(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 878 902 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
03.06.2015 Bulletin 2015/23

(21) Application number: **12881820.0**

(22) Date of filing: **24.07.2012**

(51) Int Cl.:
F25B 5/02 (2006.01) ***F24F 5/00*** (2006.01)
F25B 1/00 (2006.01)

(86) International application number:
PCT/JP2012/004708

(87) International publication number:
WO 2014/016865 (30.01.2014 Gazette 2014/05)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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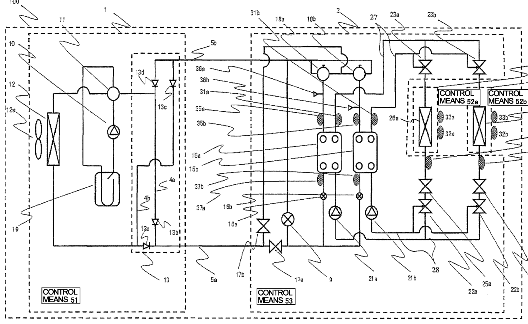
(54) **AIR-CONDITIONING DEVICE**

(57) An air-conditioning apparatus 100 includes a heat source-side unit 1 including a compressor 10 that compresses a refrigerant and a heat source-side heat exchanger 12 that exchanges heat between air and the refrigerant, a plurality of use-side units 2a, 2b each including a use-side heat exchanger 26a that exchanges heat between air and a heat medium, and a plurality of intermediate heat exchangers 15a, 15b connected to the heat source-side unit 1 via a refrigerant pipe and to the use-side units 2a, 2b via a heat medium pipe, and configured to exchange heat between the refrigerant and the heat medium. Target determination means 521 detects condensation status of each of the use-side units 2a, 2b and determines whether to perform condensation suppression control for suppressing condensation with respect to each of the use-side units 2a, 2b according to the condensation status. The use-side unit 2b determined by the target determination means 521 to be subjected to the condensation suppression control is connected to an intermediate heat exchanger for adjustment 15b among the plurality of intermediate heat exchangers 15a, 15b. Refrigerant circuit control means 53c controls a temperature of the refrigerant flowing into the intermediate heat exchanger for adjustment 15b so that the heat medium temperature T of the heat medium flowing into at least one use-side unit the use-side units 2b enters a predetermined target set temperature range.

FIG. 1



EP 2 878 902 A1

Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus capable of performing an air-conditioning operation utilizing cold water or hot water generated from a heat pump cycle (refrigeration cycle).

Background Art

[0002] Air-conditioning apparatuses have been proposed that include a heat pump cycle in which heat exchange is performed between a refrigerant and water, and are configured to transport the cold water or hot water to the indoor side for air conditioning, thereby preventing leakage of the refrigerant and contributing to reducing CFCs emission. In some of such apparatuses, a water heat exchanger is adopted in the air-conditioning refrigerant system composed of a compressor, an outdoor heat exchanger, an expansion device, an indoor heat exchanger, and an accumulator, and cold water or hot water generated in the water heat exchanger is transported by a pump and a valve so as to perform both cooling operation and heating operation at the same time, for example as disclosed in Patent Literature 1. In the air-conditioning apparatus according to Patent Literature 1, a unit including the refrigerant-water heat exchanger, and a water-based indoor unit are connected to the heat source unit, to thereby enable water-based air conditioning, despite being designed as a multi-air-conditioning apparatus for building.

Citation List

Patent Literature

[0003] Patent Literature 1: International Publication No. 2010/049998 (Fig. 3)

Summary of Invention

Technical Problem

[0004] However, in the case where water is used as the transport fluid for exchanging heat with air as proposed in Patent Literature 1, condensation is prone to take place because of higher specific heat. In particular, in the case where some of the indoor units performing the cooling operation are only designed for natural convection (for example, chilled beam), the temperature of the entirety of such indoor units drops and hence condensation often takes place, because the heat exchange amount by natural convection is small. Accordingly, it is preferable to suppress the condensation with respect to each individual indoor unit, when the system includes a plurality of indoor units as in Patent Literature 1. However, it is technically difficult to perform the control for suppressing the condensation with respect to each individual indoor unit.

[0005] The present invention has been accomplished in view of the foregoing problem, and provides an air-conditioning apparatus capable of independently performing condensation suppression control with respect to each of use-side units that are likely to suffer condensation, out of a plurality of use-side units. Solution to Problem

[0006] In an aspect, the present invention provides an air-conditioning apparatus that includes a heat source-side unit including a compressor that compresses a refrigerant and a heat source-side heat exchanger that exchanges heat between air and the refrigerant, a plurality of use-side units each including a use-side heat exchanger that exchanges heat between air and a heat medium, a plurality of intermediate heat exchangers connected to the heat source-side unit via a refrigerant pipe and connected to the use-side units via a heat medium pipe, and configured to exchange heat between the refrigerant and the heat medium, a heat medium flow switching device configured to switch combinations of connection between each of the use-side units and a corresponding one of the intermediate heat exchangers, condensation means configured to detect a condensation state of each of the use-side units, target determination means that determine whether to perform condensation suppression control for suppressing condensation with respect to each of the use-side units according to the condensation status detected by the condensation means, temperature means configured to detect, as a heat medium temperature, a temperature of the heat medium flowing into at least one use-side unit of the use-side units determined by the target determination means to be subjected to the condensation suppression control, heat medium circuit control means configured to control the heat medium flow switching device so as to connect the at least one use-side unit of the use-side units determined by the target determination means to be subjected to the condensation suppression control to an intermediate heat exchanger for adjustment assigned for the condensation suppression control among the plurality of intermediate heat exchangers, and refrigerant circuit control means configured to control a temperature of the refrigerant flowing into the intermediate heat exchanger for adjustment so that the heat medium temperature detected by the temperature detection means falls within a predetermined target set temperature range.

Advantageous Effects of Invention

[0007] The air-conditioning apparatus according to the present invention raises the temperature of the heat medium using the intermediate heat exchanger for adjustment when one or more of the plurality of use-side units have condensation or are likely to suffer condensation, and provides the heat medium to the use-side heat exchanger to thereby suppress the condensation. Such an arrangement enables suppression of condensation with respect to a specific use-side unit, without the need to suspend the normal operation of the remaining use-side units.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a circuit diagram showing a configuration of an air-conditioning apparatus 100 according to Embodiment 1 of the present invention.
[Fig. 2] Fig. 2 is a block diagram showing an example of the use-side unit control means shown in Fig. 1.
[Fig. 3] Fig. 3 is a block diagram showing an example of the intermediate unit control means shown in Fig. 1.
[Fig. 4] Fig. 4 is a control flowchart of condensation suppression control performed by the use-side unit control means of the air-conditioning apparatus 100 according to Embodiment 1 of the present invention.
[Fig. 5] Fig. 5 is a control flowchart of condensation suppression control performed by the intermediate unit control means of the air-conditioning apparatus 100 according to Embodiment 1 of the present invention.

Description of Embodiments

Embodiment 1

(Configuration of Air-Conditioning Apparatus)

[0009] Fig. 1 is a circuit diagram showing a configuration of an air-conditioning apparatus 100 according to Embodiment 1 of the present invention. The air-conditioning apparatus 100 shown in Fig. 1 is designed to be installed in a building, a condominium, a hotel, and the like, and to provide a cooling load and a heating load utilizing a heat pump cycle (refrigeration cycle) in which a refrigerant is circulated. The air-conditioning apparatus 100 adopts a system to indirectly utilize a heat source-side refrigerant. Specifically, the air-conditioning apparatus 100 transmits cooling energy or heating energy stored in the heat source-side refrigerant to a heat medium flowing in a circuit different from a circuit for the heat source-side refrigerant, to thereby cool or heat an air-conditioned space with the cooling energy or the heating energy transmitted to the heat medium.
[0010] The air-conditioning apparatus 100 includes one heat source unit 1 serving as a heat source device, a plurality of use-side units (indoor units) 2a, 2b, and an intermediate unit 3. The heat source unit 1 and the intermediate unit 3 are connected to each other via a refrigerant pipe (high-pressure main pipe 5a and low-pressure main pipe 5b), and the use-side units 2a, 2b are each connected to the intermediate unit 3 via a heat medium pipe. The cooling energy or the heating energy generated in the heat source unit 1 is transmitted to the use-side units 2a, 2b through the intermediate unit 3.
[0011] The heat source unit 1 is installed in a space outside of the building, for example on the roof thereof, and serves to provide the use-side units 2a, 2b with the cooling energy or the heating energy through the intermediate unit 3. Here, it is not mandatory that the heat source unit 1 be installed in a space outside of the building. For example, the heat source unit 1 may be installed in a surrounded space such as a machine room with a ventilation port, or inside of the building provided that waste heat can be discharged out of the building through an exhaust duct. Further, in the case of employing a water-cooling heat source unit 1, the heat source unit 1 may be installed inside of the building. Installing the heat source unit 1 in the cited locations will not incur particular inconvenience.
[0012] The use-side units 2a, 2b are, for example, indoor units of a ceiling cassette type, and installed in a position appropriate to supply cooling air or heating air to an air-conditioned space located inside the building, to provide the air-conditioned space with the cooling air or the heating air.
[0013] Here, the use-side units 2a, 2b are not limited to the ceiling cassette type, but may be recessed in the ceiling or suspended from the ceiling, or installed in any desired manner provided that the heating air or the cooling air can be blown into the air-conditioned space directly or via a duct or the like. In addition, although two use-side units 2a, 2b are shown in Fig. 1, three or more use-side units may be provided in the air-conditioning apparatus 100.

[0014] The intermediate unit 3 serves to transmit the cooling energy or the heating energy supplied from the heat source unit 1 to the use-side units 2a, 2b, by exchanging heat between the refrigerant flowing in a refrigerant circuit A on the side of the heat source unit 1 and the heat medium flowing in a heat medium circuit B on the side of the use-side units 2a, 2b. The intermediate unit 3 is installed in a casing independent from that of the heat source unit 1 and the use-side units 2a, 2b, so as to be placed at a position different from the outer space and the air-conditioned space. The intermediate unit 3 is connected to the heat source unit 1 via a high-pressure main pipe 5a and a low-pressure main pipe 5b, and to the use-side units 2a, 2b via heat medium pipes 27, 28, respectively.

(Configuration of Heat Source Unit 1)

[0015] The heat source unit 1 includes a compressor 10, a first refrigerant flow switching device 11, a heat source-side heat exchanger 12, and an accumulator 19, which are serially connected via a refrigerant pipe. The heat source unit 1 also includes heat source unit control means 51 that controls the frequency of the compressor 10 and flow path switching of the first refrigerant flow switching device 11. The compressor 10 sucks a refrigerant in a gas phase and compresses the refrigerant to increase the temperature and pressure thereof. The compressor 10 may be of a reciprocating, a rotary, a scroll, or a screw type, and may preferably include an inverter for controlling the capacity.

[0016] The first refrigerant flow switching device 11 includes a four-way valve for example, and serves to switch a refrigerant flow path according to a required operation mode. More specifically, the first refrigerant flow switching device 11 switches between a refrigerant flow path (heating flow path) used in a heating operation (heating-only operation mode and heating-main operation mode to be subsequently described) and the other refrigerant flow path (cooling flow path) used in a cooling operation (cooling-only operation and cooling-main operation mode to be subsequently described).

[0017] The heat source-side heat exchanger 12 exchanges heat between air supplied from an air-sending device 12a and the refrigerant, and serves as an evaporator in the heating operation and as a radiator (gas cooler) in the cooling operation. Although the heat source-side heat exchanger 12 of Embodiment 1 is an air heat exchanger which exchanges heat with the air supplied from the air-sending device 12a, the heat source-side heat exchanger 12 is not limited thereto; the heat source-side heat exchanger 12 may be a water heat exchanger which utilizes water or brine as heat source.

[0018] The accumulator 19 is provided on the suction side of the compressor 10, and serves to accumulate a surplus refrigerant generated from a difference between the heating operation and the cooling operation, or from a transition of an operation condition, such as a change in number of indoor units in operation.

[0019] The heat source unit 1 further includes a flow path provision section 13 composed of a first joint pipe 4a, a second joint pipe 4b, and check valves 13a to 13d. The first joint pipe 4a connects, in the heat source unit 1, a refrigerant pipe connecting between the first refrigerant flow switching device 11 and the check valve 13d to be subsequently described, to a refrigerant pipe connecting between the high-pressure main pipe 5a through which the refrigerant flows out of the heat source unit 1 and the check valve 13a to be subsequently described. The second joint pipe 4b connects, in the heat source unit 1, a refrigerant pipe connecting between the low-pressure main pipe 5b through which the refrigerant flows into the heat source unit 1 and the check valve 13d to be subsequently described, to a refrigerant pipe connecting between the heat source-side heat exchanger 12 and the check valve 13a to be subsequently described. Forming the flow path provision section 13 thus configured allows the refrigerant directed to the intermediate unit 3 through the high-pressure main pipe 5a and the low-pressure main pipe 5b to flow in a constant direction, irrespective of the operation mode required by the use-side units 2a, 2b.

[0020] The check valve 13a is provided in the refrigerant pipe connecting between the heat source-side heat exchanger 12 and the high-pressure main pipe 5a through which the refrigerant flows out of the heat source unit 1, and allows the refrigerant to flow only in the direction from the heat source-side heat exchanger 12 toward the intermediate unit 3. The check valve 13b is provided in the first joint pipe 4a, and allows the refrigerant discharged from the compressor 10 to flow only in the direction toward the intermediate unit 3, in the heating operation. The check valve 13c is provided in the second joint pipe 4b, and allows the refrigerant that has returned from the intermediate unit 3 to flow only in the direction toward the heat source-side heat exchanger 12, in the heating operation. The check valve 13d is provided in the refrigerant pipe connecting between the first refrigerant flow switching device 11 and the low-pressure main pipe 5b through which the refrigerant flows into the heat source unit 1, and allows the refrigerant to flow only in the direction from the low-pressure main pipe 5b toward the first refrigerant flow switching device 11.

(Configuration of Use-Side Units 2a, 2b)

[0021] The plurality of use-side units 2a, 2b respectively include use-side heat exchangers 26a, 26b, inlet temperature sensors 32a, 32b, and inlet humidity sensors 33a, 33b. Further, the use-side units 2a, 2b respectively include use-side unit control means 52a, 52b, configured to receive inlet temperature information detected by the inlet temperature sensors 32a, 32b and inlet humidity information detected by the inlet humidity sensors 33a, 33b, and to perform arithmetic operation on the basis of such information.

[0022] The use-side heat exchangers 26a, 26b are each connected to the heat medium pipe 27 through which the heat medium from the intermediate unit 3 flows, and the heat medium pipe 28 through which the heat medium from the use-side units 2 flows. The use-side heat exchangers 26a, 26b serve as radiators (gas coolers) in the heating operation, and as heat removers in the cooling operation. The use-side heat exchangers 26a, 26b exchange heat between indoor air supplied from a non-illustrated air-sending device such as a fan and the heat medium to thereby provide the air with cooling energy or heating energy, thus generating heating air or cooling air provided to the air-conditioned space. Here, although the use-side heat exchangers 26a, 26b are configured to receive the air supplied by a fan or the like in Embodiment 1, the use-side heat exchangers 26a, 26b may be coil-shaped heat exchangers with a wide fin pitch installed in a ceiling to utilize natural convection, generally known as a chilled beam.

(Configuration of Intermediate Unit 3)

[0023] The intermediate unit 3 includes an expansion device 9, a plurality of intermediate heat exchangers 15a, 15b, a plurality of refrigerant expansion devices 16a, 16b, a liquid refrigerant supply valve 17a, a gas refrigerant supply valve 17b, second refrigerant flow switching devices 18a, 18b, pumps 21 a, 21 b, secondary-side flow switching devices 22a, 22b, primary-side flow switching devices 23a, 23b, and heat medium control valves 25a, 25b.

[0024] The intermediate heat exchangers 15a, 15b each serve to exchange heat between the refrigerant and the heat medium, so as to transmit cooling energy or heating energy generated in the heat source unit 1 and stored in the refrigerant to the heat medium. The intermediate heat exchanger 15a is provided between the refrigerant expansion device 16a and the second refrigerant flow switching device 18a in the refrigerant circuit A. The intermediate heat exchanger 15b is provided between the refrigerant expansion device 16b and the second refrigerant flow switching device 18b in the refrigerant circuit A.

[0025] The refrigerant expansion devices 16a, 16b are each constituted of an electronic expansion valve capable of variably controlling the amount of expansion, and serve as an expansion/depressurizing valve in the refrigerant circuit A to expand and depressurize the refrigerant. The expansion device 16a has an end connected to the intermediate heat exchanger 15a and the other end connected to the liquid refrigerant supply valve 17a. The expansion device 16b has an end connected to the intermediate heat exchanger 15b and the other end connected to the liquid refrigerant supply valve 17a.

[0026] The intermediate heat exchangers 15a, 15b can set the heat medium to different temperatures, through control of the expansion devices 16a, 16b. For example, to make the temperature of the heat medium generated by the intermediate heat exchanger 15b higher than the temperature of the heat medium generated by the intermediate heat exchanger 15a, the expansion device 16b on the side of the intermediate heat exchanger 15b is made narrower than the expansion device 16a on the side of the intermediate heat exchanger 15a. In this case, the temperature of the refrigerant flowing into the intermediate heat exchanger 15b becomes higher than the temperature of the refrigerant flowing into the intermediate heat exchanger 15a, and therefore the temperature of the heat medium generated by the intermediate heat exchanger 15b becomes higher. Likewise, the temperature of the heat medium generated by the intermediate heat exchanger 15b can also be made higher than the temperature of the heat medium generated by the intermediate heat exchanger 15a. Thus, the refrigerant expansion devices 16a, 16b allow generation of the heat medium of different temperatures, despite the operation status being kept unchanged.

[0027] The liquid refrigerant supply valve 17a and the gas refrigerant supply valve 17b are for example two-way valves, and serve to open and close the refrigerant pipe in the refrigerant circuit A. The liquid refrigerant supply valve 17a has an end connected to the high-pressure main pipe 5a through which the refrigerant flows into the intermediate unit 3, and the other end connected to the expansion devices 16a, 16b. The gas refrigerant supply valve 17b has an end connected to the high-pressure main pipe 5a through which the refrigerant flows into the intermediate unit 3, and the other end connected to the second refrigerant flow switching devices 18a, 18b. The liquid refrigerant supply valve 17a and the gas refrigerant supply valve 17b may be selected according to the amount of the refrigerant flowing through the valve and the purpose thereof and, for example, a four-way valve may be employed in the case where each of the valves is controlled so as to open and close in different timings.

[0028] The second refrigerant flow switching devices 18a, 18b are each constituted of a four-way valve, and serve to switch the flow direction of the refrigerant according to the operation mode. More specifically, when the intermediate heat exchanger 15a serves as a radiator (the refrigerant radiates heat to the heat refrigerant), the second refrigerant flow switching device 18a is switched to a heating flow path which causes the high-temperature/high-pressure refrigerant coming through the gas refrigerant supply valve 17b to flow into the refrigerant flow path of the intermediate heat exchanger 15a. When the intermediate heat exchanger 15a serves as an evaporator (the refrigerant removes heat from the heat refrigerant), the second refrigerant flow switching device 18a is switched to a cooling flow path that causes the refrigerant flowing out of the refrigerant flow path of the intermediate heat exchanger 15a to flow toward the low-pressure main pipe 5b. Likewise, when the intermediate heat exchanger 15b serves as a radiator (the refrigerant radiates heat to water), the second refrigerant flow switching device 18b is switched to a heating flow path which causes the high-temperature/high-pressure refrigerant coming through the liquid refrigerant supply valve 17b to flow into the refrigerant flow path of the intermediate heat exchanger 15b. When the intermediate heat exchanger 15b serves as an evaporator (the refrigerant removes heat from water), the second refrigerant flow switching device 18b is switched to a cooling flow path that causes the refrigerant flowing out of the refrigerant flow path of the intermediate heat exchanger 15b to flow toward the low-pressure main pipe 5b.

[0029] The second refrigerant flow switching device 18a and the second refrigerant flow switching device 18b are configured to switch the refrigerant flow to different flow paths. For example, when the intermediate heat exchanger 15a generates a cooled heat medium and the intermediate heat exchanger 15b generates a heat medium higher in temperature than the heat medium of the intermediate heat exchanger 15a, the second refrigerant flow switching device 18a switches the flow path to the cooling flow path, and the second refrigerant flow switching device 18b switches to the heating flow path. Likewise, the temperature of the heat medium generated by the intermediate heat exchanger 15b can also be made higher than the temperature of the heat medium generated by the intermediate heat exchanger 15a. Thus, the intermediate heat exchangers 15a, 15b can be caused to generate the heat medium of different temperatures, by controlling the second refrigerant flow switching devices 18a, 18b.

[0030] The expansion device 9 has an end connected to the liquid refrigerant supply valve 17a and the other end connected to the low-pressure main pipe 5b in the refrigerant circuit A, and serves as an expansion/depressurizing valve to expand and depressurize the refrigerant.

[0031] The pumps 21 a, 21 b apply pressure to the water so as to circulate through the heat medium circuit B. The pump 21 a is provided in the heat medium pipe between the intermediate heat exchanger 15a and the heat medium flow switching devices 22. The pump 21 b is provided in the heat medium pipe between the intermediate heat exchanger 15b and the heat medium flow switching devices 22. Preferably, the capacity of the pumps 21 a, 21 b may be variably controllable by an inverter, or by the number of the pumps. In addition, although the pumps 21 a, 21 b are respectively provided on the suction side of the intermediate heat exchangers 15a, 15b, the pumps 21 a, 21 b may be provided on the outlet side of the intermediate heat exchangers 15a, 15b.

[0032] The heat medium flow switching devices 22, 23 are each constituted of a three-way valve for example, and serve to switch the combination of connection between the use-side units 2a, 2b and the intermediate heat exchangers 15a, 15b. The number of heat medium flow switching devices 22, 23 is determined in accordance with the number of use-side units 2a, 2b. The heat medium flow switching devices 22, 23 each have an end among the three ends connected to the pump 21 a, another end connected to the pump 21 b, and the remaining end connected to the flow rate control means 25.

[0033] The primary-side flow switching devices 23 are each constituted of a three-way valve for example, and serve to switch the water flow path in the heat medium circuit B, according to the operation mode. The number of the primary-side flow switching devices 23 is determined in accordance with the number of use-side units 2 (two in Fig. 1). In addition, the primary-side flow switching device 23 has an end among the three ends connected to the intermediate heat exchanger 15a, another end connected to the intermediate heat exchanger 15b, and the remaining end connected to the use-side heat exchangers 26.

[0034] The flow rate control means 25a, 25b are constituted of a two-way valve with variable aperture area, and have an end connected to the use-side heat exchangers 26 of the use-side units 2 and the other end connected to the secondary-side flow switching devices 22. The flow rate control means 25a, 25b serve to control the flow rate of the heat medium flowing through the use-side heat exchangers 26a, 26b, respectively. Although the flow rate control means 25a, 25b are provided in the heat medium pipe system on the outlet side of the use-side heat exchangers 26a, 26b in Fig. 1, the configuration is not limited thereto, the flow rate control means 25a, 25b may be provided in the heat medium pipe system on the inlet side of the use-side heat exchangers 26a, 26b (e.g., on the outlet side of the primary-side flow switching devices 23a, 23b).

[0035] The intermediate unit 3 also includes heat medium temperature sensors 31 a, 31 b, outlet water temperature sensors 34a, 34b, first refrigerant temperature sensors 35a, 35b, pressure sensors 36a, 36b, and second refrigerant temperature sensors 37a, 37b. Further, the intermediate unit 3 includes intermediate unit control means 53 that performs arithmetic operations on the basis of information provided from each of the sensors cited above.

[0036] The temperature sensors 31 a, 31 b serve to detect the temperature of the water flowing out of the intermediate heat exchangers 15a, 15b respectively, in other words the temperature of the water at the outlet of the flow path of the intermediate heat exchangers 15, and may be constituted of a thermistor for example. The temperature sensor 31 a is provided in the heat medium pipe on the outlet side of the intermediate heat exchanger 15a. The temperature sensor 31 b is provided in the heat medium pipe 28 on the outlet side of the intermediate heat exchanger 15b.

[0037] The outlet water temperature sensor 34a is provided between the use-side heat exchanger 26a and the flow rate control means 25a and serves to detect the temperature of the water flowing out of the use-side heat exchanger 26a, and may be constituted of a thermistor for example. The number of outlet water temperature sensors 34 is determined in accordance with the number of use-side units 2 (two in Fig. 1).

[0038] The first refrigerant temperature sensors 35 are respectively provided between the intermediate heat exchangers 15 and the second refrigerant flow switching devices 18 to detect the temperature of the refrigerant flowing into and out of the intermediate heat exchangers 15, and may be constituted of a thermistor for example. The first refrigerant temperature sensor 35a is provided between the intermediate heat exchanger 15a and the second refrigerant flow switching device 18a. The first refrigerant temperature sensor 35b is provided between the intermediate heat exchanger 15b and the second refrigerant flow switching device 18b.

[0039] The pressure sensors 36 are, like the first refrigerant temperature sensors 35, provided between the intermediate heat exchangers 15 and the second refrigerant flow switching devices 18a, 18b, and serve to detect the pressure of the refrigerant flowing between the intermediate heat exchangers 15a, 15b and the refrigerant flow switching devices 18a, 18b. The pressure sensor 36a is provided between the intermediate heat exchanger 15a and the refrigerant flow switching device 18a. The pressure sensor 36b is provided between the intermediate heat exchanger 15b and the second refrigerant flow switching device 18b.

[0040] The second refrigerant temperature sensors 37 are respectively provided between the intermediate heat exchangers 15 and the expansion devices 16 to detect the temperature of the refrigerant flowing into and out of the intermediate heat exchangers 15, and may be constituted of a thermistor for example. The second refrigerant temperature sensor 37a is provided between the intermediate heat exchanger 15a and the expansion device 16a. The second refrigerant temperature sensor 37b is provided between the intermediate heat exchanger 15b and the expansion device 16b.

[0041] Now, the air-conditioning apparatus 100 includes the refrigerant circuit A and the heat medium circuit B, and the heat exchange is performed between the refrigerant circulating in the refrigerant circuit A through the intermediate heat exchangers 15a, 15b and the water circulating in the heat medium circuit B.

[0042] Specifically, the refrigerant circuit A is composed of the compressor 10, the first refrigerant flow switching device 11, the heat source-side heat exchanger 12, the flow path provision section 13, the accumulator 19, the liquid refrigerant supply valve 17a, the gas refrigerant supply valve 17b, the second refrigerant flow switching devices 18a, 18b, the refrigerant flow path in the intermediate heat exchangers 15a, 15b, the expansion devices 16a, 16b, and the expansion device 9, which are connected via the refrigerant pipe.

[0043] Although the refrigerant circulating in the refrigerant circuit A is not specifically limited, non-azeotropic refrigerant mixtures, near-azeotropic refrigerant mixtures, single refrigerants, and natural refrigerants are applicable to the refrigeration cycle of the air-conditioning apparatus 100 according to Embodiment 1. Examples of the non-azeotropic refrigerant mixture include R407C (R32/R125/R134a) which is a hydro fluorocarbon (HFC) refrigerant. The non-azeotropic refrigerant mixture is a mixture of refrigerants having different boiling points, and hence has different composition ratios between liquid-phase refrigerants and gas-phase refrigerants. Examples of the near-azeotropic refrigerant mixture include R410A (R32/R125) and R404A (R125/R143a/R134a) which are HFC refrigerants. The near-azeotropic refrigerant mixture has a characteristic similar to that of the non-azeotropic refrigerant mixture and, in addition, provides a working pressure approximately 1.6 times higher than the pressure of R22. Examples of the single refrigerant include R22 which is a hydrochlorofluorocarbon (HCFC) refrigerant, and R134a which is a HFC refrigerant. The single refrigerant is easy to handle, because of not being a mixture. Examples of the natural refrigerant include carbon dioxide, propane, isobutane, and ammonium. Here, R22 represents chlorodifluoromethane, R32 represents difluoromethane, R125 represents pentafluoromethane, R134a represents 1,1,1,2-tetrafluoromethane, and R143a represents 1,1,1-trifluoroethane. Therefore, it is preferable to employ a suitable refrigerant according to the purpose and the condition of use of the air-conditioning apparatus 100.

[0044] On the other hand, the flow paths of the intermediate heat exchangers 15a, 15b, the pumps 21 a, 21 b, the secondary-side flow switching devices 22a, 22b, the flow rate control means 25a, 25b, the use-side heat exchangers 26a, 26b, and the primary-side flow switching devices 23a, 23b are connected via the heat medium pipe, thus constituting the heat medium circuit B.

[0045] For example, water or brine (antifreeze solution) may be employed as the heat medium circulating in the heat medium circuit B. The type of the antifreeze agent of the antifreeze solution is not specifically limited, but preferably ethyleneglycol, propyleneglycol, or the like may be adopted according to the purpose of use. Since the cited heat media have high level of safety, there is little likelihood that harm or trouble is incurred even though the heat medium leaks out of the use-side units 2a, 2b into the air-conditioned space.

[0046] Hereunder, description will be given on the operation modes performed by the air-conditioning apparatus 100 shown in Fig. 1. The air-conditioning apparatus 100 is configured to receive an instruction from each of the use-side units 2a, 2b and to cause the corresponding use-side units 2a, 2b to perform a cooling operation or heating operation. Further, the air-conditioning apparatus 100 is configured to cause both of the use-side units 2a, 2b to perform the same operation, or allow each of the use-side units 2 to perform a different operation.

[0047] The operation modes that the air-conditioning apparatus 100 is configured to perform include a cooling-only operation mode in which all of the use-side units 2 perform the cooling operation, a heating-only operation mode in which all of the use-side units 2 perform the heating operation, a cooling-main operation mode in which the cooling load is larger, and a heating-main operation mode in which the heating load is larger. Each of the mentioned operation modes will described hereunder, along with the flow of the refrigerant and the water.

(Cooling-Only Operation Mode)

[0048] In the cooling-only operation mode, on the side of the refrigerant circuit A the refrigerant flow path is switched by the first refrigerant flow switching device 11 so as to cause the refrigerant discharged from the compressor 10 to flow into the heat source-side heat exchanger 12. In addition, in the intermediate unit 3 the liquid refrigerant supply valve 17a is opened and the gas refrigerant supply valve 17b is closed. Further, the second refrigerant flow switching devices 18a, 18b respectively set the cooling flow paths that cause the refrigerant flowing out of the refrigerant flow path in the intermediate heat exchangers 15a, 15b to flow toward the low-pressure main pipe 5b. On the side of the heat medium circuit B, on the other hand, the pumps 21 a, 21 b are activated and the flow rate control means 25a, 25b are opened so as to cause the heat medium to circulate between the intermediate heat exchangers 15a, 15b and the use-side heat exchangers 26a, 26b, respectively, in the intermediate unit 3.

[0049] Referring first to Fig. 1, the flow of the refrigerant in the refrigerant circuit A will be described. The low-temperature/low-pressure gas refrigerant is compressed by the compressor 10 and discharged in the state of the high-temperature/high-pressure refrigerant. The high-temperature/high-pressure refrigerant discharged from the compressor 10 passes through the first refrigerant flow switching device 11 and flows into the heat source-side heat exchanger 12 which serves as a condenser. The high-temperature/high-pressure gas refrigerant is condensed through heat exchange with outside air while passing through the heat source-side heat exchanger 12, and turns into a high-pressure liquid refrigerant. Thus, the high-temperature/high-pressure refrigerant turns into the high-pressure refrigerant by radiating heat to the outdoor air, and flows out of the heat source unit 1 through the check valve 13a. Then the high-pressure refrigerant flows into the intermediate unit 3 through the high-pressure main pipe 5a.

[0050] The high-pressure refrigerant which has entered the intermediate unit 3 is branched after passing through the liquid refrigerant supply valve 17a, and flows into the expansion devices 16a, 16b. The high-pressure heat medium is expanded and depressurized in the expansion devices 16a, 16b, thus to turn into a low-temperature/low-pressure gas-liquid two-phase refrigerant. The gas-liquid two-phase refrigerant flows into each of the intermediate heat exchangers 15a, 15b which serve as evaporators, and cools the heat medium circulating in the heat medium circuit B by removing heat from that heat medium, by which the two-phase refrigerant is evaporated thus to turn into the low-temperature/low-pressure gas refrigerant. The gas refrigerant which flows out from each of the intermediate heat exchangers 15a, 15b joins after respectively passing through the second refrigerant flow switching devices 18a, 18b, and flows out of the intermediate unit 3. The gas refrigerant then passes through the low-pressure main pipe 5b and again flows into the heat source unit 1. The gas refrigerant which has entered heat source unit 1 passes through the check valve 13d, the first refrigerant flow switching device 11, and the accumulator 19, and is again sucked into the compressor 10.

[0051] Still referring to Fig. 1, the flow of the heat medium in the heat medium circuit B will be described. In the cooling-only operation mode, the cooling energy of the refrigerant is transmitted to the heat medium in the intermediate heat exchangers 15a, 15b, and the cooled water is driven by the pumps 21 a, 21 b to flow through the heat medium circuit B. The heat medium pressurized and driven out from the pumps 21 a, 21 b flows into the intermediate heat exchangers 15a, 15b respectively, and is cooled by the refrigerant circulating in the refrigerant circuit A. The heat medium which has flowed out of the intermediate heat exchanger 15a is branched halfway and flows out of the intermediate unit 3 through each of the primary-side flow switching devices 23a, 23b, and then flows into each of the use-side units 2a, 2b. Likewise, the heat medium which has flowed out of the intermediate heat exchanger 15b is branched halfway and flows out of the intermediate unit 3 through each of the primary-side flow switching devices 23a, 23b, and then flows into each of the use-side units 2a, 2b.

[0052] The heat medium which has entered the use-side unit 2a, 2b flows into the use-side heat exchangers 26a, 26b, respectively, and cools the air-conditioned space by removing heat from the air in the air-conditioned space. The heat medium which has flowed out of the use-side heat exchangers 26a, 26b flows out of the use-side units 2a, 2b respectively, and flows into the intermediate unit 3 through the heat medium pipe.

[0053] The heat medium which has entered the intermediate unit 3 flows into each of the flow control valves 25a, 25b. At this point, the heat medium flows into the use-side heat exchangers 26a, 26b at a flow rate controlled by the flow control valves 25a, 25b so as to satisfy the air-conditioning load required in the air-conditioned space. The heat medium which has flowed out of the flow control valve 25a is branched at the secondary-side flow switching device 22a and sucked into each of the pumps 21 a, 21 b. The water which has flowed out of the flow control valve 25b passes through the flow control valve 25b and is branched at the secondary-side flow switching device 22b, and then sucked into each of the pumps 21 a, 21 b.

(Heating-Only Operation Mode)

[0054] In the heating-only operation mode, on the side of the refrigerant circuit A the refrigerant flow path is switched by the first refrigerant flow switching device 11 so as to cause the refrigerant discharged from the compressor 10 to flow into the intermediate unit 3. In addition, the liquid refrigerant supply valve 17a is closed and the gas refrigerant supply valve 17b is opened. Further, the second refrigerant flow switching device 18b sets the heating flow path that causes the high-temperature/high-pressure refrigerant flowing from the gas refrigerant supply valve 17b to flow into the refrigerant flow path in the intermediate heat exchanger 15b to flow toward the low-pressure main pipe 5b. On the side of the heat medium circuit B, the pumps 21 a, 21 b are activated and the flow rate control means 25a, 25b are opened so as to cause the heat medium to circulate between the intermediate heat exchangers 15a, 15b and the use-side heat exchangers 26a, 26b, respectively, in the intermediate unit 3.

[0055] First, the flow of the refrigerant in the refrigerant circuit A will be described. The low-temperature/low-pressure gas refrigerant is compressed by the compressor 10 and discharged in the state of the high-temperature/high-pressure refrigerant. The high-temperature/high-pressure refrigerant discharged from the compressor 10 passes through the first refrigerant flow switching device 11, flows out of the heat source unit 1 through the check valve 13b in the first joint pipe 4a, and flows into the intermediate unit 3 through the high-pressure main pipe 5a.

[0056] The high-temperature/high-pressure refrigerant which has entered the intermediate unit 3 is branched after passing through the gas refrigerant supply valve 17b, and flows into the intermediate heat exchangers 15a, 15b, which serve as radiators, through the second refrigerant flow switching devices 18a, 18b, respectively. The high-temperature/high-pressure refrigerant which has entered each of the intermediate heat exchangers 15a, 15b turns into the high-pressure refrigerant while heating the water by radiating heat to the refrigerant circulating in the heat medium circuit B. The high-pressure refrigerant flows out of the intermediate heat exchangers 15a, 15b and flows into the expansion devices 16a, 16b respectively, to be expanded and depressurized thus to turn into the low-temperature/low-pressure gas-liquid two-phase refrigerant. The gas-liquid two-phase refrigerant joins and is further expanded and depressurized by the expansion device 9, and then flows out of the intermediate unit 3 and again flows into the heat source unit 1 through the low-pressure main pipe 5b.

[0057] The gas-liquid two-phase refrigerant which has entered the heat source unit 1 flows into the heat source-side heat exchanger 12 through the check valve 13c in the second joint pipe 4b, and vaporizes by removing heat from outdoor air thus to turn into the low-temperature/low-pressure gas refrigerant, and then again flows into the compressor 10 through the first refrigerant flow switching device 11 and the accumulator 19.

[0058] Still referring to Fig. 1, the flow of the heat medium in the heat medium circuit B will be described. In the heating-only operation mode, the heating energy of the refrigerant is transmitted to the water in both of the intermediate heat exchangers 15a, 15b, and the heated heat medium is driven by the pumps 21 a, 21 b to flow through the heat medium circuit B. The heat medium pressurized and driven out from the pumps 21 a, 21 b flows into the intermediate heat exchangers 15a, 15b respectively, and is heated by the refrigerant circulating in the refrigerant circuit A. The heat medium which has flowed out of the intermediate heat exchanger 15a is branched halfway and flows out of the intermediate unit 3 through each of the primary-side flow switching devices 23a, 23b, and then flows into each of the use-side units 2a, 2b. Likewise, the heat medium which has flowed out of the intermediate heat exchanger 15b is branched halfway and flows out of the intermediate unit 3 through each of the primary-side flow switching devices 23a, 23b, and then flows into each of the use-side units 2a, 2b.

[0059] The heat medium which has entered the use-side units 2a, 2b flows into the use-side heat exchangers 26a, 26b, respectively, and radiates heat to the air in the air-conditioned space, thereby performing the heating operation for the air-conditioned space. Then the heat medium which has flowed out of the use-side heat exchangers 26a, 26b flows out of the use-side units 2a, 2b, respectively, and flows into the intermediate unit 3 through the heat medium pipe.

[0060] The heat medium which has entered the intermediate unit 3 flows into each of the flow control valves 25a, 25b. At this point, the heat medium flows into the use-side heat exchangers 26a, 26b at a flow rate controlled by the flow control valves 25a, 25b so as to satisfy the air-conditioning load required in the air-conditioned space. The heat medium which has flowed out of the flow control valve 25a passes through the flow control valve 25a and is branched at the secondary-side flow switching device 22a, and then sucked into each of the pumps 21 a, 21 b. The heat medium which has flowed out of the flow control valve 25b passes through the flow control valve 25b and is branched at the secondary-side flow switching device 22b, and then sucked into each of the pumps 21 a, 21 b.

(Cooling-Main Operation Mode)

[0061] The cooling-main operation mode performed by the air-conditioning apparatus 100 shown in Fig. 1 will be described hereunder, on the assumption that a cooling load is required by the use-side heat exchanger 26a and a heating load is required by the use-side heat exchanger 26b. Here, in the cooling-main operation mode the refrigerant flow path is switched by the first refrigerant flow switching device 11 so as to cause the refrigerant discharged from the compressor 10 to flow into the heat source-side heat exchanger 12. In addition, the expansion device 16a is fully opened, the liquid refrigerant supply valve 17a is opened, and the gas refrigerant supply valve 17b is opened. Further, in the intermediate unit 3 the pumps 21 a, 21 b are activated and the flow rate control means 25a, 25b are opened, so as to cause the heat medium to circulate between the intermediate heat exchangers 15a, 15b and the use-side heat exchangers 26a, 26b.

[0062] Referring again to Fig. 1, the flow of the refrigerant in the refrigerant circuit A will be described.

[0063] The low-temperature/low-pressure gas refrigerant is compressed by the compressor 10 and discharged in the state of the high-temperature/high-pressure refrigerant. The high-temperature/high-pressure refrigerant discharged from the compressor 10 flows into the heat source-side heat exchanger 12 through the first refrigerant flow switching device 11, turns into the high-pressure refrigerant having a lowered temperature by radiating heat to outdoor air, flows out of the heat source unit 1 through the check valve 13a, and flows into the intermediate unit 3 through the high-pressure main pipe 5a.

[0064] The high-pressure refrigerant which has entered the intermediate unit 3 flows into the intermediate heat exchanger 15b which serves as a radiator through the gas refrigerant supply valve 17b and the second refrigerant flow switching device 18b. Then the high-pressure refrigerant radiates heat through the intermediate heat exchanger 15b to the heat medium circulating in the heat medium circuit B. Accordingly, the high-pressure refrigerant heats the heat medium and turns into the high-pressure refrigerant having a further lowered temperature. The high-pressure refrigerant which has flowed out of the intermediate heat exchanger 15b is expanded and depressurized by the expansion device 16b thus turning into the low-temperature/low-pressure gas-liquid two-phase refrigerant, flows into the intermediate heat exchanger 15a which serves as an evaporator through the expansion device 16a, and vaporizes while cooling the heat medium circulating in the heat medium circuit B by removing heat from the heat medium, thereby turning into the low-temperature/low-pressure gas refrigerant. The gas refrigerant which has flowed out of the intermediate heat exchanger 15a flows out of the intermediate unit 3 through the second refrigerant flow switching device 18a, and again flows into the heat source unit 1 through the low-pressure main pipe 5b. The gas refrigerant which has entered the heat source unit 1 passes through the check valve 13d, the first refrigerant flow switching device 11, and the accumulator 19, and is again sucked into the compressor 10.

[0065] Still referring to Fig. 1, the flow of the heat medium in the heat medium circuit B will be described. In the cooling-main operation mode, the cooling energy of the refrigerant is transmitted to the heat medium in the intermediate heat exchanger 15a, and the cooled heat medium is driven by the pump 21 a to flow through the heat medium circuit B. In addition, in the cooling-main operation mode the heating energy of the refrigerant is transmitted to the heat medium in the intermediate heat exchanger 15b, and the heated heat medium is driven by the pump 21 b to flow through the heat medium circuit B.

[0066] The heat medium pressurized and driven out from the pump 21 a flows into the intermediate heat exchanger 15a and is cooled by the refrigerant circulating in the refrigerant circuit A. The heat medium pressurized and driven out from the pump 21 b flows into the intermediate heat exchanger 15b and is heated by the refrigerant circulating in the refrigerant circuit A. The heat medium which has flowed out of the intermediate heat exchanger 15a flows out of the intermediate unit 3 through the primary-side flow switching device 23a and flows into the use-side unit 2a. The heat medium which has flowed out of the intermediate heat exchanger 15b flows out of the intermediate unit 3 through the primary-side flow switching device 23b, and flows into the use-side unit 2b.

[0067] The cooled heat medium which has entered the use-side unit 2a flows into the use-side heat exchanger 26a, while the heated heat medium which has entered the use-side unit 2b flows into the use-side heat exchanger 26b. The heat medium which has entered the use-side heat exchanger 26a removes heat from the air in the air-conditioned space, thereby cooling the air-conditioned space. In contrast, the heat medium which has entered the use-side heat exchanger 26b radiates heat to the air in the air-conditioned space, thereby heating the air-conditioned space. Then the heat medium flowing out of the use-side heat exchanger 26a and now having an increased temperature flows out of the use-side unit 2a and flows into the intermediate unit 3 through the heat medium pipes 27, 28. On the other hand, the heat medium flowing out of the use-side heat exchanger 26b and now having a lower temperature flows out of the use-side unit 2b and flows into the intermediate unit 3 through the heat medium pipes 27, 28.

[0068] The heat medium which has entered the intermediate unit 3 from the use-side heat exchanger 26a flows into the flow rate control means 25a, while the heat medium which has entered the intermediate unit 3 from the use-side heat exchanger 26b flows into the flow rate control means 25b. At this point, the heat medium flows into the use-side heat exchangers 26a, 26b at a flow rate controlled by the flow control valves 25a, 25b so as to satisfy the air-conditioning load required in the air-conditioned space. The heat medium which has flowed out of the flow control valve 25a passes through the secondary-side flow switching device 22a and is again sucked into the pump 21 a. Likewise, the heat medium which has flowed out of the flow control valve 25b passes through the secondary-side flow switching device 22b and is again sucked into the pump 21 b. As described above, in the cooling-main operation mode the portions of the heat medium set to different temperatures can be separately supplied, without being mixed with each other, to the use-side heat exchangers 26 where the cooling load and the heating load are required, owing to the operation of the primary-side flow switching devices 23 and the secondary-side flow switching devices 22.

(Heating-Main Operation Mode)

[0069] The heating-main operation mode performed by the air-conditioning apparatus 100 shown in Fig. 1 will be described hereunder, on the assumption that a heating load is required by the use-side heat exchanger 26a and a cooling load is required by the use-side heat exchanger 26b. In the heating-main operation mode, the refrigerant flow path is switched by the first refrigerant flow switching device 11 so as to cause the refrigerant discharged from the compressor 10 to flow into the intermediate unit 3 without passing through the heat source-side heat exchanger 12, in the heat source unit 1. In addition, the expansion device 16a is fully opened, the liquid refrigerant supply valve 17a is closed, and the gas refrigerant supply valve 17b is opened. Further, in the intermediate unit 3 the pumps 21 a, 21 b are activated and the flow rate control means 25a, 25b are opened, so as to cause the heat medium to circulate between the intermediate heat exchangers 15a, 15b and the use-side heat exchangers 26a, 26b, respectively.

[0070] Referring again to Fig. 1, the flow of the refrigerant in the refrigerant circuit A will be described. The low-temperature/low-pressure gas refrigerant is compressed by the compressor 10 and discharged in the state of the high-temperature/high-pressure refrigerant. The high-temperature/high-pressure refrigerant discharged from the compressor 10 passes through the first refrigerant flow switching device 11 and flows out of the heat source unit 1 through the check valve 13b in the first joint pipe 4a, and then flows into the intermediate unit 3 through the high-pressure main pipe 5a.

[0071] The high-temperature/high-pressure refrigerant which has entered the intermediate unit 3 flows into the intermediate heat exchanger 15b which serves as a radiator through the gas refrigerant supply valve 17b and the second refrigerant flow switching device 18b, and heats the heat medium circulating in the heat medium circuit B by radiating heat to the heat medium, thus turning into the high-pressure refrigerant. The high-pressure refrigerant which has flowed out of the intermediate heat exchanger 15b is expanded and depressurized by the expansion device 16b thus turning into the low-temperature/low-pressure gas-liquid two-phase refrigerant. The low-temperature/low-pressure gas-liquid two-phase refrigerant flows into the intermediate heat exchanger 15a which serves as an evaporator through the expansion device 16a, and cools the heat medium circulating in the heat medium circuit B by removing heat from the heat medium, thus turning into the refrigerant having an increased temperature. The refrigerant which has flowed out of the intermediate heat exchanger 15a flows out of the intermediate unit 3 through the second refrigerant flow switching device 18a, and again flows into the heat source unit 1 through the low-pressure main pipe 5b.

[0072] The refrigerant which has entered the heat source unit 1 flows into the heat source-side heat exchanger 12 through the check valve 13c in the second joint pipe 4b, vaporizes by removing heat from outdoor air thus turning into the low-temperature/low-pressure gas refrigerant, and is again sucked into the compressor 10 through the first refrigerant flow switching device 11 and the accumulator 19.

[0073] Still referring to Fig. 1, the flow of the heat medium in the heat medium circuit B will be described. In the heating-main operation mode, the cooling energy of the refrigerant is transmitted to the heat medium in the intermediate heat exchanger 15a, and the cooled heat medium is driven by the pump 21 a to flow through the heat medium circuit B. In addition, in the heating-main operation mode the heating energy of the refrigerant is transmitted to the heat medium in the intermediate heat exchanger 15a, and the heated heat medium is driven by the pump 21 b to flow through the heat medium circuit B.

[0074] The heat medium pressurized and driven out from the pump 21 a flows into the intermediate heat exchanger 15a and is cooled by the refrigerant circulating in the refrigerant circuit A. The heat medium pressurized and driven out from the pump 21 b flows into the intermediate heat exchanger 15b and is heated by the refrigerant circulating in the refrigerant circuit A. The heat medium which has flowed out of the intermediate heat exchanger 15a flows out of the intermediate unit 3 through the primary-side flow switching device 23b and flows into the use-side unit 2b. The heat medium which has flowed out of the intermediate heat exchanger 15b flows out of the intermediate unit 3 through the primary-side flow switching device 23a, and flows into the use-side unit 2a.

[0075] The heat medium which has entered the use-side unit 2a flows into the use-side heat exchanger 26a, while the heat medium which has entered the use-side unit 2b flows into the use-side heat exchanger 26b. The heat medium which has entered the use-side heat exchanger 26a radiates heat to the air in the air-conditioned space, thereby heating the air-conditioned space. In contrast, the heat medium which has entered the use-side heat exchanger 26b removes heat from the air in the air-conditioned space, thereby cooling the air-conditioned space. Then the heat medium flowing out of the use-side heat exchanger 26a and now having a lowered temperature flows out of the use-side unit 2a and flows into the intermediate unit 3 through the heat medium pipes 27, 28. On the other hand, the heat medium flowing out of the use-side heat exchanger 26b and now having an increased temperature flows out of the use-side unit 2b and flows into the intermediate unit 3 through the heat medium pipes 27, 28.

[0076] The heat medium which has entered the intermediate unit 3 from the use-side heat exchanger 26a flows into the flow rate control means 25a, while the heat medium which has entered the intermediate unit 3 from the use-side heat exchanger 26b flows into the flow rate control means 25b. At this point, the heat medium flows into the use-side heat exchangers 26a, 26b at a flow rate controlled by the flow control valves 25a, 25b so as to satisfy the air-conditioning load required in the air-conditioned space. The heat medium which has flowed out of the flow control valve 25a passes through the secondary-side flow switching device 22a and is again sucked into the pump 21 b. Likewise, the heat medium which has flowed out of the flow control valve 25b passes through the secondary-side flow switching device 22b and is again sucked into the pump 21 a. As described above, in the heating-main operation mode the portions of the heat medium set to different temperatures can be separately supplied, without being mixed with each other, to the use-side heat exchangers 26 where the cooling load and the heating load are required, owing to the operation of the primary-side flow switching devices 23 and the secondary-side flow switching devices 22.

[0077] The four operation modes have been described on the assumption that both of the use-side units 2a, 2b are operated for cooling or heating. In the case where either of the use-side units 2a, 2b is out of operation, the flow rate control means 25 is closed, so as not to perform the cooling or heating operation.

(Configuration of Control Device)

[0078] The air-conditioning apparatus 100 shown in Fig. 1 includes the heat source unit control means 51, the use-side unit control means 52a, 52b, and the intermediate unit control means 53. The heat source unit control means 51 is provided in the heat source unit 1, the use-side unit control means 52a, 52b are respectively provided in the use-side units 2, and the intermediate unit control means 53 is provided in the intermediate unit 3. The control means 51 to 53 are communicable with each other via a non-illustrated communication means (wired or wireless), and configured to control the corresponding units by exchanging information via the communication means.

[0079] The control means 51 to 53 are each constituted of a microcomputer, a digital signal processor (DSP), or the like, and serve to control the overall operation of the air-conditioning apparatus 100. The control means 51 to 53 may be set up so as to perform distributed autonomous cooperative control, to independently control the respective corresponding units (heat source unit 1, use-side units 2a, 2b, and intermediate unit 3). Alternatively, control means may be provided in one of the units, so as to collectively control the actuator and other components of each of the units.

[0080] The control means 51 to 53 are configured to perform condensation suppression control. The condensation suppression control herein referred to includes determining whether condensation takes place with respect to each of the use-side units 2a, 2b, and generating, upon determining that the condensation is taking place or is likely to take place, the heat medium of a temperature different from the temperature for the normal operation and supplying such heat medium to the use-side heat exchanger 26a or 26b of the corresponding use-side unit 2a or 2b. The heat medium of the different temperature for suppressing condensation is generated by one or more intermediate heat exchangers for adjustment 15b among the plurality of intermediate heat exchangers 15a, 15b. Which of the intermediate heat exchangers is designated as the intermediate heat exchanger for adjustment is determined in advance in each of the control means 51 to 53.

[0081] The heat source unit control means 51 controls the flow path, the pressure condition, and the temperature condition of the refrigerant in the heat source unit 1. More specifically, the heat source unit control means 51 performs arithmetic operations on the basis of pressure information and temperature information respectively detected by a pressure sensor and a temperature sensor (neither shown), and then controls the frequency of the compressor 10, the fan rotation speed of the air-sending device 12a, the flow path switching of the first refrigerant flow switching device 11, and so forth.

[0082] Fig. 2 is a block diagram showing an example of the use-side unit control means 52a, 52b. Here, it is assumed that the use-side unit control means 52a, 52b have the same configuration. The use-side unit control means 52a, 52b serve to perform, mainly, the condensation suppression control, operation control, and thermostat control. The use-side unit control means 52a, 52b each include target identification means 520, target determination means 521, and dew point calculation means 522, to perform the condensation suppression control.

[0083] The target identification means 520 stores therein the unit type information about the use-side units 2a, 2b themselves. The target determination means 521 determines whether the use-side unit should undergo the condensation suppression control, on the basis of the unit type information, the temperature information, and humidity information. More specifically, the target determination means 521 determines whether the condensation suppression control should be performed on the basis of the unit type information about the use-side units 2a, 2b. In the case, for example, where the use-side heat exchangers 26a, 26b are designed to utilize natural convection like a chilled beam, the target determination means 521 determines that the use-side units 2a, 2b are the type of units that should undergo the condensation suppression control.

[0084] The target determination means 521 also receives inlet temperature information detected by an inlet temperature sensor 32 and inlet humidity information detected by an inlet humidity sensor 33. The target determination means 521 possesses, for example, a threshold preset therein, and determines that the unit should undergo the condensation suppression control in the case where the inlet temperature information indicates a value lower than the temperature threshold. Likewise, the target determination means 521 determines that unit should undergo the condensation suppression control in the case where the inlet humidity information indicates a value higher than the preset threshold.

[0085] The dew point calculation means 522 calculates a dew point on the basis of the inlet temperature information detected by the inlet temperature sensor 32 and the inlet humidity information detected by the inlet humidity sensor 33. Here, a known method may be adopted for the calculation of the dew point. For example, a vapor pressure (= saturated vapor pressure) may be calculated from relative humidity (absolute humidity) detected by the sensor, and the dew point may be calculated from the vapor pressure.

[0086] The dew point calculation means 522 outputs dew point information to the intermediate unit control means 53 when the target determination means 521 determines that the unit should undergo the condensation suppression control. Here, the target determination means 521 may determine whether to perform the condensation suppression control depending on the dew point calculated by the dew point calculation means 522, instead of the temperature information and the humidity information.

[0087] Further, the use-side unit control means 52a, 52b each include comparative calculation means 523, thermostat determination means 524, and operation signal transmission means 525 to perform the operation control and the thermostat control. The operation signal transmission means 525 outputs an operation signal for supplying cold water or hot water to the intermediate unit control means 53, on the basis of operation request information transmitted from a control panel 526 (or a remote controller) by wired or wireless communication. The comparative calculation means 523 transmits temperature difference information indicating a difference between the inlet temperature information detected by the inlet temperature sensor 32 and set temperature information transmitted from the control panel 526, to the thermostat determination means 524. The thermostat determination means 524 determines whether to continue the operation (thermostat ON) or to suspend the operation (thermostat OFF), and transmits the thermostat determination information to the intermediate unit control means 53.

[0088] Fig. 3 is a block diagram showing an example of the intermediate unit control means 53. The intermediate unit control means 53 shown in Fig. 3 includes maximum dew point detection means 53a, heat medium circuit control means 53b, and refrigerant circuit control means 53c. The maximum dew point detection means 53a detects a maximum dew point Tmax which is a highest temperature among the dew point information about the use-side units 2a, 2b acquired from the plurality of use-side unit control means 52a, 52b. The maximum dew point detection means 53a is also configured to determine whether the dew point information corresponding to each of the plurality of use-side units 2a, 2b has been acquired. In the case where the dew point information can be acquired from neither of the use-side units 2a, 2b, the maximum dew point detection means 53a finishes the reception of the dew point information. In contrast, when the dew point information is received from any of the use-side units 2a, 2b, the maximum dew point detection means 53a calculates the maximum dew point information indicating the highest dew point among the dew point information received.

[0089] The heat medium circuit control means 53b controls the section constituting the heat medium circuit B in the refrigerant-intermediate unit 3. The heat medium circuit control means 53b controls the flow rate in each of the operation modes described above, on the basis of a heat medium temperature T detected by the temperature sensors 31 a, 31 b and outlet water temperature information detected by an outlet water temperature sensor 34. In the condensation suppression control, the heat medium circuit control means 53b controls the primary-side switching device 23b and the secondary-side switching device 22b so as to connect the heat medium flow path of all the use-side heat exchangers 26b that the dew point information of which has been received to the intermediate heat exchanger for adjustment 15b.

[0090] The refrigerant circuit control means 53c controls the section constituting the refrigerant circuit A in the refrigerant-intermediate unit 3. The refrigerant circuit control means 53c receives refrigerant pressure information detected by pressure sensors 36a, 36b, and refrigerant temperature information detected by first refrigerant temperature sensors 35 and second refrigerant temperature sensors 37a, 37b. The refrigerant circuit control means 53c outputs an expansion device amount of expansion instruction, a refrigerant flow path switching instruction, a gas refrigerant supply valve instruction, and a liquid refrigerant supply valve instruction to each actuator, on the basis of the received refrigerant pressure information and the refrigerant temperature information.

[0091] The refrigerant circuit control means 53c is also configured to control, in the condensation suppression control, the expansion device 26b and the second refrigerant flow switching device 18b connected to the intermediate heat exchanger 15b on the basis of the maximum dew point Tmax detected by the maximum dew point detection means 53a and the heat medium temperature T detected by the temperature sensor 31 b.

[0092] Specifically, the refrigerant circuit control means 53c acquires the maximum dew point Tmax detected by the maximum dew point detection means 53a. As stated above, the use-side heat exchanger 26b which has outputted the dew point information is already connected to the intermediate heat exchanger for adjustment 15b under the control of the heat medium circuit control means 53b. Accordingly, the refrigerant circuit control means 53c acquires the temperature T of the heat medium flowing in the intermediate heat exchanger for adjustment 15b, from the temperature sensor 31 b.

[0093] A target temperature setting device 53x of the refrigerant circuit control means 53c calculates a target water temperature Tt of the temperature T of the heat medium flowing into the use-side heat exchanger 26b utilizing the maximum dew point Tmax, through the following equation (1).

Target water temperature Tt = maximum dew point Tmax + α (α: predetermined temperature) … (1)

[0094] Here, α is a parameter for determination of the flow path switching at a temperature higher than the maximum dew point Tmax, so as to assure that condensation is suppressed. Then the refrigerant circuit control means 53c sets a target set temperature range Tr using the maximum dew point Tmax as reference, as maximum dew point Tmax $\leq$ heat medium temperature T $\leq$ target water temperature Tt + β (β: predetermined temperature).

[0095] In the case where "maximum dew point Tmax $\leq$ heat medium temperature T $\leq$ target water temperature Tt + β (β: predetermined temperature)" is satisfied, the refrigerant circuit control means 53c controls the amount of expansion of the expansion device 16b according to the difference between the heat medium temperature T and the target water temperature Tt. Here, β is a parameter for preventing excessively frequent switching actions of the flow switching device, thereby preventing switching malfunction due to insufficient differential pressure and securing sufficient stability of the refrigerant temperature. Through the control of the amount of expansion, the refrigerant circuit control means 53c controls so as to maintain the heat medium temperature T within the target set temperature range Tr.

[0096] As above, occurrence of condensation can be prevented in advance while maintaining the operation mode, in the use-side heat exchanger 26b where maximum dew point Tmax is equal to or lower than the heat medium temperature T and condensation has not yet taken place but is likely to take place. When the use-side unit control means 52b determines that it is not necessary to perform the condensation suppression control, the control of the amount of expansion for the condensation suppression control is finished.

[0097] In the case where the heat medium temperature T is lower than the maximum dew point Tmax (heat medium temperature T < maximum dew point Tmax), the refrigerant circuit control means 53c controls the second refrigerant flow switching device 18b so as to set the refrigerant circuit A of the intermediate heat exchanger for adjustment 15b to the heating flow path. Accordingly, the heat medium temperature T of the heat medium is increased through heat exchange with the refrigerant flowing through the heating flow path. The heat medium temperature T is controlled so as to enter the target set temperature range Tr. In other words, in the case where it is determined that condensation is taking place because the heat medium temperature T is lower than the maximum dew point max, the intermediate heat exchanger for adjustment 15b is switched to the heating flow path to thereby promptly remove the condensation taking place in the use-side heat exchanger 26b. Here, when the heat medium temperature T increases until entering the target set temperature range Tr, the mentioned operation may be continued until the heat medium temperature becomes lower than the target water temperature + β (described later), or the intermediate heat exchanger for adjustment 15b may be again switched to the cooling flow path to perform the control based on the amount of expansion.

[0098] In the case where the heat medium temperature is higher than the target water temperature + β, the refrigerant circuit control means 53c determines whether the intermediate heat exchanger for adjustment 15b is connected to the heating flow path. In the case where the intermediate heat exchanger for adjustment 15b is connected to the heating flow path, the refrigerant circuit control means 53c controls the second refrigerant flow switching device 18b so as to connect the intermediate heat exchanger 15b to the cooling flow path. Then the refrigerant circuit control means 53c controls the heat medium temperature T so as to enter the target set temperature range Tr. When the use-side unit control means 52b determines that it is not necessary to perform the condensation suppression control, the control of the amount of expansion for the condensation suppression control is finished.

[0099] Here, the heat medium circuit control means 53b may control the flow rate of the heat medium on the side of the heat medium circuit B to enhance the condensation suppression control, in addition to the condensation suppression control performed by the refrigerant circuit control means 53c on the side of the refrigerant circuit A. For example, when the temperature T of the incoming heat medium is largely deviated from the target set temperature range Tr, the heat medium circuit control means 53b may control the flow rate control means 25a, 25b so as to increase the flow rate of the heat medium flowing out of the intermediate heat exchanger for adjustment 15b. In contrast, when the temperature T of the incoming heat medium is slightly deviated from the target set temperature range Tr, the heat medium circuit control means 53b may control the flow rate control means 25a, 25b so as to decrease the flow rate of the heat medium flowing out of the intermediate heat exchanger for adjustment 15b. Such an operation contributes to quickening and optimization of the condensation suppression control to set the temperature T of the incoming heat medium within the target set temperature range Tr.

[0100] Although the target set temperature range Tr is set as "maximum dew point Tmax $\leq$ heat medium temperature T $\leq$ target water temperature Tt + β" in the foregoing description, the maximum dew point Tmax may be utilized as it is, so as to set the target set temperature range Tr as "maximum dew point Tmax $\leq$ heat medium temperature T $\leq$ Tmax + β". In this case, it is determined whether the heat medium temperature T is higher than the maximum dew point Tmax + β, instead of whether higher than the target water temperature + β.

(Condensation Suppression Control Method of Air-Conditioning Apparatus 100)

[0101] Fig. 4 is a flowchart of an operation performed by the use-side unit control means 52 in the condensation suppression control of the air-conditioning apparatus 100, and Fig. 5 is a flowchart of an operation performed by the intermediate unit control means 53 in the condensation suppression control of the air-conditioning apparatus 100. Referring to Fig. 1 through Fig. 5, an example of the condensation suppression control method will be described. Referring first to Fig. 4, description will be given on the operation performed by the use-side unit control means 52 for the condensation suppression control.

[0102] The use-side unit control means 52 each receive target indoor unit determination information from the target identification means 520, and the inlet temperature information detected by the inlet temperature sensor 32 and the inlet humidity information detected by the inlet humidity sensor 33 (step S1). The target determination means 521 determines, according to the target indoor unit determination information, whether the flow rate control means 25 is not closed and out of operation, and whether the use-side units 2 are not the use-side unit 2 that do not suit for the condensation suppression control and the use-side units 2 are in the state that requires the condensation suppression control (step S2). In the case where the use-side units 2 are to be subjected to the condensation suppression control as result of the determination, the use-side unit control means 52 calculate the dew point (step S3), and transmit the dew point to the intermediate unit control means 53 (step S4). In the case where the condensation suppression control is not required, the use-side unit control means 52 finishes the condensation suppression control. The following description represents the case where the use-side unit control means 52b outputs the dew point information while the use-side unit control means 52a does not.

[0103] Referring now to Fig. 5, description will be given on the operation performed by the intermediate unit control means 53 for the condensation suppression control. The intermediate unit control means 53 receives dew point information from the use-side unit control means 52b (step S11), through steps S21 to S24 described below. Specifically, he intermediate unit control means 53 receives the dew point information from the intermediate unit control means 52b (step S21). The intermediate unit control means 53 determines whether the dew point information corresponding to the use-side units 2 has been received from the use-side unit control means 52 (step S22).

[0104] In the case where the dew point information corresponding to either of the use-side units 2a, 2b has not been received as result of the determination, the intermediate unit control means 53 finishes the reception of the dew point information (step S23). Meanwhile, in the case where the dew point information corresponding to the use-side unit 2b has been received, the intermediate unit control means 53 connects the use-side heat exchanger 26b of the use-side unit 2b to the intermediate heat exchanger for adjustment 15b (step S23).

[0105] Then the intermediate unit control means 53 counts the number of the use-side units 2b that the dew point information of which has been received (step S12). In the case where 1 or more units have been counted, the intermediate unit control means 53 calculates the maximum dew point Tmax indicating the highest value among the dew point information received (step S13). In Embodiment 1, the dew point of the use-side unit 2b is adopted as the maximum dew point Tmax. The intermediate unit control means 53 then calculates the target water temperature Tt based on the maximum dew point Tmax, for the temperature T of the heat medium flowing into the use-side unit 2b with the foregoing equation (1) (step S14), and performs the switching control of the refrigerant circuit according to the heat medium temperature T (step S15).

[0106] Specifically, in the case where it is determined that the heat medium temperature T is lower than the maximum dew point Tmax (heat medium temperature < maximum dew point + β), the intermediate heat exchanger for adjustment 15b is switched from the cooling flow path to the heating flow path in which hot water is flowing (step S16). Accordingly, the heat medium that the temperature of which has been increased by the intermediate heat exchanger 15a flows into the use-side heat exchanger 26a, so that the occurrence of condensation can be suppressed.

[0107] In the case where it is determined that "maximum dew point Tmax $\leq$ heat medium temperature T $\leq$ target water temperature + β (β: predetermined temperature)" is satisfied, the refrigerant circuit control means 53c controls the amount of expansion of the expansion device 16b on the basis of the difference between the heat medium temperature T and the target water temperature Tt (step S17). As above, occurrence of condensation can be prevented in advance while maintaining the operation mode, in the use-side heat exchanger 26b where condensation has not yet taken place but is likely to take place.

[0108] In the case where the heat medium temperature is higher than the target water temperature + β and the heat medium temperature T is lower than the target water temperature Tt + β, the refrigerant circuit control means 53c determines whether the intermediate heat exchanger for adjustment 15b is connected to the heating flow path (step S18). In the case where the intermediate heat exchanger for adjustment 15b is connected to the heating flow path, the refrigerant circuit control means 53c controls the second refrigerant flow switching device 18b so as to connect the intermediate heat exchanger 15b to the cooling flow path (step S19).

[0109] The above-mentioned condensation suppression control by the intermediate unit control means 53 is performed according to a predetermined schedule, for which the time interval between the control sessions may be determined to an optimum value according to the system configuration. Likewise, the predetermined temperature β necessary for the calculation of the target water temperature and the predetermined temperature β necessary for the comparative calculation of the heat medium temperature T may be set to optimum values according to the system configuration.

[0110] The configuration according to Embodiment 1 allows removal or prevention of condensation, in the case where the condensation has taken place or is likely to take place in the use-side heat exchangers 26a, 26b, by increasing the temperature of the refrigerant flowing through the intermediate heat exchanger for adjustment 15b, without disturbing the operation of the other use-side heat exchanger 26a. In particular, in the case of employing heat exchangers that utilize natural convection, such as a chilled beam, as the use-side heat exchangers 26a, 26b, the use-side heat exchangers 26a, 26b can only exchange a small amount of heat. Accordingly, the use-side units 2a, 2b themselves may suffer condensation in an environment where the dew point in the air-conditioned space is high. Even in such a case, the condensation can be removed or prevented, by increasing the temperature of the refrigerant flowing through the intermediate heat exchanger for adjustment 15b. Further, even under a high-sensible heat operation for lowering only the temperature (sensible heat) while maintaining the moisture in the air of the air-conditioned space as much as possible, the condensation can be securely removed or prevented.

[0111] Further, controlling the operation of the intermediate heat exchanger for adjustment 15b on the basis of the maximum dew point Tmax as shown in Fig. 5 allows the condensation suppression control to be performed with respect to the use-side heat exchanger suffering the worst condensation impact among the plurality of use-side heat exchangers that require the condensation suppression control, and therefore condensation can be securely suppressed in all of the use-side heat exchangers that require the condensation suppression control. Here, in the case where an appropriate temperature has been attained in the use-side heat exchangers other than the use-side heat exchanger 26b having the maximum dew point Tmax, the primary-side flow switching device 23b and the primary-side flow switching device 23a may be controlled so as to return to the normal operation. Still further, since providing at least one intermediate heat exchanger for adjustment 15b allows the condensation suppression control to be performed for the plurality of use-side units, there is no need to generate the heat medium of different temperatures for each of the use-side heat exchangers, which enables efficient performance of the condensation suppression control.

[0112] The present invention is in no way limited to Embodiment 1. For example, although the use-side units 2a, 2b have the same configuration in Fig. 1, the use-side units 2a, 2b of different configurations may be installed. In this case also, the dew point information is outputted from the use-side units 2a, 2b to the intermediate unit control means 53 (see Fig. 3), so as to perform the condensation suppression control.

[0113] In addition, although the temperature means 34a, 34b are respectively provided for the intermediate heat exchangers 15a, 15b in Fig. 1, the temperature means may be excluded from the use-side heat exchanger that does not require the condensation suppression control.

[0114] Further, although two intermediate heat exchangers 15a, 15b are provided as shown in Fig. 1, two or more intermediate heat exchangers may be provided. Since the heat exchange characteristic can be controlled with respect to each of the intermediate heat exchangers 15a, 15b as stated above, the heat medium of different temperatures can be generated for each of the intermediate heat exchangers. Therefore, while the single intermediate heat exchanger for adjustment 15b is utilized to perform the condensation suppression control in Embodiment 1, two or more intermediate heat exchangers for adjustment may be employed to perform the condensation suppression control in the case where the intermediate unit 3 includes three or more intermediate heat exchangers. Reference Signs List

[0115] 1: heat source unit, 2, 2a, 2b: use-side unit, 3: intermediate unit, 4a: first joint pipe, 4b: second joint pipe, 5a: high-pressure main pipe, 5b: low-pressure main pipe, 9: expansion device, 10: compressor, 11: first refrigerant flow switching device, 12: heat source-side heat exchanger, 12a: air-sending device, 13: flow path provision section, 13a to 13d: check valve, 15, 15a, 15b: intermediate heat exchanger, 16, 16a, 16b: expansion device, 17a: liquid refrigerant supply valve, 17b: gas refrigerant supply valve, 18, 18a, 18b: second refrigerant flow switching device, 19: accumulator, 21, 21 a, 21b: pump, 22, 22a, 22b: secondary-side flow switching device, 23, 23a, 23b: primary-side flow switching device, 25, 25a, 25b: flow rate control means, 26, 26a, 26b: use-side heat exchanger, 27, 28: heat medium pipe, 31, 31 a, 31b: heat medium temperature sensor, 32, 32a, 32b: inlet temperature sensor, 33, 33a, 33b: inlet humidity sensor, 34, 34a, 34b: outlet water temperature sensor, 35, 35a, 35b: first refrigerant temperature sensor, 36, 36a, 36b: pressure sensor, 37, 37a, 37b: second refrigerant temperature sensor, 51: heat source unit control means, 52a, 52b: use-side unit control means, 53: intermediate unit control means, 53a: maximum dew point detection means, 53b: heat medium circuit control means, 53c: refrigerant circuit control means, 53d: calculation processing circuit, 100: air-conditioning apparatus, 520: target identification means, 521: target determination means, 522: dew point calculation means, 523: comparative calculation means, 524: thermostat determination means, 525: operation signal transmission means, 526: control panel, A: refrigerant circuit, B: heat medium circuit, T: heat medium temperature, Tr: target set temperature range, Tt: target water temperature, Tmax: maximum dew point

Claims

1. An air-conditioning apparatus comprising:

   a heat source-side unit including a compressor that compresses a refrigerant and a heat source-side heat exchanger that exchanges heat between air and the refrigerant;
   a plurality of use-side units each including a use-side heat exchanger that exchanges heat between air and a heat medium;
   a plurality of intermediate heat exchangers connected to the heat source-side unit via a refrigerant pipe and connected to the use-side units via a heat medium pipe, and configured to exchange heat between the refrigerant and the heat medium;
   a heat medium flow switching device configured to switch combinations of connection between each of the use-side units and a corresponding one of the intermediate heat exchangers;
   target determination means configured to detect a condensation state of each of the use-side units and determine whether to perform condensation suppression control for suppressing condensation with respect to each of the use-side units;
   temperature detection means configured to detect, as a heat medium temperature, a temperature of the heat medium flowing into at least one use-side unit of the use-side units determined by the target determination means to be subjected to the condensation suppression control;
   heat medium circuit control means configured to control the heat medium flow switching device so as to connect the at least one use-side unit of the use-side units determined by the target determination means to be subjected to the condensation suppression control to an intermediate heat exchanger for adjustment assigned for the condensation suppression control among the plurality of intermediate heat exchangers; and
   refrigerant circuit control means configured to control a temperature of the refrigerant flowing into the intermediate heat exchanger for adjustment so that the heat medium temperature detected by the temperature detection means falls within a predetermined target set temperature range.

2. The air-conditioning apparatus of claim 1, further comprising a refrigerant expansion device configured to expand or depressurize the refrigerant flowing into the intermediate heat exchanger for adjustment,
   wherein the refrigerant circuit control means controls the temperature of the refrigerant by controlling an amount of expansion of the refrigerant expansion device.

3. The air-conditioning apparatus of claim 2,
   wherein the refrigerant circuit control means controls the refrigerant expansion device so as to keep the heat medium temperature within the target set temperature range, when the heat medium temperature is within the target set temperature range.

4. The air-conditioning apparatus of any one of claims 1 to 3,
   wherein the heat source-side unit is configured to perform a heating operation and a cooling operation,
   the air-conditioning apparatus further comprises a refrigerant flow switching device configured to switch a flow path of the refrigerant flowing into the intermediate heat exchanger for adjustment to a heating flow path for the heating operation and to a cooling flow path for the cooling operation, and
   the refrigerant circuit control means controls the temperature of the refrigerant flowing into the intermediate heat exchanger for adjustment by causing the refrigerant flow switching device to switch the flow path of the intermediate heat exchanger for adjustment.

5. The air-conditioning apparatus of claim 4,
   wherein the refrigerant circuit control means causes the refrigerant flow switching device to set the flow path of the refrigerant flowing into the intermediate heat exchanger for adjustment to the heating flow path when the heat medium temperature is lower than the target set temperature range.

6. The air-conditioning apparatus of claim 4 or 5,
   wherein the refrigerant flow control means causes the refrigerant flow switching device to set the flow path of the refrigerant flowing into the intermediate heat exchanger for adjustment to the cooling flow path when the heat medium temperature is higher than the target set temperature range.

7. The air-conditioning apparatus of any one of claims 1 to 6, further comprising:

inlet temperature detection means configured to detect a temperature of air sucked into each of the use-side units; and
inlet humidity detection means configured to detect humidity of the air sucked into each of the use-side units,
wherein the target determination means detects the condensation status on a basis of the inlet temperature detected by the inlet temperature detection means and the inlet humidity detected by the inlet humidity detection means, so as to determine whether to perform the condensation suppression control.

8. The air-conditioning apparatus of any one of claims 1 to 7, further comprising:

inlet temperature detection means configured to detect a temperature of air sucked into each of the use-side unit;
inlet humidity detection means configured to detect humidity of the air sucked into each of the use-side unit; and
dew point calculation means configured to calculate a dew point on a basis of the inlet temperature detected by the inlet temperature detection means and the inlet humidity detected by the inlet humidity detection means,
wherein the refrigerant circuit control means sets the predetermined target set temperature range on a basis of the dew point calculated by the dew point calculation means.

9. The air-conditioning apparatus of claim 8,
wherein the refrigerant circuit control means detects a maximum dew point which is a highest dew point among the dew points of the at least one use-side unit of the use-side units determined to be subjected to the condensation suppression control, and sets the predetermined target set temperature range on a basis of the detected maximum dew point.

10. The air-conditioning apparatus of any one of claims 1 to 9, further comprising:

flow rate control means configured to control a flow rate of the heat medium flowing through the intermediate heat exchanger for adjustment and the use-side units; and
heat medium circuit control means configured to control the flow rate control means,
wherein the heat medium circuit control means controls the flow rate control means so that the heat medium temperature falls within the predetermined target set temperature range.

F I G. 1

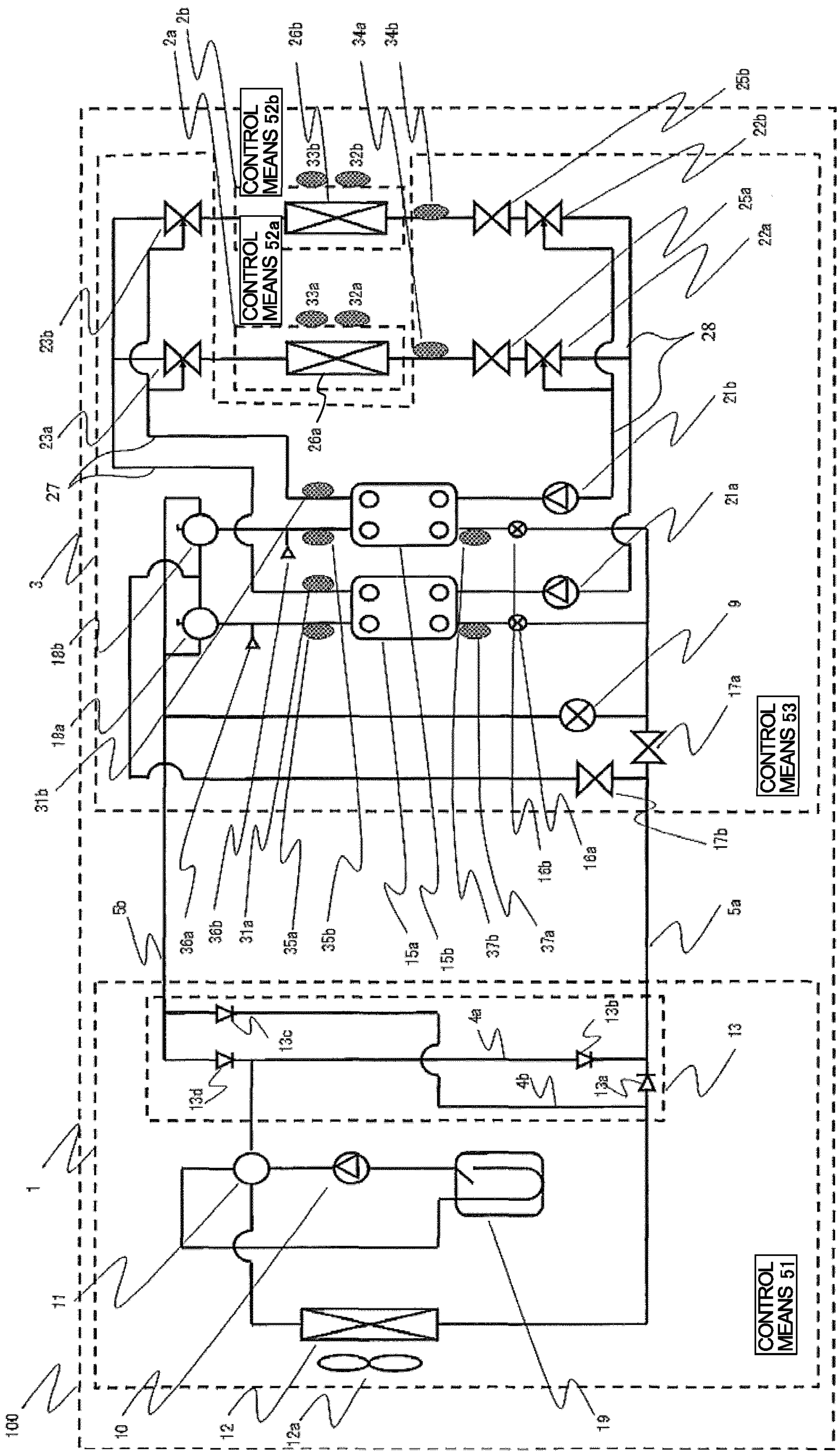
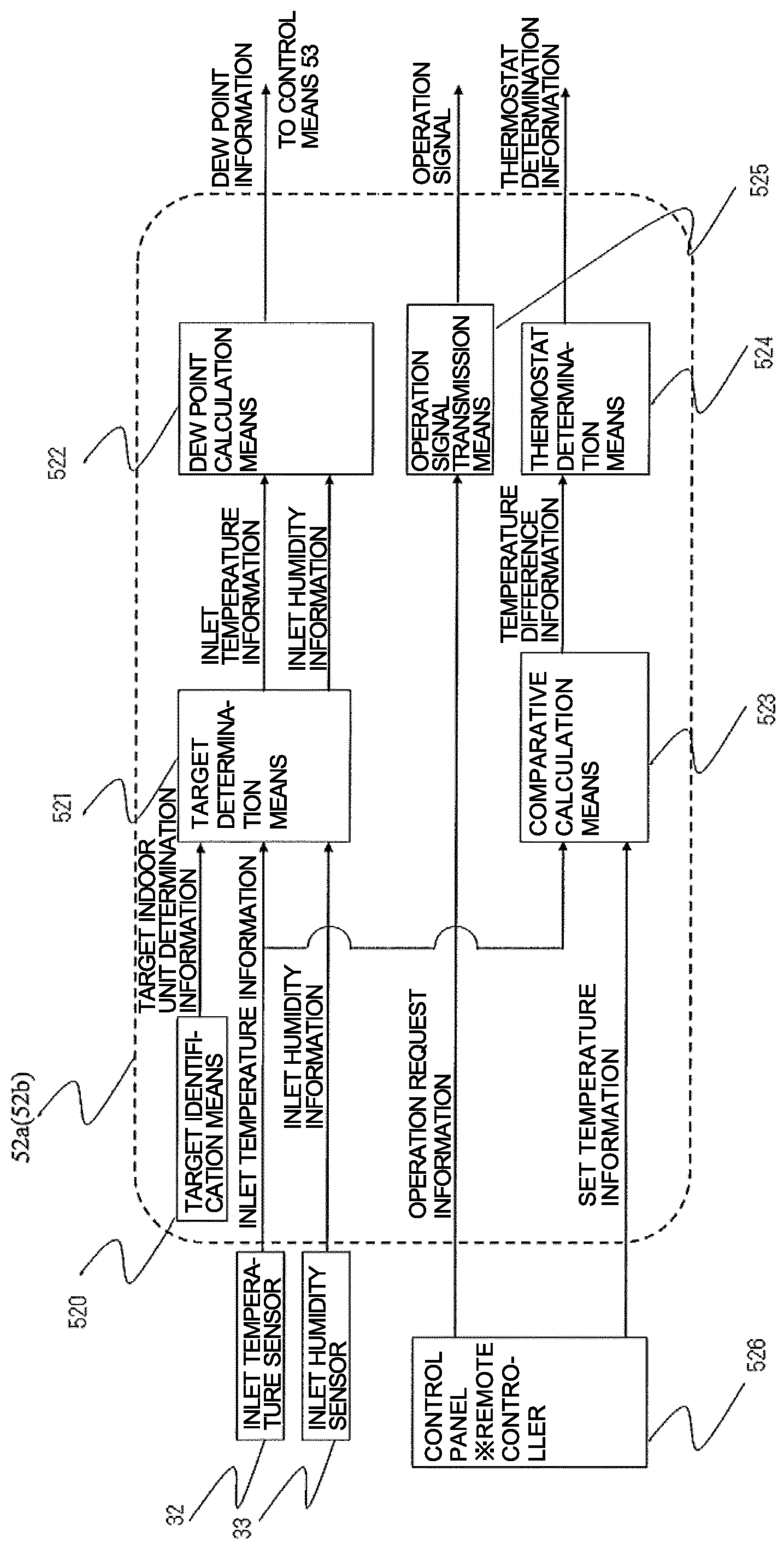
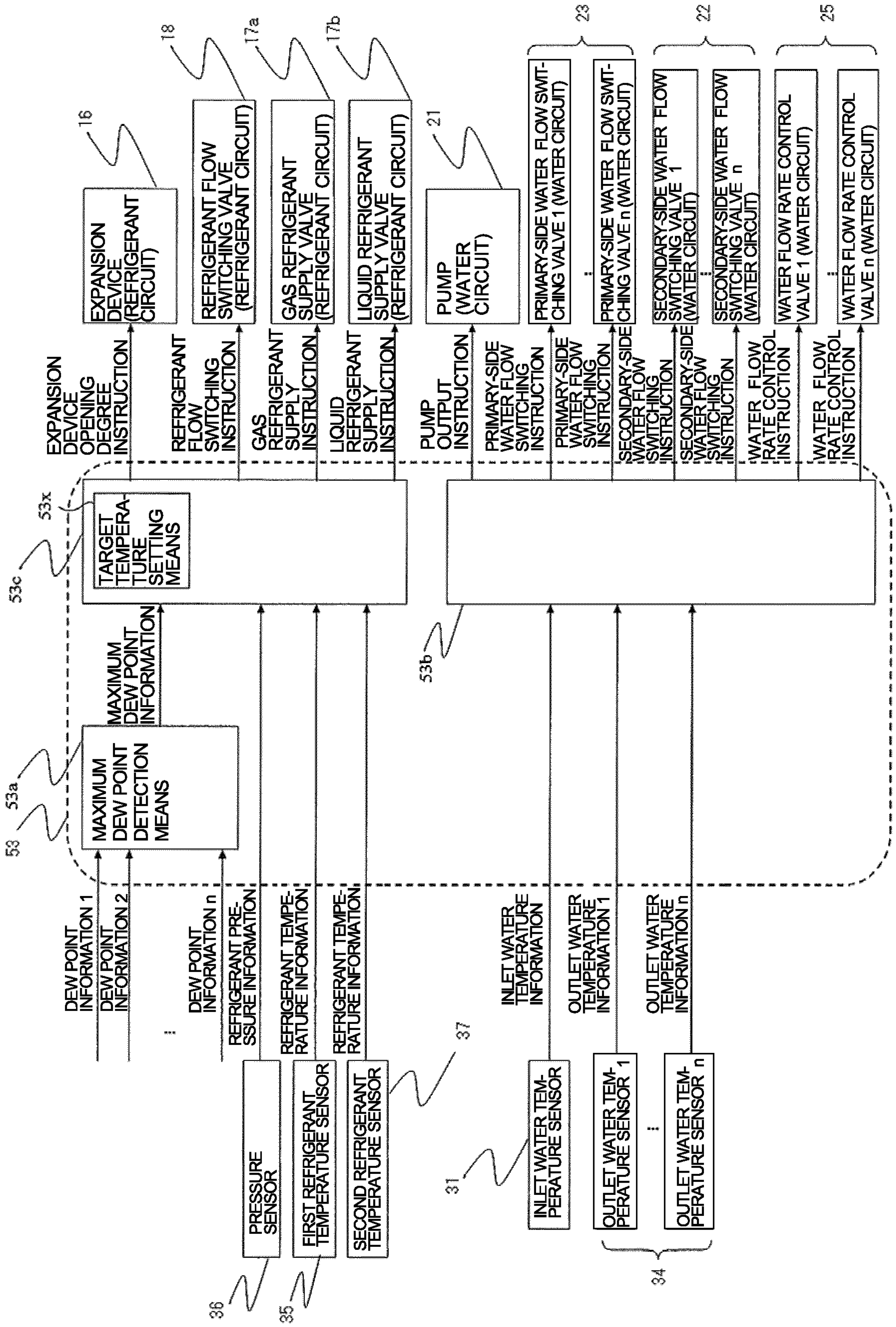

CONTROL MEANS 52b
CONTROL MEANS 52a
CONTROL MEANS 53
CONTROL MEANS 51
100
1
3
10
11
12
12a
19
2a
2b
26a
26b
34a
34b
25a
25b
22a
22b
23a
23b
27
28
21a
21b
9
17a
17b
16a
16b
18a
18b
31a
31b
32a
32b
33a
33b
35a
35b
36a
36b
37a
37b
15a
15b
5a
5b
4a
4b
13
13a
13b
13c
13d

FIG. 2


INLET TEMPERATURE SENSOR
INLET HUMIDITY SENSOR
CONTROL PANEL ※REMOTE CONTROLLER
TARGET IDENTIFICATION MEANS
TARGET INDOOR UNIT DETERMINATION INFORMATION
INLET TEMPERATURE INFORMATION
INLET HUMIDITY INFORMATION
OPERATION REQUEST INFORMATION
SET TEMPERATURE INFORMATION
TARGET DETERMINATION MEANS
COMPARATIVE CALCULATION MEANS
INLET TEMPERATURE INFORMATION
INLET HUMIDITY INFORMATION
TEMPERATURE DIFFERENCE INFORMATION
DEW POINT CALCULATION MEANS
OPERATION SIGNAL TRANSMISSION MEANS
THERMOSTAT DETERMINATION MEANS
DEW POINT INFORMATION
TO CONTROL MEANS 53
OPERATION SIGNAL
THERMOSTAT DETERMINATION INFORMATION
32
33
520
52a(52b)
521
522
523
524
525
526

F I G. 3



DEW POINT INFORMATION 1
DEW POINT INFORMATION 2
DEW POINT INFORMATION n
REFRIGERANT PRESSURE INFORMATION
REFRIGERANT TEMPERATURE INFORMATION
REFRIGERANT TEMPERATURE INFORMATION
PRESSURE SENSOR
FIRST REFRIGERANT TEMPERATURE SENSOR
SECOND REFRIGERANT TEMPERATURE SENSOR
36
35
37
INLET WATER TEMPERATURE INFORMATION
OUTLET WATER TEMPERATURE INFORMATION 1
OUTLET WATER TEMPERATURE INFORMATION n
INLET WATER TEMPERATURE SENSOR
OUTLET WATER TEMPERATURE SENSOR 1
OUTLET WATER TEMPERATURE SENSOR n
31
34
53
53a
MAXIMUM DEW POINT DETECTION MEANS
MAXIMUM DEW POINT INFORMATION
53c
53x
TARGET TEMPERATURE SETTING MEANS
53b
EXPANSION DEVICE OPENING DEGREE INSTRUCTION
REFRIGERANT FLOW SWITCHING INSTRUCTION
GAS REFRIGERANT SUPPLY INSTRUCTION
LIQUID REFRIGERANT SUPPLY INSTRUCTION
PUMP OUTPUT INSTRUCTION
PRIMARY-SIDE WATER FLOW SWITCHING INSTRUCTION
PRIMARY-SIDE WATER FLOW SWITCHING INSTRUCTION
SECONDARY-SIDE WATER FLOW SWITCHING INSTRUCTION
SECONDARY-SIDE WATER FLOW SWITCHING INSTRUCTION
WATER FLOW RATE CONTROL INSTRUCTION
WATER FLOW RATE CONTROL INSTRUCTION
16
EXPANSION DEVICE (REFRIGERANT CIRCUIT)
18
REFRIGERANT FLOW SWITCHING VALVE (REFRIGERANT CIRCUIT)
17a
GAS REFRIGERANT SUPPLY VALVE (REFRIGERANT CIRCUIT)
17b
LIQUID REFRIGERANT SUPPLY VALVE (REFRIGERANT CIRCUIT)
21
PUMP (WATER CIRCUIT)
23
PRIMARY-SIDE WATER FLOW SWITCHING VALVE 1 (WATER CIRCUIT)
PRIMARY-SIDE WATER FLOW SWITCHING VALVE n (WATER CIRCUIT)
22
SECONDARY-SIDE WATER FLOW SWITCHING VALVE 1 (WATER CIRCUIT)
SECONDARY-SIDE WATER FLOW SWITCHING VALVE n (WATER CIRCUIT)
25
WATER FLOW RATE CONTROL VALVE 1 (WATER CIRCUIT)
WATER FLOW RATE CONTROL VALVE n (WATER CIRCUIT)

F I G. 4

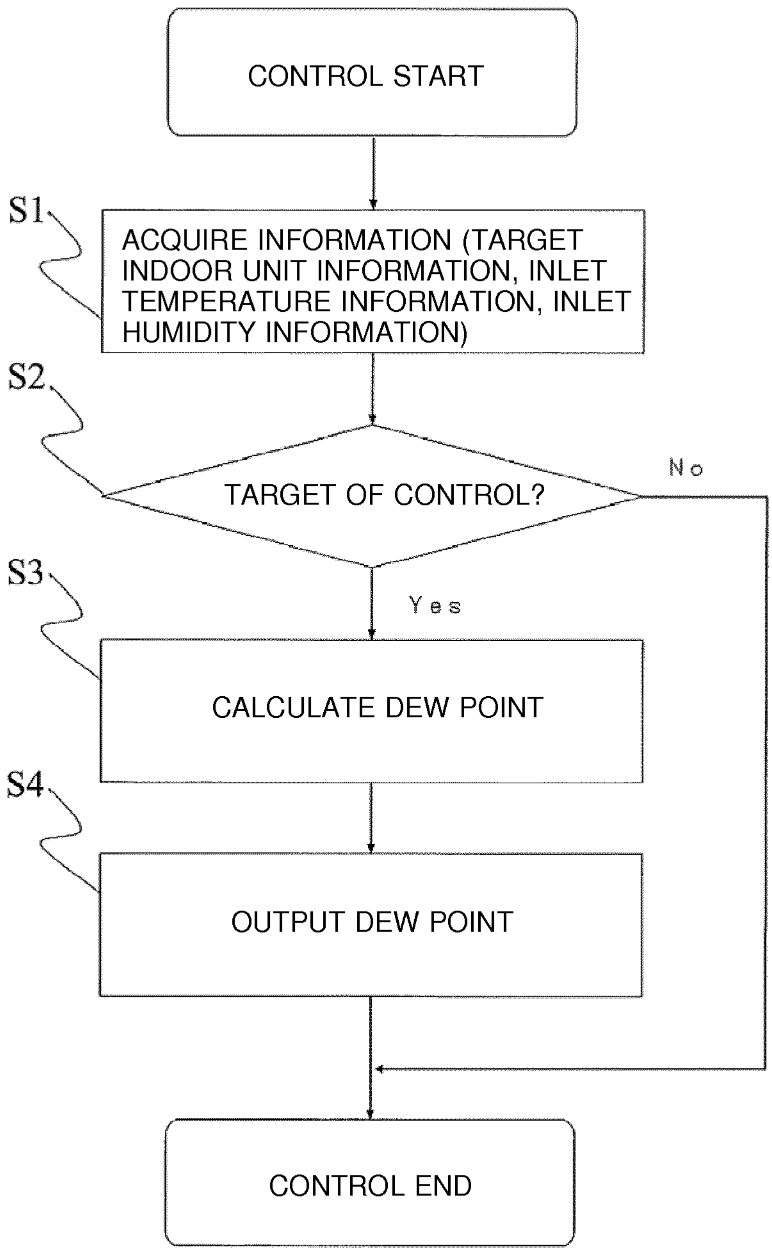
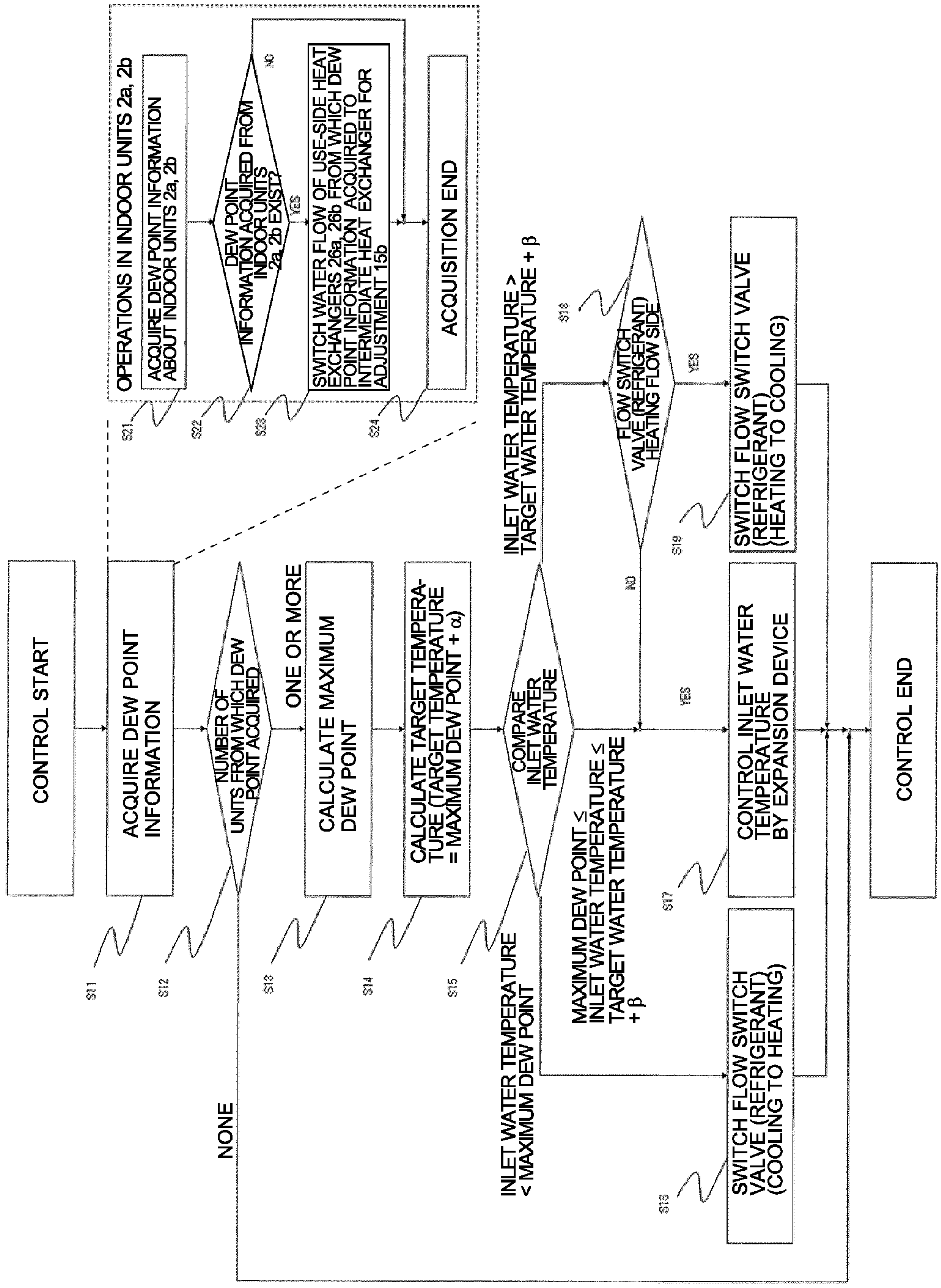

CONTROL START
S1
ACQUIRE INFORMATION (TARGET INDOOR UNIT INFORMATION, INLET TEMPERATURE INFORMATION, INLET HUMIDITY INFORMATION)
S2
TARGET OF CONTROL?
No
Yes
S3
CALCULATE DEW POINT
S4
OUTPUT DEW POINT
CONTROL END

FIG. 5


CONTROL START
ACQUIRE DEW POINT INFORMATION
NUMBER OF UNITS FROM WHICH DEW POINT ACQUIRED
NONE
ONE OR MORE
CALCULATE MAXIMUM DEW POINT
CALCULATE TARGET TEMPERATURE (TARGET TEMPERATURE = MAXIMUM DEW POINT + α)
COMPARE INLET WATER TEMPERATURE
INLET WATER TEMPERATURE < MAXIMUM DEW POINT
MAXIMUM DEW POINT ≤ INLET WATER TEMPERATURE ≤ TARGET WATER TEMPERATURE + β
INLET WATER TEMPERATURE > TARGET WATER TEMPERATURE + β
SWITCH FLOW SWITCH VALVE (REFRIGERANT) (COOLING TO HEATING)
CONTROL INLET WATER TEMPERATURE BY EXPANSION DEVICE
FLOW SWITCH VALVE (REFRIGERANT) HEATING FLOW SIDE
YES
NO
SWITCH FLOW SWITCH VALVE (REFRIGERANT) (HEATING TO COOLING)
CONTROL END
S11
S12
S13
S14
S15
S16
S17
S18
S19
OPERATIONS IN INDOOR UNITS 2a, 2b
ACQUIRE DEW POINT INFORMATION ABOUT INDOOR UNITS 2a, 2b
DEW POINT INFORMATION ACQUIRED FROM INDOOR UNITS 2a, 2b EXIST?
YES
NO
SWITCH WATER FLOW OF USE-SIDE HEAT EXCHANGERS 26a, 26b FROM WHICH DEW POINT INFORMATION ACQUIRED TO INTERMEDIATE HEAT EXCHANGER FOR ADJUSTMENT 15b
ACQUISITION END
S21
S22
S23
S24

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2012/004708

A. CLASSIFICATION OF SUBJECT MATTER
F25B5/02(2006.01)i, *F24F5/00*(2006.01)i, *F25B1/00*(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)
F25B5/02, F24F5/00, F25B1/00

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	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
A	WO 2011/052040 A1 (Mitsubishi Electric Corp.), 05 May 2011 (05.05.2011), fig. 3; claim 1 (Family: none)	1-10
A	JP 2011-112312 A (Hitachi, Ltd.), 09 June 2011 (09.06.2011), fig. 1; paragraphs [0121] to [0124] & WO 2011/065075 A1 & CN 102472531 A	1-10
A	JP 3-113229 A (Matsushita Refrigeration Co.), 14 May 1991 (14.05.1991), fig. 1; claim 1 (Family: none)	1-10

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
04 October, 2012 (04.10.12)	16 October, 2012 (16.10.12)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/004708

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-212085 A (Ishimoto Architectural & Engineering Firm, Inc.), 23 August 2007 (23.08.2007), claim 12; fig. 1 (Family: none)	1-10
A	JP 2005-16858 A (Mitsubishi Electric Corp.), 20 January 2005 (20.01.2005), claim 13; paragraphs [0031] to [0035]; fig. 7 to 9 (Family: none)	1-10

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2010049998 A **[0003]**