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(54) **HEAT PUMP SYSTEM WITH THE FUNCTION OF DEHUMIDIFICATION UNIT INSIDE INDOOR UNIT AND ITS CONTROLLING METHOD**

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(57) **ABSTRACT**

Provided is a cooling/heating heat pump system, including a cooling line in which a high-temperature and high-pressure refrigerant passes through a 4-way valve and changes into a low-temperature and low-pressure refrigerant, flows into the 4-way valve through an indoor heat exchanger seated in an interior unit, and circulates back to an intake side of the compressor; and a dehumidification line that is formed between the discharge side and the 4-way valve and in which the refrigerant discharged from the compressor is discharged to the dehumidification line, a high-temperature and high-pressure refrigerant coming through an upper refrigerant line of a dehumidification heat exchanger changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve, and flows back into a lower refrigerant line of the dehumidification heat exchanger, and the passing refrigerant circulates to the compressor through the intake side of the compressor.

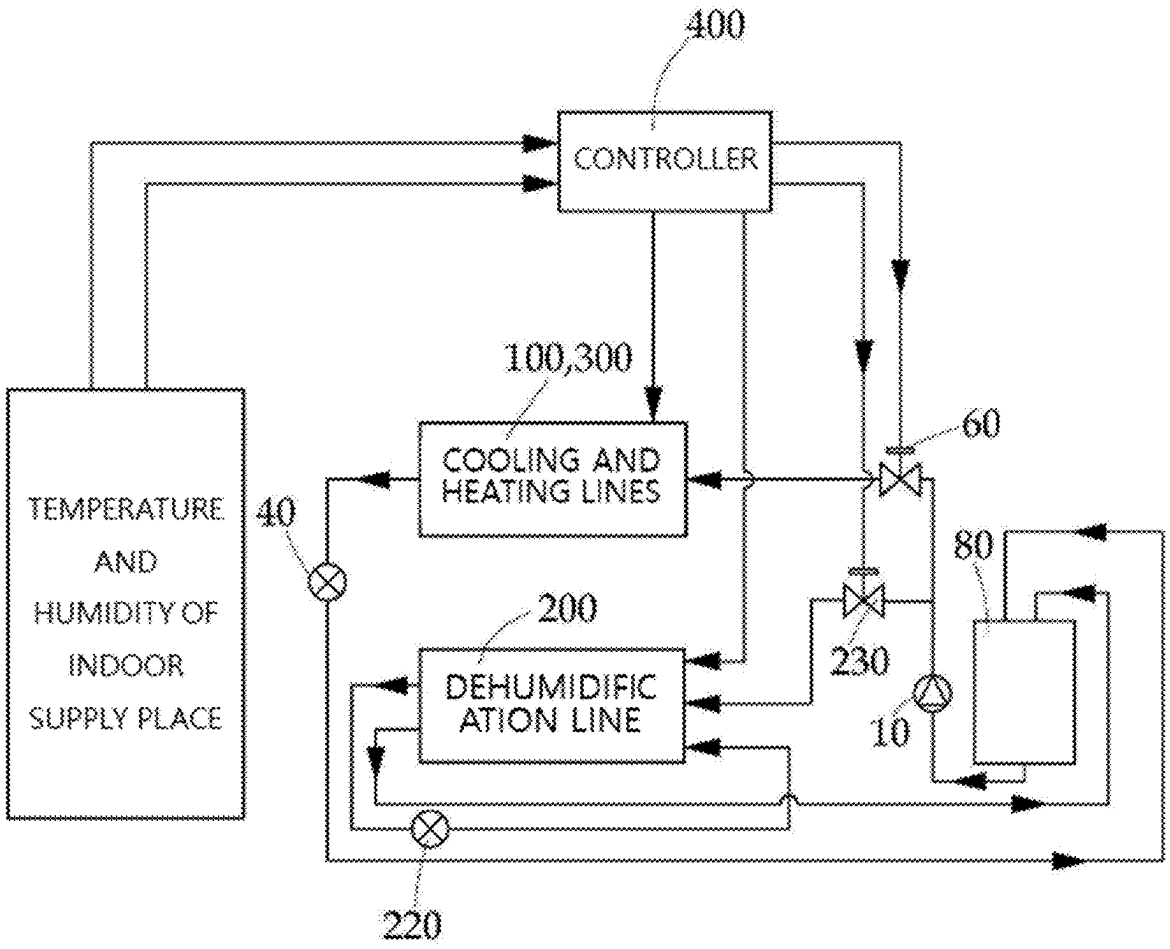


FIG. 1

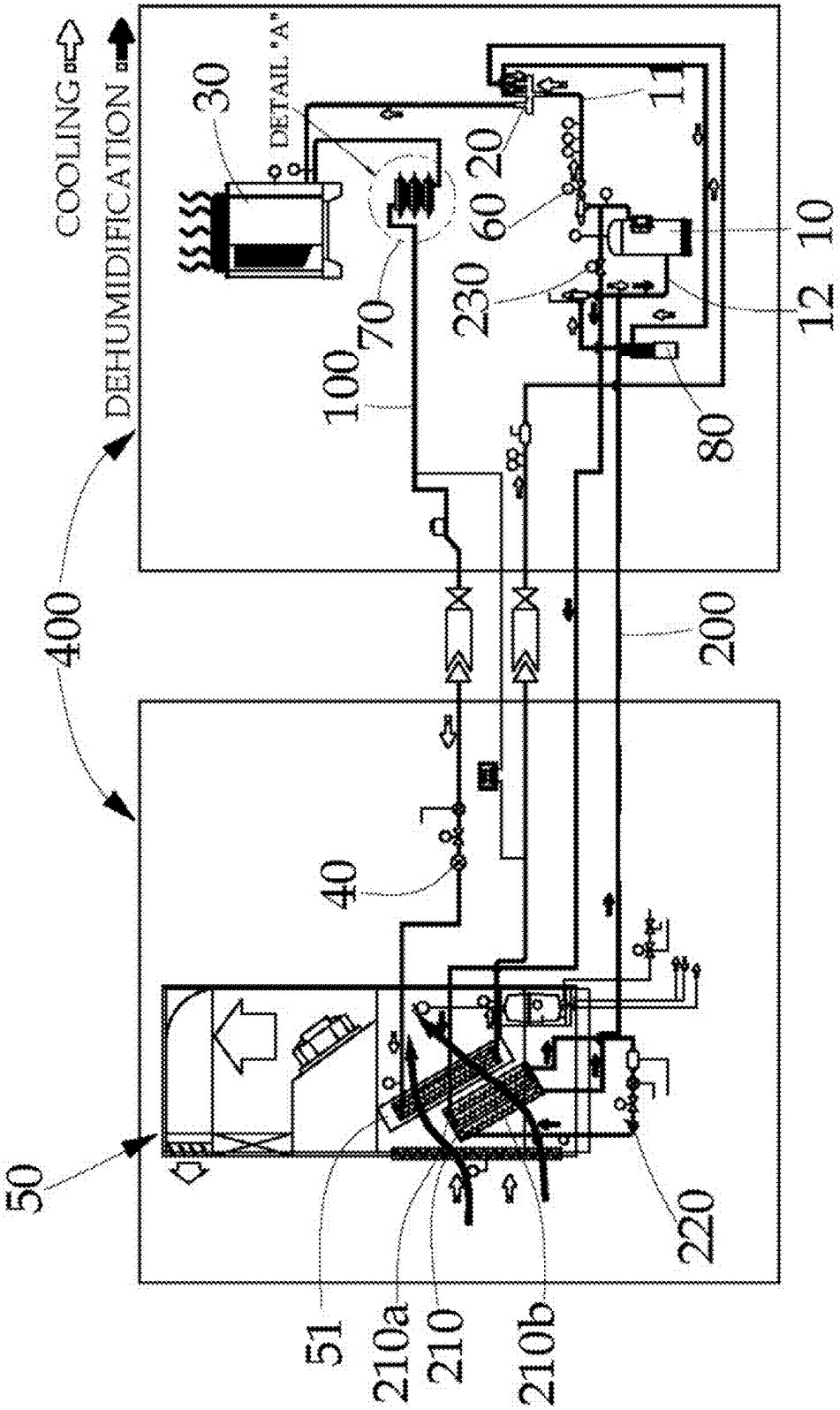

COOLING
DEHUMIDIFICATION
DETAIL "A"
30
11
20
60
10
230
12
70
100
80
400
200
40
50
51
210a
210
210b
220

FIG. 2

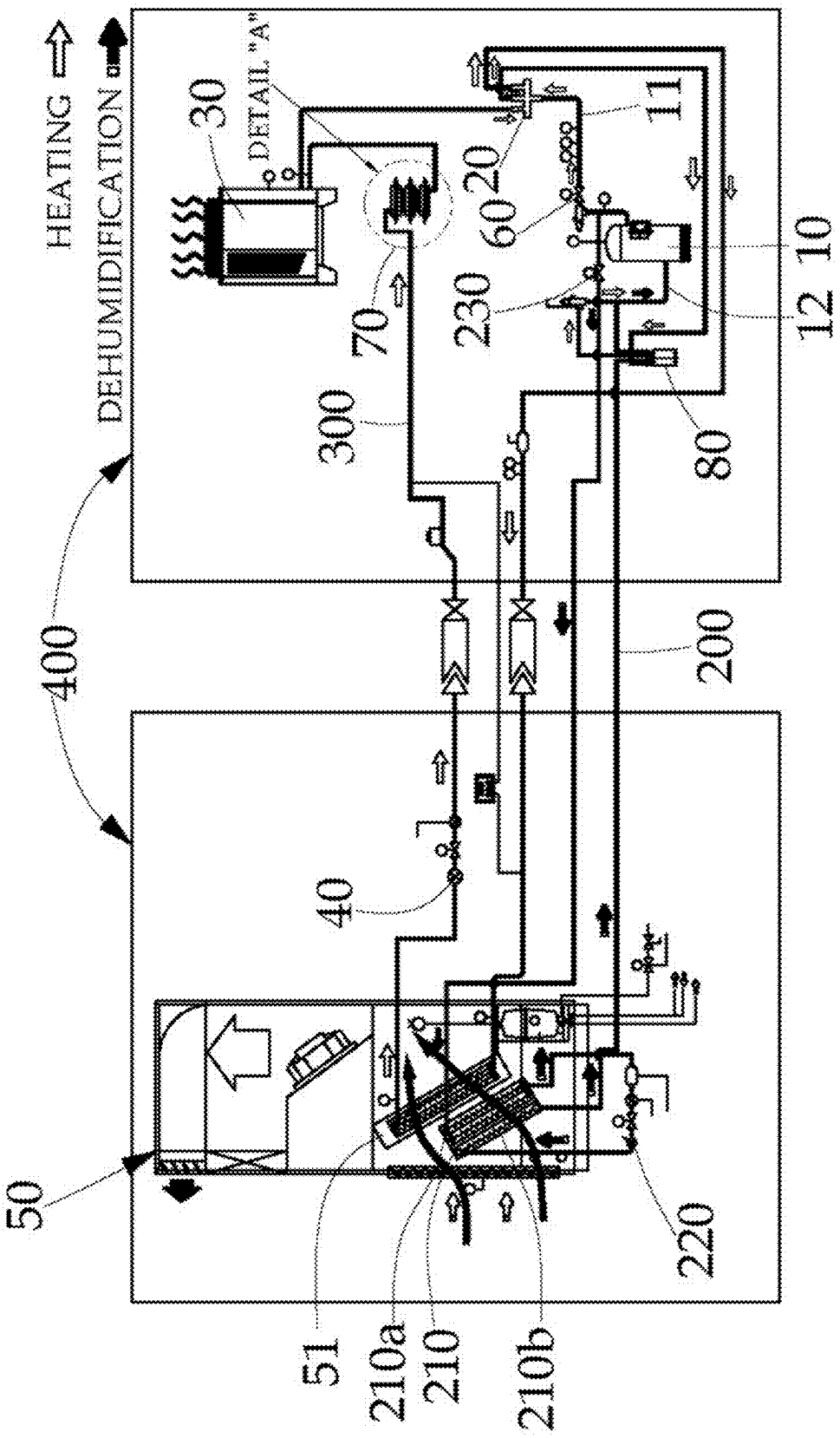
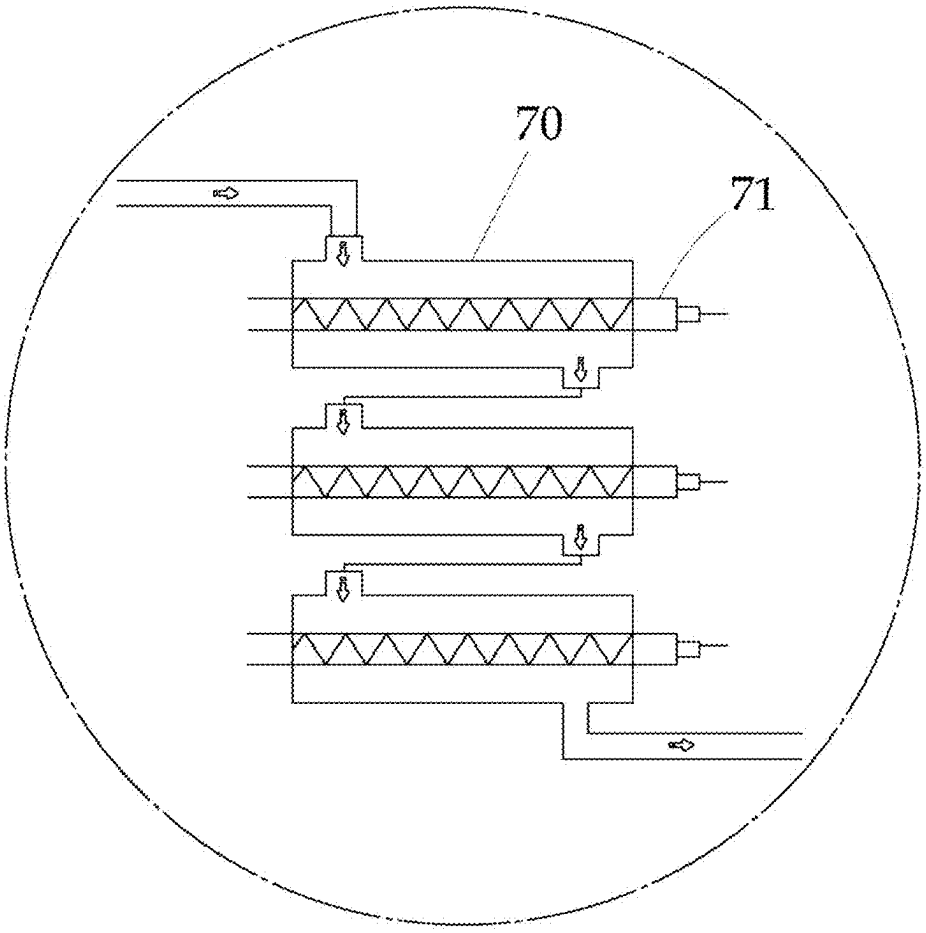
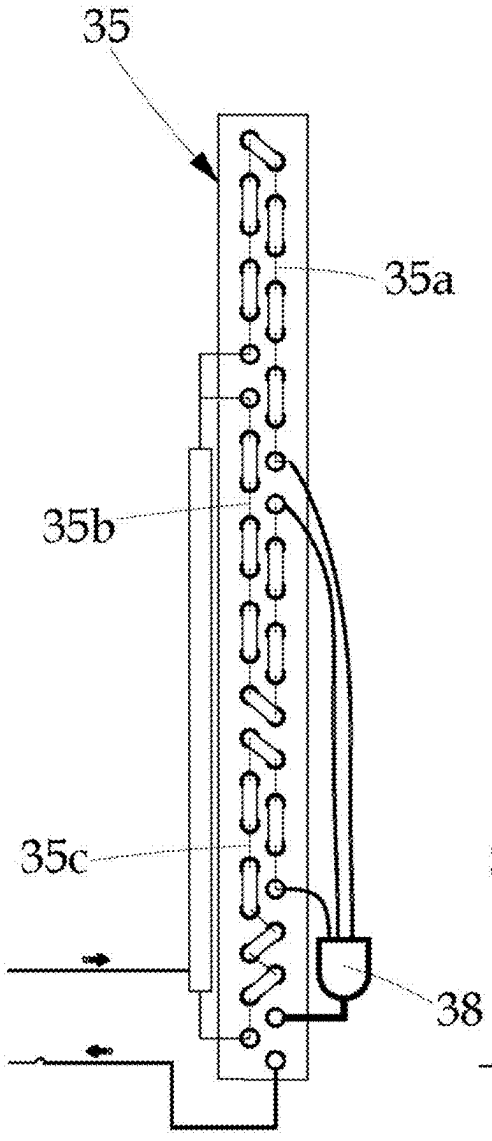

HEATING
DEHUMIDIFICATION
DETAIL "A"
30
11
20
60
70
230
12
10
300
80
400
200
40
50
51
210a
210
210b
220

FIG. 3



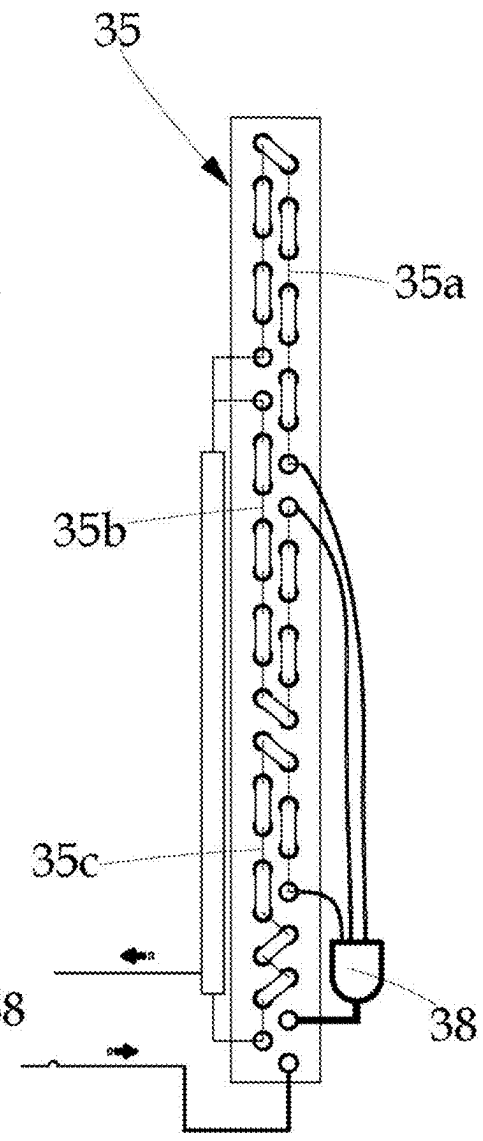
DETAIL "A"

FIG. 4A



DETAIL CONDENSER "B"(COOLING)

FIG. 4B



DETAIL CONDENSER "B"(HEATING)

FIG. 5

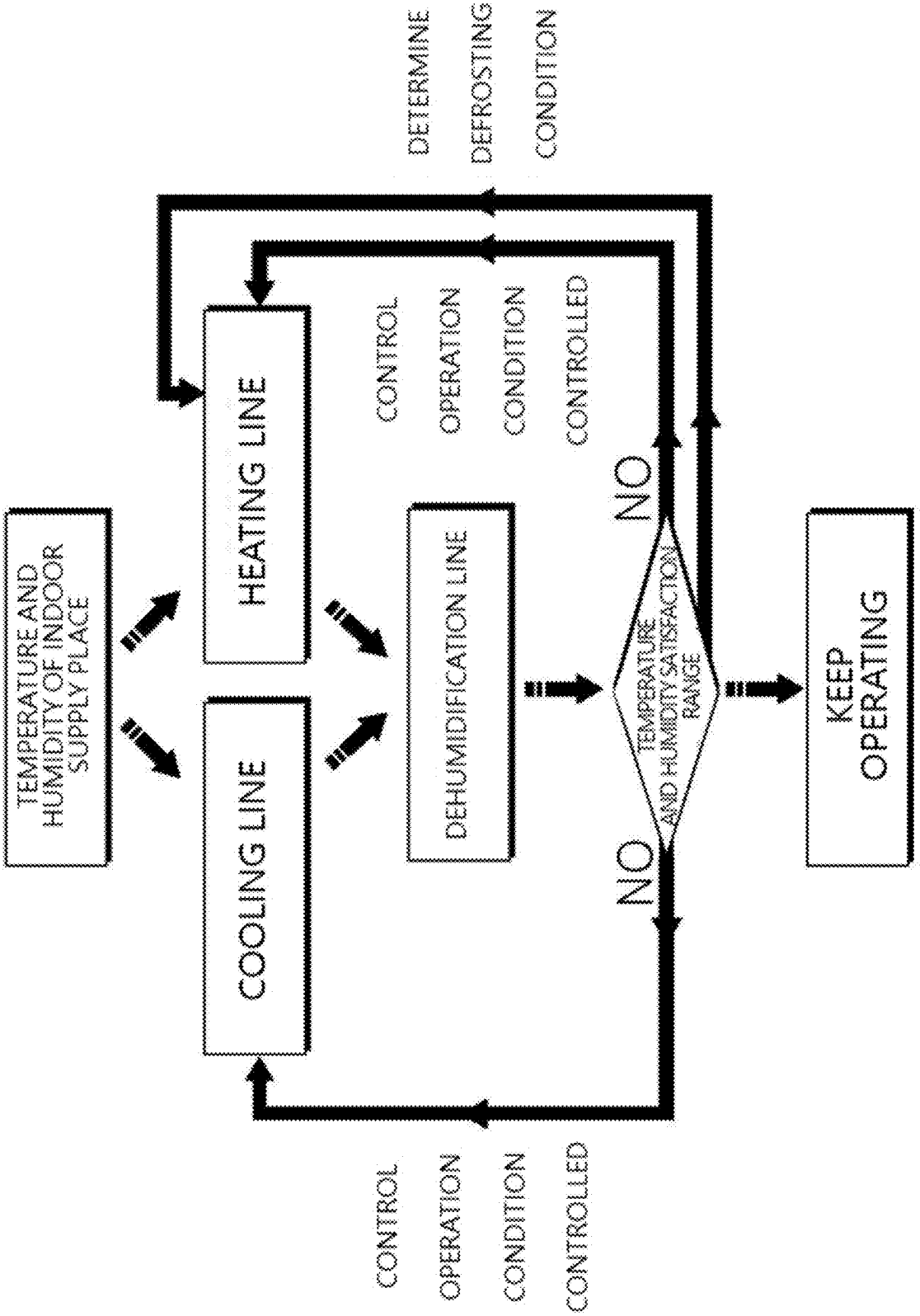
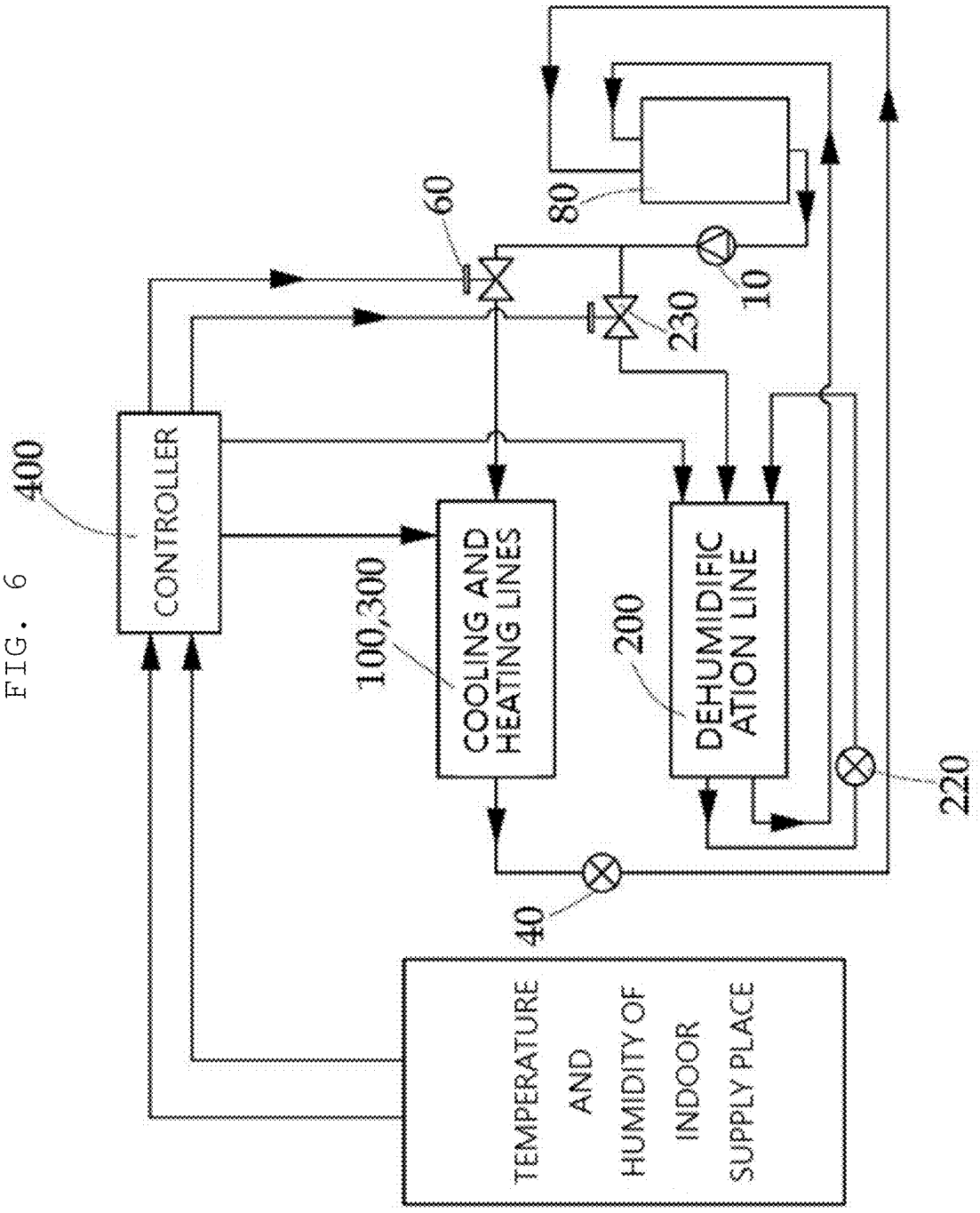

TEMPERATURE AND HUMIDITY OF INDOOR SUPPLY PLACE
HEATING LINE
COOLING LINE
DEHUMIDIFICATION LINE
DETERMINE DEFROSTING CONDITION
CONTROL OPERATION CONDITION CONTROLLED
CONTROL OPERATION CONDITION CONTROLLED
TEMPERATURE AND HUMIDITY SATISFACTION RANGE
NO
NO
KEEP OPERATING

FIG. 6


400
CONTROLLER
100,300
COOLING AND HEATING LINES
200
DEHUMIDIFICATION LINE
60
230
10
80
220
40
TEMPERATURE AND HUMIDITY OF INDOOR SUPPLY PLACE

HEAT PUMP SYSTEM WITH THE FUNCTION OF DEHUMIDIFICATION UNIT INSIDE INDOOR UNIT AND ITS CONTROLLING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present disclosure relates to a heat pump system with the function of a dehumidification unit inside an indoor unit and a method of controlling the heat pump. In detail, the present disclosure relates to a heat pump system having a system that separately or simultaneously performs dehumidification in cooling and heating operations, and having a heat exchanger for dehumidification in an indoor unit separately from a normal refrigeration cycle operation.

Description of the Related Art

[0002] In general, a heat pump, which is a cooling/heating system that transmits a low-temperature heat to a high-temperature side or transmits high-temperature heat to a low-temperature side using generation heat or condensation heat of a refrigerant, is classified into an electric type and an engine type in accordance with driving types, and currently, most heat pumps are designed to provide both cooling and heating.

[0003] Such cooling/heating systems using a heat pump are composed of a compressor, a condenser, an expansion valve, and an evaporator, which form a refrigeration cycle, and operate the condenser as the evaporator and operate the evaporator as the condenser using a 4-way valve or an electronic valve, thereby performing cooling and heating.

[0004] Such cooling/heating systems using a heat pump are used for cooling and heating for various facilities and are applied also to cultivation facilities for crops such as fruits, vegetables, and specialty crops to optimize the cultivation conditions by appropriately controlling the cultivation temperature.

[0005] However, the existing cooling/heating systems using a heat pump have a weak humidity control function, so there is a problem that when they are applied to cultivation facilities for crops that are sensitive to not only temperature control, but humidity control, it is required to additionally install a separate dehumidifier.

[0006] Further, according to such existing dehumidification heating systems, a refrigerant becomes short due to condensation of a refrigerant in the winter season at low temperature, and the efficiency of the functions of cooling, heating, and dehumidifying decreases due to saturation of a refrigerant in the summer season at high temperature, so there is a problem that it is required to additionally install and operate an air-conditioning system in the summer season and to separately operate an electric heater and a space heater in the winter season, whereby it is cumbersome and takes high costs for equipment installation.

[0007] Further, in the summer season, cooling water supplied by a cooling/heating load pump cools and dehumidifies air in a greenhouse through a cold/hot water heat exchanger. However, cultivation greenhouses are generally very higher in humidity load than common air-conditioning spaces, so it is required to remove a large amount of moisture. However, when a great amount of moisture is removed, not only humidity, but temperature is decreased by the cold/hot water heat exchanger, so the temperature of the air that is supplied to a greenhouse is excessively decreased.

[0008] When air at temperature excessively lower than the average temperature of a greenhouse is supplied to the greenhouse, undesirable results such as poor growing and poor flowering are caused.

[0009] However, when the difference in temperature between ventilation air and supplied air is decreased to prevent poor growing and poor flowering, it is required to circulate a great amount of air in order to handle the cooling load in a greenhouse, which results in an increase of the size and the power of the fan of an air-conditioning system. Further, a large number of revolutions of air increases the amount of air bypassing a cold/hot water heat exchanger and time for dew to form on a coil decreases, which causes a disadvantage of insufficient dehumidification.

CITATION LIST

Patent Literature

[0010] Patent Literature 1: Korean Patent No. 10-1075778

[0011] Patent Literature 2: Korean Patent No. 10-2021525

[0012] Patent Literature 3: Korean Patent No. 10-2050694

SUMMARY OF THE INVENTION

[0013] The present disclosure has been made in an effort to solve the problems described above, and an objective of the present disclosure is to provide a cooling/heating system that increases dehumidification operation efficiency by separately or simultaneously performing a cooling/heating operation and a dehumidification operation, provides a system operating to remove a large amount of moisture, and does not need a separate dehumidifier, and a method of controlling the cooling/heating system.

[0014] In order to solve the problems described above, the present disclosure relates to a heat pump system and a method of controlling the heat pump system.

[0015] The heat pump system includes:

[0016] a cooling line in which a high-temperature and high-pressure refrigerant discharged from a discharge side of a compressor passes through a 4-way valve and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve after passing through an outdoor unit, flows into the 4-way valve through an indoor heat exchanger seated in an interior unit, and circulates back to an intake side of the compressor; and

[0017] a dehumidification line that is formed between the discharge side and the 4-way valve and in which the high-temperature and high-pressure refrigerant discharged from the discharge side of the compressor is discharged to the dehumidification line, a high-temperature and high-pressure refrigerant coming through an upper refrigerant line of a dehumidification heat exchanger spaced apart from and seated parallel with a lower end of the indoor heat exchanger of the interior unit changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve, and flows back into a lower refrigerant line of the dehumidification heat exchanger, and the passing

refrigerant circulates to the compressor through the intake side of the compressor;

[0018] wherein when a cooling mode is started by a controller, a dehumidification valve formed on the dehumidification line of the discharge side of the compressor is closed and simultaneously a cooling/heating valve is opened;

[0019] when a dehumidification mode is started, the dehumidification valve formed on the dehumidification line of the discharge side of the compressor is opened and simultaneously the cooling/heating valve is closed;

[0020] when a cooling/dehumidification mode is started, the dehumidification valve formed on the dehumidification line of the discharge side of the compressor is opened and simultaneously the cooling/heating valve is also opened; and

[0021] a refrigerant discharged from the compressor is distributed and supplied at a preset ratio to the cooling line and the dehumidification line and flows inside from a liquid separator mounted at a front end of the compressor to circulate to the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a schematic diagram showing a cooling heat pump system with a dehumidification unit in an indoor unit according to the present disclosure;

[0023] FIG. **2** is a schematic diagram showing a heating heat pump system with a dehumidification unit in an indoor unit according to the present disclosure;

[0024] FIG. **3** is a schematic diagram showing reheat pipes of the cooling/heating heat pump system with a dehumidification unit in an indoor unit according to the present disclosure;

[0025] FIGS. **4**A and **4**B are schematic diagrams showing a refrigerant path of an outdoor heat exchanger of cooling and heating heat pump systems with a dehumidification unit in an indoor unit according to the present disclosure;

[0026] FIG. **5** is a flowchart showing control of cooling/heating, dehumidifying, and defrosting by a heat pump with a dehumidification unit in an indoor unit according to the present disclosure; and

[0027] FIG. **6** is a schematic diagram showing a method of controlling a heat pump with a dehumidification unit in an indoor unit according to the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Before describing embodiments of the present disclosure in detail, it will be understood that the present disclosure is not limited to the components and arrangements of the components described below and shown in drawings. The present disclosure may be accomplished by other embodiments in various ways. Expressions and predicates stated herein in association with terms such as a device and directional terms (for example, "front," "back," "up," "down," "top," "bottom," "left," "right," and "lateral") are used only for simplifying the following description, and it does not mean that related devices and elements should simply have specific directions. Further, terms such as "first" and "second" are used in the detailed description and claims but are not intended to mean relative priority or objects.

[0029] The present disclosure has the following characteristics to achieve the objects.

[0030] Hereinafter, exemplary embodiments of the present disclosure are described in detail with reference to the accompanying drawings. First, the terms and words used in the present specification and claims should not be interpreted as being limited to typical meanings or dictionary definitions, but should be interpreted as having meanings and concepts relevant to the technical scope of the present disclosure based on the rule according to which an inventor can appropriately define the concepts of the terms to describe most appropriately the best method he or she knows for carrying out the disclosure.

[0031] Therefore, the configurations described in the embodiments and drawings of the present disclosure are merely most preferable embodiments but do not represent all of the technical spirit of the present disclosure. Thus, it should be understood that the present disclosure should be construed as including all the changes, equivalents, and substitutions included in the spirit and scope of the present disclosure at the time of filing this application.

[0032] Describing an embodiment according to the present disclosure,

[0033] a heat pump system is a heat pump system with a function of a dehumidification unit inside an indoor unit that includes:

[0034] a cooling line **100** in which a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an outdoor unit **30**, flows into the 4-way valve **20** through an indoor heat exchanger **51** seated in an interior unit, and circulates back to an intake side **12** of the compressor **10**; and

[0035] a dehumidification line **200** that is formed between the discharge side **11** and the 4-way valve **20** and in which the high-temperature and high-pressure refrigerant discharged from the discharge side **11** of the compressor **10** is discharged to the dehumidification line **200**, a high-temperature and high-pressure refrigerant coming through an upper refrigerant line **210***a* of a dehumidification heat exchanger **210** spaced apart from and seated parallel with a lower end of the indoor heat exchanger **51** of the interior unit **50** changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve **220**, and flows back into a lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the passing refrigerant circulates to the compressor **10** through the intake side **12** of the compressor **10**,

[0036] indoor air flowing inside through the front surface of the interior unit **50** is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line **210***a* and is then cooled and dehumidified while passing through the indoor heat exchanger **51** and supplied to an interior;

[0037] when a cooling mode is started by a controller **400**, a dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously a cooling/heating valve **60** is opened;

[0038] when a dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed;

[0039] when a cooling/dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is also opened; and

[0040] a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the cooling line **100** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0041] Further, as another embodiment of the present disclosure,

[0042] there is added a heating line **300** in which a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an indoor heat exchanger **51** seated in an interior unit **30**, and circulates back to an intake side **12** of the compressor **10** through an outdoor unit **30** and the 4-way valve **20**,

[0043] several reheat pipes **70** having an electric heater rod **71** are formed at an inflow side of the outdoor unit **30** of the heating line **300**, surface temperature of the outdoor heat exchanger **35** of the outdoor unit **30** and humidity and temperature of inflow air flowing into the outdoor unit **30** are measured, the controller **400** determines whether to perform defrosting, and when a defrosting condition is reached,

[0044] the electric heater rods **71** are operated such that several pieces are selectively simultaneously operated;

[0045] when a heating mode is started by a controller **400**, a dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously a cooling/heating valve **60** is opened;

[0046] when a dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed,

[0047] when a heating/dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is also opened, and

[0048] a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the heating line **300** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0049] Further, as another embodiment of the present disclosure,

[0050] the dehumidification heat exchanger **210** has thermal capacity smaller than that of the indoor heat exchanger **51**.

[0051] Further, as another embodiment of the present disclosure,

[0052] the number of refrigerant pipes forming the upper refrigerant line **210***a* functioning as the condenser of the dehumidification heat exchanger **210** is greater than the number of refrigerant pipes forming the lower refrigerant lines **210***b* functioning as the evaporator.

[0053] Further, as another embodiment of the present disclosure,

[0054] several refrigerant divergent paths of the outdoor heat exchanger **35** of the outdoor unit **30** are composed of an upper path part **35***a*, a middle path part **35***b*, and a lower path part **35***c*,

[0055] in the upper path part **35***a*, a refrigerant flows into the upper end, forms a preset refrigerant path channel, is discharged to the upper end, and flows into an outdoor refrigerant collector **38** positioned at outer lower end of the outdoor heat exchanger **35**;

[0056] in the middle path part **35***b*, a refrigerant flows into the middle portion, forms a preset refrigerant path channel, is discharged to the middle portion, and flows into the outdoor refrigerant collector **38**;

[0057] in the lower path part **35***c*, a refrigerant flows into the lower end of the middle path part **35***b*, forms a preset refrigerant path channel, is discharged to the lower end, and flows into the outdoor refrigerant collector **38**; and

[0058] a refrigerant mixed in the outdoor refrigerant collector **38** flows back into the outdoor heat exchanger **35**, exchanges heat, and is then discharged back to the outdoor heat exchanger **35**.

[0059] Further, as another embodiment of the present disclosure,

[0060] a method of controlling a heat pump is a method of controlling a cooling/heating heat pump with the function of a dehumidification unit inside an indoor unit, in which

[0061] a dehumidification heat exchanger **210** spaced apart from an indoor heat exchanger **51** and correspondingly mounted at the lower end is separately mounted on an indoor unit **50**,

[0062] a controller **400** is formed for the cooling/heating heat pump composed of:

[0063] a cooling line **100** and a heating line **300** connected to an outdoor heat exchanger **31** of an outdoor unit **30** and formed by connecting the indoor heat exchanger **51** and the outdoor heat exchanger **31**; and

[0064] a dehumidification line **200** by an upper refrigerant line **210***a* functioning as a condenser in the dehumidification heat exchanger **210** and a lower refrigerant line **210***b* functioning as an evaporator separately from the cooling line **100** and the heating line **300**,

[0065] the dehumidification line **200** that is formed between the discharge side **11** and the 4-way valve **20** and in which the high-temperature and high-pressure refrigerant discharged from the discharge side **11** of the compressor **10** is discharged to the dehumidification line **200**, a high-temperature and high-pressure refrigerant coming through an upper refrigerant line **210***a* of a dehumidification heat exchanger **210** spaced apart from and seated parallel with a lower end of the indoor heat exchanger **51** of the interior unit **50** changes into

a low-temperature and low-pressure refrigerant while passing through a second expansion valve **220**, and flows back into a lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the passing refrigerant circulates to the compressor **10** through the intake side **12** of the compressor **10**;

[0066] indoor air flowing inside through the front surface of the interior unit **50** is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line **210***a* and is then cooled and dehumidified while passing through the indoor heat exchanger **51** and supplied to an interior;

[0067] the controller **400** receives temperature and humidity measured in real time at an indoor supply place, surface temperature of the outdoor heat exchanger **31**, and humidity flowing into the outdoor heat exchanger **31**, and controls them at preset values;

[0068] a control method of the cooling line **100** in which, in a cooling operation mode, the humidification line **200** is turned off, the indoor heat exchanger **51** is changed to function as an evaporator, and a refrigerant is supplied to control preset temperature and humidity;

[0069] a control method of the dehumidification line **20** in which, in a dehumidification operation mode, the cooling line **100** and the heating line **300** are turned off and a refrigerant is supplied to the dehumidification heat exchanger **210** to control temperature and humidity set in advance at the indoor supply place;

[0070] a control method of the heating line **300** in which, in a heating operation mode, the humidification line **200** is turned off, the indoor heat exchanger **51** is changed to function as a condenser, and a refrigerant is supplied to control preset temperature and humidity;

[0071] the cooling line **100** and the dehumidification line **200** are controlled to simultaneously operate in cooling and dehumidification simultaneous operation mode,

[0072] the heating line **300** and the dehumidification line **200** are controlled to simultaneously operate in heating and dehumidification simultaneous operation mode,

[0073] the discharge side **11** of one compressor **10** constituting the heat pump is diverged into two refrigerant supplies, one is controlled such that a high-temperature and high-pressure refrigerant is supplied to the cooling line **100** and the heating line **300**; the other is controlled such that each valve is opened/closed so that high-temperature and high-pressure refrigerant is supplied to the dehumidification line **200**;

[0074] the controller **400** measures the surface temperature of the outdoor heat exchanger **31** and humidity temperature of inflow air and determines whether to perform defrosting, and when a defrosting condition is reached, several reheat pipes **70** equipped with an electric heater rod **71** installed at the inflow side of the outdoor unit **30** are operated such that several pieces are selectively simultaneously operated, and

[0075] the controller **400**, in the cooling and dehumidification simultaneous operation mode and the heating and dehumidification simultaneous operation mode, controls the amounts of refrigerants supplied separately from the discharge side **11** of the compressor **10** such that the real-time temperature and humidity at the indoor supply place reach the preset temperature and humidity.

[0076] Hereafter, a heat pump system with a function of a dehumidification unit inside an indoor unit according to a preferred embodiment of the present disclosure and a method of controlling the heat pump are described with reference to FIGS. **1** to **6**.

[0077] FIG. **1** is a schematic diagram showing a cooling heat pump system with a dehumidification unit in an indoor unit according to the present disclosure, and in the heat pump system,

[0078] a cooling line **100** is formed such that a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an outdoor unit **30**, flows into the 4-way valve **20** through an indoor heat exchanger **51** seated in an exterior unit **50**, and circulates back to an intake side **12** of the compressor **10**, in which indoor air that has passed through the indoor heat exchanger **51** is cooled and dehumidified and supplied to the indoor, and high-temperature and high-humidity air is cooled and dehumidified.

[0079] Further, as a technical feature of the present disclosure, a refrigerant system is formed separately from the cooling line **100**.

[0080] The dehumidification line **200** is formed between the discharge side **11** and the 4-way valve **20** and in which the high-temperature and high-pressure refrigerant discharged from the discharge side **11** of the compressor **10** is discharged to the dehumidification line **200**, a high-temperature and high-pressure refrigerant coming through an upper refrigerant line **210***a* of a dehumidification heat exchanger **210** spaced apart from and seated parallel with a lower end of the indoor heat exchanger **51** of the interior unit **50** changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve **220**, and flows back into a lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the passing refrigerant circulates to the compressor **10** through the intake side **12** of the compressor **10**.

[0081] Indoor air flowing inside through the front surface of the interior unit **50** is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line **210***a* and is then cooled and dehumidified while passing through the indoor heat exchanger **51** and supplied to an interior.

[0082] Further, when indoor air is sufficiently cooled but has high humidity, the cooling line **100** stops operating and only the dehumidification line **200** is operated. To this end, a separate dehumidification heat exchanger **210** is provided in the interior unit **50**, and a high-temperature and high-pressure refrigerant and a low-temperature and low-pressure refrigerant line passing a second expansion valve **220** are disposed together in the dehumidification heat exchanger **210**.

[0083] To this end, the present disclosure is characterized in that when a cooling mode is started by a controller **400**, a dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously a cooling/heating valve **60** is opened, and only the cooling operation is operated, and

[0084] when a dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed, and only the dehumidification operation is operated.

[0085] Further, according to the present disclosure, cooling and dehumidification operations are simultaneously operated, and

[0086] when a cooling/dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is also opened; and a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the cooling line **100** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0087] Indoor air passing through the dehumidification heat exchanger **210** of the dehumidification line **200** increases in temperature and is cooled and dehumidified while passing through the indoor heat exchanger **51**. This is operated in a supplier that precisely simultaneously controls temperature and humidity such as semiconductor equipment that precisely controls temperature and humidity of indoor air.

[0088] Further, for this purpose, a refrigerant discharged from the compressor **10** is distributed at a preset ratio to the cooling line **100** and the dehumidification line **200** and then supplied to the cooling line **100** and the dehumidification line **200**, respectively, and for the amounts of distributed refrigerants, temperature and humidity of the indoor air are measured in real time and the degrees of opening/closing of the cooling/heating valve **60** and the dehumidification valve **230** are automatically adjusted such that the temperature and humidity become preset temperature and humidity.

[0089] FIG. **2** is a schematic diagram showing a heating heat pump system with a dehumidification unit in an indoor unit according to the present disclosure.

[0090] The present disclosure further includes a heating line **300** in which a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an indoor heat exchanger **51** seated in an interior unit **50**, and circulates back to an intake side **12** of the compressor **10** through an outdoor unit **30** and the 4-way valve **20**. This is formed by reversing the refrigerant circulation direction of the cooling line **100**.

[0091] When a heating mode is started by the controller **400** of the present disclosure, the dehumidification valve **230** formed in the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously the cooling/heating valve **60** is opened, whereby the indoor air passing through the indoor heat exchanger **51** seated in the interior unit **50** increases in temperature and set indoor air is provided to the indoor supply place.

[0092] A technical feature of the present disclosure is that when a dehumidification mode is started, the dehumidification valve **230** formed in the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed, which is used for a low-temperature and high-humidity supply place with high humidity even in the winter season and is an operation mode for low-temperature and high-humidity indoor supply places such as a greenhouse that requires cultivation of plants.

[0093] Further, a technical feature of the present disclosure is characterized in that when a heating/dehumidification mode is started,

[0094] the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is also opened, and

[0095] a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the heating line **300** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0096] For a low-temperature and high-humidify indoor environment, indoor air passing through the dehumidification heat exchanger **210** of the dehumidification line **200** increases in temperature and is cooled and dehumidified while passing through the indoor heat exchanger **51**. This is operated in a supplier that precisely simultaneously controls temperature and humidity such as semiconductor equipment that precisely controls temperature and humidity of indoor air.

[0097] Further, for this purpose, a refrigerant discharged from the compressor **10** is distributed at a preset ratio to the cooling line **100** and the dehumidification line **200** and then supplied to the cooling line **100** and the dehumidification line **200**, respectively, and for the amounts of distributed refrigerants, temperature and humidity of the indoor air are measured in real time and the degrees of opening/closing of the cooling/heating valve **60** and the dehumidification valve **230** are automatically adjusted such that the temperature and humidity become the preset temperature and humidity.

[0098] FIG. **3** is a schematic diagram showing reheat pipes of the cooling/heating heat pump system with a dehumidification unit in an indoor unit according to the present disclosure, which relates to adjustment of defrosting and the degree of overheat of the outdoor unit **30** and is characterized in that several reheat pipes **70** equipped with an electronic heater rod **71** are formed at the inflow side of the outdoor unit **30** of the heating line **300**, surface temperature of the outdoor heat exchanger **31** of the outdoor unit **30** and humidity temperature of intake air flowing into the outdoor unit **30** are measured, whether to perform defrosting is determined by the controller **400**, and when a defrosting condition is reached, the electronic heater rods **71** are operated, that is, several pieces are simultaneously operated for quick defrosting.

[0099] Including a defrosting operation of the outdoor unit **30**, the surface temperature of the outdoor heat exchanger **31** is measured for the temperature of the refrigerant discharged from the outdoor unit **30**, and when the temperature is lower than preset refrigerant temperature, it is determined as a

non-condensed refrigerant gas and the electronic heater rods **71** are operated to keep the refrigerant gas within a preset degree of overheat.

[0100] Further, as another embodiment of the present disclosure, as shown in FIGS. **1** and **2**, the dehumidification heat exchanger **210** is formed smaller than the indoor heat exchanger **51**, and the thermal capacity of indoor air by the dehumidification heat exchanger **210** is relatively smaller than the thermal capacity that is heat exchanged from the indoor heat exchanger **51**.

[0101] Further, as an embodiment, when cooling and dehumidification or heating and dehumidification operations are both operated and when the size of the dehumidification heat exchanger **210** is smaller than that of the indoor heat exchanger **51**, first indoor air coming out of the dehumidification heat exchanger **210** flows into the indoor heat exchanger **51**, exchanges heat, and passes through the indoor heat exchanger **51**, and

[0102] the temperature of the indoor air passing through the dehumidification heat exchanger **210** is increased, and second indoor air passing through the indoor heat exchanger **51** spaced upward is mixed with the first indoor air and supplied to the indoor supply place.

[0103] Further, as another embodiment, when the size of the dehumidification heat exchanger **210** and the size of the indoor heat exchanger **51** are the same, indoor air that has increased in temperature through the dehumidification heat exchanger **210** all passes through the indoor heat exchanger **51** and is supplied to the indoor supply place.

[0104] Another technical feature of the present disclosure is characterized in that the dehumidification heat exchanger **210** of the dehumidification line **200** that is responsible for a dehumidification function is formed to serve as a condenser at the upper end and serve as an evaporator at the lower end, in which for dehumidification efficiency, the condenser is configured to have a thermal capacity greater than the evaporator, which usually generates a relative thermal value difference of 1.3 times to 1.4 times.

[0105] To this end, the number of refrigerant pipes forming the upper refrigerant line **210***a* functioning as the condenser is greater than the number of refrigerant pipes forming the lower refrigerant lines **210***b* functioning as the evaporator, and

[0106] as an embodiment, the upper refrigerant line **210***a* is formed in two rows and the lower refrigerant lines **210***b* is formed in one row.

[0107] FIGS. **4**A and **4**B are schematic diagrams showing a refrigerant path of an outdoor heat exchanger of cooling and heating heat pump systems with a dehumidification unit in an indoor unit according to the present disclosure.

[0108] This is a configuration for increasing the efficiency of the outdoor heat exchanger **35**, in which refrigerant pipes flowing into the outdoor heat exchanger **35** composed of several refrigerant channels exchange heat therein, come out of the outdoor heat exchanger **35**, are mixed and stored, flow back into the outdoor heat exchanger **35** and exchange heat, whereby refrigerant that can be mixed with a refrigerant gas and refrigerant liquid all exchange heat into a refrigerant gas.

[0109] To this end, the present disclosure is configured such that:

[0110] several refrigerant divergent paths of the outdoor heat exchanger **35** of the outdoor unit **30** are composed of an upper path part **35***a*, a middle path part **35***b*, and a lower path part **35***c*, in the upper path part **35***a*, a refrigerant flows into the upper end, forms a preset refrigerant path channel, is discharged to the upper end, and flows into an outdoor refrigerant collector **38** positioned at outer lower end of the outdoor heat exchanger **35**;

[0111] in the middle path part **35***b*, a refrigerant flows into the middle portion of the middle path part **35***b*, forms a preset refrigerant path channel, is discharged to the middle portion, and flows into the outdoor refrigerant collector **38**;

[0112] in the lower path part **35***c*, a refrigerant flows into the lower end of the middle path part **35***b*, forms a preset refrigerant path channel, is discharged to the lower end, and flows into the outdoor refrigerant collector **38**; and

[0113] a refrigerant mixed in the outdoor refrigerant collector **38** flows back into the outdoor heat exchanger **35**, exchanges heat, and is then discharged back to the outdoor heat exchanger **35**.

[0114] FIG. **5** is a flowchart showing control of cooling/heating, dehumidifying, and defrosting by a heat pump with a dehumidification unit in an indoor unit according to the present disclosure, and FIG. **6** is a schematic diagram showing a method of controlling a heat pump with a dehumidification unit in an indoor unit according to the present disclosure, and

[0115] FIGS. **1** to **4** are refrigerant system diagrams and schematic diagrams about main configurations for the control method of the present disclosure.

[0116] A method of controlling a heat pump of the present disclosure is characterized in that a controller **400** of the cooling/heating heat pump is formed, the cooling/heating heat pump comprising:

[0117] a dehumidification heat exchanger **210** spaced apart from an indoor heat exchanger **51** and correspondingly mounted at the lower end is separately mounted on an interior unit **50**;

[0118] a cooling line **100** and a heating line **300** connected to an outdoor heat exchanger **31** of an outdoor unit **30** and formed by connecting the indoor heat exchanger **51** and the outdoor heat exchanger **31**; and

[0119] a dehumidification line **200** by an upper refrigerant line **210***a* functioning as a condenser in the dehumidification heat exchanger **210** and a lower refrigerant line **210***b* functioning as an evaporator separately from the cooling line **100** and the heating line **300**.

[0120] FIG. **1** is a schematic diagram showing a refrigerant system diagram for cooling and dehumidification by the method of controlling a heat pump with a dehumidification unit in an indoor unit according to the present disclosure.

[0121] In a heat pump system, a cooling line **100** is formed such that a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an outdoor unit **30**, flows into the 4-way valve **20** through an indoor heat exchanger **51** seated in an interior unit, and circulates back to an intake side **12** of the compressor **10**, in which indoor air that has passed through the indoor heat

exchanger **51** is cooled and dehumidified and supplied to the indoor, and high-temperature and high-humidity air is cooled and dehumidified.

[0122] Further, as a technical feature of the present disclosure, a refrigerant system is formed separately from the cooling line **100**.

[0123] The high-temperature and high-pressure refrigerant discharged from the discharge side **11** of the compressor **10** is discharged to the dehumidification line **200** formed between the discharge side **11** and the 4-way valve **20**, and a high-temperature and high-pressure refrigerant coming through an upper refrigerant line **210***a* of a dehumidification heat exchanger **210** spaced apart from and seated parallel with a lower end of the indoor heat exchanger **51** of the interior unit **50** changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve **220**, and flows back into a lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the passing refrigerant circulates to the compressor **10** through the intake side **12** of the compressor **10**.

[0124] Indoor air flowing inside through the front surface of the interior unit **50** is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line **210***b* of the dehumidification heat exchanger **210**, and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line **210***a* and is then cooled and dehumidified while passing through the indoor heat exchanger **51** and supplied to an interior.

[0125] Further, when indoor air is sufficiently cooled but has high humidity, the cooling line **100** stops operating and only the dehumidification line **200** is operated. To this end, a separate dehumidification heat exchanger **210** is provided in the interior unit **50**, a high-temperature and high-pressure refrigerant and a low-temperature and low-pressure refrigerant line passing a second expansion valve **220** are disposed together in the dehumidification heat exchanger **210**.

[0126] To this end,

[0127] the present disclosure is characterized in that when a cooling mode is started by a controller **400**, a dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously a cooling/heating valve **60** is opened, and only the cooling operation is operated, and

[0128] when a dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed, and

[0129] only the dehumidification operation is operated.

[0130] Further, according to the present disclosure, cooling and dehumidification operations are simultaneously operated, and

[0131] when a cooling/dehumidification mode is started, the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is also opened; and

[0132] a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the refrigerant line **100** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0133] Indoor air passing through the dehumidification heat exchanger **210** of the dehumidification line **200** increases in temperature, and is cooled and dehumidified while passing through the indoor heat exchanger **51**. This is operated at a supply place that precisely simultaneously controls temperature and humidity such as semiconductor equipment that precisely controls temperature and humidity of indoor air.

[0134] Further, the controller **400** of the present disclosure, in the cooling and dehumidification simultaneous operation mode and the heating and dehumidification simultaneous operation mode, controls the amounts of refrigerants supplied separately from the discharge side **11** of the compressor **10** such that the real-time temperature and humidity at the indoor supply place reach preset temperature and humidity; and

[0135] for this purpose, a refrigerant discharged from the compressor **10** is distributed at a preset ratio to the cooling and heating lines **100** and **300** and the dehumidification line **200**, and then supplied to the cooling and heating lines **100** and **300** and the dehumidification line **200**, respectively, and for the amounts of distributed refrigerants, temperature and humidity of the indoor air are measured in real time and the degrees of opening/closing of the cooling/heating valve **60** and the dehumidification valve **230** are automatically adjusted such that the temperature and humidity become preset temperature and humidity.

[0136] FIG. **2** is a schematic diagram showing a refrigerant system diagram for heating and dehumidification by the method of controlling a heat pump with a dehumidification unit in an indoor unit according to the present disclosure.

[0137] The present disclosure further includes a heating line **300** in which a high-temperature and high-pressure refrigerant discharged from a discharge side **11** of a compressor **10** passes through a 4-way valve **20** and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve **40** after passing through an indoor heat exchanger **51** seated in an interior unit **30**, and circulates back to an intake side **12** of the compressor **10** through an outdoor unit **30** and the 4-way valve **20**. This is formed by reversing the refrigerant circulation direction of the cooling line **100**.

[0138] When a heating mode is started by the controller **400** of the present disclosure, the dehumidification valve **230** formed in the dehumidification line **200** of the discharge side **11** of the compressor **10** is closed and simultaneously the cooling/heating valve **60** is opened, whereby the indoor air passing through the indoor heat exchanger **51** seated in the interior unit **50** increases in temperature and set indoor air is provided to the indoor supply place.

[0139] A technical feature of the present disclosure is that when a dehumidification mode is started, the dehumidification valve **230** formed in the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is closed, which is used for a low-temperature and high-humidity supply place with high humidity even in the winter season and is an operation mode for low-temperature and high-humidity indoor supply places such as a greenhouse that requires cultivation of plants.

[0140] Further, a technical feature of the present disclosure is characterized in that when a heating/dehumidification mode is started,

[0141] the dehumidification valve **230** formed on the dehumidification line **200** of the discharge side **11** of the compressor **10** is opened and simultaneously the cooling/heating valve **60** is opened, and

[0142] a refrigerant discharged from the compressor **10** is distributed and supplied at a preset ratio to the heating line **300** and the dehumidification line **200** and flows inside from a liquid separator **80** mounted at a front end of the compressor **10** to circulate to the compressor **10**.

[0143] For a low-temperature and high-humidify indoor environment, indoor air passing through the dehumidification heat exchanger **210** of the dehumidification line **200** increases in temperature, and is cooled and dehumidified while passing through the indoor heat exchanger **51**. This is operated in a supplier that precisely simultaneously controls temperature and humidity such as semiconductor equipment that precisely controls temperature and humidity of indoor air.

[0144] Further, for this purpose, a refrigerant discharged from the compressor **10** is distributed at a preset ratio to the refrigerant line **100** and the dehumidification line **200** and then supplied to the refrigerant line **100** and the dehumidification line **200**, respectively, and for the amounts of distributed refrigerants, temperature and humidity of the indoor air are measured in real time and the degrees of opening/closing of the cooling/heating valve **60** and the dehumidification valve **230** are automatically adjusted such that the temperature and humidity become preset temperature and humidity.

[0145] Although the present disclosure was described with reference to limited exemplary embodiments and drawings, the present disclosure is not limited thereto and may be changed and modified in various ways within the spirit of the present disclosure and claims described below by those skilled in the art.

[0146] As described above, the present disclosure has an effect that since a cooling/heating operation and a dehumidification operation are separately or simultaneously operated, it is easy to control cooling/heating and dehumidification operations and the dehumidification operation efficiency is increased.

[0147] Further, there is an effect that a system that operates to remove a large amount of humid is provided, and there is no need for a separate dehumidifier.

[0148] Further, in order to prevent reduction of efficiency and heating value and rapid reduction of heating efficiency due to defrosting of an evaporator of an outdoor heat exchanger in the wintertime, reheat pipes are used and heat is supplied through several steps to the reheat pipes, depending on the degree of defrosting and the degree of reduction of efficiency in the heating operation, thereby achieving a normal operation.

What is claimed is:

1. A cooling/heating heat pump system with a function of a dehumidification unit (**200**) inside an indoor unit, comprising:

a cooling line (**100**) in which a high-temperature and high-pressure refrigerant discharged from a discharge side (**11**) of a compressor (**10**) passes through a 4-way valve (**20**) and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve (**40**) after passing through an outdoor unit (**30**), flows into the 4-way valve (**20**) through an indoor heat exchanger (**51**) seated in an interior unit (**50**), and circulates back to an intake side (**12**) of the compressor (**10**); and

a dehumidification line (**200**) that is formed between the discharge side (**11**) and the 4-way valve (**20**) and in which the high-temperature and high-pressure refrigerant discharged from the discharge side (**11**) of the compressor (**10**) is discharged to the dehumidification line (**200**), a high-temperature and high-pressure refrigerant coming through an upper refrigerant line (**210***a*) of a dehumidification heat exchanger (**210**) spaced apart from and seated parallel with a lower end of the indoor heat exchanger (**51**) of the interior unit (**50**) changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve (**220**), and flows back into a lower refrigerant line of the dehumidification heat exchanger (**210**), and the passing refrigerant circulates to the compressor (**10**) through the intake side (**12**) of the compressor (**10**),

wherein indoor air flowing inside through a front surface of the interior unit (**50**) is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line (**210***b*) of the dehumidification heat exchanger (**210**), and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line (**210***a*) and is then cooled and dehumidified while passing through the indoor heat exchanger (**51**) and supplied to an interior;

when a cooling mode is started by a controller (**400**), a dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is closed and simultaneously a cooling/heating valve (**60**) is opened;

when a dehumidification mode is started, the dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is opened and simultaneously the cooling/heating valve (**60**) is closed,

when a cooling/dehumidification mode is started, the dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is opened and simultaneously the cooling/heating valve (**60**) is opened; and

a refrigerant discharged from the compressor (**10**) is distributed and supplied at a preset ratio to the cooling line (**100**) and the dehumidification line (**200**), and flows inside from a liquid separator (**80**) mounted at a front end of the compressor (**10**) to circulate to the compressor (**10**);

there is added a heating line (**300**) that includes the dehumidification line (**200**) and in which a high-temperature and high-pressure refrigerant discharged from a discharge side (**11**) of a compressor (**10**) passes through a 4-way valve (**20**) and changes into a low-temperature and low-pressure refrigerant while passing through a first expansion valve (**40**) after passing through an indoor heat exchanger (**51**) seated in an interior unit (**50**), and circulates back to an intake side (**12**) of the compressor (**10**) through an outdoor unit (**30**) and the 4-way valve (**20**),

several reheat pipes (**70**) having an electric heater rod (**71**) are formed at an inflow side of the outdoor unit (**30**) of the heating line (**300**), surface temperature of the outdoor heat exchanger (**31**) of the outdoor unit (**30**) and humidity temperature of inflow air flowing into the outdoor unit (**30**) are measured, the controller (**400**) determines whether to perform defrosting, and when a defrosting condition is reached, the electric heater rods (**70**) are operated such that several pieces are selectively simultaneously operated;

when a heating mode is started by a controller (**400**), a dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is closed and simultaneously a cooling/heating valve (**60**) is opened;

when a dehumidification mode is started, the dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is opened and simultaneously the cooling/heating valve (**60**) is closed,

when a heating/dehumidification mode is started, the dehumidification valve (**230**) formed on the dehumidification line (**200**) of the discharge side (**11**) of the compressor (**10**) is opened and simultaneously the cooling/heating valve (**60**) is also opened, and

a refrigerant discharged from the compressor (**10**) is distributed and supplied at a preset ratio to the heating line (**300**) and the dehumidification line (**200**) and flows inside from a liquid separator (**80**) mounted at a front end of the compressor (**10**) to circulate to the compressor (**10**);

several refrigerant divergent paths of the outdoor heat exchanger (**35**) of the outdoor unit (**30**) are composed of an upper path part (**35***a*), a middle path part (**35***b*), and a lower path part (**35***c*),

in the upper path part (**35***a*), a refrigerant flows into the upper end of the upper path part, forms a preset refrigerant path channel, is discharged to the upper end, and flows into an outdoor refrigerant collector (**38**) positioned at outer lower end of the outdoor heat exchanger;

in the middle path part (**35***b*), a refrigerant flows into the middle portion of the middle path part, forms a preset refrigerant path channel, is discharged to the middle portion, and flows into the outdoor refrigerant collector (**38**);

in the lower path part (**35***c*), a refrigerant flows into the lower end of the middle path part, forms a preset refrigerant path channel, is discharged to the lower end, and flows into the outdoor refrigerant collector (**38**); and

a refrigerant mixed in the outdoor refrigerant collector (**38**) flows back into the outdoor heat exchanger (**35**), exchanges heat, and is then discharged back to the outdoor heat exchanger (**35**).

2. The heat pump system of claim **1**, wherein the number of refrigerant pipes forming the upper refrigerant line (**210***a*) functioning as the condenser of the dehumidification heat exchanger (**210**) is greater than the number of refrigerant pipes forming the lower refrigerant lines (**210***b*) functioning as the evaporator.

3. The cooling/heating heat pump system of claim **1**, wherein the dehumidification heat exchanger (**210**) has thermal capacity smaller than that of the indoor heat exchanger (**51**).

4. The cooling/heating heat pump system of claim **2**, wherein the dehumidification heat exchanger (**210**) has thermal capacity smaller than that of the indoor heat exchanger (**51**).

5. A method of controlling a cooling/heating heat pump with a function of a dehumidification unit inside an interior unit (**50**), wherein

an indoor heat exchanger and a dehumidification heat exchanger (**210**) spaced apart from the indoor heat exchanger (**51**) and correspondingly mounted at the lower end is separately mounted on an interior unit (**50**),

a controller (**400**) is formed for the cooling/heating heat pump composed of:

a cooling line (**100**) and a heating line (**300**) connected to an outdoor heat exchanger (**31**) of an outdoor unit (**30**) and formed by connecting the indoor heat exchanger (**51**) and the outdoor heat exchanger (**31**); and

a dehumidification line (**200**) by an upper refrigerant line (**210***a*) functioning as a condenser in the dehumidification heat exchanger (**210**) and a lower refrigerant line (**210***b*) functioning as an evaporator separately from the cooling line (**100**) and the heating line (**300**),

the dehumidification line (**200**) is formed between the discharge side (**11**) and the 4-way valve (**20**) and in which the high-temperature and high-pressure refrigerant discharged from the discharge side (**11**) of the compressor (**10**) is discharged to the dehumidification line (**200**), a high-temperature and high-pressure refrigerant coming through an upper refrigerant line (**210***a*) of a dehumidification heat exchanger (**210**) spaced apart from and seated parallel with a lower end of the indoor heat exchanger (**51**) of the interior unit (**50**) changes into a low-temperature and low-pressure refrigerant while passing through a second expansion valve (**220**), and flows back into a lower refrigerant line (**210***b*) of the dehumidification heat exchanger (**210**), and the passing refrigerant circulates to the compressor (**10**) through the intake side (**12**) of the compressor (**10**);

indoor air flowing inside through a front surface of the interior unit (**50**) is cooled and dehumidified while passing through a heat exchanger of the lower refrigerant line (**210***b*) of the dehumidification heat exchanger (**210**), and the cooled and dehumidified air increases in temperature while passing through a heat exchanger of the upper refrigerant line (**210***a*) and is then cooled and dehumidified while passing through the indoor heat exchanger (**51**) and supplied to an interior;

the controller (**400**) receives temperature and humidity measured in real time at an indoor supply place, surface temperature of the outdoor heat exchanger (**31**), and humidity flowing into the outdoor heat exchanger (**31**), and controls them at preset values;

a control method of the cooling line (**100**) in which, in a cooling operation mode, the humidification line (**200**) is turned off, the indoor heat exchanger (**51**) is changed to function as an evaporator, a refrigerant is supplied, and preset temperature and humidity are controlled;

a control method of the dehumidification line (**200**) in which, in a dehumidification operation mode, the cooling line (**100**) and the heating line (**300**) are turned off, a refrigerant is supplied to the dehumidification heat exchanger (**210**), and temperature and humidity set in advance at the indoor supply place are controlled;

a control method of the heating line (**300**) in which, in a heating operation mode, the humidification line (**200**) is turned off, the indoor heat exchanger (**51**) is changed to function as a condenser, a refrigerant is supplied, and preset temperature and humidity are controlled;

the cooling line (**100**) and the dehumidification line (**200**) are controlled to simultaneously operate in cooling and dehumidification simultaneous operation mode,

the heating line (**300**) and the dehumidification line (**200**) are controlled to simultaneously operate in heating and dehumidification simultaneous operation mode,

the discharge side (**11**) of one compressor (**10**) constituting the heat pump is diverged into two refrigerant supplies, one is controlled such that a high-temperature and high-pressure refrigerant is supplied to the cooling line (**100**) and the heating line (**300**); the other is controlled such that each valve is opened/closed such that high-temperature and high-pressure refrigerant is supplied to the dehumidification line (**200**);

the controller (**400**) measures the surface temperature of the outdoor heat exchanger (**31**) and humidity temperature of inflow air and determines whether to perform defrosting, and when a defrosting condition is reached, several reheat pipes (**70**) equipped with an electric heater rod (**71**) installed at the inflow side of the outdoor unit (**30**) are operated such that several pieces are selectively simultaneously operated, and

the controller (**400**), in the cooling and dehumidification simultaneous operation mode and the heating and dehumidification simultaneous operation mode, controls the amounts of refrigerants supplied separately from the discharge side (**11**) of the compressor (**10**) such that the real-time temperature and humidity at the indoor supply place reach preset temperature and humidity.

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