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(72) Inventors:
• **ISHIMURA, Katsuhiro**
Tokyo 100-8310 (JP)
• **INOUE, Seiji**
Tokyo 100-8310 (JP)
• **MORIMOTO, Osamu**
Tokyo 100-8310 (JP)
• **MOTOMURA, Yuji**
Tokyo 100-8310 (JP)

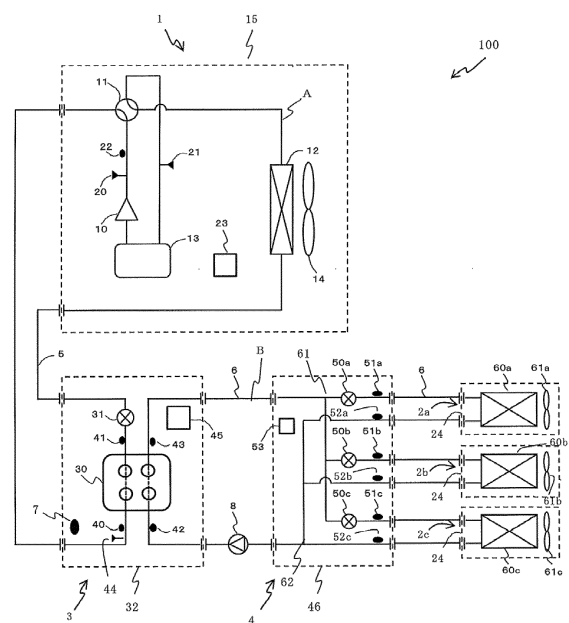
(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

(74) Representative: **Pfenning, Meinig & Partner mbB**
Patent- und Rechtsanwälte
Joachimsthaler Straße 10-12
10719 Berlin (DE)

(54) **AIR-CONDITIONING DEVICE**

(57) Provided is an air-conditioning apparatus capable of reducing an amount of refrigerant being used and of preventing a leakage of the refrigerant to a room space. The air-conditioning apparatus includes an outdoor-unit casing accommodating therein a compressor, a refrigerant flow switching device, and a heat-source-side heat exchanger; a heat-medium-relay-unit casing accommodating therein an expansion device and an intermediate heat exchanger; a heat-medium-flow-control-unit casing accommodating therein a heat medium flow control device; an indoor-unit casing accommodating therein a load-side heat exchanger and an indoor air-sending device; and a heat medium conveying device configured to convey a heat medium. In the air-conditioning apparatus, the compressor, the refrigerant flow switching device, the heat-source-side heat exchanger, the expansion device, and a refrigerant passage of the intermediate heat exchanger communicate with each other via refrigerant pipes to form a refrigerant circuit, refrigerant flowing through the refrigerant pipe; and a heat medium passage of the intermediate heat exchanger, the heat medium conveying device, the heat medium flow control device, and the load-side heat exchanger communicate with each other via heat medium pipes to form a heat medium circuit, the heat medium flowing through the heat medium pipe.

FIG. 1



Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus using a heat medium.

Background Art

[0002] In some of current air-conditioning apparatuses such as multi-air-conditioning apparatuses for buildings, an outdoor unit and a plurality of indoor units communicate with each other via refrigerant pipes. When the total length of such refrigerant pipes reaches several hundreds of meters, an amount of refrigerant being used significantly increases with extension of the pipes. If a leakage of refrigerant occurs in such air-conditioning apparatuses and the leaked refrigerant flows into one of rooms, the space inside the room may be filled with the refrigerant and an oxygen-deficient state may occur.

[0003] In addition, R410A that is a refrigerant mainly used currently has a global warming potential of 2088. A large global warming potential of R410A is considered to be problematic. Note that the global warming potential is sometimes abbreviated as GWP. For the above reason, a switch to a refrigerant having a small global warming potential is desired. However, since many of refrigerants having small global warming potentials are flammable, consideration needs to be given to a risk such as ignition of the refrigerant.

[0004] A method that adopts a secondary loop scheme in which refrigerant is circulated through a refrigerant circuit and a harmless heat medium, such as water or brine, is circulated through a heat medium circuit to transfer heating energy or cooling energy of the refrigerant to the heat medium has been proposed in Patent Literature 1, for example. For example, in systems such as a water air-conditioning system and a chiller system that adopt the secondary loop scheme, an outdoor unit and an intermediate heat exchanger communicate with the refrigerant circuit and the intermediate heat exchanger and indoor units communicate with the heat medium circuit. The intermediate heat exchanger is placed in a non-room space, such as a space above a ceiling, to prevent oxygen deficiency or ignition caused by a leakage of the refrigerant and to decrease a distance over which the refrigerant is conveyed.

Citation List

Patent Literature

[0005] Patent Literature 1: International Publication No. 12/073293

Summary of Invention

Technical Problem

[0006] However, when an intermediate heat exchanger is disposed in a space such as a space above a ceiling as in Patent Literature 1, refrigerant may enter a room space if the refrigerant leaks from a pipe of a refrigerant circuit that is laid in a space such as a space above the ceiling. Thus, it is difficult to prevent an influence of the refrigerant leakage. In addition, since the refrigerant pipe is extended from the outdoor unit to the space above the ceiling, it is difficult to say that the necessary amount of refrigerant is reduced.

[0007] In addition, in water air-conditioning systems and chiller systems configured as described in Patent Literature 1, indoor unit capacities are controlled by a flow control device included in a heat medium relay unit in water air-conditioning systems, whereas indoor unit capacities are controlled by respective flow control devices that are provided as optional components in respective indoor units in chiller systems. As described above, regardless of the fact that both the water air-conditioning systems and the chiller systems that include heat medium relay units are indirect air-conditioning systems that supply a heat medium such as water to rooms, the methods for controlling the supply capacities of the respective indoor units are different and are not standardized.

[0008] The present invention has been made to overcome the issues described above and aims to provide an air-conditioning apparatus, serving as a multi-air-conditioning apparatus for a building, capable of reducing an amount of refrigerant being used and of reducing the influence of a leakage of refrigerant to a room space. Solution to Problem

[0009] An air-conditioning apparatus according to one embodiment of the present invention includes an outdoor-unit casing accommodating therein a compressor, a refrigerant flow switching device, and a heat-source-side heat exchanger; a heat-medium-relay-unit casing accommodating therein an expansion device and an intermediate heat exchanger; a heat-medium-flow-control-unit casing accommodating therein a heat medium flow control device; an indoor-unit casing accommodating therein a load-side heat exchanger and an indoor air-sending device; and a heat medium conveying device configured to convey a heat medium, the compressor, the refrigerant flow switching device, the heat-source-side heat exchanger, the expansion device, and a refrigerant passage of the intermediate heat exchanger communicating with each other via refrigerant pipes to form a refrigerant circuit, refrigerant flowing through the refrigerant pipe, and a heat medium passage of the intermediate heat exchanger, the heat medium conveying device, the heat medium flow control device, and the load-side heat exchanger communicating with each other via heat medium pipes to form a heat medium circuit, the

heat medium flowing through the heat medium pipe.

Advantageous Effects of Invention

[0010] In the air-conditioning apparatus according to the embodiment of the present invention, the casing of the indoor unit and the casing of the heat medium flow control unit in which the refrigerant does not circulate is provided separately from the casing of the outdoor unit and the casing of the heat medium relay unit in which the refrigerant circulates. Thus, the heat medium circuit can be provided near a room space and the refrigerant circuit can be provided at a place separated from the room space. With this configuration, the amount of necessary refrigerant can be reduced and a leakage of refrigerant to a room space can be prevented. Brief Description of Drawings

[0011]

[Fig. 1] Fig. 1 is a schematic circuit configuration diagram illustrating an example of a circuit configuration of an air-conditioning apparatus according to Embodiment.

[Fig. 2] Fig. 2 is a circuit diagram illustrating flows of refrigerant and a heat medium in a cooling only operation mode of the air-conditioning apparatus illustrated in Fig. 1.

[Fig. 3] Fig. 3 is a circuit diagram illustrating flows of the refrigerant and the heat medium in a heating only operation mode of the air-conditioning apparatus illustrated in Fig. 1.

[Fig. 4] Fig. 4 is a schematic circuit configuration diagram illustrating an example of a circuit configuration of an air-conditioning apparatus according to Modification.

[Fig. 5] Fig. 5 is a circuit diagram illustrating flows of refrigerant and a heat medium in a cooling only operation mode of the air-conditioning apparatus according to Modification.

[Fig. 6] Fig. 6 is a circuit diagram illustrating flows of the refrigerant and the heat medium in a heating only operation mode of the air-conditioning apparatus according to Modification.

Description of Embodiments

Embodiment.

[0012] An air-conditioning apparatus 100 according to Embodiment is, for example, an apparatus such as a multi-air-conditioning apparatus for a building whose operation mode is selectable from a cooling only operation mode in which all indoor units perform cooling, a heating only operation mode in which all indoor units perform heating, or other modes. Fig. 1 is a schematic circuit configuration diagram illustrating an example of a circuit configuration of the air-conditioning apparatus 100 according to Embodiment. As illustrated in Fig. 1, the air-condition-

ing apparatus 100 according to Embodiment includes an outdoor unit 1, a heat medium relay unit 3, a heat medium flow control unit 4, and indoor units 2a, 2b, and 2c that are coupled by a refrigerant circuit A and a heat medium circuit B. Heating energy or cooling energy is generated by a refrigeration cycle that uses refrigerant circulating through the refrigerant circuit A, and conditioned air is supplied to the room space by a heat medium that circulates through the heat medium circuit B.

[Refrigerant Cycle Circuit A]

[0013] The refrigerant circuit A includes a refrigerant pipe 5 and couples the outdoor unit 1 and the heat medium relay unit 3 to each other. Refrigerant flows through the refrigerant pipe 5 of the refrigerant circuit A. Although the refrigerant is not limited particularly, for example, difluoromethane or tetrafluoropropene that is flammable can be used as the refrigerant having a low global warming potential.

[Heat medium circuit B]

[0014] The heat medium circuit B includes a heat medium pipe 6 and couples the heat medium relay unit 3, the heat medium flow control unit 4, and the indoor units 2a, 2b, and 2c to each other. A heat medium conveying device 8 is coupled between the heat medium relay unit 3 and the heat medium flow control unit 4. A heat medium that is harmless and highly safe to people flows through the heat medium pipe 6 of the heat medium circuit B. For example, an anti-freeze solution such as brine, water, a mixed solution of brine and water, or a mixed solution of water and an additive having a high corrosion protection effect is used as the heat medium.

[0015] In the air-conditioning apparatus 100, the outdoor unit 1 accommodated in a casing 15 is placed outdoors such as at a rooftop of a building or in a room such as a machine room where a ventilation device is located. The heat medium relay unit 3 accommodated in a casing 32 is placed in a machine room where devices such as a ventilation device and a refrigerant leakage detecting device are installed. In addition, the heat medium flow control unit 4 accommodated in a casing 46 is placed in a machine room or a space above a ceiling. Each of the indoor units 2a, 2b, and 2c accommodated in respective casing 24 is placed in a space in which air-conditioning is needed. Note that Fig. 1 illustrates the case where three indoor units 2a, 2b, and 2c are coupled as an example; however, the number of indoor units is not limited.

[Outdoor Unit 1]

[0016] The casing 15 of the outdoor unit 1 accommodates therein a compressor 10, a refrigerant flow switching device 11 such as a four-way valve, a heat-source-side heat exchanger 12, and an accumulator 13 that communicate with each other by the refrigerant pipe 5. In

addition, an outdoor air-sending device 14 is provided near the heat-source-side heat exchanger 12 and sends air to the heat-source-side heat exchanger 12. The compressor 10, the rotation speed of the outdoor air-sending device 14, and other devices are controlled by a first controller 23.

[0017] The compressor 10 suctions low-temperature low-pressure refrigerant and compresses the refrigerant to create a high-temperature high-pressure state. The compressor 10 includes, for example, a volume-controllable inverter compressor. The refrigerant flow switching device 11 switches between the flow of the refrigerant in the cooling operation mode and the flow of the refrigerant in the heating operation mode.

[0018] The heat-source-side heat exchanger 12 serves as a condenser in the cooling operation and serves as an evaporator in the heating operation. The heat-source-side heat exchanger 12 exchanges heat between the refrigerant and air supplied from the outdoor air-sending device 14, such as a fan.

[0019] The accumulator 13 has a function of accumulating a surplus amount of refrigerant in the heating only operation mode and also operates to prevent liquid refrigerant from flowing into the compressor 10.

[0020] The outdoor unit 1 also includes a first pressure detecting device 20 and a second pressure detecting device 21 as pressure detecting devices. The first pressure detecting device 20 is disposed at the refrigerant pipe 5 that couples a discharge side of the compressor 10 and the refrigerant flow switching device 11 to each other and detects pressure of the high-temperature high-pressure refrigerant compressed and discharged by the compressor 10. In addition, the second pressure detecting device 21 is disposed at the refrigerant pipe 5 that couples the refrigerant flow switching device 11 and a suction side of the compressor 10 to each other and detects pressure of the low-temperature low-pressure refrigerant to be suctioned by the compressor 10.

[0021] The outdoor unit 1 also includes a first temperature detecting device 22 as a temperature detecting device. The first temperature detecting device 22 is disposed at the refrigerant pipe 5 that couples the discharge side of the compressor 10 and the refrigerant flow switching device 11 to each other and detects temperature of the high-temperature high-pressure refrigerant compressed and discharged by the compressor 10. A device such as a thermistor can be used as the first temperature detecting device 22.

[Heat Medium Relay Unit 3]

[0022] The casing 32 of the heat medium relay unit 3 accommodates therein an intermediate heat exchanger 30 that exchanges heat between the refrigerant and the heat medium, a first expansion device 31 that reduces the pressure of the refrigerant, and a refrigerant leakage detecting device 7. The intermediate heat exchanger 30 includes a refrigerant side and a heat medium side. The

refrigerant side is connected to the refrigerant pipe 5 that constitutes the refrigerant circuit A, and the heat medium side is connected to the heat medium pipe 6 that constitutes the heat medium circuit B. The refrigerant leakage detecting device 7 is a device such as an alarming device that detects the concentration of the refrigerant in the air and outputs an alarm upon detecting a value greater than or equal to a predetermined value.

[0023] The intermediate heat exchanger 30 serves as a condenser or an evaporator to exchange heat between the refrigerant and the heat medium and transfers cooling energy or heating energy generated and stored in the refrigerant by the outdoor unit 1 to the heat medium. A heat exchanger such as a plate-type heat exchanger is preferably used as the intermediate heat exchanger 30. A double-wall plate-type heat exchanger is more preferably used to reduce the risk of the refrigerant leaking to the room space.

[0024] The first expansion device 31 is connected to the refrigerant pipe of the refrigerant side of the intermediate heat exchanger 30, reduces the pressure of the refrigerant to expand the refrigerant, and serves as a pressure reducing valve or an expansion valve. For example, an area of an opening port of the first expansion device 31 is controlled by a second controller 45. The first expansion device 31 is preferably a device whose opening degree is variable in accordance with control, for example, an electronic expansion valve.

[0025] The casing 32 of the heat medium relay unit 3 also includes a third pressure detecting device 44 as a pressure detecting device. The third pressure detecting device 44 is disposed on a side of the refrigerant pipe 5 connected to the intermediate heat exchanger 30, the side being opposite to the first expansion device 31, and detects pressure of the refrigerant that flows into or out from the intermediate heat exchanger 30.

[0026] The casing 32 of the heat medium relay unit 3 also accommodates therein a second temperature detecting device 40, a third temperature detecting device 41, a fourth temperature detecting device 42, and a fifth temperature detecting device 43 as temperature detecting devices. The second temperature detecting device 40 is disposed on a side of the refrigerant pipe 5 connected to the intermediate heat exchanger 30, the side being opposite to the first expansion device 31. The third temperature detecting device 41 is disposed on the refrigerant pipe 5 coupling the intermediate heat exchanger 30 and the first expansion device 31 to each other. In addition, the fourth temperature detecting device 42 is disposed on the heat medium pipe connected to the flow-in side of the intermediate heat exchanger 30. The fifth temperature detecting device 43 is disposed on the heat medium pipe connected to the flow-out side of the intermediate heat exchanger 30.

[0027] Note that Fig. 1 illustrates an example in which a single intermediate heat exchanger 30 and a single first expansion device 31 are provided as an example; however, the configuration is not limited to this one. A plurality

of intermediate heat exchangers 30 and a plurality of first expansion devices 31 may be connected in parallel in accordance with the cooling capacity or the heating capacity of the air-conditioning apparatus 100.

[Heat Medium Flow Control Unit 4]

[0028] The casing 46 of the heat medium flow control unit 4 accommodates therein heat medium flow control devices 50a, 50b, and 50c coupled by the heat medium pipe 6. The heat medium pipe 6 has a branch portion 61 at which the heat medium is distributed to the indoor units 2a, 2b, and 2c and a junction portion 62 at which the heat medium flowing from the indoor units 2a, 2b, and 2c gathers. The casing 46 of the heat medium flow control unit 4 also accommodates therein sixth temperature detecting devices 51a, 51b, and 51c and seventh temperature detecting devices 52a, 52b, and 52c as temperature detecting devices. Fig. 1 illustrates an example in which the three indoor units 2a, 2b, and 2c communicate with the heat medium flow control unit 4; however, the number of indoor units may be one or plural such as two or more.

[0029] Each of the heat medium flow control devices 50a, 50b, and 50c is disposed on the heat medium pipe 6 located immediately downstream of the branch portion 61 that the heat medium conveyed from the heat medium flow control unit 4 to a corresponding one of the indoor units 2a, 2b, and 2c passes through and controls a flow-rate of the heat medium to be supplied to the corresponding one of the indoor units 2a, 2b, and 2c. The heat medium flow control unit 4 distributes, to the indoor units 2a, 2b, and 2c, the heat medium whose flowrates are controlled in accordance with air-conditioning loads of the indoor units 2a, 2b, and 2c, respectively. In the flow control, for example, the areas of opening ports of the heat medium flow control devices 50a, 50b, and 50c are controlled by a third controller 53. For example, two-way valves whose areas of opening ports are controllable can be used as the heat medium flow control devices 50a, 50b, and 50c so that the flowrates of the heat medium are controlled in a given manner. Note that the heat medium flow control devices 50a, 50b, and 50c may be disposed on the heat medium pipes 6 located immediately downstream of the branch portion 61 as illustrated in Fig. 1. Alternatively, the heat medium flow control devices 50a, 50b, and 50c may be disposed on the heat medium pipe 6 located immediately upstream of the junction portion 62.

[0030] Each of the sixth temperature detecting devices 51a, 51b, and 51c is disposed on the heat medium pipe 6 located immediately downstream of the branch portion 61 that the heat medium conveyed from the heat medium flow control unit 4 to a corresponding one of the indoor units 2a, 2b, and 2c passes through and detects temperature of the heat medium to be supplied to the corresponding one of the indoor units 2a, 2b, and 2c. Each of the seventh temperature detecting devices 52a, 52b, and 52c is disposed on the heat medium pipe 6 located im-

mediately upstream of the junction portion 62 that the heat medium returning from a corresponding one of the indoor units 2a, 2b, and 2c flows into the heat medium flow control unit 4 and detects temperature of the heat medium that flows out from the corresponding one of the indoor units 2a, 2b, and 2c.

[Heat medium conveying device 8]

[0031] The heat medium conveying device 8 is disposed midway of the heat medium pipe 6 coupling the heat medium relay unit 3 and the heat medium flow control unit 4 to each other. The heat medium conveying device 8 is, for example, a device such as a pump that circulates the heat medium. Through circulation of the heat medium, heating energy or cooling energy supplied from the refrigerant side of the heat medium relay unit 3 can be supplied to the indoor units 2a, 2b, and 2c. The heat medium conveying device 8 may be disposed midway of the heat medium pipe 6 coupling the heat medium relay unit 3 and the heat medium flow control unit 4 as illustrated in Fig. 1. Alternatively, the heat medium conveying device 8 may be disposed at the heat medium pipe 6 located in the heat medium relay unit 3 or at the heat medium pipe 6 located in the heat medium flow control unit 4.

[0032] When the heat medium conveying device 8 is disposed inside the heat medium relay unit 3, the heat medium conveying device 8 may control an output so that a difference between temperatures detected by the fourth temperature detecting device 42 and the fifth temperature detecting device 43 that are disposed upstream and downstream of the intermediate heat exchanger 30 is equal to a predetermined value, for example. Since this allows the heat medium conveying device 8 to operate with a power according to the indoor air-conditioning load, power consumption can be reduced.

[0033] When the heat medium relay unit 3 is disposed at a short distance from each of the indoor units 2a, 2b, and 2c, the distance over which the heat medium moves decreases and the pressure loss caused during circulation through the heat medium circuit B decreases. Thus, the heat medium conveying device 8 can be made compact or power consumption can be reduced.

[Indoor Units 2a, 2b, and 2c]

[0034] The casing 24 of the indoor units 2a, 2b, and 2c respectively accommodate therein load-side heat exchangers 60a, 60b, and 60c and indoor air-sending devices 61a, 61b, and 61c and communicate with the heat medium flow control unit 4 by the heat medium pipe 6. Each of the load-side heat exchangers 60a, 60b, and 60c exchanges heat between the heat medium and the air supplied from a corresponding one of the indoor air-sending devices 61a, 61b, and 61c, such as fans, to generate air for heating or air for cooling to be supplied to the room space.

[First Controller 23, Second Controller 45, and Third Controller 53]

[0035] Each of the first controller 23, the second controller 45, and the third controller 53 includes a computer such as a microcomputer. The first controller 23, the second controller 45, and the third controller 53 are mounted in the outdoor unit 1, the heat medium relay unit 3, and the heat medium flow control unit 4, respectively.

[0036] The first controller 23 mounted in the outdoor unit 1 controls, for example, the driving frequency of the compressor 10, the rotation speed and on/off of the outdoor air-sending device 14, and switching performed by the refrigerant flow switching device 11 in accordance with information detected by various detecting devices and an instruction sent from a remote control.

[0037] The second controller 45 mounted in the heat medium relay unit 3 controls the first expansion device 31. For example, the second controller 45 performs control based on the degree of superheat of the refrigerant when the refrigerant evaporates in the intermediate heat exchanger 30 and performs control based on the degree of supercooling when the refrigerant condenses. Detection values obtained by any two of the second temperature detecting device 40, the third temperature detecting device 41, the third pressure detecting device 44, the first pressure detecting device 20, or the second pressure detecting device 21 can be used in the control.

[0038] The second controller 45 may be configured to be able to control an output of the heat medium conveying device 8 that is disposed in or near the heat medium relay unit 3 by communication, for example. In this case, the output of the heat medium conveying device 8 is controlled based on detection values obtained by the fourth temperature detecting device 42 and the fifth temperature detecting device 43 disposed upstream and downstream of the intermediate heat exchanger 30 on the heat medium side. For example, if the control target value is set to a value such as a difference between the detection values detected by the fourth temperature detecting device 42 and the fifth temperature detecting device 43, the heat medium can be supplied at a flowrate according to the indoor-side load.

[0039] The third controller 53 mounted in the heat medium flow control unit 4 controls, for example, areas of the opening ports of the heat medium flow control devices 50a, 50b, and 50c, so that the heat medium is supplied at flowrates according to the loads required by the respective indoor units 2a, 2b, and 2c. Detection value(s) of at least one or more of the sixth temperature detecting devices 51a, 51b, and 51c and the seventh temperature detecting devices 52a, 52b, and 52c may be obtained, and the areas of the opening ports of the heat medium flow control devices 50a, 50b, and 50c may be controlled based on a difference in temperature. For example, if control is performed to make a difference between water temperatures at the inlet and the outlet of the indoor unit, such as temperatures detected by the sixth temperature

detecting device 51a and the seventh temperature detecting device 52a, the capacity control can be performed in accordance with the air-conditioning load required by the indoor unit.

[0040] The example has been described in which the first controller 23, the second controller 45, and the third controller 53 are mounted in different places in the above; however, the mounted places are not limited. Any one of the control devices may cause a corresponding control target to operate by communication, for example. In addition, a plurality of control devices, that is, two or more of the control devices, may be mounted in a given apparatus.

[Description of Operation Modes]

[0041] Operation modes carried out by the air-conditioning apparatus 100 will be described next. The air-conditioning apparatus 100 according to Embodiment is capable of selecting a cooling only operation mode in which all the operating indoor units perform cooling or a heating only operation mode in which all the indoor units perform heating.

[Cooling Only Operation Mode]

[0042] Fig. 2 is a circuit diagram illustrating flows of the refrigerant and the heat medium in the cooling only operation mode of the air-conditioning apparatus 100 illustrated in Fig. 1. In Fig. 2, the flow direction of the refrigerant is denoted by a solid-line arrow, and the flow direction of the heat medium is denoted by a dash-line arrow. The cooling only operation mode will be described by using the case where cooling energy loads are generated in the indoor units 2a, 2b, and 2c as an example in the description below.

[0043] In the refrigerant circuit A, the refrigerant that flows on the heat source side is compressed by the compressor 10 and is discharged as high-temperature high-pressure gas refrigerant. The high-temperature high-pressure gas refrigerant that has been discharged from the compressor 10 flows into the heat-source-side heat exchanger 12 through the refrigerant flow switching device 11. The high-temperature high-pressure gas refrigerant that has flowed into the heat-source-side heat exchanger 12 transfers heat to outdoor air and condenses to be high-pressure liquid refrigerant. The high-pressure liquid refrigerant that has flowed out from the heat-source-side heat exchanger 12 flows out from the outdoor unit 1, flows through the refrigerant pipe 5, and flows into the heat medium relay unit 3. The pressure of the high-pressure liquid refrigerant that has flowed into the heat medium relay unit 3 is reduced by the first expansion device 31, and consequently the high-pressure liquid refrigerant becomes low-temperature low-pressure two-phase refrigerant. Then, the low-temperature low-pressure two-phase refrigerant flows into the intermediate heat exchanger 30 operating as an evaporator, removes

heat to cool the area nearby, and becomes low-temperature low-pressure gas. The low-temperature low-pressure gas refrigerant that has flowed out from the intermediate heat exchanger 30 flows into the outdoor unit 1 through the refrigerant pipe 5. The refrigerant that has flowed into the outdoor unit 1 flows through the refrigerant flow switching device 11 and the accumulator 13 and is suctioned by the compressor 10.

[0044] On the other hand, in the heat medium circuit B, the pressure of the heat medium is increased by the heat medium conveying device 8 of the heat medium pipe 6, so that the heat medium circulates through the heat medium pipe 6. The heat medium whose pressure has been increased by the heat medium conveying device 8 flows into the heat medium relay unit 3. The heat of the heat medium is removed by the refrigerant on the heat source side of the intermediate heat exchanger 30, and consequently the heat medium is cooled and flows out. After flowing out from the heat medium relay unit 3, the heat medium is conveyed to the heat medium flow control unit 4 and flows into the heat medium flow control unit 4. The heat medium that has flowed into the heat medium flow control unit 4 is distributed at the branch portion 61, flows through the heat medium flow control devices 50a, 50b, and 50c, flows out from the heat medium flow control unit 4, and flows into the indoor units 2a, 2b, and 2c through the heat medium pipe 6. The heat medium removes heat from the indoor air in the load-side heat exchangers 60a, 60b, and 60c of the indoor units 2a, 2b, and 2c, respectively, to cool the room space, and flows out from the indoor units 2a, 2b, and 2c. The heat medium that has flowed out flows through the heat medium pipe 6, gathers at the junction portion 62 of the heat medium flow control unit 4, and flows into the heat medium conveying device 8.

[Heating Only Operation Mode]

[0045] Fig. 3 is a circuit diagram illustrating flows of the refrigerant and the heat medium in the heating only operation mode of the air-conditioning apparatus 100 illustrated in Fig. 1. As illustrated in Fig. 3, the flow direction of the refrigerant is denoted by a solid-line arrow, and the flow direction of the heat medium is denoted by a dash-line arrow. The heating only operation mode will be described by using the case where heating energy loads are generated in the indoor units 2a, 2b, and 2c as an example in the following description.

[0046] In the refrigerant circuit A, the refrigerant that flows on the heat source side is compressed by the compressor 10 and is discharged as high-temperature high-pressure gas refrigerant. The high-temperature high-pressure gas refrigerant that has been discharged from the compressor 10 flows out from the outdoor unit 1 through the refrigerant flow switching device 11 and flows into the heat medium relay unit 3 through the refrigerant pipe 5. The high-temperature high-pressure gas refrigerant that has flowed into the heat medium relay unit 3

transfers heat and condenses in the intermediate heat exchanger 30 functioning as a condenser, and flows into the first expansion device 31 as high-pressure liquid refrigerant. Then, the pressure of the high-pressure liquid refrigerant is reduced by the first expansion device 31, and consequently the high-pressure liquid refrigerant becomes low-temperature low-pressure two-phase refrigerant. Then, the low-temperature low-pressure two-phase refrigerant flows out from the heat medium relay unit 3, flows through the refrigerant pipe 5, and flows into the outdoor unit 1. The low-temperature low-pressure gas refrigerant that has flowed into the outdoor unit 1 flows into the heat-source-side heat exchanger 12 operating as an evaporator, removes heat from the outdoor air to evaporate and become low-temperature low-pressure gas. The low-temperature low-pressure gas refrigerant that has flowed out from the heat-source-side heat exchanger 12 flows through the refrigerant flow switching device 11 and the accumulator 13 and is suctioned by the compressor 10.

[0047] On the other hand, in the heat medium circuit B, the heat medium whose pressure has been increased by the heat medium conveying device 8 flows into a heat medium relay device, is heated by heating energy of the refrigerant on the heat source side of the intermediate heat exchanger 30, and flows out. The heat medium flows out from the heat medium relay unit 3. After flowing out from the heat medium relay unit 3, the heat medium is conveyed to the heat medium flow control unit 4 and flows into the heat medium flow control unit 4. The heat medium that has flowed into the heat medium flow control unit 4 is distributed at the branch portion 61, flows through the heat medium flow control devices 50a, 50b, and 50c, flows out from the heat medium flow control unit 4, and flows into the indoor units 2a, 2b, and 2c through the heat medium pipe 6. The heat medium transfers heat to the indoor air in the load-side heat exchangers 60a, 60b, and 60c of the indoor units 2a, 2b, and 2c to heat the room space, and flows out from the indoor units 2a, 2b, and 2c. The heat medium that has flowed out flows into the heat medium conveying device 8 again through the heat medium pipe 6 and the heat medium flow control unit 4.

[0048] As described above, the outdoor unit 1, each of the indoor units 2a, 2b, and 2c, the heat medium relay unit 3, and the heat medium flow control unit 4 are accommodated in the separate casing 15, 24, 32, and 46, respectively. The outdoor unit 1 and the heat medium relay unit 3 communicate with each other by the refrigerant circuit A. The heat medium relay unit 3, the heat medium flow control unit 4, and the indoor units 2a, 2b, and 2c communicate with each other by the heat medium circuit B. That is, the casing 46 of the heat medium flow control unit 4 is separate from the casing 32 of the heat medium relay unit 3. Thus, the influence of a leakage of the refrigerant can be reduced by placing the refrigerant circuit A in the outdoor space and placing the heat medium circuit B in the indoor space. Further, distributing the casing 15, 24, 32, and 46 enables a flexible arrange-

ment even at a place where a sufficient outdoor space is not provided. Since the components are separately distributed in the casing 15, 24, 32, and 46, the sizes of the individual casing 15, 24, 32, 46 can be suppressed.

[0049] In the examples illustrated in Figs. 2 and 3, the compressor 10 is controlled by using the first controller 23 such that at least one of the detection value of the first pressure detecting device 20 or the detection value of the second pressure detecting device 21 is equal to a predetermined value. For example, in the case of the cooling only operation mode, the refrigerant can be supplied at flowrates according to cooling loads needed by the indoor units 2a, 2b, and 2c if control is performed such that evaporating temperature determined from the detection value of the second pressure detecting device 21 is equal to a predetermined value. In addition, in the case of the heating only operation mode, the refrigerant can be supplied at flowrates according to heating loads needed by the indoor units 2a, 2b, and 2c if control is performed such that condensing temperature that can be determined from the detection value of the first pressure detecting device 20 is equal to a predetermined value.

[0050] The outdoor air-sending device 14 is controlled by using the first controller 23 such that at least one of the detection value of the first pressure detecting device 20 or the detection value of the second pressure detecting device 21 is equal to a predetermined value. For example, in the case of the cooling only operation mode, control may be performed such that condensing temperature determined from the detection value of the first pressure detecting device 20 is equal to a predetermined value. In addition, in the case of the heating only operation mode, control may be performed such that evaporating temperature that can be determined from the detection value of the second pressure detecting device 21 is equal to a predetermined value.

[0051] The opening degree of the first expansion device 31 is controlled by using the second controller 45 such that the degree of superheat obtained as a difference between the second temperature detecting device 40 and the third temperature detecting device 41 is constant in the case of the cooling only operation mode. Alternatively, control may be performed such that the degree of superheat obtained from a difference between evaporating temperature determined from the third pressure detecting device 44 and detection temperature of the second temperature detecting device 40 is constant, or a value determined from the second pressure detecting device 21 mounted in the outdoor unit 1 may be used as the evaporating temperature. In the case of the heating only operation mode, the opening degree is controlled by using the second controller 45 such that the degree of supercooling obtained as a difference between condensing temperature calculated from the detection value of the third pressure detecting device 44 and the detection value of the second temperature detecting device 40 is constant. Alternatively, control may be performed such

that the degree of supercooling obtained as a difference between condensing temperature calculated from the detection value of the first pressure detecting device 20 and the detection value of the second temperature detecting device 40 is constant.

[0052] The opening degrees of the heat medium flow control devices 50a, 50b, and 50c are controlled such that temperature differences between detection values of the sixth temperature detecting devices 51a, 51b, and 51c and detection values of the seventh temperature detecting devices 52a, 52b, and 52c are equal to predetermined values, respectively. In this way, air-conditioning loads required in the respective rooms are covered. The predetermined value is, for example, 2 degrees C to 7 degrees C in the case of the cooling only operation mode and is, for example, 5 degrees C to 10 degrees C in the case of the heating only operation mode. If the temperature difference is smaller than the predetermined value, the opening degree of the heat medium flow control device 50a, 50b, or 50c is controlled in a closing direction. If the temperature difference is larger than the predetermined value, the opening degree is controlled in the opening direction. As described above, the heat medium flows into the load-side heat exchanger 60a, 60b, or 60c after the flowrate of the heat medium is controlled to the required flowrate in accordance with the air-conditioning load required in the corresponding room.

[0053] The heat medium conveying device 8 may have an output of a constant rotation speed. Thus, the opening degree may be controlled such that a temperature difference between the detection values of the fourth temperature detecting device 42 and the fifth temperature detecting device 43 that are disposed upstream and downstream of the intermediate heat exchanger 30 is equal to a predetermined value. In this case, the predetermined value may be, for example, 2 degrees C to 7 degrees C in the case of the cooling only operation mode and may be, for example, 5 degrees C to 10 degrees C in the case of the heating only operation mode.

[0054] In the description of Figs. 2 and 3, the cases where the indoor units 2a, 2b, and 2c carry out the cooling only operation mode or the heating only operation mode have been described by way of example. However, the operation modes may include a mode in which an indoor unit that does not perform the cooling operation may present as the indoor unit is stopped or is in a thermostat state. In such a case, if the heat medium flow control device 50a, 50b, or 50c connected to the indoor unit that does not perform the cooling operation is controlled to have an opening degree at which the heat medium does not flow, for example, the completely closed opening degree, the loss of the heat medium conveying power can be reduced.

Modification.

[0055] Fig. 4 is a schematic circuit configuration diagram illustrating an example of a circuit configuration of

an air-conditioning apparatus 200 according to Modification. As illustrated in Fig. 4, the air-conditioning apparatus 200 according to Modification includes a casing 54 of an outdoor unit 16 accommodating therein components coupled by the refrigerant circuit A, the casing 46 of the heat medium flow control unit 4, and the casing 24 of the indoor units 2a, 2b, and 2c. In addition, the outdoor unit 16 includes the refrigerant leakage detecting device 7.

[0056] The components accommodated in the casing 54 of the outdoor unit 1 are the compressor 10, the refrigerant flow switching device 11 such as a four-way valve, the heat-source-side heat exchanger 12, the accumulator 13, the intermediate heat exchanger 30, and the first expansion device 31 that communicate with each other by the refrigerant pipe 5. The heat medium pipe 6 that extends from outside of the outdoor unit 16 is connected to the intermediate heat exchanger 30. That is, in the air-conditioning apparatus 200 according to Modification, components that are separately accommodated in the casing 15 and the casing 32 in the air-conditioning apparatus 100 according to Embodiment are collectively accommodated in the casing 54 of the outdoor unit 16. This configuration is generally called a chiller unit, for example. The heat medium circuit B that extends from the outdoor unit 16 is connected to the heat medium flow control unit 4 that distributes the heat medium at flowrates according to the respective air-conditioning loads, and is further connected to each of the indoor units 2a, 2b, and 2c.

[Cooling Only Operation Mode]

[0057] Fig. 5 is a circuit diagram illustrating flows of the refrigerant and the heat medium in the cooling only operation mode of the air-conditioning apparatus 200 according to Modification. In Fig. 5, the flow direction of the refrigerant is denoted by a solid-line arrow, and the flow direction of the heat medium is denoted by a dash-line arrow.

[0058] In the cooling only operation mode in which the cooling loads are generated in the indoor units 2a, 2b, and 2c, the operation similar to that described in Fig. 2 is performed. Specifically, the refrigerant that flows through the refrigerant circuit A is changed to gas refrigerant by the compressor 10 accommodated in the casing 54 of the outdoor unit 16, flows into the heat-source-side heat exchanger 12 through the refrigerant flow switching device 11, transfers heat to the outdoor air to become high-pressure liquid refrigerant, and flows out. Then, the pressure is reduced by the first expansion device 31, and the refrigerant flows into the intermediate heat exchanger 30 operating as an evaporator and removes heat from the heat medium that flows through the heat medium pipe 6 to become low-temperature low-pressure gas.

[0059] On the other hand, in the heat medium circuit B, the heat of the heat medium is removed by the refrigerant in the intermediate heat exchanger 30 to which the heat medium pipe 6 that extends from outside of the out-

door unit 16 is coupled, and the heat medium flows out from the intermediate heat exchanger 30 in the cooled state. Then, the heat medium is conveyed to each of the components in the casing 46 of the heat medium flow control unit 4 and the casing 24 of the indoor units 2a, 2b, and 2c through the heat medium pipe 6 and circulates through the heat medium circuit B.

[Heating Only Operation Mode]

[0060] Fig. 6 is a circuit diagram illustrating flows of the refrigerant and the heat medium in the heating only operation mode of the air-conditioning apparatus 200 according to Modification. In Fig. 6, the flow direction of the refrigerant is denoted by a solid-line arrow, and the flow direction of the heat medium is denoted by a dash-line arrow.

[0061] In the heating only operation mode in which heating loads are generated in the indoor units 2a, 2b, and 2c, the operation similar to that described in Fig. 3 is performed. Specifically, the refrigerant that flows through the refrigerant circuit A is changed to gas refrigerant by the compressor 10 accommodated in the casing 54 of the outdoor unit 16, flows into the intermediate heat exchanger 30 through the refrigerant flow switching device 11, transfers heat and condenses in the intermediate heat exchanger 30, and flows into the first expansion device 31. Then, after the pressure is reduced by the first expansion device 31, the refrigerant flows into the heat-source-side heat exchanger 12, removes heat from the outdoor air to evaporate and become low-pressure gas refrigerant, and is suctioned by the compressor 10 through the refrigerant flow switching device 11 and the accumulator 13.

[0062] On the other hand, in the heat medium circuit B, heating energy of the refrigerant is transferred to the heat medium in the intermediate heat exchanger 30 to which the heat medium pipe 6 that extends from outside of the outdoor unit 16 is coupled, and the heat medium flows out from the heat medium relay unit 3 in the heated state. Then, the heat medium is conveyed to each of the components in the casing 46 of the heat medium flow control unit 4 and the casing 24 of the indoor units 2a, 2b, and 2c through the heat medium pipe 6 and circulates through the heat medium circuit B.

[0063] As described above, since the series of operations performed using the refrigerant that flows through the refrigerant circuit A is performed by each of the components accommodated in the casing 54 of the outdoor unit, the risk of refrigerant leakage to the room space can be reduced greatly. In addition, since the heat medium flow control unit 4 disposed in the heat medium circuit B distributes the heat medium at flowrates according to air-conditioning loads of the respective indoor units 2a, 2b, and 2c, the comfortableness improves in the respective rooms. This consequently enables an installation to be updated with high system configuration flexibility in accordance with the structure of a building or the usage of

a building.

[0064] In addition, in a building in which an air-conditioning system that uses a heat medium, such as a chiller unit, is already installed, the air-conditioning apparatus 100 according to Embodiment 1 or the air-conditioning apparatus 200 according to Modification can be installed. In this case, the installation can be updated easily by using the existing indoor units and a pipe such as a heat medium pipe connected to the existing indoor units. In addition, since the casing 46 of the heat medium flow control unit 4 and the casing 32 of the heat medium relay unit 3 are separate, an installation update needed for the existing installation is minimized by using the heat medium flow control unit 4 according to Embodiment described above. Thus, a cost-cutting effect can also be expected as a result of standardization of the unit.

[0065] Note that the intermediate heat exchanger 30 may be used in common in either Embodiment in which separate casing are used as the casing 32 of the heat medium relay unit 3 and the casing 15 of the outdoor unit 1 or a configuration of Modification in which the casing 54 of the outdoor unit 1 is used. In this case, the common intermediate heat exchanger 30 can be installed by selecting one of the configurations in accordance with the existing pipes.

[0066] According to the air-conditioning apparatus 100 according to Embodiment described above, the casing 24 of the indoor units 2a, 2b, and 2c and the casing 46 of the heat medium flow control unit 4 in which the refrigerant does not circulate are provided separately from the casing 15 of the outdoor unit 1 and the casing 32 of the intermediate heat exchanger 30 in which the refrigerant circulates. Each of the casing 15, 24, 32, and 46 is placed at a desired position. The outdoor unit 1 and the heat medium relay unit 3 communicate with each other by the refrigerant circuit A. The heat medium relay unit 3, the heat medium flow control unit 4, and the indoor units 2a, 2b, and 2c communicate with each other by the heat medium circuit B. Since heat can be exchanged between the refrigerant and the heat medium at a place separate from the room space with this configuration and cooling energy conveyed by the heat medium circuit B can be distributed to each of the indoor units 2a, 2b, and 2c, the necessary amount of refrigerant can be reduced and a leakage of the refrigerant to the room space can be prevented.

[0067] Since the intermediate heat exchanger 30 can be used in common, one of the configurations can be selected in accordance with the existing pipes and the common intermediate heat exchanger 30 may be mounted. Consequently, the control method regarding supplying of the heat medium to the indoor units is standardized, and the unit can be standardized.

[0068] Since the intermediate heat exchanger 30 and the heat medium flow control unit 4 are accommodated in separate casing, the installation flexibility increases, the system modification at the time of the installation update becomes easier, and the degree of freedom in sys-

tem selection improves.

[0069] A chiller unit including both the casing 15 of the outdoor unit 1 and the casing 32 of the heat medium relay unit 3 can be formed and installed by using the existing pipes.

[0070] Since the outdoor unit 1 and the heat medium relay unit 3 in which the refrigerant flows are placed outdoors, a leakage of the refrigerant to the room space where people are present can be prevented.

[0071] The opening degrees of the heat medium flow control devices 50a, 50b, and 50c can be controlled in accordance with air-conditioning loads of the load-side heat exchangers 60a, 60b, and 60c, respectively.

[0072] The air-conditioning loads of the load-side heat exchangers 60a, 60b, and 60c can be calculated from temperatures at the inlets and the outlets of the load-side heat exchangers 60a, 60b, and 60c, respectively.

[0073] Since the heat medium conveying device 8 is operated by calculating the indoor air-conditioning load based on a difference between temperatures of the heat medium that flows into and flows out from the intermediate heat exchanger 30, power consumption is suppressed.

[0074] Since each of the casing 15 of the outdoor unit 1, the casing 32 of the heat medium relay unit 3, and the casing 46 of the heat medium flow control unit 4 includes a control device that controls the components accommodated therein, each of the casing 15, 32, and 46 can be placed at a desired position.

[0075] The influence of a leakage can be suppressed by detecting the refrigerant that has leaked from the refrigerant pipe 5 by using the refrigerant leakage detecting device 7 that is included in the casing 32 of the heat medium relay unit 3 or the casing 15 of the outdoor unit 1.

Reference Signs List

[0076] 1, 16 outdoor unit, 2a, 2b, 2c indoor unit, 3 heat medium relay unit, 4 heat medium flow control unit, 5 refrigerant pipe, 6 heat medium pipe, 7 refrigerant leakage detecting device, 8 heat medium conveying device, 10 compressor, 11 refrigerant flow switching device, 12 heat-source-side heat exchanger, 13 accumulator, 14 outdoor air-sending device, 15, 24, 32, 46, 54 casing, 20 first pressure detecting device, 21 second pressure detecting device, 22 first temperature detecting device, 23 first controller, 30 intermediate heat exchanger, 31 first expansion device, 40 second temperature detecting device, 41 third temperature detecting device, 42 fourth temperature detecting device, 43 fifth temperature detecting device, 44 third pressure detecting device, 45 second controller, 50a, 50b, 50c heat medium flow control device, 51a, 51b, 51c sixth temperature detecting device, 52a, 52b, 52c seventh temperature detecting device, 53 third controller, 60a, 60b, 60c load-side heat exchanger, 61 branch portion, 61a, 61b, 61c indoor air-sending device, 62 junction portion, 100, 200 air-conditioning apparatus.

Claims

1. An air-conditioning apparatus comprising:

an outdoor-unit casing accommodating therein a compressor, a refrigerant flow switching device, and a heat-source-side heat exchanger; a heat-medium-relay-unit casing accommodating therein an expansion device and an intermediate heat exchanger; a heat-medium-flow-control-unit casing accommodating therein a heat medium flow control device; an indoor-unit casing accommodating therein a load-side heat exchanger and an indoor air-sending device; and a heat medium conveying device configured to convey a heat medium, the compressor, the refrigerant flow switching device, the heat-source-side heat exchanger, the expansion device, and a refrigerant passage of the intermediate heat exchanger communicating with each other via refrigerant pipes to form a refrigerant circuit, refrigerant flowing through the refrigerant pipe, and a heat medium passage of the intermediate heat exchanger, the heat medium conveying device, the heat medium flow control device, and the load-side heat exchanger communicating with each other via heat medium pipes to form a heat medium circuit, the heat medium flowing through the heat medium pipe.

2. The air-conditioning apparatus of claim 1, wherein the intermediate heat exchanger is used in common in a configuration in which the outdoor-unit casing and the heat-medium-relay-unit casing are accommodated in a single casing, and a configuration in which the outdoor-unit casing and the heat-medium-relay-unit casing are accommodated in separate casings.

3. The air-conditioning apparatus of claim 1 or 2, wherein the intermediate heat exchanger and the heat medium flow control device are respectively accommodated in the heat-medium-relay-unit casing and the heat-medium-flow-control-unit casing provided separately.

4. The air-conditioning apparatus of any one of claims 1 to 3, wherein the outdoor-unit casing and the heat-medium-relay-unit casing are accommodated in a single casing.

5. The air-conditioning apparatus of any one of claims 1 to 4, wherein

the outdoor-unit casing and the heat-medium-relay-unit casing are disposed in an outdoor space, and the heat-medium-flow-control-unit casing and the indoor-unit casing are disposed in an indoor space.

6. The air-conditioning apparatus of any one of claims 1 to 5, wherein the heat medium conveying device is accommodated in the heat-medium-relay-unit casing.

7. The air-conditioning apparatus of any one of claims 1 to 6, wherein the heat medium flow control device is configured to control a flowrate of the heat medium such that a temperature difference between an inlet temperature and an outlet temperature of the load-side heat exchanger is equal to a predetermined value.

8. The air-conditioning apparatus of claim 7, further comprising:

a first temperature detecting device configured to detect the inlet temperature; and a second temperature detecting device configured to detect the outlet temperature.

9. The air-conditioning apparatus of claim 8, wherein the first temperature detecting device and the second temperature detecting device are accommodated in the heat-medium-relay-unit casing.

10. The air-conditioning apparatus of any one of claims 7 to 9, wherein the predetermined value for the temperature difference between the inlet temperature and the outlet temperature is greater in a heating operation in which the heat-source-side heat exchanger serves as an evaporator than in a cooling operation in which the heat-source-side heat exchanger serves as a condenser.

11. The air-conditioning apparatus of any one of claims 1 to 10, wherein the heat-medium-relay-unit casing accommodates therein

a third temperature detecting device configured to detect a temperature of the heat medium flowing into the intermediate heat exchanger, and a fourth temperature detecting device configured to detect a temperature of the heat medium flowing out from the intermediate heat exchanger, and

the heat medium conveying device is configured to control a flowrate of the heat medium such that a difference between a detection value of the third temperature detecting device and a detection value of the fourth temperature detecting device is equal to

a predetermined value.

12. The air-conditioning apparatus of claim 11, wherein the predetermined value for the difference between the detection value of the third temperature detecting device and the detection value of the fourth temperature detecting device is greater in a heating operation in which the heat-source-side heat exchanger serves as an evaporator than in a cooling operation in which the heat-source-side heat exchanger serves as a condenser. 5 10
13. The air-conditioning apparatus of any one of claims 1 to 12, further comprising: 15
- a first controller accommodated in the outdoor-unit casing and configured to control the compressor and the refrigerant flow switching device; 20
 - a second controller accommodated in the heat-medium-relay-unit casing and configured to control the expansion device; and
 - a third controller accommodated in the heat-medium-flow-control-unit casing and configured to control the heat medium flow control device. 25
14. The air-conditioning apparatus of any one of claims 1 to 13, wherein a refrigerant leakage detecting device is included in at least one of the outdoor-unit casing and the heat-medium-relay-unit casing. 30

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FIG. 1

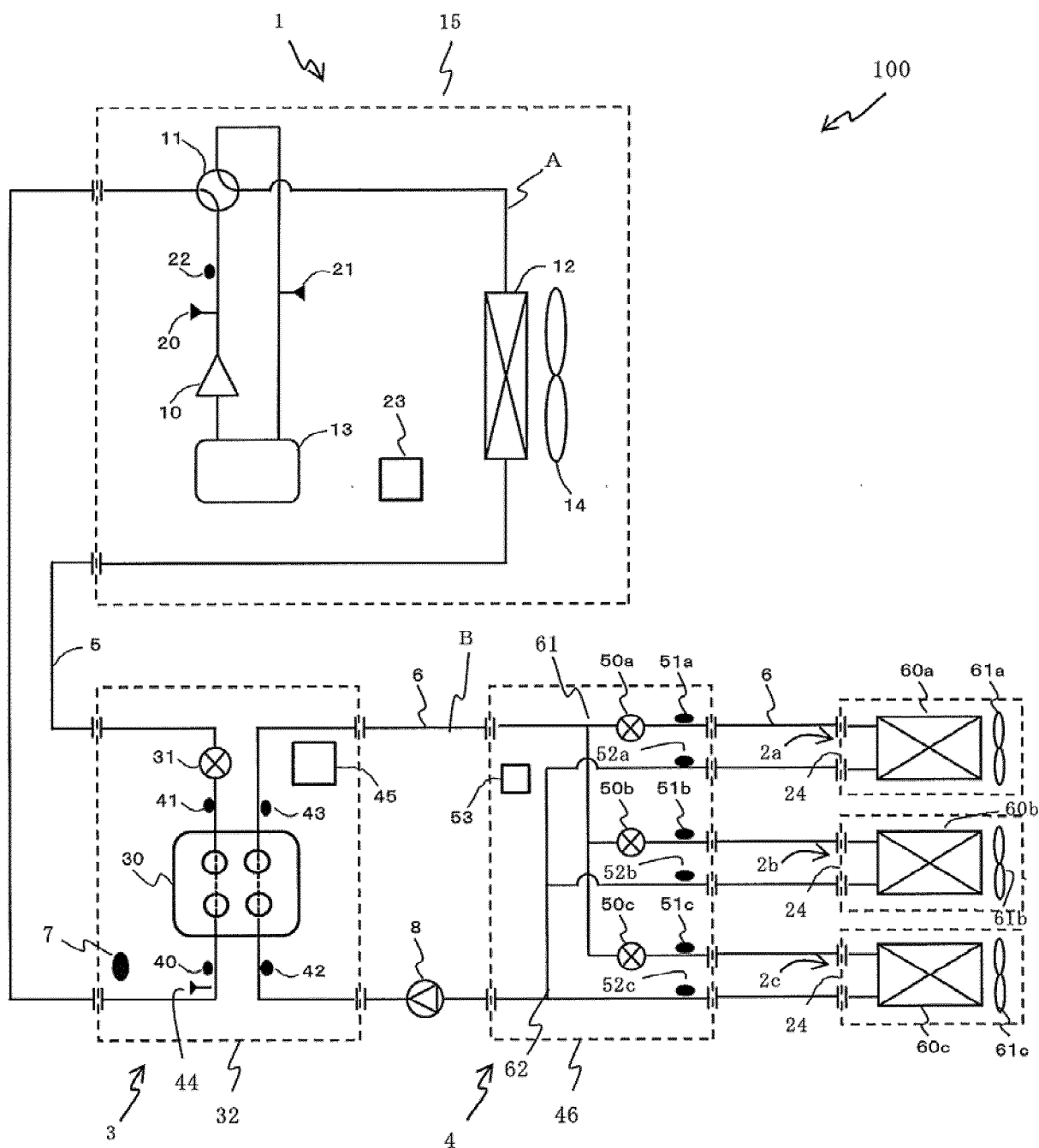


FIG. 2

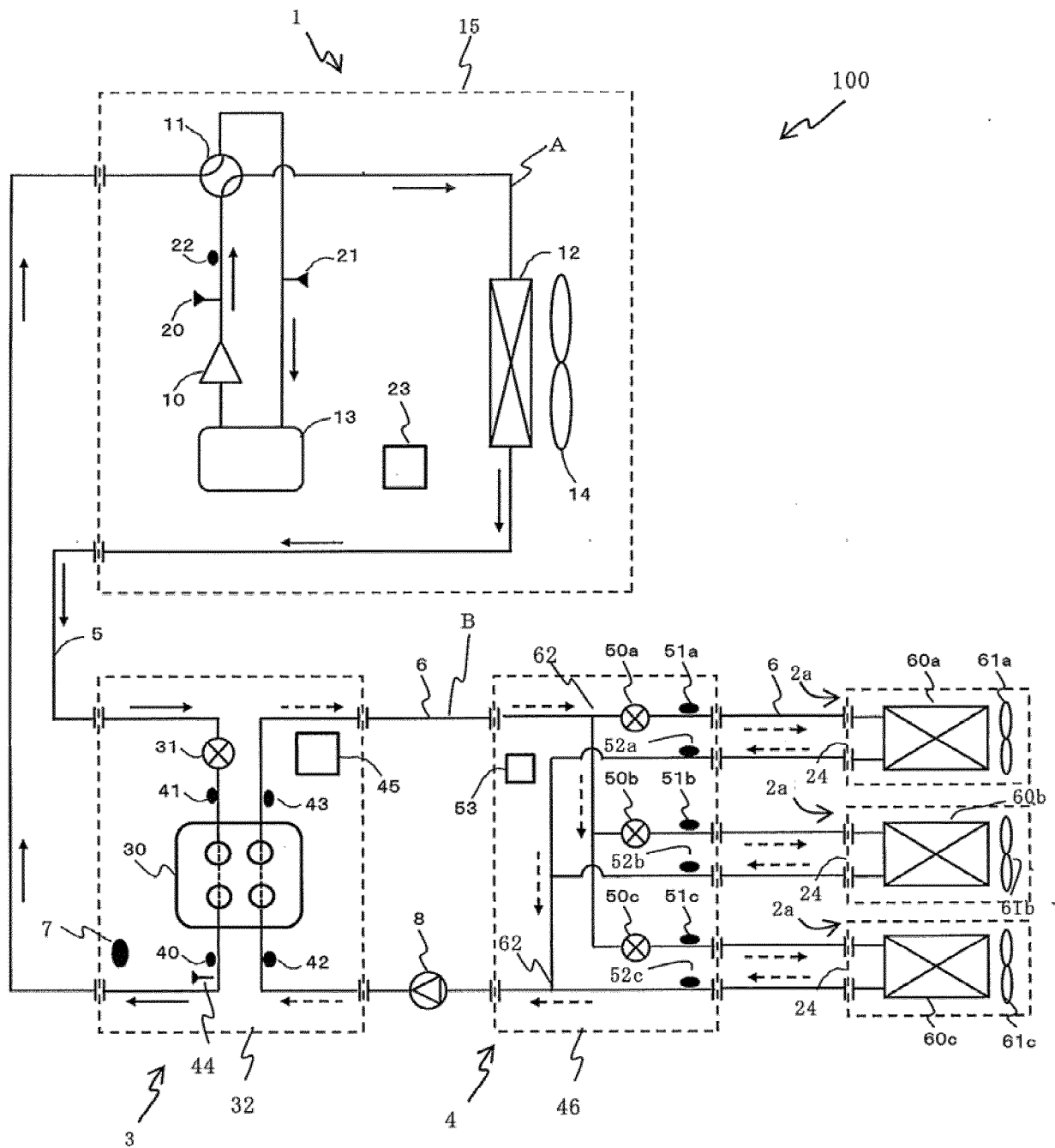


FIG. 3

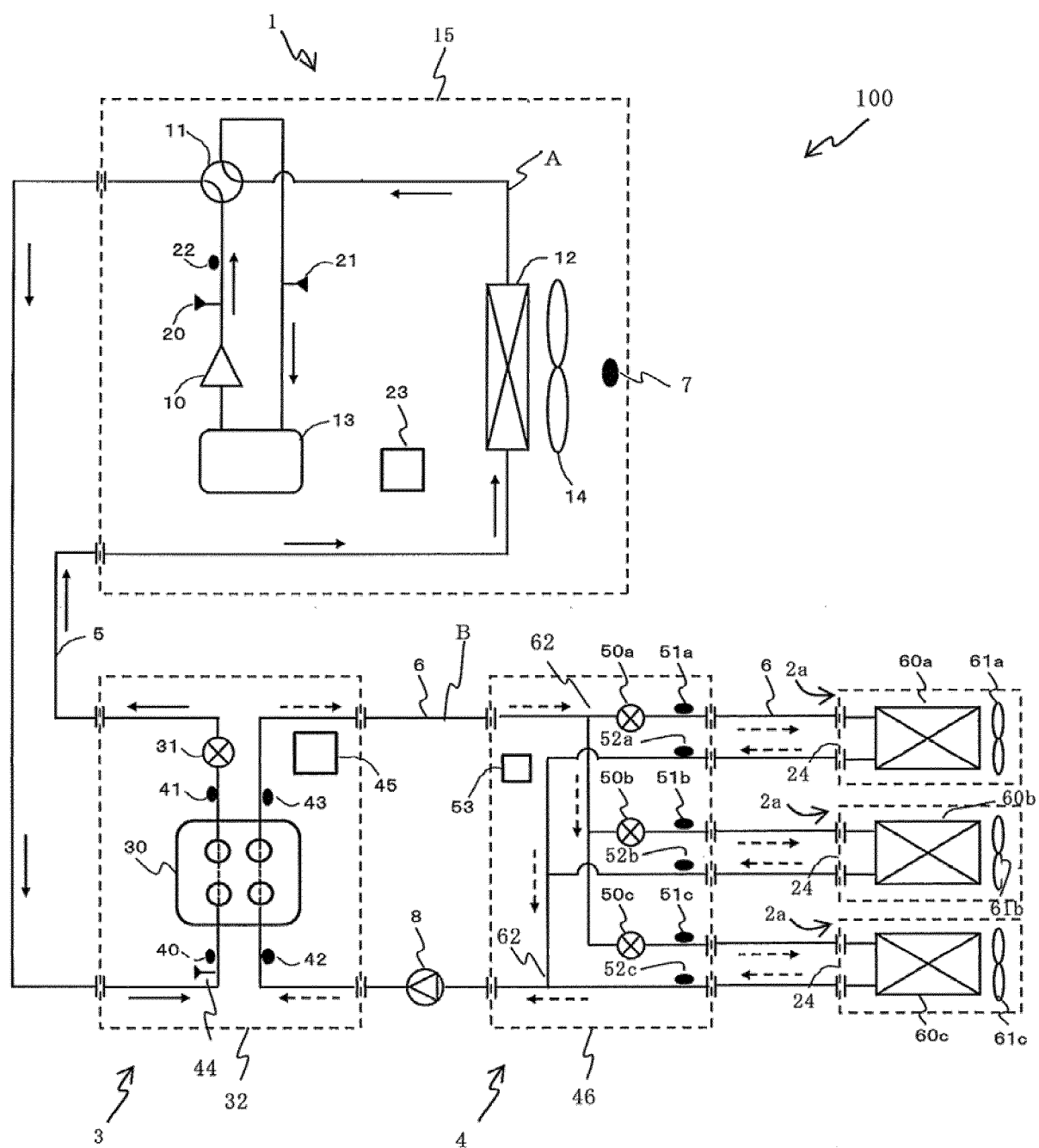


FIG. 4

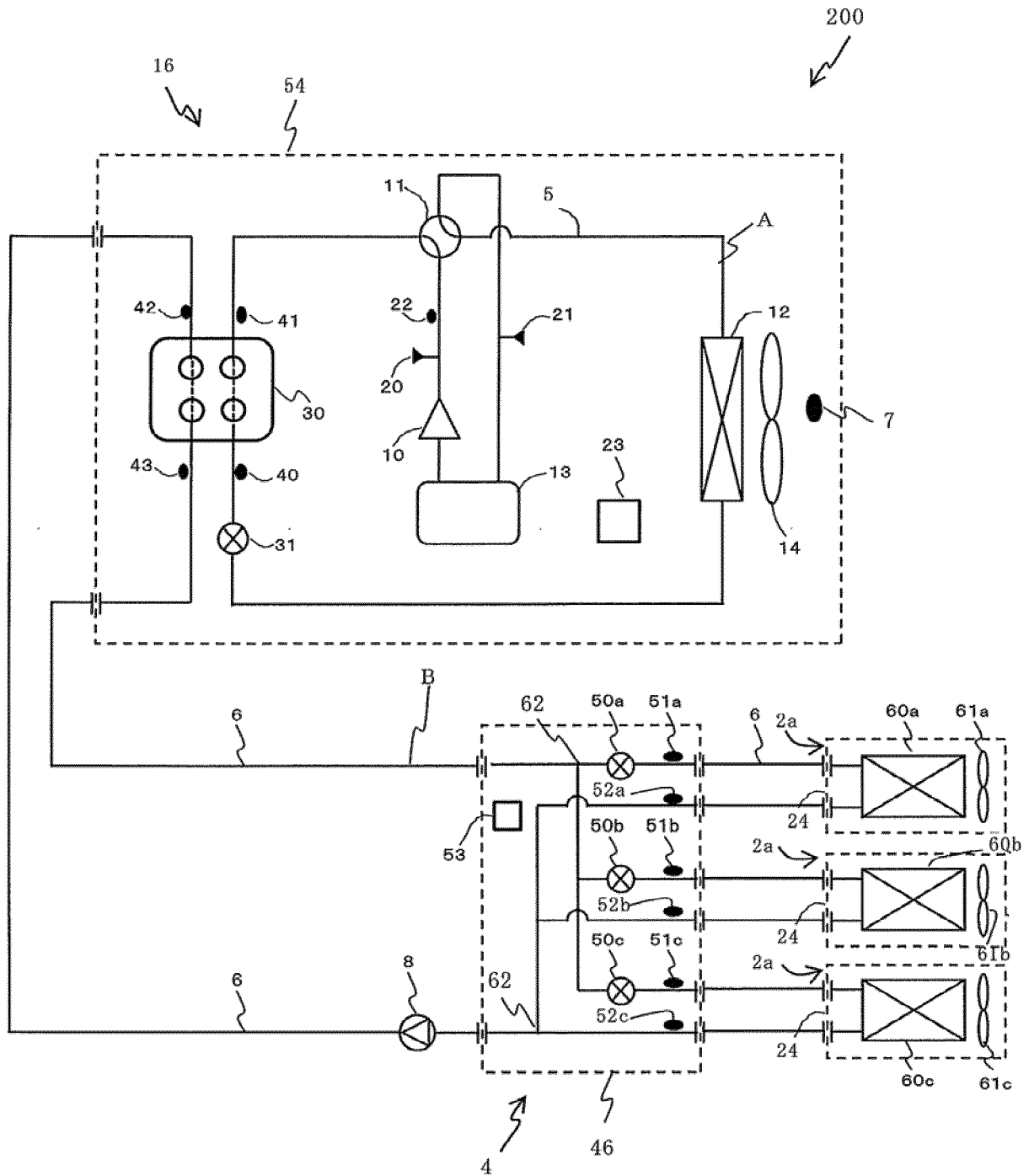


FIG. 5

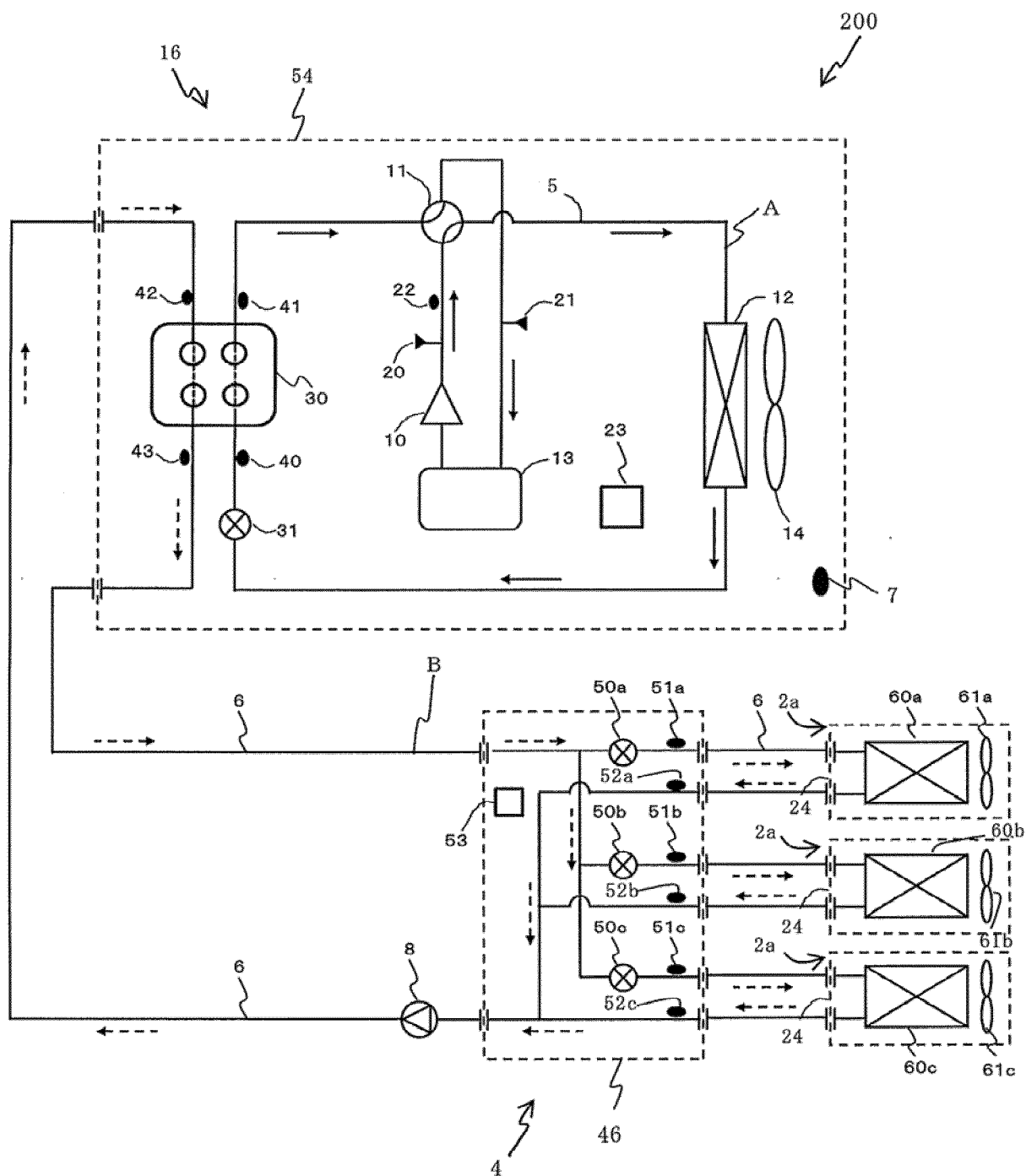
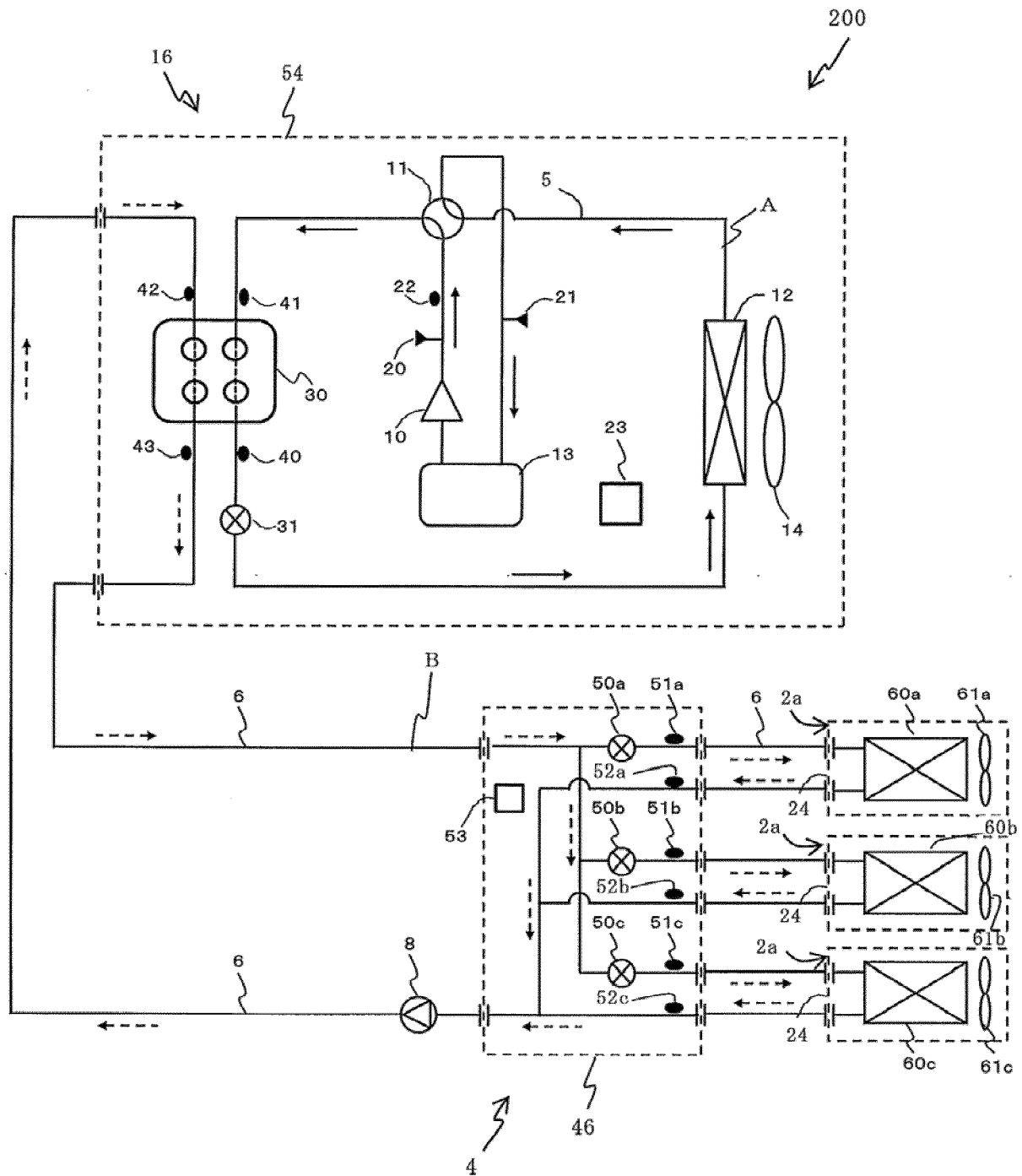


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/050578

A. CLASSIFICATION OF SUBJECT MATTER

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)

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 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/057550 A1 (Mitsubishi Electric Corp.), 17 April 2014 (17.04.2014), paragraphs [0013] to [0102]; fig. 1 to 9 & US 2015/0253020 A1 paragraphs [0028] to [0195] & EP 2908070 A1 & CN 104704300 A	1-14
Y	JP 2014-102011 A (Mitsubishi Heavy Industries, Ltd.), 05 June 2014 (05.06.2014), paragraphs [0014] to [0065]; fig. 1 to 4 & EP 2733441 A2 paragraphs [0028] to [0118]	1-14

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

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3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

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