the valve V32 to ensure that freezing does not occur as a result of the temperature of the refrigerant in the refrigerant pipe P301 being too low.

<Embodiment 2>

[0099] First, a circuit structure of an air conditioning system 1 A of embodiment 2 of the present invention will be described with reference to FIG. 2. In FIG. 2, parts identical to those in embodiment 1 are identified by identical reference signs.

[0100] Furthermore, the air conditioning system 1 A of embodiment 2 is structurally substantially identical to the air conditioning system 1 of embodiment 1, so mainly the differences with embodiment 1 will be described next.

[0101] In the present embodiment, an outdoor unit 100' includes a four-port switching valve VF1 (which corresponds to a first switching device of the present invention) that can switch between a first switching state and a second switching state. In the first switching state of the four-port switching valve VF1 the first coupling pipe P1 and the discharge pipe Po communicate with each other and the second coupling pipe P2 and the suction pipe Pi communicate with each other, and in the second switching state of the four-port switching valve VF1 the first coupling pipe P1 and the suction pipe Pi communicate with each other and the second coupling pipe P2 and the discharge pipe Po communicate with each other.

[0102] Specifically, as shown in FIG. 2, the four-port switching valve VF1 has a first port a, a second port b, a third port c, and a fourth port d. The first port a is coupled to the other end of the discharge pipe Po, the second port b is coupled to the one end of the second coupling pipe P2, the third port c is coupled to the other end of the suction pipe Pi, and the fourth port d is coupled to the one end of the first coupling pipe P1; in the first switching state of the four-port switching valve VF1 the first port a and the fourth port d communicate with each other and the second port b and the third port c communicate with each other, and in the second switching state of the four-port switching valve VF1 the first port a and the second port b communicate with each other and the third port c and the fourth port d communicate with each other.

[0103] Next, the operation of the air conditioning system 1 A of the present embodiment will be described with reference to FIG. 2.

[0104] The air conditioning system 1A of the present embodiment can switch operation between a hot water supply/dehumidification/heating mode, a dehumidification/heating-only mode, a heating/hot water supply mode, and a hot water supply-only mode. In the hot water supply/dehumidification/heating mode and the dehumidification/heating-only mode the four-port switching valve VF1 is switched to the first switching state, and in the heating/hot water supply mode and the hot water supply-only mode the four-port switching valve VF1 is switched to the second switching state.

[0105] Furthermore, the hot water supply/dehumidification/heating mode and the dehumidification/heating-only mode of the air conditioning system 1A of the present embodiment are respectively identical to the hot water supply/dehumidification/heating mode and the dehumidification/heating-only mode of the air conditioning system 1 of embodiment 1, so just the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode will be described next.

(Heating/Hot Water Supply Mode)

[0106] In the heating/hot water supply mode the four-port switching valve VF1 of the outdoor unit 100' is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 2) and the valve V11, the valve V21, the valve V22, the valve V31, and the valve V32 are opened by the control unit of the air conditioning system 1. At this time, in the refrigerant-water heat exchange unit 300, preferably it is ensured that the water in the water pipe P302 of the water circuit SH flows in the direction of the arrow in FIG. 1.

[0107] In this state, the refrigerant is compressed by the compressor 110 of the outdoor unit 100', and the refrigerant compressed in the compressor 110 and discharged to the discharge pipe Po branches at the place of point K11, with some of the refrigerant flowing into the third coupling pipe P3 and with the rest of the refrigerant flowing via the four-port switching valve VF1 into the second coupling pipe P2.

[0108] The refrigerant that has flowed into the third coupling pipe P3 flows via the cutoff valve VC3 out from the outdoor unit 100' and further branches at the place of point K23, with some of the refrigerant flowing into the second indoor-side pipe P202 and being carried to the heating heat exchanger 220 of the indoor dehumidification and heating unit 200 and with the rest of the refrigerant flowing into the refrigerant pipe P301.

[0109] Furthermore, the refrigerant that has flowed into the second coupling pipe P2 flows via the cutoff valve VC2 out from the outdoor unit 100', flows into the first indoor-side pipe P201 at the place of point K21, and is carried to the dehumidification heat exchanger 210 of the indoor dehumidification and heating unit 200. The refrigerant that has been carried to the dehumidification heat exchanger 210 exchanges heat in the dehumidification heat exchanger 210 with the room air delivered from the indoor blower device 230 to thereby heat the room air and then flows through the valve V21.

[0110] The refrigerant that has been carried to the heating heat exchanger 220 of the indoor dehumidification and heating unit 200 exchanges heat in the heating heat exchanger 220 with the room air delivered from the indoor blower device 230 to thereby heat the room air and then flows through the valve V22. The refrigerant that has flowed through the valve V22 and the refrigerant that has flowed through the valve V21 merge at the place of point K22 and then flow out from the indoor dehumidification and heating unit 200.

[0111] Furthermore, the refrigerant that has flowed into the refrigerant pipe P301 flows through the valve V32, flows into the refrigerant-water heat exchanger 310, and exchanges heat in the refrigerant-water heat exchanger 310 with the water flowing in the water pipe P302 to thereby heat the water flowing in the water pipe P302 and provide hot water. The refrigerant that has exchanged heat in the refrigerant-water heat exchanger 310 with the water flowing in the water pipe P302 flows through the valve V31, then flows into the first coupling pipe P1 at the place of point K30, and merges at the place of point K20 with the refrigerant flowing out from the indoor dehumidification and heating unit 200, and the merged flows of refrigerant together flow via the cutoff valve VC1 into the outdoor unit 100'.

[0112] The refrigerant that has flowed into the outdoor unit 100' flows through the valve V11, is then carried to the outdoor heat exchanger 120, and exchanges heat in the outdoor heat exchanger 120 with the outdoor air delivered from the outdoor blower device 140. The refrigerant that has exchanged heat in the outdoor heat exchanger 120 with the outdoor air flows via the four-port switching valve VF1 into the suction pipe Pi, and returns via the reserve tank 130 to the compressor 110.

(Hot Water Supply-Only Mode)

[0113] In the hot water supply-only mode the four-port switching valve VF1 of the outdoor unit 100' is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 2), the valve V11, the valve V31, and the valve V32 are opened, and the valve V21 and the valve V22 are partially opened by the control unit of the air conditioning system 1. At this time, in the refrigerant-water heat exchange unit 300, preferably it is ensured that the water in the water pipe P302 of the water circuit SH flows in the direction of the arrow in FIG. 1.

[0114] Here, other than the fact that the refrigerant does not flow in the indoor dehumidification and heating unit 200, the way the refrigerant flows is substantially identical to the way the refrigerant flows in the heating/hot water supply mode, so it will not be described in detail again here.

(Heating-Only Mode)

[0115] In the heating-only mode the four-port switching valve VF1 of the outdoor unit 100' is switched to the second

switching state (i.e., the state indicated by the solid lines in FIG. 2), the valve V11, the valve V21, and the valve V22 are opened, and the valve V31 is closed by the control unit of the air conditioning system 1, but here the valve V32 may be opened or may be closed. At this time, in the refrigerant-water heat exchange unit 300, it is alright not to ensure that the water in the water circuit SH flows.

[0116] Here, other than the fact that the refrigerant does not flow in the refrigerant-water heat exchange unit 300, the way the refrigerant flows is substantially identical to the way the refrigerant flows in the heating/hot water supply mode, so it will not be described in detail again here.

[0117] According to the air conditioning system 1A of the present embodiment, the air conditioning system 1A can operate in the hot water supply/dehumidification/heating mode, the dehumidification/heating-only mode, the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode.

[0118] Furthermore, according to the air conditioning system 1 A of the present embodiment, technical effects identical to those of embodiment 1 can also be achieved by switching the four-port switching valve VF1 of the outdoor unit 100' to the first switching state.

[0119] Furthermore, according to the air conditioning system 1A of the present embodiment, the four-port switching valve VF1 of the outdoor unit 100' can be switched to the second switching state to thereby cause both the dehumidification heat exchanger 210 and the heating heat exchanger 220 to fulfill roles as condensers to heat the room air. For this reason, overall efficiency can be enhanced.

<Embodiment 3>

[0120] First, a circuit structure of an air conditioning system 1B of embodiment 3 of the present invention will be described in detail with reference to FIG. 3. In FIG. 3, parts identical to those in embodiment 2 are identified by identical reference signs.

[0121] Furthermore, the air conditioning system 1B of embodiment 3 is structurally substantially identical to the air conditioning system 1 A of embodiment 2, so mainly the differences with embodiment 2 will be described next.

[0122] In the present embodiment, an outdoor unit 100" is provided with a first outdoor-side branching pipe P101 having one end (the end portion positioned in the place of point K13 in FIG. 3) coupled to the suction pipe Pi.

[0123] Moreover, the third coupling pipe P3 has a first section P3-1 (the section from point K11 in FIG. 3 to a port a1 of a four-port switching valve VF2 described below) and a second section P3-2 (the section from a port b1 of the four-port switching valve VF2 described below to point K31 in FIG. 3), with the first section P3-1 being coupled to the discharge pipe Po and with the second section P3-2 being coupled to the second indoor-side pipe P202.

[0124] Furthermore, the outdoor unit 100" further includes a four-port switching valve VF2 (which corresponds to a second switching device of the present invention) that can switch between a first switching state and a second switching state. In the first switching state of the four-port switching valve VF2 the second section P3-2 of the third coupling pipe P3 and the first section P3-1 of the third coupling pipe P3 communicate with each other, and in the second switching state of the four-port switching valve VF2 the second section P3-2 of the third coupling pipe P3 and another end of the first outdoor-side branching pipe P101 communicate with each other.

[0125] Specifically, the four-port switching valve VF2 has a first port a1, a second port b1, and a third port c1. The first port a1 is coupled to the first section P3-1 of the third coupling pipe P3, the second port b1 is coupled to the second section P3-2 of the third coupling pipe P3, and the third port c1 is coupled to the other end of the first outdoor-side branching pipe P101; in the first switching state of the four-port switching valve VF2 the first port a1 and the second port b1 communicate with each other, and in the second switching state of the four-port switching valve VF2 the second port b1 and the third port c1 communicate with each other.

[0126] Here, as shown in FIG. 3, the outdoor unit 100" is further provided with a second outdoor-side branching pipe P102 having one end (the end portion positioned in the place of point K14 in FIG. 3) coupled to the first outdoor-side branching pipe P101, and a throttling device T1 is provided in the middle of the second outdoor-side branching pipe P102. The four-port switching valve VF2 further has a fourth port d1 coupled to another end of the second outdoor-side branching pipe P102; in the first switching state of the four-port switching valve VF2 the first port a1 and the second port b1 communicate with each other and the third port c1 and the fourth port d1 communicate with each other, and in the second switching state of the four-port switching valve VF2 the second port b1 and the third port c1 communicate with each other and the first port a1 and the fourth port d1 communicate with each other. Furthermore, a capillary tube is suitable for the throttling device T1, whereby the throttling device T1 guides machine oil accumulating in the four-port switching valve VF2 to the circuit, separates and recovers the machine oil, and prevents the machine oil from accumulating in and damaging the four-port switching valve VF2.

[0127] Next, the operation of the air conditioning system 1B of the present embodiment will be described with reference to FIG. 3.

[0128] The air conditioning system 1 B of the present embodiment can switch operation between a hot water supply/dehumidification/heating mode, a dehumidification/heating-only mode, a heating/hot water supply mode, a hot water

supply-only mode, a heating-only mode, a cooling/cold water supply mode, a cooling-only mode, and a cold water supply-only mode. In the hot water supply/dehumidification/heating mode and the dehumidification/heating-only mode the four-port switching valve VF1 is switched to the first switching state and the four-port switching valve VF2 is switched to the first switching state, in the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode the four-port switching valve VF1 is switched to the second switching state and the four-port switching valve VF2 is switched to the first switching state, and in the cooling/cold water supply mode, the cooling-only mode, and the cold water supply-only mode the four-port switching valve VF1 is switched to the first switching state and the four-port switching valve VF2 is switched to the second switching state.

[0129] Furthermore, the hot water supply/dehumidification/heating mode, the dehumidification/heating-only mode, the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode of the air conditioning system 1B of the present embodiment are respectively identical to the hot water supply/dehumidification/heating mode, the dehumidification/heating-only mode, the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode of the air conditioning system 1A of embodiment 2, so just the cooling/cold water supply mode, the cooling-only mode, and the cold water supply-only mode will be described next. (Cooling/Cold Water Supply Mode)

[0130] In the cooling/cold water supply mode the four-port switching valve VF1 is switched to the first switching state (i.e., the state indicated by the solid lines in FIG. 3), the four-port switching valve VF2 is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 3), and the valve V11, the valve V21, the valve V22, the valve V31, and the valve V32 are opened by the control unit of the air conditioning system 1B. At this time, in the refrigerant-water heat exchange unit 300, preferably it is ensured that the water in the water pipe P302 of the water circuit SH flows in the direction of the arrow in FIG. 3.

[0131] In this state, the refrigerant is compressed by the compressor 110 of the outdoor unit 100", and the refrigerant compressed in the compressor 110 and discharged to the discharge pipe Po flows into the first coupling pipe P1 and is carried to the outdoor heat exchanger 120. The refrigerant that has been carried to the outdoor heat exchanger 120 exchanges heat in the outdoor heat exchanger 120 with the outdoor air delivered from the outdoor blower device 140 and then flows through the valve V11. The refrigerant that has flowed through the valve V11 flows via the cutoff valve VC1 out from the outdoor unit 100" and branches at the place of point K20, with some of the refrigerant flowing into the refrigerant pipe P301 of the refrigerant-water heat exchange unit 300 at the place of point K30 and with the rest of the refrigerant flowing into the first indoor-side pipe P201 of the indoor dehumidification and heating unit 200.

[0132] The refrigerant that has flowed into the refrigerant pipe P301 flows through the valve V31 and is carried to the refrigerant-water heat exchanger 310. The refrigerant that has been carried to the refrigerant-water heat exchanger 310 exchanges heat in the refrigerant-water heat exchanger 310 with the water flowing in the water pipe P302 of the water circuit SH to thereby cool the water in the water pipe P302 and utilize the water circuit SH to provide cold water. Thereafter, the refrigerant flows into the third coupling pipe P3 at the place of point K31.

[0133] The refrigerant that has flowed into the first indoor-side pipe P201 of the indoor dehumidification and heating unit 200 further branches at the place of point K22 in FIG. 3, with some of the refrigerant flowing through the valve V21 and being carried to the dehumidification heat exchanger 210 and with the rest of the refrigerant flowing through the valve V22 and being carried to the heating heat exchanger 220.

[0134] The refrigerant that has been carried to the dehumidification heat exchanger 210 exchanges heat in the dehumidification heat exchanger 210 with the room air delivered from the indoor blower device 230 to thereby cool the room air. The refrigerant that has exchanged heat in the dehumidification heat exchanger 210 with the room air flows into the second coupling pipe P2 at the place of point K21, then flows via the cutoff valve VC2 into the outdoor unit 100", and then flows via the four-port switching valve VF1 into the suction pipe Pi.

[0135] Furthermore, the refrigerant that has been carried to the heating heat exchanger 220 exchanges heat in the heating heat exchanger 220 with the room air delivered from the indoor blower device 230 to thereby cool the room air. The refrigerant that has exchanged heat in the heating heat exchanger 220 with the room air merges at the place of point K23 with the refrigerant that has flowed thereto from the place of point K31, and the merged refrigerant flows via the third cutoff valve VC3 into the outdoor unit 100". Then, the refrigerant flows via the four-port switching valve VF2 into the first outdoor-side branching pipe P101 and merges at the place of point K13 in FIG. 3 with the refrigerant that has flowed from the second coupling pipe P2 into the suction pipe Pi, and the merged refrigerant then returns via the reserve tank 130 to the compressor 110.

(Cooling-Only Mode)

[0136] In the cooling-only mode the four-port switching valve VF1 is switched to the first switching state (i.e., the state indicated by the solid lines in FIG. 3), the four-port switching valve VF2 is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 3), the valve V11, the valve V21, and the valve V22 are opened, and the valve V31 is closed by the control unit of the air conditioning system 1B, but here the valve V32 may be opened or closed. At this time, in the refrigerant-water heat exchange unit 300, it is alright not to ensure that the water in the water

circuit SH flows.

[0137] Here, other than the fact that the refrigerant does not flow in the refrigerant-water heat exchange unit 300, the way the refrigerant flows is substantially identical to the way the refrigerant flows in the cooling/cold water supply mode, so it will not be described in detail again here.

(Cold Water Supply-Only Mode)

[0138] In the cold water supply-only mode the four-port switching valve VF1 is switched to the first switching state (i.e., the state indicated by the solid lines in FIG. 3), the four-port switching valve VF2 is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 3), the valve V11, the valve V31, and the valve V32 are opened, and the valve V21 and the valve V22 are partially opened by the control unit of the air conditioning system 1B. At this time, in the refrigerant-water heat exchange unit 300, preferably it is ensured that the water in the water pipe P302 of the water circuit SH flows in the direction of the arrow in FIG. 3.

[0139] Here, other than the fact that the refrigerant does not flow in the indoor dehumidification and heating unit 200, the way the refrigerant flows is substantially identical to the way the refrigerant flows in the cooling/cold water supply mode, so it will not be described in detail again here.

[0140] Here, for convenience of understanding, the states (including the coupling state of each port of the four-port switching valves) of the four-port switching valve VF1, the four-port switching valve VF2, the valve P11, the valve V21, the valve V22, the valve V31, and the valve V32 in each mode of the air conditioning system 1 B of the present embodiment are shown in Table 1 below.

Table 1

	Four-Port Switching Valve VF1	Four-Port Switching Valve VF2	Valve V11	Valve V21	Valve V22	Valve V31	Valve V32
Hot Water Supply/ Dehumidification/ Heating Mode	First Switching State: a-d and b-c	First Switching State: a1-b1 and c1-d1	Open	Open	Open	Open	Open
Dehumidification/ Heating-Only Mode	First Switching State: a-d and b-c	First Switching State: a1-b1 and c1-d1	Open	Open	Open	Closed	Open/ Closed
Heating/Hot Water Supply Mode	Second Switching State: a-b and c-d	First Switching State: a1-b1 and c1-d1	Open	Open	Open	Open	Open
Hot Water Supply-Only Mode	Second Switching State: a-b and c-d	First Switching State: a1-b1 and c1-d1	Open	Partially Open	Partially Open	Open	Open
Heating-Only Mode	Second Switching State: a-b and c-d	First Switching State: a1-b1 and c1-d1	Open	Open	Open	Closed	Open/ Closed
Cooling/Cold Water Supply Mode	First Switching State: a-d and b-c	Second Switching State: a1-d1 and b1-c1	Open	Open	Open	Open	Open
Cooling-Only Mode	First Switching State: a-d and b-c	Second Switching State: a1-d1 and b1-c1	Open	Open	Open	Closed	Open/ Closed

(continued)

	Four-Port Switching Valve VF1	Four-Port Switching Valve VF2	Valve V11	Valve V21	Valve V22	Valve V31	Valve V32
Cold Water Supply-Only Mode	First Switching State: a-d and b-c	Second Switching State: a1-d1 and b1 to c1	Open	Partially Open	Partially Open	Open	Open

[0141] As a further note, in Table 1 above, the hot water supply/dehumidification/heating mode and the dehumidification/heating-only mode correspond to a second mode of the present invention, the heating/hot water supply mode, the hot water supply-only mode, and the heating-only mode correspond to a first mode of the present invention, and the cooling/cold water supply mode, the cooling-only mode, and the cold water supply-only mode correspond to a third mode of the present invention.

[0142] According to the air conditioning system 1B of the present embodiment, the air conditioning system 1B can operate in the hot water supply/dehumidification/heating mode, the dehumidification/heating-only mode, the heating/hot water supply mode, the hot water supply-only mode, the heating-only mode, the cooling/cold water supply mode, the cooling-only mode, and the cold water supply-only mode.

[0143] Furthermore, according to the air conditioning system 1B of the present embodiment, by switching the four-port switching valve VF2 to the first switching state, technical effects identical to those of embodiment 2 can also be achieved.

[0144] Furthermore, according to the air conditioning system 1B of the present embodiment, the four-port switching valve VF1 can be switched to the first switching state and the four-port switching valve VF2 can be switched to the second switching state to thereby cause both the dehumidification heat exchanger 210 and the heating heat exchanger 220 to fulfill roles as evaporators to cool the room air. For this reason, overall efficiency can be enhanced.

[0145] Furthermore, according to the air conditioning system 1B of the present embodiment, even when the system efficiency has dropped because of frosting of the outdoor unit 100", the air conditioning system 1B can perform a routine defrost operation in the cooling-only mode. At this time, preferably the operation of the indoor blower device 230 is stopped so that the drop in the room temperature does not affect the comfort experienced by persons in the room, but the indoor blower device 230 is not limited to this and can also be operated at a low speed to provide a weak airflow to the room. In this connection, compared to the constant-temperature defrost operation mentioned in embodiment 1, the defrost speed of the routine defrost operation performed in the cooling-only mode is faster.

<Embodiment 4>

[0146] Next, an air conditioning system 1C of embodiment 4 of the present invention will be described with reference to FIG. 4. In FIG. 4, parts identical to those in embodiment 3 are identified by identical reference signs.

[0147] Furthermore, the air conditioning system 1C of embodiment 4 is structurally substantially identical to the air conditioning system 1B of embodiment 3, so mainly the differences with embodiment 3 will be described next.

[0148] In the present embodiment, as shown in FIG. 4, the air conditioning system 1C is based on the air conditioning system 1B of embodiment 3 and further includes an indoor unit 400A and an indoor unit 400B that include an indoor unit-side refrigerant pipe P401A and an indoor unit-side refrigerant pipe P401B, one ends (the end portions positioned in the places of point K40A and point K40B in FIG. 4) of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B are coupled to the section of the first coupling pipe P1 positioned outside the outdoor unit 100, other ends (the end portions positioned in the places of point K41A and point K41B in FIG. 4) of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B are coupled to the section of the second coupling pipe P2 positioned outside the outdoor unit 100, and a valve V41A and a valve V41 B (which correspond to an indoor unit-side refrigerant regulating device of the present invention) and an indoor unit-side heat exchanger 410A and an indoor unit-side heat exchanger 410B are provided in the middle of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B sequentially from the one ends of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B.

[0149] According to the air conditioning system 1C of the present embodiment, technical effects substantially identical to those of the air conditioning system 1B of embodiment 3 can be achieved.

[0150] Furthermore, according to the air conditioning system 1C of the present embodiment, by switching the four-port switching valve VF1 to the first switching state (i.e., the state indicated by the solid lines in FIG. 4), the indoor unit 400A and the indoor unit 400B can perform the cooling operation, and by switching the four-port switching valve VF1 to

the second switching state (i.e., the state indicated by the dashed lines in FIG. 4), the indoor unit 400A and the indoor unit 400B can perform the heating operation.

<Embodiment 5>

[0151] Next, an air conditioning system 1D of embodiment 5 of the present invention will be described with reference to FIG. 5. In FIG. 5, parts identical to those in embodiment 4 are identified by identical reference signs.

[0152] Furthermore, the air conditioning system 1D of embodiment 5 is structurally substantially identical to the air conditioning system 1C of embodiment 4, so mainly the differences with embodiment 4 will be described next.

[0153] In the present embodiment, as shown in FIG. 5, the air conditioning system 1D includes an outdoor unit 100A corresponding to the outdoor unit 100" of embodiment 4 and further includes an outdoor unit 100B whose structure is identical to that of the outdoor unit 100A, and the outdoor unit 100A and the outdoor unit 100B are coupled in parallel to each other utilizing the first coupling pipe P1, the second coupling pipe P2, and the third coupling pipe P3.

[0154] Specifically, an outdoor unit coupling pipe span P1A and an outdoor unit coupling pipe span P1B of the first coupling pipe P1 that are coupled to the outdoor unit 100A and the outdoor unit 100B merge with a total coupling pipe span P1T of the first coupling pipe P1 outside the outdoor unit 100A and the outdoor unit 100B; the one end (the end portion positioned in the place of point K20 in FIG. 5) of the first indoor-side pipe P201, the one end (the end portion positioned in the place of point K30 in FIG. 5) of the refrigerant pipe P310 of the refrigerant-water heat exchange unit 300, and the one ends (the end portions positioned in the places of point K40A and point K40B in FIG. 5) of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B are coupled to the total coupling pipe span P1T of the first coupling pipe P1; an outdoor unit coupling pipe span P2A and an outdoor unit coupling pipe span P2B of the second coupling pipe P2 that are coupled to the outdoor unit 100A and the outdoor unit 100B merge with a total coupling pipe span P2T of the second coupling pipe P2 outside the outdoor unit 100A and the outdoor unit 100B; the other end (the end portion positioned in the place of point K21 in FIG. 5) of the first indoor-side pipe P201 and the other ends (the end portions positioned in the places of point K41A and point K41B in FIG. 5) of the indoor unit-side refrigerant pipe P401A and the indoor unit-side refrigerant pipe P401B are coupled to the total coupling pipe span P2T of the second coupling pipe P2; an outdoor unit coupling pipe span P3A and an outdoor unit coupling pipe span P3B of the third coupling pipe P3 that are coupled to the outdoor unit 100A and the outdoor unit 100B merge with a total coupling pipe span P3T of the third coupling pipe P3 outside the outdoor unit 100A and the outdoor unit 100B; and the other end (the end portion positioned in the place of point K23 in FIG. 5) of the second indoor-side pipe P202 and the other end (the end portion positioned in the place of point K31 in FIG. 5) of the refrigerant pipe P310 are coupled to the total coupling pipe span P3T of the third coupling pipe P3.

[0155] According to the air conditioning system 1D of the present embodiment, technical effects substantially identical to those of the air conditioning system 1C of embodiment 4 can be achieved.

[0156] Furthermore, according to the air conditioning system 1D of the present embodiment, even in a case where capacity is deficient when just one outdoor unit among the outdoor unit 100A and the outdoor unit 100B is started up, refrigerant of a suitable temperature, a suitable quantity, and a suitable pressure can be supplied to, for example, the indoor dehumidification and heating unit 200 and the refrigerant-water heat exchange unit 300 by simultaneously starting up the outdoor unit 100A and the outdoor unit 100B.

<Other Embodiments>

[0157] Specific embodiments of the present invention have been described above, but the specific embodiments are not intended to limit the present invention, and it should be understood by persons skilled in the art of this field that various modifications can be made without going beyond the scope of the present invention based on the content disclosed above.

[0158] For example, in embodiment 1, as shown in FIG. 6, a sub-cooling circuit including a sub-cooling pipe P106, a valve V12 (which corresponds to a refrigerant regulating device of the present invention), and a sub-cooler 150 can also be provided in the outdoor unit 100. One end (the end portion positioned in the place of point K16 in FIG. 6) of the sub-cooling pipe P106 is coupled to the first coupling pipe P1 in a position located on the side of the outdoor heat exchanger 120 corresponding to another end of the first coupling pipe P1, another end (the end portion positioned in the place of point K15 in FIG. 6) of the sub-cooling pipe P106 is coupled to the suction pipe Pi, the valve V12 is provided in the middle of the sub-cooling pipe P106, and the sub-cooler 150 exchanges heat between the refrigerant flowing in the first coupling pipe P1 and the refrigerant that has flowed through the valve V12 in the sub-cooling pipe P106.

[0159] According to this structure, the sub-cooler 150 can be utilized to cool the refrigerant flowing in the first outdoor-side branching pipe P101, whereby the capacity to dehumidify the room air delivered from the indoor blower device 230 utilizing the dehumidification heat exchanger 210 of the indoor dehumidification and heating unit 200 can be enhanced.

[0160] In the same way, a sub-cooling circuit such as shown in FIG. 6 can also be provided in embodiment 2 to

embodiment 5.

[0161] Furthermore, in embodiment 2, as shown in FIG. 7, a valve V13 (which corresponds to a refrigerant control valve of the present invention) can also be provided in the middle of the second coupling pipe P2 (the section between the one end of the second coupling pipe P2 and the cutoff valve VC2 in FIG. 7, but it is not limited to this). Here, any one type among a motor-operated valve, an electromagnetic valve, or a pilot valve can be used as the valve V 13.

[0162] According to this structure, when the four-port switching valve VF1 is switched to the second switching state (i.e., the state indicated by the solid lines in FIG. 7), and the valve V11, the valve V31, and the valve V32 are opened, and the valve V21 and the valve V22 are partially opened to switch to the hot water supply-only mode, as shown in FIG. 7, the refrigerant accumulating in the indoor dehumidification and heating unit 200 can be effectively reduced, whereby the refrigerant flowing in the refrigerant-water heat exchange unit 300 can be increased, so that the heating capacity of the refrigerant with respect to the water in the refrigerant-water heat exchange unit 300 can be enhanced.

[0163] In the same way, the valve V 13 shown in FIG. 7 can also be provided in embodiment 3 to embodiment 5.

[0164] Furthermore, in embodiment 3, the one end of the first outdoor-side branching pipe P201 is coupled to the suction pipe Pi, but it is not limited to this; as shown in FIG. 8, the one end of the first outdoor-side branching pipe P101 can also be coupled to the reserve tank 130. In the same way, the coupling configuration of the first outdoor-side branching pipe P101 such as shown in FIG. 8 can also be used in embodiment 4 and embodiment 5.

[0165] Furthermore, in embodiment 1 to embodiment 5, as shown in FIG. 9, a floor heating water circuit 500, a water tank SX, and a fan coil unit 700 can also be connected to the water circuit SH of the refrigerant-water heat exchange unit 300. Here, the water pipe P302 includes a main pipeline P3021 and a branching pipeline P3022 that is connected via a three-port valve VC4 to the main pipeline P3021. The floor heating water circuit 500 includes a floor heating water pipe P501 both ends of which are connected to the main pipeline P3021 of the water pipe P302. The branching pipeline P3022 runs through the water tank SX, which is provided with a water suction pipe P601 and a domestic water pipe P602 that is connected to a terminal end 610 of domestic water such as a faucet or a shower head. The fan coil unit 700 includes a coil circuit water pipe P701 both ends of which are connected to the main pipeline P3021 of the water pipe P302. Furthermore, here a case is shown where the floor heating water circuit 500 includes only one floor heating water pipe P501, but the floor heating water circuit 500 is not limited to this and may also include plural floor heating water pipes P501 connected in parallel. In the same way, here a case is shown where the fan coil unit 700 includes only one coil circuit water pipe P701, but the fan coil unit 700 is not limited to this and may also include plural coil circuit water pipes P701 connected in parallel. Of course, in the structure shown in FIG. 9, just an arbitrary one or two among the floor heating water circuit 500, the water tank SX (together with the water suction pipe P601, the domestic water pipe P602, and the terminal end 610 of domestic water), and the fan coil unit 700 may also be connected to the water circuit SH of the refrigerant-water heat exchange unit 300.

[0166] Furthermore, in embodiment 1 to embodiment 5, the dehumidification heat exchanger 210 is provided on the upstream side of the heating heat exchanger 220 in the flow path of the air formed by the indoor blower device 230, so that the air is first heated and is then dehumidified, but the dehumidification heat exchanger is not limited to this and may also be provided on the downstream side of the heating heat exchanger in the flow path of the air formed by the indoor blower device, so that the air is first heated and is then dehumidified. In addition, the dehumidification heat exchanger and the heating heat exchanger can also be provided side by side in the flow path of the air formed by the indoor blower device, so that some of the air is dehumidified and some of the air is heated. Furthermore, the dehumidification heat exchanger and the heating heat exchanger are not limited to being disposed in the flow path of the air formed by the indoor blower device, and, for example, a water circulation device can also be utilized to perform heat exchange; specifically, a water circulation pipe that exchanges heat with either one of or both the dehumidification heat exchanger and the heating heat exchanger may be provided around either one of or both the dehumidification heat exchanger and the heating heat exchanger to thereby deliver a heat quantity or a cold quantity to the room via circulating water that circulates and flows in the pipe.

[0167] Furthermore, in embodiment 1 to embodiment 5, the outdoor unit 100 includes the valve V11, but the outdoor unit 100 is not limited to this and the valve V11 may also be omitted.

[0168] Furthermore, in embodiment 1 to embodiment 5, the refrigerant-water heat exchange unit 300 includes the valve V32, but the refrigerant-water heat exchange unit 300 is not limited to this and the valve V32 may also be omitted.

[0169] Furthermore, in embodiment 3 to embodiment 5, in addition to a capillary tube a motor-operated valve or an electromagnetic valve may also be used as the throttling device T1.

[0170] Furthermore, in embodiment 3 to embodiment 5, if the four-port switching valve VF2 serving as the second switching device is provided in the outdoor unit of the air conditioning system, this is useful for making compact and miniaturizing the structure of the air conditioning system, but the four-port switching valve VF2 is not limited to this and may also be provided in the indoor dehumidification and heating unit or may also be provided between the outdoor unit and the indoor dehumidification and heating unit.

[0171] Furthermore, in embodiment 3 to embodiment 5, the four-port switching valve VF2 is used as the second switching device, but the second switching device is not limited to this and a three-port valve may also be utilized instead

of the four-port switching valve VF2. In this case, the second outdoor-side branching pipe P102 and the throttling device T1 in embodiment 3 to embodiment 5 are removed, and it suffices to couple the three-port valve in such a way that it can switch between a state in which the second section P3-2 of the third coupling pipe P3 and the first section P3-1 of the third coupling pipe P3 communicate with each other and a state in which the second section P3-2 of the third coupling pipe P3 and the other end of the first outdoor-side branching pipe P101 communicate with each other.

[0172] Furthermore, in embodiment 4 and embodiment 5, two indoor units comprising the indoor unit 400A and the indoor unit 400B are coupled in parallel to each other by the first coupling pipe P1 and the second coupling pipe P2, but embodiment 4 and embodiment 5 are not limited to this; just one indoor unit may also be connected by the first coupling pipe P1 and the second coupling pipe P2, or three or more indoor units may also be connected in parallel.

[0173] Furthermore, in embodiment 4 and embodiment 5, the indoor unit 400A and the indoor unit 400B have identical structures, but the structures of the indoor unit 400A and the indoor unit 400B are not limited to this and may also be different.

[0174] Furthermore, embodiment 5 includes two indoor units comprising the outdoor unit 100A and the outdoor unit 100B, but embodiment 5 is not limited to this and may also include three or more outdoor units.

[0175] Furthermore, in embodiment 5, the outdoor unit 100A and the outdoor unit 100B have identical structures, but the structures of the outdoor unit 100A and the outdoor unit 100B are not limited to this and may also be different.

[0176] Furthermore, in embodiment 1 to embodiment 5, the reserve tank 130 is provided in the middle of the suction pipe Pi, but embodiment 1 to embodiment 5 are not limited to this and the reserve tank 130 may also be omitted.

[0177] Furthermore, although it is not shown in the drawings, in embodiment 1 to embodiment 5, a branching pipe part such as a Y-connector, for example, may also be used for branching pipes in the circuit, or pipes may be used as is, have holes bored in them, and be welded together.

[0178] Furthermore, the structures shown in FIG. 1 to FIG. 9 can also be combined with each other provided they are not incompatible with each other, and some constituent parts thereof can also be removed therefrom.

REFERENCE SIGNS LIST

(Embodiment 1)

[0179]

1 Air Conditioning System
100 Outdoor Unit
110 Compressor
120 Outdoor Heat Exchanger
130 Reserve Tank (Reservoir Device)
140 Outdoor Blower Device
V11 Valve
Po Discharge Pipe
Pi Suction Pipe
K10 to K12 Points
200 Indoor Dehumidification and Heating Unit
210 First Indoor-side Heat Exchanger
V21 First Indoor-side Refrigerant Regulating Device
220 Second Indoor-side Heat Exchanger
V22 Second Indoor-side Refrigerant Regulating Device
230 Indoor Blower Device (Heat Cycle Device)
P201 First Indoor-side Pipe
P202 Second Indoor-side Pipe
K20 to K23 Points
300 Refrigerant-water Heat Exchange Unit
P301 Refrigerant Pipe
P302 Water Pipe
310 Refrigerant-water Heat Exchanger
SH Water Circuit
V31 Valve (Refrigerant-water Heat Exchange Unit-side Refrigerant Regulating Device)
V32 Valve
K30, K31 Points
P1 First Coupling Pipe

P2 Second Coupling Pipe
P3 Third Coupling Pipe
VC1 Cutoff Valve
VC2 Cutoff Valve
VC3 Cutoff Valve

(Embodiment 2)

[0180]

1A Air Conditioning System
100' Outdoor Unit
VF1 Four-port Switching Valve (First Switching Device)
a First Port
b Second Port
c Third Port
d Fourth Port

(Embodiment 3)

[0181]

1 B Air Conditioning System
100" Outdoor Unit
VF2 Four-port Switching Valve (Second Switching Device)
a1 First Port
b1 Second Port
c1 Third Port
d1 Fourth Port
P101 First Outdoor-side Branching Pipe
P102 Second Outdoor-side Branching Pipe
P3-1 First Section of Third Coupling Pipe
P3-2 Second Section of Third Coupling Pipe
T1 Throttling Device
K13, K14 Points

(Embodiment 4)

[0182]

1C Air Conditioning System
400A Indoor Unit
400B Indoor Unit
P401A Indoor Unit-side Refrigerant Pipe
P401B Indoor Unit-side Refrigerant Pipe
V41 A Indoor Unit-side Refrigerant Regulating Device
V41B Indoor Unit-side Refrigerant Regulating Device
410A Indoor Unit-side Heat Exchanger
410B Indoor Unit-side Heat Exchanger
K40A, K41A Points
K40B, K41B Points

(Embodiment 5)

[0183]

1D Air Conditioning System
100A Outdoor Unit

100B Outdoor Unit
P1A to P3A Outdoor Unit Coupling Pipe Spans
P1B to P3B Outdoor Unit Coupling Pipe Spans
P1T to P3T Total Coupling Pipe Spans

(Other Embodiments)

[0184]

P106 Sub-cooling Pipe
150 Sub-cooler
V12 Valve (Refrigerant Regulating Device)
K15, K16 Points
V13 Valve (Refrigerant Control Valve)
P3021 Main Pipeline
P3022 Branching Pipeline
VC4 Three-port Valve
500 Floor Heating Water Circuit
P501 Floor Heating Water Pipe
610 Terminal End of Domestic Water
SX Water Tank
P601 Water Suction Pipe
P602 Domestic Water Pipe
700 Fan Coil Unit
P701 Coil Circuit Water Pipe

CITATION LIST

<Patent Literature>

[0185] Patent Document 1: CN1590890A

Claims

1. An air conditioning system (1, 1A, 1B, 1C, 1D) equipped with an outdoor unit (100, 100', 100", 100A, 100B) and an indoor dehumidification and heating unit (200) that are coupled to each other via coupling pipes (P1, P2, P3),
in the outdoor unit (100, 100', 100", 100A, 100B) a discharge side of a compressor (110) is coupled to one end of a discharge pipe (Po), another end of the discharge pipe (Po) is coupled to one end of a first coupling pipe (P1) of the coupling pipes (P1, P2, P3), a suction side of the compressor (110) is coupled to one end of a suction pipe (Pi), another end of the suction pipe (Pi) is coupled to one end of a second coupling pipe (P2) of the coupling pipes (P1, P2, P3), and an outdoor heat exchanger (120) is provided in a section of the first coupling pipe (P1) positioned inside the outdoor unit (100, 100', 100", 100A, 100B),
in the indoor dehumidification and heating unit (200) a first indoor-side refrigerant regulating device (V21) and a first heat exchanger (210) are provided in a first indoor-side pipe (P201) sequentially from one end (K20) of the first indoor-side pipe (P201), the one end of the first indoor-side pipe (P201) is coupled to a section of the first coupling pipe (P1) positioned outside the outdoor unit (100, 100', 100", 100A, 100B), and another end of the first indoor-side pipe (P201) is coupled to a section of the second coupling pipe (P2) positioned outside the outdoor unit (100, 100', 100", 100A, 100B), and
in the indoor dehumidification and heating unit (200) a heat cycle device (230) for delivering a heat quantity or a cold quantity of the indoor dehumidification and heating unit to a room is also provided,
wherein
the coupling pipes (P1, P2, P3) further include a third coupling pipe (P3) having one end coupled to the discharge pipe (Po),
in the indoor dehumidification and heating unit (200) a second indoor-side refrigerant regulating device (V22) and a second heat exchanger (220) are provided in a second indoor-side pipe (P202) sequentially from one end of the second indoor-side pipe (P202), the one end of the second indoor-side pipe (P202) is coupled to the first indoor-side pipe (P201) and is positioned between the first indoor-side refrigerant regulating device (V21) and the one end

of the first indoor-side pipe (P201), and another end of the second indoor-side pipe (P202) is coupled to a section of the third coupling pipe (P3) positioned outside the outdoor unit (100, 100', 100", 100A, 100B), and
the air conditioning system (1, 1A, 1B, 1C, 1D) further includes a refrigerant-water heat exchange unit (300) including a refrigerant pipe (P301), a water circuit (SH) configured by a water pipe (P302), and a refrigerant-water heat exchanger (310) that exchanges heat between refrigerant flowing in the refrigerant pipe (P301) and water flowing in the water pipe (P302), with one end of the refrigerant pipe (P301) being coupled to the section of the first coupling pipe (P1) positioned outside the outdoor unit (100, 100', 100", 100A, 100B) and with another end of the refrigerant pipe (P301) being coupled to the section of the third coupling pipe (P3) positioned outside the outdoor unit (100, 100', 100", 100A, 100B).

2. The air conditioning system (1A, 1B, 1C, 1D) according to claim 1, wherein the outdoor unit (100', 100", 100A, 100B) further includes a first switching device (VF1) that can switch between a first switching state and a second switching state, in the first switching state of the first switching device (VF1) the first coupling pipe (P1) and the discharge pipe (Po) communicate with each other and the second coupling pipe (P2) and the suction pipe (Pi) communicate with each other, and in the second switching state of the first switching device (VF1) the first coupling pipe (P1) and the suction pipe (Pi) communicate with each other and the second coupling pipe (P2) and the discharge pipe (Po) communicate with each other.

3. The air conditioning system (1B, 1C, 1D) according to claim 2, wherein
the outdoor unit (100", 100A, 100B) is further provided with a first outdoor-side branching pipe (P101) having one end coupled to the suction pipe (Pi),
the third coupling pipe (P3) has a first section (P3-1) and a second section (P3-2), with the first section (P3-1) being coupled to the discharge pipe (Po) and with the second section (P3-2) being coupled to the second indoor-side pipe (P202), and
the air conditioning system (1B, 1C, 1D) further includes a second switching device (VF2) that can switch between a first switching state and a second switching state, in the first switching state of the second switching device (VF2) the second section (P3-2) of the third coupling pipe (P3) and the first section (P3-1) of the third coupling pipe (P3) communicate with each other, and in the second switching state of the second switching device (VF2) the second section (P3-2) of the third coupling pipe (P3) and another end of the first outdoor-side branching pipe (P101) communicate with each other.

4. The air conditioning system (1A, 1B, 1C, 1D) according to claim 2, wherein the first switching device (VF1) is a four-port valve.

5. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 1 or 2, wherein the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are motor-operated valves or electromagnetic valves.

6. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 1 or 2, wherein the heat cycle device is an indoor blower device (230), and the first heat exchanger (210) and the second heat exchanger (220) are provided in a flow path of an airflow formed by the indoor blower device (230).

7. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 6, wherein
the first heat exchanger (210) is provided on an upstream side or a downstream side of the second heat exchanger (220) in the flow path
or
the first heat exchanger (210) and the second heat exchanger (220) are provided side by side in the flow path.

8. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 1 or 2, wherein a reservoir device (130) is provided in the suction pipe (Pi).

9. The air conditioning system according to claim 1 or 2, wherein the air conditioning system further includes a floor heating water circuit (500) connected to the water circuit (SH).

10. The air conditioning system according to claim 9, wherein
the air conditioning system further includes a water tank (SX) provided with a domestic water pipe (P602) connected to a terminal end (610) of domestic water, and
the water pipe (P302) configuring the water circuit (SH) runs through the water tank.

11. The air conditioning system according to claim 10, wherein there is an electric heating device in the water tank (SX).

12. The air conditioning system according to claim 9, wherein the air conditioning system further includes a fan coil unit (700) connected to the water circuit (SH).

13. The air conditioning system according to claim 1 or 2, wherein
the outdoor unit further includes a sub-cooling pipe (P106), a refrigerant regulating device (V12), and a sub-cooler (150),
one end (K16) of the sub-cooling pipe (P106) is coupled to the first coupling pipe (P1) in a position located on the side of the outdoor heat exchanger (120) corresponding to another end of the first coupling pipe (P1), and another end of the sub-cooling pipe (P106) is coupled to the suction pipe (Pi),
the refrigerant regulating device (V12) is provided in the sub-cooling pipe (P106), and
the sub-cooler (150) exchanges heat between refrigerant flowing in the first coupling pipe (P1) and refrigerant that has flowed through the refrigerant regulating device (V12) in the sub-cooling pipe (P106).

14. The air conditioning system (1C, 1D) according to claim 1 or 2, wherein the air conditioning system (1C, 1D) further includes at least one indoor unit (400A, 400B), the indoor unit (400A, 400B) includes an indoor unit-side refrigerant pipe (P401 A, P401B), one end of the indoor unit-side refrigerant pipe (P401 A, P401B) is coupled to the section of the first coupling pipe (P1) positioned outside the outdoor unit (100", 100A, 100B), another end of the indoor unit-side refrigerant pipe is coupled to the section of the second coupling pipe (P2) positioned outside the outdoor unit (100", 100A, 100B), and an indoor unit-side refrigerant regulating device (V41A, V41B) and an indoor unit-side heat exchanger (410A, 410B) are provided in the indoor unit-side refrigerant pipe (P401A, P401B) sequentially from the one end of the indoor unit-side refrigerant pipe.

15. The air conditioning system (1D) according to claim 1 or 2, wherein
the air conditioning system (1D) includes a plurality of the outdoor units (100A, 100B),
outdoor unit coupling pipe spans (P1A, P1B) of the first coupling pipe (P1) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P1T) of the first coupling pipe (P1) outside the outdoor units (100A, 100B), the one end (K20) of the first indoor-side pipe (P201) and the one end (K30) of the refrigerant pipe (P310) of the refrigerant-water heat exchange unit (300) are coupled to the total coupling pipe span (P1T) of the first coupling pipe (P1),
outdoor unit coupling pipe spans (P2A, P2B) of the second coupling pipe (P2) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P2T) of the second coupling pipe (P2) outside the outdoor units (100A, 100B), the other end (K21) of the first indoor-side pipe (P201) is coupled to the total coupling pipe span (P2T) of the second coupling pipe (P2), and
outdoor unit coupling pipe spans (P3A, P3B) of the third coupling pipe (P3) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P3T) of the third coupling pipe (P3) outside the outdoor units (100A, 100B), and the other end (K23) of the second indoor-side pipe (P202) and the other end (K31) of the refrigerant pipe (P310) are coupled to the total coupling pipe span (P3T) of the third coupling pipe (P3).

16. The air conditioning system (1B, 1C, 1D) according to claim 3, wherein the second switching device (VF2) is provided in the outdoor unit (100", 100A, 100B).

17. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 3, wherein the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are motor-operated valves or electromagnetic valves.

18. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 3, wherein the heat cycle device is an indoor blower device (230), and the first heat exchanger (210) and the second heat exchanger (220) are provided in a flow path of an airflow formed by the indoor blower device (230).

19. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 18, wherein
the first heat exchanger (210) is provided on an upstream side or a downstream side of the second heat exchanger (220) in the flow path
or
the first heat exchanger (210) and the second heat exchanger (220) are provided side by side in the flow path.

20. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 3, wherein a reservoir device (130) is provided

in the suction pipe (Pi).

21. The air conditioning system according to claim 3, wherein the air conditioning system further includes a floor heating water circuit (500) connected to the water circuit (SH).

22. The air conditioning system according to claim 21, wherein
the air conditioning system further includes a water tank (SX) provided with a domestic water pipe (P602) connected to a terminal end (610) of domestic water, and
the water pipe (P302) configuring the water circuit (SH) runs through the water tank.

23. The air conditioning system according to claim 22, wherein there is an electric heating device in the water tank (SX).

24. The air conditioning system according to claim 21, wherein the air conditioning system further includes a fan coil unit (700) connected to the water circuit (SH).

25. The air conditioning system according to claim 3, wherein
the outdoor unit further includes a sub-cooling pipe (P106), a refrigerant regulating device (V12), and a sub-cooler (150),
one end (K16) of the sub-cooling pipe (P106) is coupled to the first coupling pipe (P1) in a position located on the side of the outdoor heat exchanger (120) corresponding to another end of the first coupling pipe (P1), and another end of the sub-cooling pipe (P106) is coupled to the suction pipe (Pi),
the refrigerant regulating device (V12) is provided in the sub-cooling pipe (P106), and
the sub-cooler (150) exchanges heat between refrigerant flowing in the first coupling pipe (P1) and refrigerant that has flowed through the refrigerant regulating device (V12) in the sub-cooling pipe (P106).

26. The air conditioning system (1C, 1D) according to any one of claims 16 to 25, wherein the air conditioning system (1C, 1D) further includes at least one indoor unit (400A, 400B), the indoor unit (400A, 400B) includes an indoor unit-side refrigerant pipe (P401 A, P401B), one end of the indoor unit-side refrigerant pipe (P401A, P401B) is coupled to the section of the first coupling pipe (P1) positioned outside the outdoor unit (100", 100A, 100B), another end of the indoor unit-side refrigerant pipe is coupled to the section of the second coupling pipe (P2) positioned outside the outdoor unit (100", 100A, 100B), and an indoor unit-side refrigerant regulating device (V41A, V41B) and an indoor unit-side heat exchanger (410A, 410B) are provided in the indoor unit-side refrigerant pipe (P401A, P401B) sequentially from the one end of the indoor unit-side refrigerant pipe.

27. The air conditioning system (1D) according to any one of claims 16 to 25, wherein
the air conditioning system (1D) includes a plurality of the outdoor units (100A, 100B),
outdoor unit coupling pipe spans (P1A, P1B) of the first coupling pipe (P1) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P1T) of the first coupling pipe (P1) outside the outdoor units (100A, 100B), the one end (K20) of the first indoor-side pipe (P201) and the one end (K30) of the refrigerant pipe (P310) of the refrigerant-water heat exchange unit (300) are coupled to the total coupling pipe span (P1T) of the first coupling pipe (P1),
outdoor unit coupling pipe spans (P2A, P2B) of the second coupling pipe (P2) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P2T) of the second coupling pipe (P2) outside the outdoor units (100A, 100B), the other end (K21) of the first indoor-side pipe (P201) is coupled to the total coupling pipe span (P2T) of the second coupling pipe (P2), and
outdoor unit coupling pipe spans (P3A, P3B) of the third coupling pipe (P3) that are coupled to the plural outdoor units (100A, 100B) merge with a total coupling pipe span (P3T) of the third coupling pipe (P3) outside the outdoor units (100A, 100B), and the other end (K23) of the second indoor-side pipe (P202) and the other end (K31) of the refrigerant pipe (P310) are coupled to the total coupling pipe span (P3T) of the third coupling pipe (P3).

28. The air conditioning system (1, 1A, 1B, 1C, 1D) according to any one of claims 1, 2, and 16 to 25, wherein a refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is provided between the one end of the refrigerant pipe (P301) and the refrigerant-water heat exchanger (310).

29. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 28, wherein the refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is a motor-operated valve or an electromagnetic valve.

30. The air conditioning system (1, 1A, 1B, 1C, 1D) according to claim 28 or 29, wherein an electromagnetic valve (V32)

is provided between the other end of the refrigerant pipe (P301) and the refrigerant-water heat exchanger (310).

31. The air conditioning system according to any one of claims 2 and 16 to 25, wherein a refrigerant control valve (V13) is provided in the second coupling pipe (P2).

32. The air conditioning system according to claim 31, wherein the refrigerant control valve (V 13) is any one type among a motor-operated valve, an electromagnetic valve, or a pilot valve.

33. An air conditioning system control method for controlling the air conditioning system according to any one of claims 3 and 16 to 27, wherein
a refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is provided between the one end of the refrigerant pipe (P301) and the refrigerant-water heat exchanger (310),
a control unit is utilized to cause the air conditioning system to switch operation between a first mode, a second mode, and a third mode,
in the first mode the first switching device (VF1) is switched to the second switching state and the second switching device (VF2) is switched to the first switching state,
in the second mode the first switching device (VF1) is switched to the first switching state, the second switching device (VF2) is switched to the first switching state, and the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are opened, and
in the third mode the first switching device (VF1) is switched to the first switching state and the second switching device (VF2) is switched to the second switching state.

34. The air conditioning system control method according to claim 33, wherein in the second mode the air conditioning system performs a defrost operation.

35. The air conditioning system control method according to claim 33, wherein in the third mode the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are opened and operation of the heat cycle device is stopped or the heat cycle device is operated at a low speed to thereby perform a defrost operation.

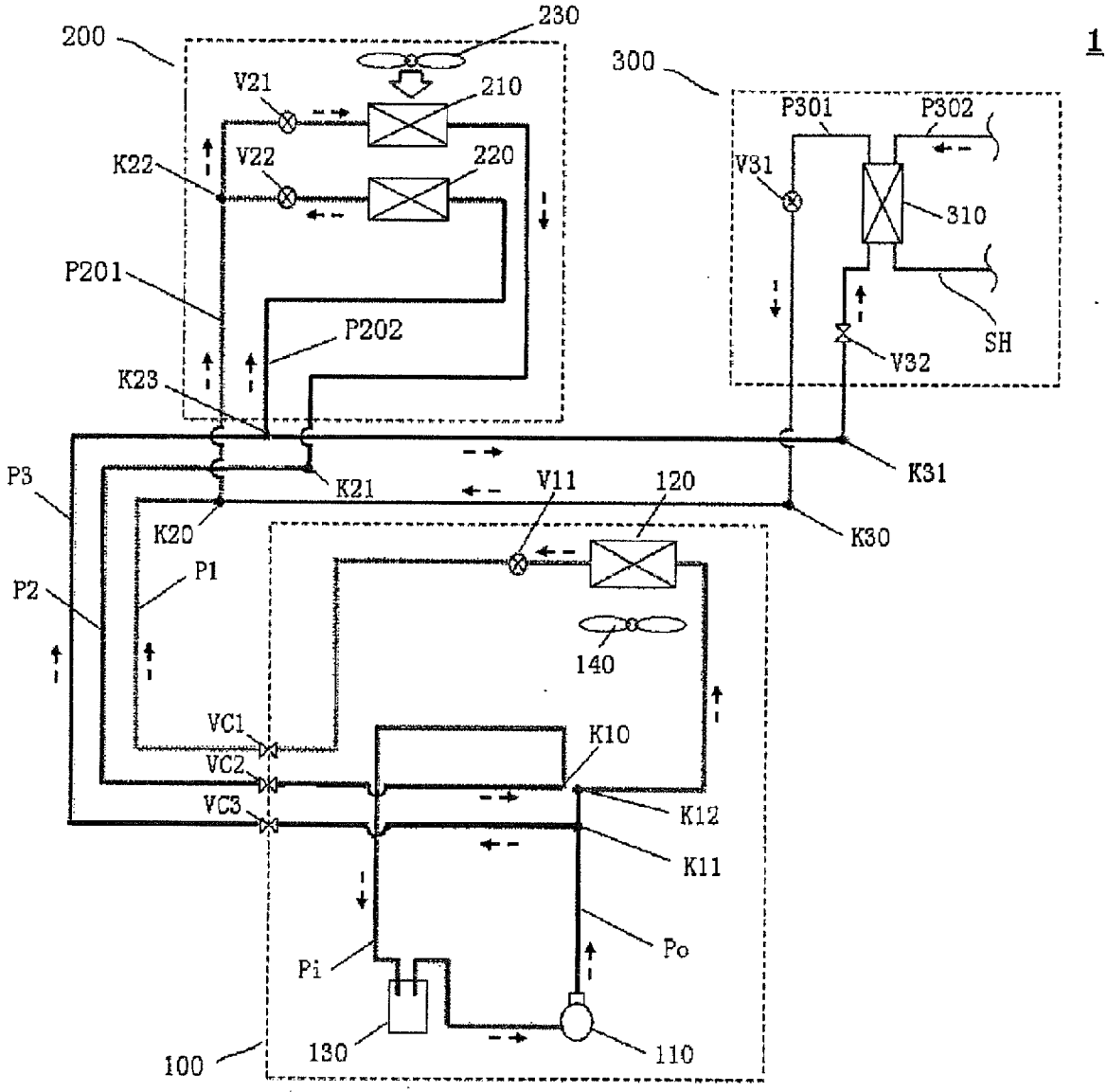
36. The air conditioning system control method according to claim 33, wherein in the first mode or the third mode the first indoor-side refrigerant regulating device (V21), the second indoor-side refrigerant regulating device (V22), and the refrigerant-water heat exchange unit-side refrigerant regulating device (V31) are opened.

37. The air conditioning system control method according to claim 33, wherein in the first mode or the third mode the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are partially opened and the refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is opened.

38. The air conditioning system control method according to claim 33, wherein in the first mode or the third mode the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are opened and the refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is closed.

39. The air conditioning system control method according to claim 33, wherein
a refrigerant control valve (V13) is provided in the second coupling pipe (P2), and
in the first mode the refrigerant control valve (V 13) is closed, the first indoor-side refrigerant regulating device (V21) and the second indoor-side refrigerant regulating device (V22) are partially opened, and the refrigerant-water heat exchange unit-side refrigerant regulating device (V31) is opened.

40. The air conditioning system control method according to claim 39, wherein the refrigerant control valve (V 13) is any one type among a motor-operated valve, an electromagnetic valve, or a pilot valve.


1
200
230
V21
210
K22
V22
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P201
P202
K23
300
P301
P302
V31
310
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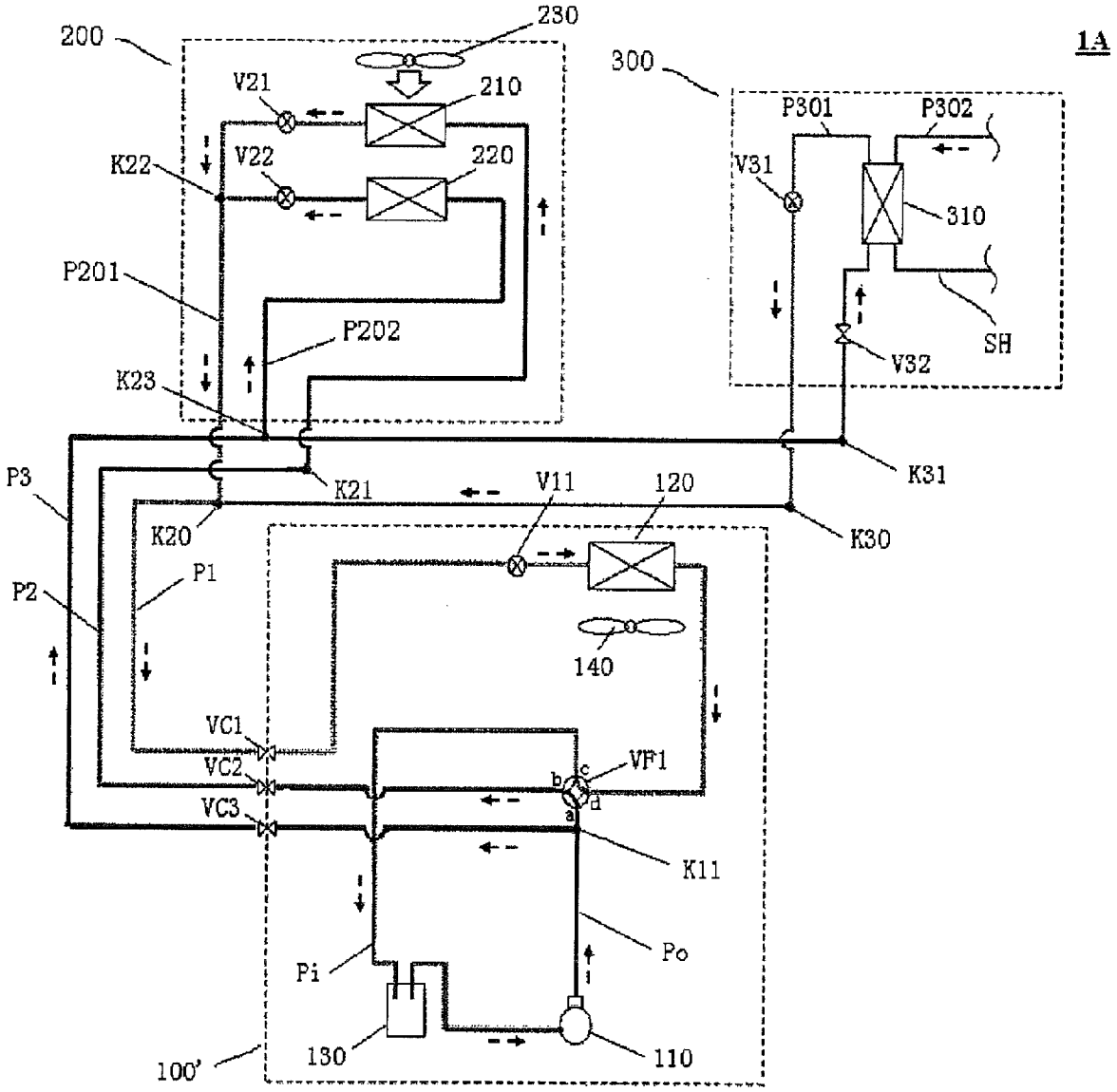
V32
K31
K21
V11
120
K30
P3
K20
P1
P2
140
VC1
K10
VC2
K12
VC3
K11
Po
Pi
130
110
100

FIG. 1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200
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V21
210
K22
V22
220
P201
P202
K23
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V31
310
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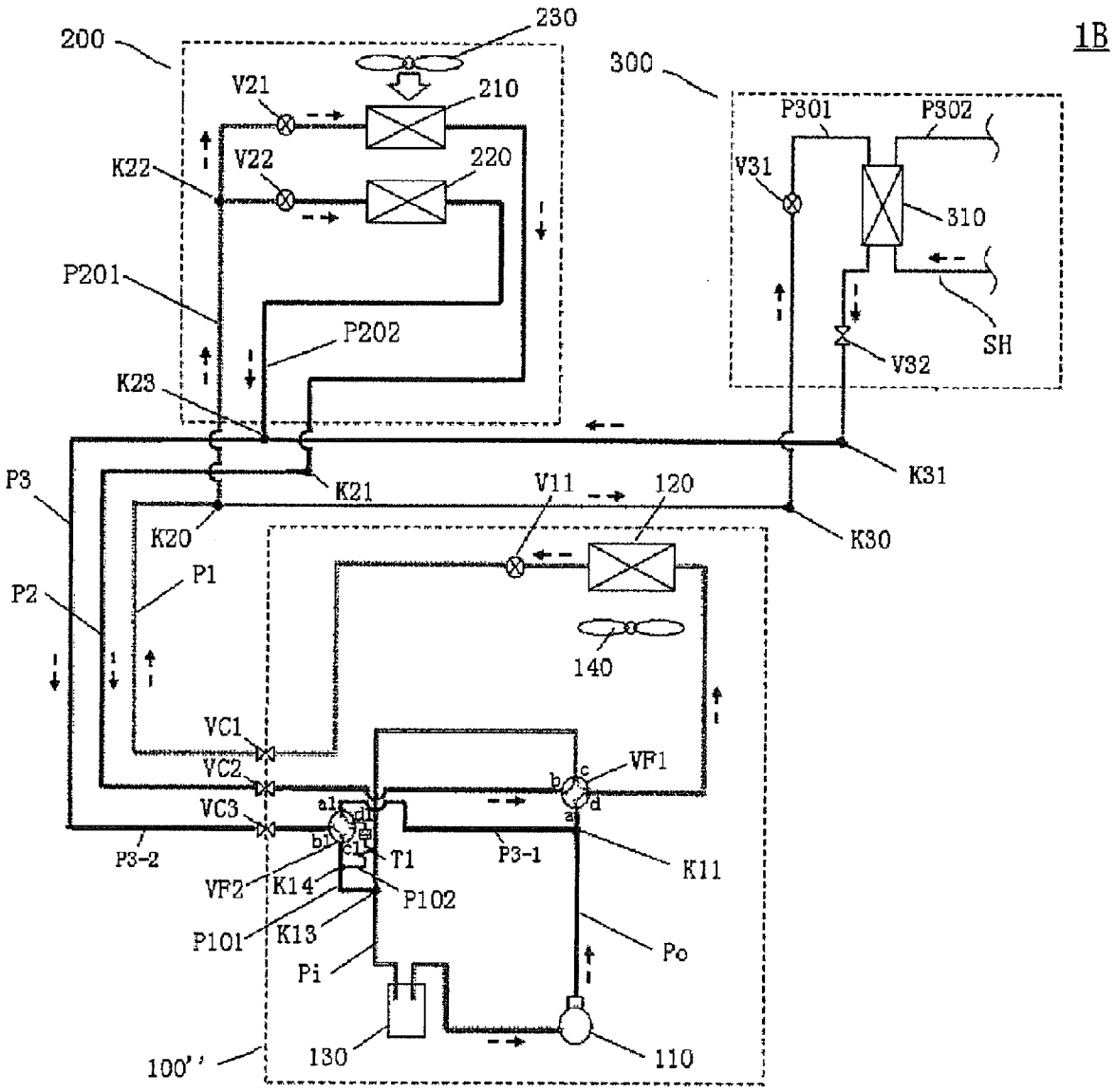
K31
K21
V11
120
K30
K20
P3
P1
P2
140
VC1
VC2
VC3
VP1
b
c
d
a
K11
Po
Pi
130
110
100'

FIG. 2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310
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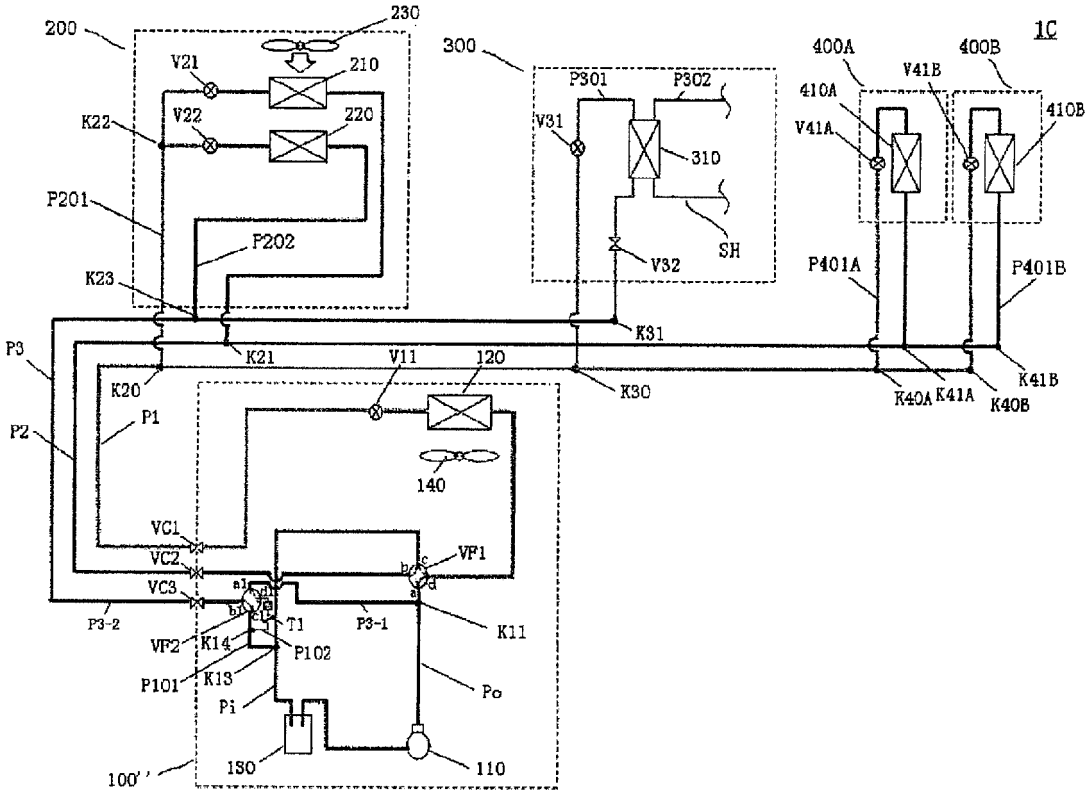
K31
K21
V11
120
K30
K20
P1
P2
P3
140
VC1
VC2
VC3
VF1
P3-2
P3-1
K11
T1
VF2
K14
P102
P101
K13
Pi
Po
130
110
100'

FIG. 3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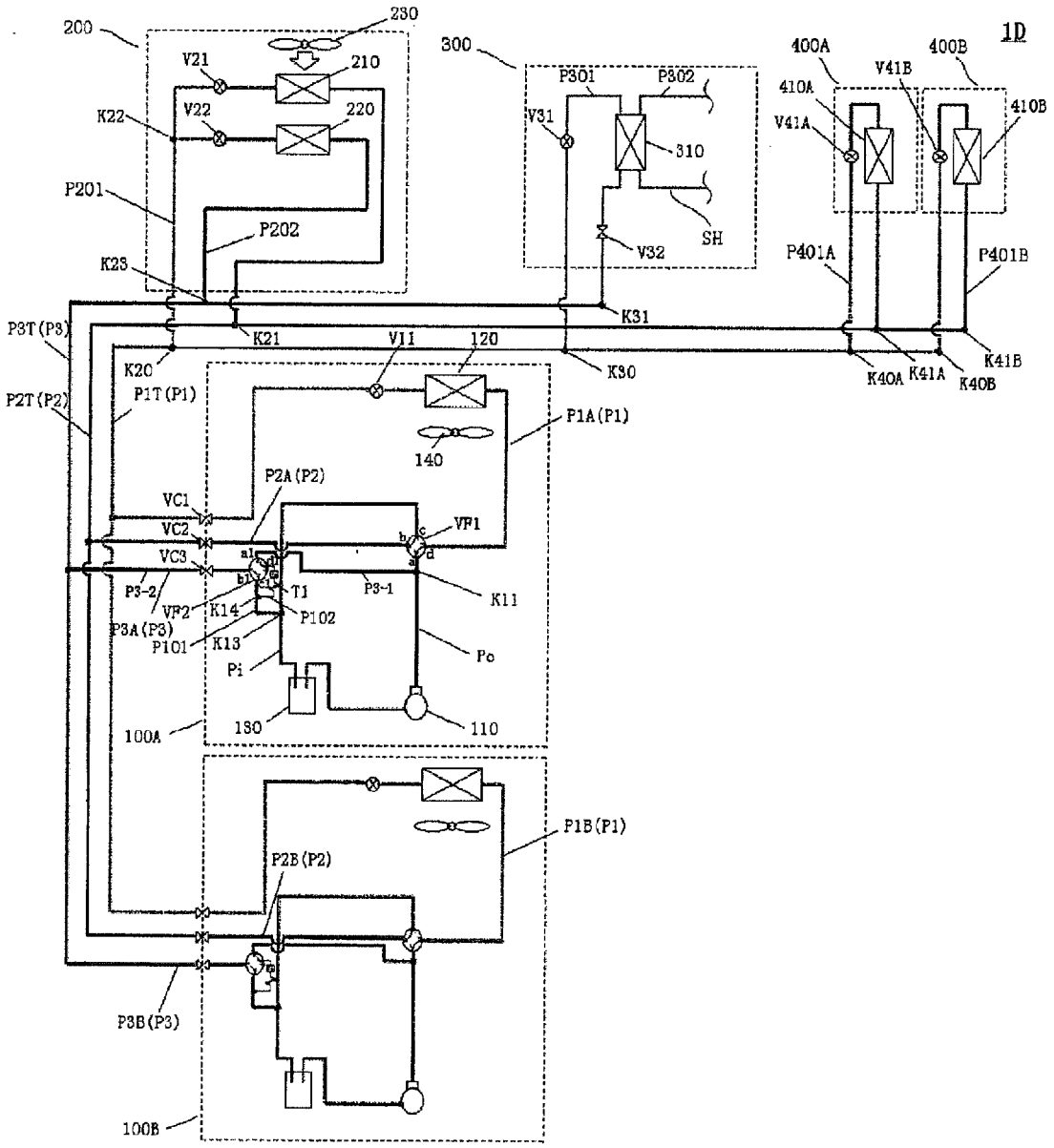
400B
410A
V41B
410B
V41A
P401A
P401B
K31
P3
K21
V11
120
K20
K30
K41B
K40A
K41A
K40B
P1
P2
140
VC1
VC2
VC3
VP1
P3-2
T1
P3-1
K11
VP2
K14
P102
P101
K13
Po
Pi
100''
ISO
110

FIG. 4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V21
210
K22
V22
220
P201
P202
K23
300
P301
P302
V31
310
SH
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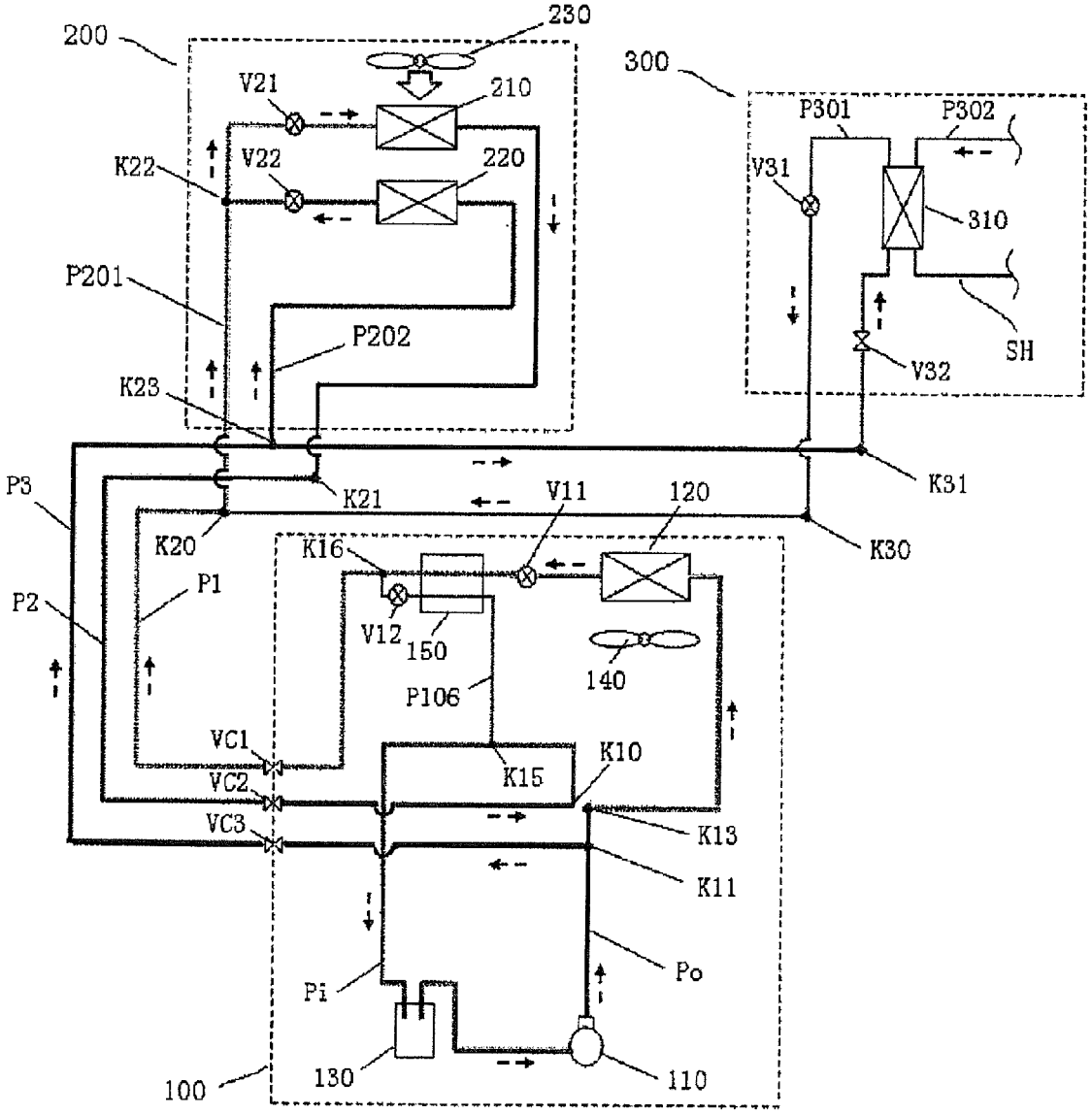
400A
400B
V41B
410A
410B
V41A
P401A
P401B
K31
P3T(P3)
K21
V11
120
K20
K30
K40A
K41A
K40B
K41B
P2T(P2)
P1T(P1)
P1A(P1)
140
P2A(P2)
VC1
VC2
VC3
VF1
P3-2
VF2
K14
T1
P3-1
K11
P3A(P3)
P101
K13
P102
Pi
Po
100A
180
110
P1B(P1)
P2B(P2)
P3B(P3)
100B

FIG. 5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V21
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K22
V22
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P201
P202
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P301
P302
V31
310
SH
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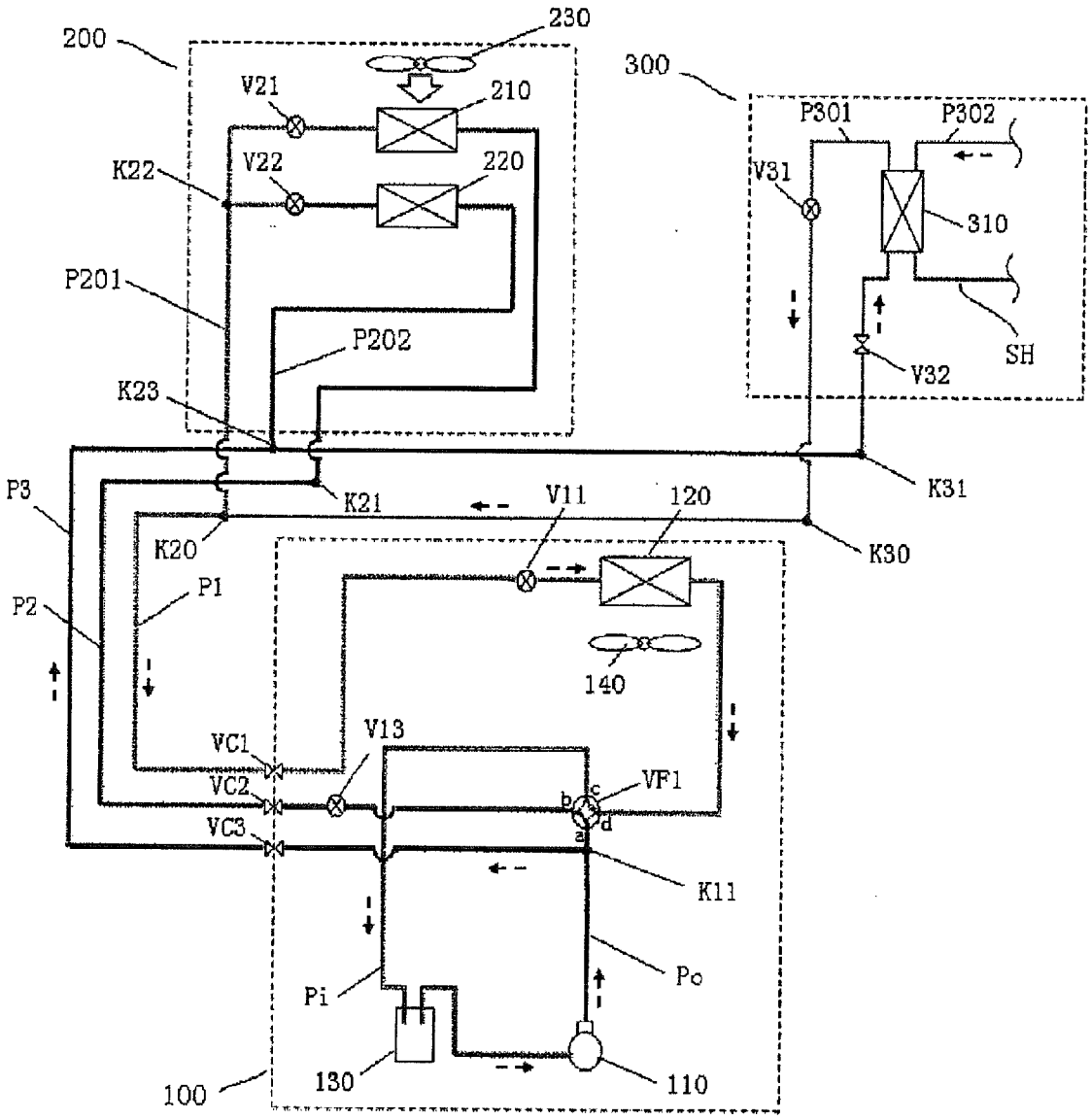
P3
K21
V11
120
K20
K16
K30
P1
P2
V12
150
140
P106
VC1
K15
K10
VC2
VC3
K13
K11
Po
Pi
130
110
100

FIG. 6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V21
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P3
K21
V11
120
K20
K30
P1
P2
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VC2
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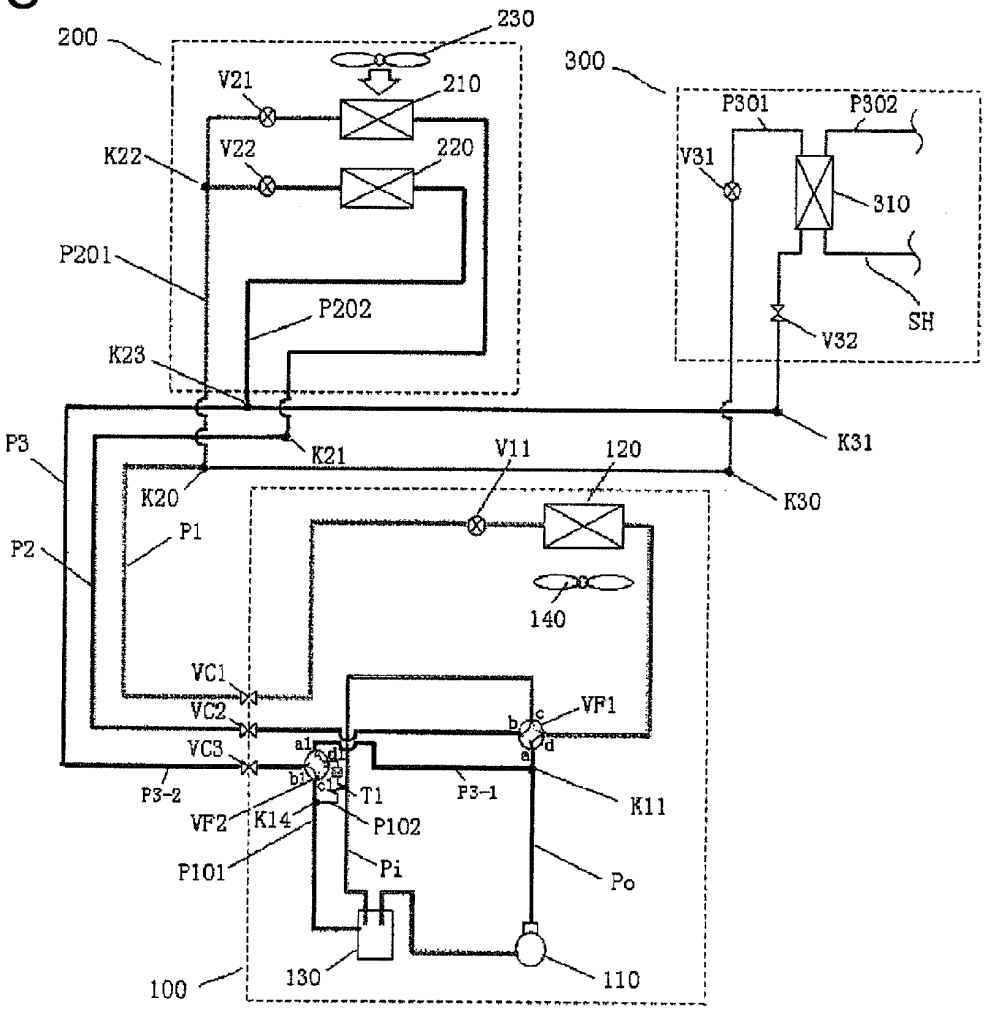
VC3
K11
Pi
Po
130
110
100

FIG. 7

FIG. 8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V21
210
K22
V22
220
P201
P202
K23
300
P301
P302
V31
310
SH
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K21
V11
120
K30
P3
K20
P1
P2
140
VC1
VC2
VC3
VF1
P3-2
T1
P3-1
K11
VF2
K14
P102
P101
Pi
Po
100
130
110

FIG. 9

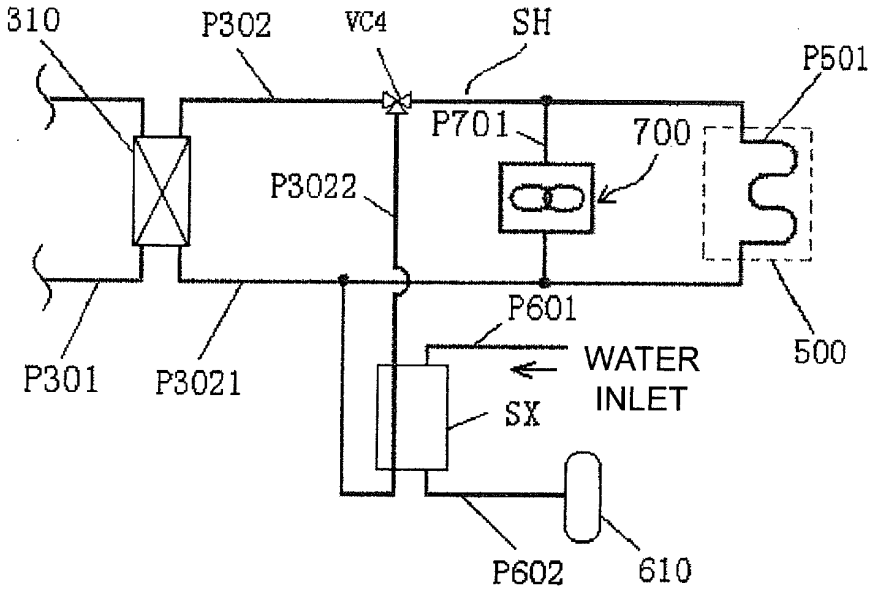

310
P302
VC4
SH
P501
P701
700
P3022
P601
WATER
INLET
500
P301
P3021
SX
P602
610

FIG. 10

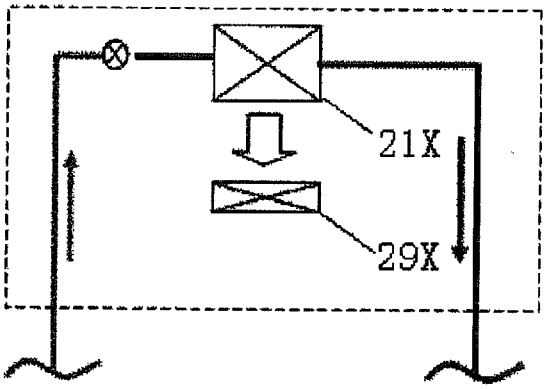
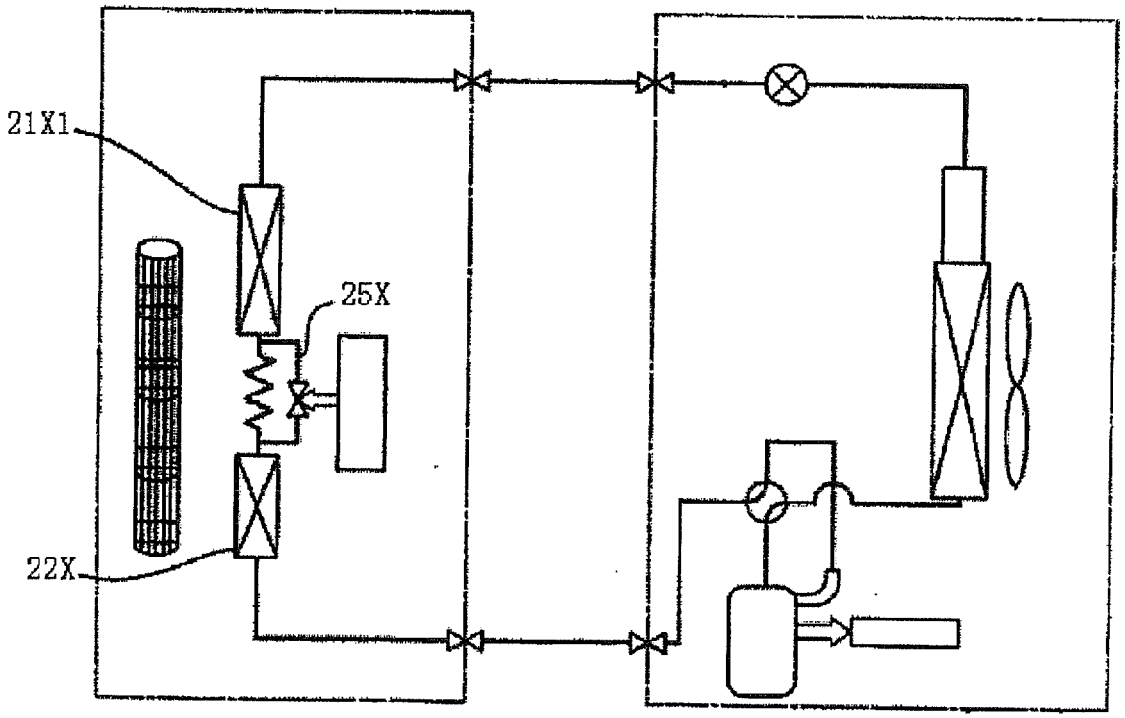


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/061141

A. CLASSIFICATION OF SUBJECT MATTER
F25B29/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2012/085965 A1 (Hitachi Appliances, Inc.), 28 June 2012 (28.06.2012), paragraphs [0009] to [0028]; fig. 1 to 8 (Family: none)	1-40
Y	JP 2-68467 A (Daikin Industries, Ltd.), 07 March 1990 (07.03.1990), page 4, lower right column, line 1 to page 6, upper right column, line 18; fig. 1, 4 (Family: none)	1-40
Y	JP 9-250839 A (Daikin Industries, Ltd.), 22 September 1997 (22.09.1997), paragraphs [0010] to [0013]; fig. 1 to 3 (Family: none)	1-40

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2016 (21.06.16)	28 June 2016 (28.06.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/061141

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2015-4482 A (Hitachi Appliances, Inc.), 08 January 2015 (08.01.2015), paragraphs [0022] to [0023], [0025]; fig. 1 (Family: none)	9-12,21-24, 26-40
Y	JP 2004-169946 A (Mori Jutaku Setsubi Kabushiki Kaisha), 17 June 2004 (17.06.2004), paragraphs [0029], [0033]; fig. 1 (Family: none)	12,24,26-40
Y	JP 2012-47375 A (Hitachi Appliances, Inc.), 08 March 2012 (08.03.2012), paragraphs [0013] to [0014], [0030] to [0031], [0039], [0041]; fig. 1, 4 & EP 2423612 A2 paragraphs [0012] to [0015], [0032] to [0034], [0039], [0044]; fig. 1, 4 & CN 102401503 A	13,15,25-40
Y	JP 10-148427 A (Daikin Industries, Ltd.), 02 June 1998 (02.06.1998), paragraph [0027]; fig. 3 (Family: none)	34-35
A	JP 2010-196944 A (Daikin Industries, Ltd.), 09 September 2010 (09.09.2010), paragraphs [0040] to [0080]; fig. 1 & US 2011/0302948 A1 paragraphs [0054] to [0103]; fig. 1 & EP 2402687 A1 & CN 102326040 A	1-40

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 1590890 A **[0005] [0185]**