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(54) **AIR CONDITIONING DEVICE**

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Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus applied to, for example, a multi-air-conditioning apparatus for buildings, and more particularly, to an air-conditioning apparatus that is capable of efficiently supplying heating energy, cooling energy, or both the heating energy and cooling energy generated by a heat source unit to a plurality of loads.

Background Art

[0002] As a related art, air-conditioning apparatuses that perform heat exchange using a heat medium (cold liquid or hot liquid) from a heat source apparatus (heat source equipment) and that perform precooling or preheating of a heat medium that circulates between a heat source unit and an indoor unit (air-conditioning unit) are available. Regarding the above-mentioned air-conditioning apparatus, a precooling/preheating control method for air-conditioning equipment configured such that "after the liquid temperature inside pipes is measured during a night time when electricity rate is low and heat source equipment is activated at the time calculated on the basis of data obtained by leaning and calculation, a valve of a cold liquid coil or hot liquid coil of an air-conditioning unit that is scheduled to operate on that day is forced to be fully opened without an air-sending fan of the air-conditioning unit being operated and the precooling/preheating for a portion from the heat source equipment to the coil of the air-conditioning unit is performed within the minimum time by the time when the air-conditioning unit actually starts to be used so that a reduction in power consumption and an elimination of wasteful supply of heat by liquid can be achieved" has been suggested (for example, see Patent Literature 1).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2000-227242 (Abstract, Fig. 1).

[0004] WO 2010/050004 A1 discloses an air conditioner with a compressor and a heat source side heat exchanger, which are received in a heat source device. Further, said air conditioner comprises an intermediate heat exchanger and a pump received in a relay unit. Further, it comprises a utilization side heat exchanger, which is received in a indoor unit. When the control device stops the compressor based on an operation stop instruction or on thermo off due to a reduction in heat load at the utilization side heat exchanger, the control device also stops the pump after or almost at the same time as the stop of the compressor.

[0005] WO 2010/049999 A1 discloses an air conditioner in which the refrigerant is adapted not to flow up to an indoor unit to further save energy. A heat medium circuit is formed by interconnecting by piping intermediate heat exchangers, a pump for pressurizing the heat medium, utilization side heat exchangers for exchanging heat between the heat medium and air in an indoor space and a flow path switching valve for allowing the passage of heated heat medium to each utilization heat exchanger or the passage of cooled heat medium to each utilization side heat exchanger.

[0006] WO 2010/131335 A1 discloses an air conditioning apparatus with a first cycle, a second cycle and a third cycle, which are connected in series with each other via a first pressure reducing valve and a second pressure reducing valve. By this arrangement, the air conditioning apparatus is capable of realizing a circuit flexibly responding to cooling, heating, simultaneous cooling and heating operation, two-temperature cooling, and two-temperature heating.

Summary of Invention

Technical Problem

[0007] For the method described in Patent Literature 1, in the case where many air-conditioning units are scheduled to operate and the scheduled operation time differs from unit to unit, a heat medium during operation and a heat medium during stopping are mixed together when an indoor unit whose scheduled operation time is later is activated. Thus, the temperature of the heat medium during operation suddenly changes. This sudden change causes a pressure variation to occur on a refrigerant side, which becomes a factor of inducing pressure anomaly. Furthermore, in the case where a simultaneous cooling and heating operation in which both an indoor unit that performs cooling and an indoor unit that performs heating exist is performed, such a situation also occurs at the time when the operation mode of an indoor unit is switched from heating to cooling (or from cooling to heating).

[0008] The present invention has been designed to solve the problems described above. An object of the present invention is to provide a highly reliable air-conditioning apparatus that is capable of performing a simultaneous cooling and heating operation, suppressing a pressure variation on a refrigerant even at the time when an indoor unit is activated or when switching of the operation mode of an indoor unit is performed, and efficiently supplying heating energy, cooling energy, or both the heating energy and cooling energy generated by a heat source unit to a plurality of loads.

Solution to Problem

[0009] An air-conditioning apparatus according to the present invention is defined in claims 1, 3 and 6, respec-

tively.

Advantageous Effects of Invention

[0010] With an air-conditioning apparatus according to the present invention, a pressure variation on a refrigerant side can be suppressed even in a system that is capable of performing a simultaneous cooling and heating operation by adjusting the flow rate of a heat medium that is caused to circulate in a target indoor unit at the time when an indoor unit is activated or when switching of the operation mode of an indoor unit is performed, and the reliability can thus be improved.

Brief Description of Drawings

[0011]

[Fig. 1] Fig. 1 is a schematic diagram illustrating an example of the installation of an air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 2] Fig. 2 is a schematic circuit diagram illustrating an example of the circuit configuration of the air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 3] Fig. 3 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus according to Embodiment 1 of the present invention is in a heating only operation mode.
[Fig. 4] Fig. 4 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus according to Embodiment 1 of the present invention is in a heating main operation mode.
[Fig. 5] Fig. 5 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus according to Embodiment 1 of the present invention is in a cooling only operation mode.
[Fig. 6] Fig. 6 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus according to Embodiment 1 of the present invention is in the cooling main operation mode.
[Fig. 7] Fig. 7 is a flowchart illustrating an example of the flow of a process of a pressure variation suppressing operation performed by the air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 8] Fig. 8 is a flowchart illustrating another example of the flow of the process of the pressure variation suppressing operation performed by the air-conditioning apparatus according to Embodiment 1 of the present invention.
[Fig. 9] Fig. 9 is an explanatory diagram for explaining a method for increasing the opening degree of a heat medium flow control device.
[Fig. 10] Fig. 10 is a flowchart illustrating an example of the flow of a process of a pressure variation suppressing operation performed by an air-conditioning apparatus according to Embodiment 2 of the present invention.
[Fig. 11] Fig. 11 is a flowchart illustrating an example of the flow of a process of a pressure variation suppressing operation performed by an air-conditioning apparatus according to Embodiment 3 of the present invention.

Description of Embodiments

[0012] Hereinafter, embodiments of the present invention will be explained with reference to the drawings.

Embodiment 1

[0013] Fig. 1 is a schematic diagram illustrating an example of the installation of an air-conditioning apparatus according to an embodiment of the present invention. The example of the installation of the air-conditioning apparatus will be explained with reference to Fig. 1. In the air-conditioning apparatus, with the use of refrigeration cycles (a refrigerant circuit A and a heat medium circuit B) for allowing refrigerants (a heat-source-side refrigerant and a heat medium) to circulate, indoor units can freely select between a cooling mode and a heating mode as an operation mode. Fig. 1 schematically illustrates the entire air-conditioning apparatus in which a plurality of indoor units 3 are connected. In the drawings provided below including Fig. 1, the size relationship of individual component parts may differ from the actual size relationship.

[0014] In Fig. 1, the air-conditioning apparatus according to Embodiment 1 includes an outdoor unit (heat source unit) 1, a plurality of indoor units 3, and a relay unit 2 that is arranged between the outdoor unit 1 and the indoor units 3. The relay unit 2 exchanges heat between a heat-source-side refrigerant and a heat medium. The outdoor unit 1 and the relay unit 2 are connected by refrigerant pipes 4 through which the heat-source side refrigerant flows. The relay unit 2 and each of the indoor units 3 are connected by pipes (heat medium pipes) 5 through which the heat medium flows. Cooling energy or heating energy generated by the outdoor unit 1 is sent through the relay unit 2 to the indoor units 3.

[0015] Normally, the outdoor unit 1 is arranged in an outdoor space 6, which is a space (for example, a rooftop or the like) outside a structure 9 such as a building, and supplies cooling energy or heating energy through the relay unit 2 to the indoor units 3. The indoor units 3 are arranged at positions from which cooling air or heating air can be supplied to an indoor space 7, which is a space (for example, a living room or the like) inside the structure 9, and supplies cooling air or heating air to the indoor space 7 serving as a space to be air-conditioned. The relay unit 2 is configured so as to be installed, as a housing different from the outdoor unit 1 and the indoor units 3, at a position (for example, a shared space in the structure 9 or a space above the ceiling) that is different from

the outdoor space 6 and the indoor space 7. The relay unit 2 is connected to the outdoor unit 1 and the indoor units 3 by the refrigerant pipes 4 and the pipes 5, respectively, and transmits to cooling energy or heating energy supplied from the outdoor unit 1 the indoor units 3.

[0016] The operation of the air-conditioning apparatus according to an embodiment of the present invention will be briefly explained. A heat-source-side refrigerant is conveyed from the outdoor unit 1 to the relay unit 2 through the refrigerant pipes 4. The conveyed heat-source-side refrigerant exchanges heat with a heat medium in an intermediate heat exchanger (will be described later) in the relay unit 2 to heat or to cool the heat medium. That is, the intermediate heat exchanger generates hot water or cold water. The hot water or cold water generated by the relay unit 2 is conveyed, by a heat medium conveyance device (will be described later), through the pipes 5 to the indoor units 3 and is used by the indoor units 3 for a heating operation or a cooling operation for the indoor space 7.

[0017] As the heat-source side refrigerant flowing through the refrigerant pipes 4, for example, a single refrigerant, such as R-22 or R-134a, a near-azeotropic refrigerant mixture, such as R-410A or R-404A, a non-azeotropic refrigerant mixture, such as R-407C, a refrigerant, such as $CF_3CF = CH_2$, containing a double bond in its chemical formula and having a relatively low global warming potential, a mixture containing the refrigerant, or a natural refrigerant, such as CO_2 or propane, can be used.

[0018] In contrast, as a heat medium flowing through the pipes 5, for example, water, antifreeze, a mixed solution of water and antifreeze, a mixed solution of water and an additive with high anticorrosive effect, or the like can be used.

[0019] As illustrated in Fig. 1, in the air-conditioning apparatus according to Embodiment 1, the outdoor unit 1 and the relay unit 2 are connected by the two refrigerant pipes 4, and the relay unit 2 and each of the indoor units 3 are connected by the two pipes 5. As described above, in the air-conditioning apparatus according to Embodiment 1, since individual units (the outdoor unit 1, the indoor units 3, and the relay unit 2) are connected using two pipes (the refrigerant pipes 4 and the pipes 5), simple construction can be achieved.

[0020] In Fig. 1, the state is illustrated as an example in which the relay unit 2 is installed in a space above the ceiling or the like (for example, simply referred to as a space 8), such as a space that is inside the structure 9 but is different from the indoor space 7. The relay unit 2 may be installed in a shared space or the like where an elevator or the like is located. Furthermore, although the case where the indoor units 3 are of a ceiling cassette type is illustrated as an example in Fig. 1, the type of the indoor units 3 is not necessarily of a ceiling cassette type. The indoor units 3 may be of any type, such as a ceiling-concealed type or a ceiling-hung type, as long as they are capable of blowing heating air or cooling air to the indoor space 7 directly or via ducts or the like.

[0021] Although the case where the outdoor unit 1 is installed in the outdoor space 6 is illustrated as an example in Fig. 1, the outdoor unit 1 is not necessarily installed in the outdoor space 6. For example, the outdoor unit 1 may be installed in a surrounded space such as a machine room provided with a ventilating opening. The outdoor unit 1 may be installed inside the structure 9 as long as waste heat can be discharged outside the structure 9 through an exhaust duct, or the outdoor unit 1 of a water-cooled type may be installed inside the structure 9. Even in the case where the outdoor unit 1 is installed in the above-mentioned place, a particular problem does not occur.

[0022] Furthermore, the relay unit 2 may be installed in the vicinity of the outdoor unit 1. However, if the distance from the relay unit 2 to each of the indoor units 3 is too long, the conveyance power for a heat medium is significantly increased. Accordingly, it is necessary to heed that the energy-saving effect is reduced. Furthermore, the number of the outdoor unit 1, the indoor units 3, and the relay unit 2 that are connected is not necessarily equal to the number illustrated in Fig. 1. The number of the outdoor unit 1, the indoor units 3, and the relay unit 2 that are connected can be determined in accordance with the structure 9 for which the air-conditioning apparatus according to Embodiment 1 is installed.

[0023] A plurality of relay units 2 may be connected to a single outdoor unit 1. In this case, the plurality of relay units 2 may be installed in different places in a shared space or a space above the ceiling in a structure such as a building. With this installation, the air-conditioning load can be compensated by intermediate heat exchangers in the individual relay units 2. Furthermore, the indoor units 3 can be installed at a distance or a height within a conveyance allowable range of the heat medium conveyance devices of the individual relay units 2, and the indoor units 3 can be arranged for the entire structure such as a building.

[0024] Fig. 2 is a schematic circuit diagram illustrating an example of the circuit configuration of the air-conditioning apparatus (hereinafter, referred to as the air-conditioning apparatus 100) according to Embodiment 1. The configuration of the air-conditioning apparatus 100, that is, operation of individual actuators configuring a refrigerant circuit, will be explained in detail with reference to Fig. 2. As illustrated in Fig. 2, the outdoor unit 1 and the relay unit 2 are connected by the refrigerant pipes 4 through an intermediate heat exchanger (refrigerant/water heat exchanger) 25a and an intermediate heat exchanger (refrigerant/water heat exchanger) 25b that are provided in the relay unit 2. In addition, the relay unit 2 and each of the indoor units 3 are connected by the pipes 5 through the intermediate heat exchanger 25a and the intermediate heat exchanger 25b.

[Outdoor unit 1]

[0025] A compressor 10, a first refrigerant flow switching device 11 having a four-way valve or the like, a heat-source-side heat exchanger 12, and an accumulator 19 are connected in series by the refrigerant pipes 4 and are mounted in the outdoor unit 1. Furthermore, a refrigerant connecting pipe 4a, a refrigerant connecting pipe 4b, a check valve 13a, a check valve 13b, a check valve 13c, and a check valve 13d are provided in the outdoor unit 1. With the provision of the refrigerant connecting pipe 4a, the refrigerant connecting pipe 4b, the check valve 13a, the check valve 13b, the check valve 13c, and the check valve 13d, the flow of the heat-source side refrigerant caused to be flowed into the relay unit 2 can be maintained in a constant direction, irrespective of operation required by the indoor units 3.

[0026] The compressor 10 sucks the heat-source side refrigerant, compresses the heat-source side refrigerant into a high-temperature and high-pressure state, and conveys the heat-source side refrigerant in that state to the refrigerant circuit A. The compressor 10 includes, for example, an inverter compressor or the like for which capacity control can be performed. The first refrigerant flow switching device 11 performs switching between the flow of the heat-source side refrigerant at the time of a heating operation (at the time in a heating only operation mode and in a heating main operation mode) and the flow of the heat-source side refrigerant at the time of a cooling operation (at the time in a cooling only operation mode and in a cooling main operation mode).

[0027] The heat-source-side heat exchanger 12 functions as an evaporator at the time of a heating operation and functions as a condenser (or a radiator) at the time of a cooling operation. The heat-source-side heat exchanger 12 performs heat exchange between air fluid supplied from an air-sending device such as a fan or the like, which is not illustrated, and the heat-source side refrigerant, and evaporates and gasifies or condenses and liquefies the heat-source side refrigerant. The accumulator 19 is arranged on the suction side of the compressor 10. The accumulator 19 accumulates a surplus refrigerant caused by a difference between the time of a heating operation and the time of a cooling operation or a surplus refrigerant for a transient operation change.

[0028] The check valve 13c is arranged at the refrigerant pipe 4 between the relay unit 2 and the first refrigerant flow switching device 11 and allows the heat-source side refrigerant to flow only in a specific direction (the direction from the relay unit 2 to the outdoor unit 1). The check valve 13a is arranged at the refrigerant pipe 4 between the heat-source-side heat exchanger 12 and the relay unit 2 and allows the heat-source side refrigerant to flow only in a specific direction (the direction from the outdoor unit 1 to the relay unit 2). The check valve 13d is arranged at the refrigerant connecting pipe 4a and allows the heat-source side refrigerant discharged from the compressor 10 at the time of a heating operation to flow to the relay unit 2. The checked valve 13b is arranged at the refrigerant connecting pipe 4b and allows the heat-source side refrigerant returned from the relay unit 2 at the time of a heating operation to flow to the suction side of the compressor 10.

[0029] The refrigerant connecting pipe 4a connects the refrigerant pipe 4 between the first refrigerant flow switching device 11 and the check valve 13c to the refrigerant pipe 4 between the check valve 13a and the relay unit 2 in the outdoor unit 1. The refrigerant connecting pipe 4b connects the refrigerant pipe 4 between the check valve 13c and the relay unit 2 to the refrigerant pipe 4 between the heat-source-side heat exchanger 12 and the check valve 13a in the outdoor unit 1. In Fig. 2, the case where the refrigerant connecting pipe 4a, the refrigerant connecting pipe 4b, the check valve 13a, the check valve 13b, the check valve 13c, and the check valve 13d are provided is illustrated as an example. However, the configuration is not limited to this. The refrigerant connecting pipe 4a, the refrigerant connecting pipe 4b, the check valve 13a, the check valve 13b, the check valve 13c, and the check valve 13d are not necessarily provided.

[Indoor unit 3]

[0030] Use-side heat exchangers 35 are mounted in the indoor units 3. The use-side heat exchangers 35 are connected to heat medium flow control devices 34 and second heat medium flow switching devices 33 in the relay unit 2 by the pipes 5. The use-side heat exchangers 35 perform heat exchange between air supplied from an air-sending device such as a fan, which is not illustrated, and a heat medium supplied from the relay unit 2, and generate heating air or cooling air to be supplied to the indoor space 7.

[0031] In Fig. 2, the case where four indoor units 3 are connected to the relay unit 2 is illustrated as an example, and an indoor unit 3a, an indoor unit 3b, an indoor unit 3c, and an indoor unit 3d are illustrated in that order from the top side in the drawing. Furthermore, regarding the use-side heat exchangers 35, a use-side heat exchanger 35a, a use-side heat exchanger 35b, a use-side heat exchanger 35c, and a use-side heat exchanger 35d are illustrated in that order from the top side in the drawing, in accordance with the indoor units 3a to 3d. As in Fig. 1, the number of indoor units 3 connected is not necessarily limited to four, which is illustrated in Fig. 2.

[Relay unit 2]

[0032] The relay unit 2 includes two or more intermediate heat exchangers 25. The intermediate heat exchangers 25 perform heat exchange between the heat-source side refrigerant and the heat medium and transmit cooling energy or heating energy generated by the outdoor unit 1 and stored in the heat-source side refrigerant to the heat medium. In the relay unit 2, two expansion devices 26, two opening/closing devices (an open-

ing/closing device 27 and an opening/closing device 29), two second refrigerant flow switching devices 28, two pumps (heat medium conveyance devices) 31, four first heat medium flow switching devices 32, four second heat medium flow switching devices 33, and four heat medium flow control devices 34 are mounted.

[0033] The two intermediate heat exchangers 25 (the intermediate heat exchanger 25a and the intermediate heat exchanger 25b) function as condensers (radiators) at the time when supplying heating energy to an indoor unit 3 that is performing a heating operation, function as evaporators at the time when supplying cooling energy to an indoor unit 3 that is performing a cooling operation, perform heat exchange between the heat-source side refrigerant and the heat medium, and transmit cooling energy or heating energy generated by the outdoor unit 1 and stored in the heat-source side refrigerant to the heat medium. The intermediate heat exchanger 25a is arranged between an expansion device 26a and a second refrigerant flow switching device 28a in the refrigerant circuit A and is used for cooling the heat medium at the time of a cooling only operation or in a cooling and heating mixed operation mode. The intermediate heat exchanger 25b is arranged between an expansion device 26b and a second refrigerant flow switching device 28b in the refrigerant circuit A and is used for heating the heat medium at the time of a heating only operation and in the cooling and heating mixed operation mode.

[0034] The two expansion devices 26 (the expansion devices 26a and 26b) each has a function of a pressure reducing valve and an expansion valve and reduce the pressure of the heat-source side refrigerant to expand the heat-source side refrigerant. The expansion device 26a is arranged on the upstream side of the intermediate heat exchanger 25a in the flow of the heat-source side refrigerant at the time of a cooling operation. The expansion device 26b is arranged on the upstream side of the intermediate heat exchanger 25b in the flow of the heat-source side refrigerant at the time of a cooling operation. The two expansion devices 26 may be devices for which the opening degree can be variably controlled, for example, such as electronic expansion valves or the like.

[0035] The two opening/closing devices (the opening/closing device 27 and the opening/closing device 29) each include a solenoid valve that is capable of performing opening and closing operations by electrification, and open and close the refrigerant pipes 4. That is, opening and closing of the two opening/closing devices is controlled in accordance with an operation mode, and the two opening/closing devices perform switching of the flow of the heat-source side refrigerant, together with the second refrigerant flow switching devices 28. The opening/closing device 27 is arranged at the refrigerant pipe 4 on the inlet side of the heat-source side refrigerant (the refrigerant pipe 4 located at the lowest portion of the drawing of the refrigerant pipes 4 that connect the outdoor unit 1 to the relay unit 2). The opening/closing device 29 is arranged at a pipe (a bypass pipe 20) that connects the refrigerant pipe 4 on the inlet side of the heat-source side refrigerant to the refrigerant pipe 4 on the outlet side of the heat-source side refrigerant. The opening/closing devices 27 and 29 need to be capable of performing switching of a refrigerant flow, and for example, devices, such as electronic expansion valves, for which the opening degree can be variably controlled, may be used.

[0036] The two second refrigerant flow switching devices 28 (the second refrigerant flow switching device 28a and the second refrigerant flow switching device 28b) each include, for example, a four-way valve, and perform switching of the flow of the heat-source side refrigerant in such a manner that the intermediate heat exchangers 25 operate as condensers or evaporators in accordance with an operation mode. The second refrigerant flow switching device 28a is arranged on the downstream side of the intermediate heat exchanger 25a in the flow of the heat-source side refrigerant at the time of a cooling operation. The second refrigerant flow switching device 28b is arranged on the downstream side of the intermediate heat exchanger 25b in the flow of the heat-source side refrigerant in the cooling only operation mode.

[0037] The two pumps 31 (pumps 31a and 31b) allow the heat medium which flows through the pipes 5 to circulate in the heat medium circuit B. The pump 31a is arranged for the pipes 5 between the intermediate heat exchanger 25a and the second heat medium flow switching devices 33. The pump 31b is arranged for the pipes 5 between the intermediate heat exchanger 25b and the second heat medium flow switching devices 33. The two pumps 31 may be, for example, pumps for which capacity control can be performed, and the flow rate of the pumps 31 may be adjusted on the basis of the size of the load in the indoor units 3. Although the state in which the two pumps 31 are installed on the heat-medium outlet side of the intermediate heat exchangers 25 is illustrated as an example, it is obvious that the pumps 31 may be installed on the heat-medium inlet side of the intermediate heat exchangers 25.

[0038] The four first heat medium flow switching devices 32 (first heat medium flow switching devices 32a to 32d) each include a three-way valve or the like and perform switching of the flow of the heat medium between the intermediate heat exchanger 25a and the intermediate heat exchanger 25b. The number of the installed first heat medium flow switching devices 32 corresponds to the number of the installed indoor units 3 (here, four). One of the three ways of each of the first heat medium flow switching devices 32 is connected to the intermediate heat exchanger 25a, another one of the three ways is connected to the intermediate heat exchanger 25b, and the other one of the three ways is connected to the corresponding one of the heat medium flow control devices 34. The first heat medium flow switching devices 32 are arranged on the outlet side of the heat medium flows of the use-side heat exchangers 35. The first heat medium flow switching device 32a, the first heat medium flow switching device 32b, the first heat medium flow

switching device 32c, and the first heat medium flow switching device 32d are illustrated in that order from the top side in the drawing, in accordance with the indoor units 3. Furthermore, the switching of the heat medium flow includes partial switching from one to another way as well as complete switching from one to another way.

[0039] The four second heat medium flow switching devices 33 (second heat medium flow switching devices 33a to 33d) each include a three-way valve or the like and perform switching of the flow of the heat medium between the intermediate heat exchanger 25a and the intermediate heat exchanger 25b. The number of the installed second heat medium flow switching devices 33 corresponds to the number of the installed indoor units 3 (here, four). One of the three ways of each of the second heat medium flow switching devices 33 is connected to the intermediate heat exchanger 25a, another one of the three ways is connected to the intermediate heat exchanger 25b, and the other one of the three ways is connected to the corresponding one of the use-side heat exchangers 35. The second heat medium flow switching devices 33 are arranged on the inlet side of the heat medium flows of the use-side heat exchangers 35. The second heat medium flow switching device 33a, the second heat medium flow switching device 33b, the second heat medium flow switching device 33c, and the second heat medium flow switching device 33d are illustrated in that order from the top side in the drawing, in accordance with the indoor units 3. Furthermore, the switching of the heat medium flow includes partial switching from one to another way as well as complete switching from one to another way.

[0040] The four heat medium flow control devices 34 (heat medium flow control devices 34a to 34d) each include a device for which the opening area can be controlled (for example, a two-way valve or a three-way valve whose one end is closed which is capable of controlling the flow rate in a flow by a stepping motor driving method) and control the flow rate of the heat medium flowing to the pipe 5. The number of the installed heat medium flow control devices 34 corresponds to the number of the installed indoor units 3 (here, four). One of the two ways of each of the heat medium flow control devices 34 is connected to the corresponding one of the use-side heat exchangers 35 and the other one of the two ways is connected to the corresponding one of the first heat medium flow switching devices 32. The heat medium flow control devices 34 are arranged on the outlet side of the heat medium flows of the use-side heat exchangers 35. That is, the heat medium flow control devices 34 adjust the amount of heat medium flowing into the indoor units 3 on the basis of the temperature of the heat medium flowing into the indoor units 3 and the temperature of the heat medium flowing out of the indoor units 3, and are capable of supplying an optimal amount of heat medium corresponding to the indoor load to the indoor units 3.

[0041] Here, the heat medium flow control device 34a, the heat medium flow control device 34b, the heat medium flow control device 34c, and the heat medium flow control device 34d are illustrated in that order from the top side in the drawing, in accordance with the indoor units 3. The heat medium flow control devices 34 may be arranged on the inlet side of the heat medium flows of the use-side heat exchangers 35. Furthermore, the heat medium flow control devices 34 may be arranged at positions on the inlet side of the heat medium flows of the use-side heat exchangers 35 and between the second heat medium flow switching devices 33 and the use-side heat exchangers 35. Furthermore, in the case of stopping, thermo-off, or the like, which does not require load, in the indoor units 3, by fully-closing the heat medium flow control devices 34, heat medium supply to the indoor units 3 can be stopped.

[0042] Here, in the case where devices having the function of the heat medium flow control devices 34 added thereto are used as the first heat medium flow switching devices 32 or the second heat medium flow switching devices 33, the heat medium flow control devices 34 may be omitted.

[0043] Furthermore, pressure sensors 41 (a pressure sensor 41a and a pressure sensor 41b) that detect the pressure of the heat-source side refrigerant flowing in the refrigerant pipes 4 are provided in the relay unit 2. Furthermore, temperature sensors 37 (temperature sensors 37a to 37d) are provided on the inlet side of heat medium flows in the relay unit 2. Information detected by such detecting devices (for example, pressure information and temperature information) is transmitted to a controller 50 that performs integrated control of the operation of the air-conditioning apparatus 100, and is used for controlling the driving frequency of the compressor 10, the rotation speed of air-sending devices, which are not illustrated, switching of the first refrigerant flow switching device 11, the driving frequency of the pumps 31, switching of the second refrigerant flow switching devices 28, switching of the flow of the heat medium, adjustment of the flow rate of the heat medium in the indoor units 3, and the like.

[0044] Furthermore, the controller 50 includes a microcomputer or the like. The controller 50 controls the individual actuators (driving components such as the pumps 31, the first heat medium flow switching devices 32, the second heat medium flow switching devices 33, the expansion devices 26, the second refrigerant flow switching devices 28, and the like) for the driving frequency of the compressor 10, the rotation speed (including ON/OFF) of the air-sending devices, switching of the first refrigerant flow switching device 11, driving of the pumps 31, the opening degree of the expansion devices 26, opening and closing of the opening/closing devices, switching of the second refrigerant flow switching devices 28, switching of the first heat medium flow switching devices 32, switching of the second heat medium flow switching devices 33, driving of the heat medium flow control devices 34, and the like, on the basis of detection information by the various detecting devices and instructions from a re-

mote control, and executes various operation modes, which will be described later. The above-mentioned control may be performed by a controller mounted in the outdoor unit 1. In this case, the controller 50 may be configured to be mounted in the outdoor unit 1.

[0045] The pipes 5 through which the heat medium flows include pipes connected to the intermediate heat exchanger 25a and pipes connected to the intermediate heat exchanger 25b. The pipes 5 are branched out in accordance with the number of the indoor units 3 connected to the relay unit 2 (here, four branches for each pipe). The pipes 5 are connected through the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33. By controlling the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33, determination as to whether the heat medium from the intermediate heat exchanger 25a is to be flowed into the use-side heat exchangers 35 or the heat medium from the intermediate heat exchanger 25b is to be flowed into the use-side heat exchangers 35 is made.

[0046] In the air-conditioning apparatus 100, the compressor 10, the first refrigerant flow switching device 11, the heat-source-side heat exchanger 12, the opening/closing device 27, the opening/closing device 29, the second refrigerant flow switching devices 28, the refrigerant flows for the intermediate heat exchangers 25, the expansion devices 26, and the accumulator 19 are connected through the refrigerant pipes 4 to configure the refrigerant circuit A. Furthermore, the heat medium flows for the intermediate heat exchangers 25, the pumps 31, the first heat medium flow switching devices 32, the heat medium flow control devices 34, the use-side heat exchangers 35, and the second heat medium flow switching devices 33 are connected through the pipes 5 to configure a heat medium circuit B. That is, the plurality of use-side heat exchangers 35 are connected in parallel to each of the intermediate heat exchangers 25, so that the heat medium circuit B is formed as plural systems.

[0047] Accordingly, in the air-conditioning apparatus 100, the outdoor unit 1 and the relay unit 2 are connected through the intermediate heat exchanger 25a and the intermediate heat exchanger 25b provided in the relay unit 2, and the relay unit 2 and the indoor units 3 are connected through the intermediate heat exchanger 25a and the intermediate heat exchanger 25b. That is, in the air-conditioning apparatus 100, heat exchange is performed, in the intermediate heat exchanger 25a and the intermediate heat exchanger 25b, between the heat-source side refrigerant circulating in the refrigerant circuit A and the heat medium circulating in the heat medium circuit B. With this configuration, the air-conditioning apparatus 100 is capable of achieving an optimal cooling operation or heating operation corresponding to the indoor load.

[Operation mode]

[0048] Various operation modes executed by the air-conditioning apparatus 100 will be explained. The air-conditioning apparatus 100 enables each of the indoor units 3 to perform a cooling operation or a heating operation on the basis of an instruction from the indoor unit 3. That is, the air-conditioning apparatus 100 is capable of allowing all the indoor units 3 to perform the same operations and allowing the individual indoor units 3 to perform different operations.

[0049] The operation modes executed by the air-conditioning apparatus 100 include a heating only operation mode in which all of the operating indoor units 3 perform heating operations, a cooling only operation mode in which all of the operating indoor units 3 perform cooling operations, a cooling main operation mode, which is a cooling and heating mixed operation mode in which the cooling load is larger than heating load, and a heating main operation, which is a cooling and heating mixed operation mode in which the heating load is larger than the cooling load. Hereinafter, the various operation modes with respect to the flows of the heat-source side refrigerant and the heat medium will be explained.

[Heating only operation mode]

[0050] Fig. 3 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus 100 is in the heating only operation mode. With reference to Fig. 3, the heating only operation mode will be explained by way of an example of the case where heating load is generated in all the use-side heat exchangers 35a to 35d. In Fig. 3, pipes expressed by thick lines represent pipes through which the heat-source side refrigerant flows. Furthermore, in Fig. 3, the direction of the flow of the heat-source side refrigerant is expressed by solid-line arrows, and the direction of the flow of a heat medium is expressed by broken-line arrows.

[0051] In the case of the heating only operation mode illustrated in Fig. 3, the outdoor unit 1 performs switching for the first refrigerant flow switching device 11 in such a manner that the heat-source side refrigerant discharged from the compressor 10 flows into the relay unit 2 without passing through the heat-source-side heat exchanger 12. In the relay unit 2, the pump 31a and the pump 31b are driven and the heat medium flow control devices 34a to 34d are opened, so that the heat medium circulates between the intermediate heat exchanger 25a and each of the use-side heat exchangers 35a to 35d and between the intermediate heat exchanger 25b and each of the use-side heat exchangers 35a to 35d. Furthermore, the second refrigerant flow switching device 28a and the second refrigerant flow switching device 28b are switched to the heating side, the opening/closing device 27 is closed, and the opening/closing device 29 is opened.

[0052] First, the flow of the heat-source side refrigerant in the refrigerant circuit A will be explained.

[0053] A low-temperature and low-pressure refrigerant is compressed by the compressor 10, and is discharged as a high-temperature and high-pressure gas refrigerant. The high-temperature and high-pressure gas refrigerant discharged from the compressor 10 passes through the first refrigerant flow switching device 11, flows through the refrigerant connecting pipe 4a, passes through the check valve 13d, and flows out of the outdoor unit 1. The high-temperature and high-pressure gas refrigerant that has flowed out of the outdoor unit 1 passes through the refrigerant pipe 4 and flows into the relay unit 2. The high-temperature and high-pressure gas refrigerant that has flowed into the relay unit 2 is split out, and the split flows of gas refrigerant pass through the second refrigerant flow switching device 28a and the second refrigerant flow switching device 28b and flow into the intermediate heat exchanger 25a and the intermediate heat exchanger 25b.

[0054] The flows of high-temperature and high-pressure gas refrigerant that have flowed into the intermediate heat exchanger 25a and the intermediate heat exchanger 25b are condensed and liquefied into flows of high-pressure liquid refrigerant while transferring heat to the heat medium circulating in the heat medium circuit B. The flows of liquid refrigerant that have flowed out of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b are expanded by the expansion device 26a and the expansion device 26b and turn into flows of low-temperature and low-pressure two-phase refrigerant. The flows of two-phase refrigerant are merged into one and pass through the opening/closing device 29 to flow in the bypass pipe 20. The merged refrigerant flows out of the relay unit 2, passes through the refrigerant pipe 4, and flows into the outdoor unit 1 again. The refrigerant that has flowed into to the outdoor unit 1 flows through the refrigerant connecting pipe 4b, passes through the check valve 13b, and flows into the heat-source-side heat exchanger 12 operating as an evaporator.

[0055] Then, the heat-source side refrigerant that has flowed into the heat-source-side heat exchanger 12 removes heat from air in the outdoor space 6 (hereinafter, referred to as outdoor air) by the heat-source-side heat exchanger 12 and turns into a low-temperature and low-pressure gas refrigerant. The low-temperature and low-pressure gas refrigerant that has flowed out of the heat-source-side heat exchanger 12 passes through the first refrigerant flow switching device 11 and the accumulator 19, and is sucked into the compressor 10 again.

[0056] Next, the flow of the heat medium in the heat medium circuit B will be explained.

[0057] In the heating only operation mode, each of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b transmits the heating energy of the heat-source side refrigerant to the heat medium, and each of the pump 31a and the pump 31b allows the heated heat medium to flow through the pipes 5. The flows of heat medium that have been pressurized by and that have flowed out of the pump 31a and the pump 31b pass through the second heat medium flow switching devices 33a to 33d, and flow into the use-side heat exchangers 35a to 35d. Then, when the heat medium transfers heat to indoor air by the use-side heat exchangers 35a to 35d, thereby heating of the indoor space 7 is performed.

[0058] Then, the heat medium flows out of the use-side heat exchangers 35a to 35d and flows into the heat medium flow control devices 34a to 34d. At this time, the heat medium flows into the use-side heat exchanges 35a to 35d in such a manner that the flow rate of the heat medium is controlled, with the operation of the heat medium flow control devices 34a to 34d, to a flow rate required for the air - conditioning load necessary for inside the room. The heat medium that has flowed out of the heat medium flow control devices 34a to 34d passes through the first heat medium flow switching devices 32a to 32d, flows into the intermediate heat exchanger 25a and the intermediate heat exchanger 25b, receives from the refrigerant side the heat quantity that corresponds to the amount supplied through the indoor units 3 to the indoor space 7, and is sucked into the pump 31a and the pump 31b again.

[0059] At this time, the opening degree of the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33 is set to an intermediate opening degree or an opening degree corresponding to the heat medium temperature at the exit of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b so that flows to both the intermediate heat exchanger 25a and the intermediate heat exchanger 25b can be secured. In the pipes 5 for the use-side heat exchangers 35, the heat medium flows in the direction in which the heat medium from the second heat medium flow switching devices 33 passes through the heat medium flow control devices 34 and flows into the first heat medium flow switching devices 32.

[0060] For execution of the heating only operation mode, since it is not necessary to cause the heat medium to be flowed into a use-side heat exchanger 35 in which heat load is not generated (including thermo-off), the passage is closed by the corresponding heat medium flow control device 34 so that the heat medium is not flowed into the use-side heat exchanger 35. In Fig. 3, the heat medium flows into all the use-side heat exchangers 35a to 35d due to the presence of the heat load in all the use-side heat exchangers 35a to 35d. However, when no heat load exists, the corresponding heat medium flow control device 34 is fully closed. In the case where heat load is generated again, the corresponding heat medium flow control device 34 can be opened so that the heat medium can circulate. This aspect is similarly applied to different operation modes described later.

[Heating main operation mode]

[0061] Fig. 4 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus 100 is in the heating main operation mode. With

reference to Fig. 4, the heating main operation mode will be explained by way of an example of the case where heating load is generated in any of the use-side heat exchangers 35 and cooling load is generated in the other use-side heat exchangers 35. In Fig. 4, pipes expressed by thick lines represent pipes through which the heat-source side refrigerant circulates. Furthermore, in Fig. 4, the direction of the flow of the heat-source side refrigerant is expressed by solid-line arrows, and the direction of the flow of the heat medium is expressed by broken-line arrows.

[0062] In the case of the heating main operation mode illustrated in Fig. 4, the outdoor unit 1 performs switching for the first refrigerant flow switching device 11 in such a manner that the heat-source side refrigerant discharged from the compressor 10 flows into the relay unit 2 without passing through the heat-source-side heat exchanger 12. In the relay unit 2, the pump 31a and the pump 31b are driven and the heat medium flow control devices 34a to 34d are opened, so that the heat medium circulates between the intermediate heat exchanger 25a and a use-side heat exchanger 35 in which cooling load is generated and between the intermediate heat exchanger 25b and a use-side heat exchanger 35 in which heating load is generated. Furthermore, the second refrigerant flow switching device 28a is switched to the cooling side, the second refrigerant flow switching device 28b is switched to the heating side, the expansion device 26a is fully opened, the opening/closing device 27 is closed, and the opening/closing device 29 is closed.

[0063] First, the flow of the heat-source side refrigerant in the refrigerant circuit A will be explained.

[0064] A low-temperature and low-pressure refrigerant is compressed by the compressor 10, and is discharged as a high-temperature and high-pressure gas refrigerant. The high-temperature and high-pressure gas refrigerant discharged from the compressor 10 passes through the first refrigerant flow switching device 11, flows through the refrigerant connecting pipe 4a, passes through the check valve 13d, and flows out of the outdoor unit 1. The high-temperature and high-pressure gas refrigerant that has flowed out of the outdoor unit 1 passes through the refrigerant pipe 4 and flows into the relay unit 2. The high-temperature and high-pressure gas refrigerant that has flowed into the relay unit 2 passes through the second refrigerant flow switching device 28b and flows into the intermediate heat exchanger 25b operating as a condenser.

[0065] The gas refrigerant that has flowed into the intermediate heat exchanger 25b is condensed and liquefied into a liquid refrigerant while transferring heat to the heat medium circulating in the heat medium circuit B. The liquid refrigerant that has flowed out of the intermediate heat exchanger 25b is expanded by the expansion device 26b and turns into a low -pressure two-phase refrigerant. The low-pressure two-phase refrigerant passes through the expansion device 26a and flows into the intermediate heat exchanger 25a operating as an evaporator. The low-pressure two-phase refrigerant that has flowed into the intermediate heat exchanger 25a evaporates by receiving heat from the heat medium circulating in the heat medium circuit B and thus cools the heat medium. The low-pressure two-phase refrigerant flows out of the intermediate heat exchanger 25a, passes through the second refrigerant flow switching device 28a, flows out of the relay unit 2, passes through the refrigerant pipe 4, and flows into the outdoor unit 1 again.

[0066] The low-temperature and low-pressure two-phase refrigerant that has flowed into the outdoor unit 1 passes through the refrigerant connecting pipe 4b and the check valve 13b, and flows into the heat-source-side heat exchanger 12 operating as an evaporator. Then, the refrigerant that has flowed into the heat-source-side heat exchanger 12 removes heat from outdoor air by the heat-source-side heat exchanger 12 and turns into a low-temperature and low-pressure gas refrigerant. The low-temperature and low-pressure gas refrigerant that has flowed out of the heat-source-side heat exchanger 12 passes through the first refrigerant flow switching device 11 and the accumulator 19, and is sucked into the compressor 10 again.

[0067] Here, the opening degree of the expansion device 26b is controlled such that the subcool (degree of supercooling) of a refrigerant at the exit of the intermediate heat exchanger 25b exhibits a target value. Here, the expansion device 26b may be fully opened, and the subcool may be controlled using the expansion device 26a.

[0068] Next, the flow of the heat medium in the heat medium circuit B will be explained.

[0069] In the heating main operation mode, the intermediate heat exchanger 25b transmits the heating energy of the heat-source side refrigerant to the heat medium, and the pump 31b allows the heated heat medium to flow through the pipes 5. Furthermore, in the heating main operation mode, the intermediate heat exchanger 25a transmits the cooling energy of the heat-source side refrigerant to the heat medium, and the pump 31a allows the cooled heat medium to flow through the pipes 5. The cooled heat medium that has been pressurized by and that has flowed out of the pump 31a passes through a corresponding second heat medium flow switching device 33 and flows into a use-side heat exchanger 35 in which cooling load is generated, and the heat medium that has been pressurized by and that has flowed out of the pump 31b passes through a corresponding second heat medium flow switching device 33 and flows into a use-side heat exchanger 35 in which heating load is generated.

[0070] Here, when the indoor unit 3 connected to a second heat medium flow switching device 33 is in the heating operation mode, the second heat medium flow switching device 33 is switched to the direction in which the intermediate heat exchanger 25b and the pump 31b are connected. When the indoor unit 3 connected to a second heat medium flow switching device 33 is in the

cooling operation mode, the second heat medium flow switching device 33 is switched to the direction in which the intermediate heat exchanger 25a and the pump 31a are connected. That is, with the second heat medium flow switching device 33, the heat medium supplied to the indoor unit 3 is switched between use for heating and use for cooling.

[0071] In the use-side heat exchangers 35, when the heat medium removes heat from indoor air, a cooling operation for the indoor space 7 is performed. In the use-side heat exchangers 35, when the heat medium transfers heat to indoor air, a heating operation for the indoor space 7 is performed. At this time, the heat medium flows into the use-side heat exchangers 35 in such a manner that the flow rate of the heat medium is controlled, with the operation of the heat medium flow control devices 34, to be a flow rate required for the air conditioning load necessary for inside the room.

[0072] The heat medium which has been used for a cooling operation, which has passed through a use-side heat exchanger 35, and whose temperature has been increased passes through a corresponding heat medium flow control device 34 and a corresponding first heat medium flow switching device 32, flows into the intermediate heat exchanger 25a, and is sucked into the pump 31a again. The heat medium which has been used for a heating operation, which has passed through a use-side heat exchanger 35, and whose temperature has been reduced passes through a corresponding heat medium flow control device 34 and a corresponding first heat medium flow switching device 32, flows into the intermediate heat exchanger 25b, and is sucked into the pump 31b again. At this time, when the indoor unit 3 connected to a first heat medium flow switching device 32 is in the heating operation mode, the first heat medium flow switching device 32 is switched to the direction in which the intermediate heat exchanger 25b and the pump 31b are connected. When the indoor unit 3 connected to a first heat medium flow switching device 32 is in the cooling operation mode, the first heat medium flow switching device 32 is switched to the direction in which the intermediate heat exchanger 25a and the pump 31a are connected.

[0073] During this processing, with the operation of the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33, the heated heat medium and the cooled heat medium are not mixed together and are individually introduced into the corresponding use-side heat exchangers 35 in which the heating load and the cooling load are generated. Accordingly, the heat medium used in the heating operation mode flows into the intermediate heat exchanger 25b in which a refrigerant supplies heat as use for heating, and the heat medium used in the cooling operation mode flows into the intermediate heat exchanger 25a in which a refrigerant receives heat for use for cooling. After heat exchange is performed between each flow of the heat medium and a refrigerant, the heat medium is conveyed to the pumps 31a and 31b.

[0074] Here, in the pipes 5 for the use-side heat exchangers 35, for both the heating side and cooling side, the heat medium flow in the direction in which the heat medium from the second heat medium flow switching devices 33 passes through the heat medium flow control devices 34 and flow into the first heat medium flow switching devices 32.

[Cooling only operation mode]

[0075] Fig. 5 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus 100 is in the cooling only operation mode. With reference to Fig. 5, the cooling only operation mode will be explained by way of an example of the case where cooling load is generated in all the use-side heat exchangers 35a to 35d. In Fig. 5, pipes expressed by thick lines represent pipes through which the heat-source side refrigerant flows. In addition, in Fig. 5, the direction of the flow of the heat-source side refrigerant is expressed by solid-line arrows and the direction of the flow of the heat medium is expressed by broken-line arrows.

[0076] In the case of the cooling only operation mode illustrated in Fig. 5, the outdoor unit 1 performs switching for the first refrigerant flow switching device 11 in such a manner that the heat-source side refrigerant discharged from the compressor 10 flows into the heat-source-side heat exchanger 12. In the relay unit 2, the pump 31a and the pump 31b are driven and the heat medium flow control devices 34a to 34d are opened, so that the heat medium circulates between the intermediate heat exchanger 25a and each of the use-side heat exchangers 35a to 35d and between the intermediate heat exchanger 25b and each of the use-side heat exchangers 35a to 35d. Furthermore, the second refrigerant flow switching device 28a and the second refrigerant flow switching device 28b are switched to the cooling side, the opening/closing device 27 is opened, and the opening/closing device 29 is closed.

[0077] First, the flow of the heat-source side refrigerant in the refrigerant circuit A will be explained.

[0078] A low-temperature and low-pressure refrigerant is compressed by the compressor 10 and is discharged as a high-temperature and high-pressure gas refrigerant. The high-temperature and high-pressure gas 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. Then, the gas refrigerant is condensed and liquefied into a high-pressure liquid refrigerant while transferring heat to outdoor air by the heat-source-side heat exchanger 12. The high-pressure liquid refrigerant that has flowed out of the heat-source-side heat exchanger 12 passes through the check valve 13a, flows out of the outdoor unit 1, passes through the refrigerant pipe 4, and flows into the relay unit 2. The high-pressure liquid refrigerant that has flowed into the relay unit 2 passes through the opening/closing device 27, is split out and expanded by the expansion device

26a and the expansion device 26b into flows of low-temperature and low-pressure two-phase refrigerant.

[0079] The flows of two-phase refrigerant flow into the intermediate heat exchanger 25a and the intermediate heat exchanger 25b operating as evaporators, and turn into low-temperature and low-pressure gas refrigerant while cooling the heat medium by removing heat from the heat medium circulating in the heat medium circuit B. The flows of gas refrigerant discharged from the intermediate heat exchanger 25a and the intermediate heat exchanger 25b pass through the second refrigerant flow switching device 28a and the second refrigerant flow switching device 28b, are merged into one. The merged gas refrigerant flows out of the relay unit 2, passes through the refrigerant pipe 4, and flows into the outdoor unit 1 again. The refrigerant that has flowed into the outdoor unit 1 passes through the check valve 13c, passes through the first refrigerant flow switching device 11 and the accumulator 19, and is sucked into the compressor 10 again.

[0080] At this time, the opening degree of the expansion devices 26 is controlled such that the superheat (degree of superheat) obtained as a difference between the temperature of the heat-source side refrigerant that flows into the intermediate heat exchangers 25 and the temperature of the heat-source side refrigerant that flows out of the intermediate heat exchangers 25 is made constant.

[0081] Next, the flow of the heat medium in the heat medium circuit B will be explained.

[0082] In the cooling only operation mode, each of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b transmits the cooling energy of the heat-source side refrigerant to the heat medium, and each of the pump 31a and the pump 31b allows the cooled heat medium to flow through the pipes 5. The flows of heat medium that have been pressurized by and have flowed out of the pump 31a and the pump 31b pass through the second heat medium flow switching devices 33a to 33d, and flow into the use-side heat exchangers 35a to 35d. When the heat medium removes heat from indoor air by the use-side heat exchangers 35a to 35d, thereby cooling of the indoor space 7 is performed.

[0083] Then, the heat medium flow out of the use-side heat exchangers 35a to 35b, and flow into the heat medium flow control devices 34a to 34d. At this time, the heat medium flow into the use-side heat exchangers 35a to 35d in such a manner that the flow rate of the heat medium is controlled, with the operation of the heat medium flow control devices 34a to 34d, to a flow rate required for the air conditioning load necessary for inside the room. The heat medium that has flowed out of the heat medium flow control devices 34a to 34d passes through the first heat medium flow switching device 32a to 32d, flows into the intermediate heat exchanger 25a and the intermediate heat exchanger 25b, provides the refrigerant side with the heat quantity that corresponds to the amount received through the indoor units 3 from air in the indoor space 7, and is sucked into the pump 31a and the pump 31b again.

[0084] At this time, the opening degree of the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33 is set to an intermediate opening degree or to an opening degree corresponding to the heat medium temperature at the exit of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b so that flows to both the intermediate heat exchanger 25a and the intermediate heat exchanger 25b can be secured. Here, in the pipes 5 for the use-side heat exchangers 35, the heat medium flows in the direction in which the heat medium from the second heat medium flow switching devices 33 passes through the heat medium flow control devices 34 and flows into the first heat medium flow switching devices 32.

[Cooling main operation mode]

[0085] Fig. 6 is a refrigerant circuit diagram illustrating the flow of a refrigerant when the air-conditioning apparatus 100 is in the cooling main operation mode. With reference to Fig. 6, a first cooling main operation mode will be explained by way of an example of the case where cooling load is generated in any of the use-side heat exchangers 35 and heating load is generated in the other use-side heat exchangers 35. In Fig. 6, pipes expressed by thick lines represent pipes through which the heat-source side refrigerant circulates. Furthermore, in Fig. 6, the direction of the flow of the heat-source side refrigerant is expressed by solid-line arrows and the direction of the flow of the heat medium is expressed by broken-line arrows.

[0086] In the case of the cooling main operation mode illustrated in Fig. 6, the outdoor unit 1 performs switching for the first refrigerant flow switching device 11 in such a manner that the heat-source side refrigerant discharged from the compressor 10 flows into the heat-source-side heat exchanger 12. In the relay unit 2, the pump 31a and the pump 31b are driven and the heat medium flow control devices 34a to 34d are opened, so that the heat medium circulates between the intermediate heat exchanger 25a and a use-side heat exchanger 35 in which cooling load is generated and between the intermediate heat exchanger 25b and a use-side heat exchanger 35 in which heating load is generated. Furthermore, the second refrigerant flow switching device 28a is switched to the cooling side, the second refrigerant flow switching device 28b is switched to the heating side, the expansion device 26a is fully opened, the opening/closing device 27 is closed, and the opening/closing device 29 is closed.

[0087] First, the flow of the heat-source side refrigerant in the refrigerant circuit A will be explained.

[0088] A low-temperature and low-pressure refrigerant is compressed by the compressor 10, and is discharged as a high-temperature and high-pressure gas refrigerant. The high-temperature and high-pressure gas 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. Then, the gas refrigerant is condensed while transferring heat to outdoor air by the heat-source-side heat exchanger 12 and turns into a high-pressure two-phase refrigerant. The two-phase refrigerant that has flowed out of the heat-source-side heat exchanger 12 passes through the check valve 13a, flows out of the outdoor unit 1, flows through the refrigerant pipe 4, and flows into the relay unit 2. The two-phase refrigerant that has flowed into the relay unit 2 passes through the second refrigerant flow switching device 28b, and flows into the intermediate heat exchanger 25b operating as a condenser.

[0089] The two-phase refrigerant that has flowed into the intermediate heat exchanger 25b is condensed and liquefied into a liquid refrigerant while transferring heat to the heat medium circulating in the heat medium circuit B. The liquid refrigerant that has flowed out of the intermediate heat exchanger 25b is expanded by the expansion device 26b, and turns into a low-pressure two-phase refrigerant. The low-pressure two-phase refrigerant passes through the expansion device 26a, and flows into the intermediate heat exchanger 25a operating as an evaporator. The low-pressure two-phase refrigerant that has flowed into the intermediate heat exchanger 25a turns into a low-pressure gas refrigerant while cooling the heat medium by removing heat from the heat medium circulating in the heat medium circuit B. The gas refrigerant flows out of the intermediate heat exchanger 25a, passes through the second refrigerant flow switching device 28a, flows out of the relay unit 2, passes through the refrigerant pipe 4, and flows into the outdoor unit 1 again. The heat-source side refrigerant that has flowed into the outdoor unit 1 passes through the check valve 13c, the first refrigerant flow switching device 11, and the accumulator 19, and is sucked into the compressor 10 again.

[0090] Here, the opening degree of the expansion device 26b is controlled such that the subcool (degree of supercooling) of a refrigerant at the exit of the intermediate heat exchanger 25b exhibits a target value. Here, the expansion device 26b may be fully opened, and the subcool may be controlled using the expansion device 26a.

[0091] Next, the flow of the heat medium in the heat medium circuit B will be explained.

[0092] In the cooling main operation mode, the intermediate heat exchanger 25b transmits the heating energy of the heat-source side refrigerant to the heat medium, and the pump 31b allows the heated heat medium to flow through the pipes 5. Furthermore, in the cooling main operation mode, the intermediate heat exchanger 25a transmits the cooling energy of the heat-source side refrigerant to the heat medium, and the pump 31a allows the cooled heat medium to flow through the pipes 5. The heat medium that has been pressurized by and has flowed out of the pump 31a and the pump 31b passes through the second heat medium flow switching device 33a and the second heat medium flow switching device 33b, and flows into the use-side heat exchanger 35a and the use-side heat exchanger 35b.

[0093] At this time, when the indoor unit 3 connected to a second heat medium flow switching device 33 is in the heating operation mode, the second heat medium flow switching device 33 is switched to the direction in which the intermediate heat exchanger 25b and the pump 31b are connected. When the indoor unit 3 connected to a second heat medium flow switching device 33 is in the cooling operation mode, the second heat medium flow switching device 33 is switched to the direction in which the intermediate heat exchanger 25a and the pump 31a are connected. That is, with the second heat medium flow switching devices 33, heat medium supplied to the indoor units 3 can be switched between use for heating and use for cooling.

[0094] In the use-side heat exchangers 35, when the heat medium transfers heat to indoor air, a heating operation for the indoor space 7 is performed. In the use-side heat exchanger 35, when the heat medium removes heat from indoor air, a cooling operation for the indoor space 7 is performed. At this time, the heat medium flows into the use-side heat exchangers 35 in such a manner that the flow rate of the heat medium is controlled, with the operation of the heat medium flow control devices 34, to be a flow rate required for the air conditioning load necessary for inside the room.

[0095] The heat medium which has been used for a heating operation, which has passed through a use-side heat exchanger 35, and whose temperature has been reduced passes through a corresponding heat medium flow control device 34 and a corresponding first heat medium flow switching device 32, flows into the intermediate heat exchanger 25b, and is sucked into the pump 31b again. The heat medium which has been used for a cooling operation, which has passed through a use-side heat exchanger 35, and whose temperature has been increased passes through a corresponding heat medium flow control device 34 and a corresponding first heat medium flow switching device 32, flows into the intermediate heat exchanger 25a, and is sucked into the pump 31a again. At this time, when the indoor unit 3 connected to a first heat medium flow switching device 32 is in the heating operation mode, the first heat medium flow switching device 32 is switched to the direction in which the intermediate heat exchanger 25b and the pump 31b are connected. When the indoor unit 3 connected to a first heat medium flow switching device 32 is in the cooling operation mode, the first heat medium flow switching device 32 is switched to the direction in which the intermediate heat exchanger 25a and the pump 31a are connected.

[0096] During this processing, with the operation of the first heat medium flow switching devices 32 and the second heat medium flow switching devices 33, the heated heat medium and the cooled heat medium are not mixed together and are individually introduced into the corresponding use-side heat exchangers 35 in which the heating load and the cooling load are generated. Accordingly,

the heat medium used in the heating operation mode flows into the intermediate heat exchanger 25b in which a refrigerant supplies heat as use for heating, and the heat medium used in the cooling operation flows into the intermediate heat exchanger 25a in which a refrigerant receives heat as use for cooling. After heat exchange is performed between each flow of the heat medium and a refrigerant, the heat medium is conveyed to the pumps 31a and 31b.

[0097] Here, in the pipes 5 for the use-side heat exchangers 35, for both the heating side and the cooling side, the heat medium flows in the direction in which the heat medium from the second heat medium flow switching devices 33 passes through the heat medium flow control devices 34 and flows into the first heat medium flow switching devices 32.

[Regarding pressure variation of refrigerant circuit A]

[0098] The air-conditioning apparatus 100 according to Embodiment 1 causes the heat medium to circulate between the relay unit 2 and the indoor units 3 (more specifically, the use-side heat exchangers 35). The pipes 5 which connect the relay unit 2 to the indoor units 3 may be about 50 meters in one way as in the case for the use in, for example, a multi-air-conditioning apparatus for buildings.

[0099] A large amount of heat medium remains in the pipes 5 for the stopped indoor units 3. Thus, for example, during the execution of operation, when a stopped indoor unit 3 is activated, the heat medium that has been supplied to an indoor unit 3 that has been operating and the heat medium that has remained during the stopping are mixed together. Accordingly, the temperature of the heat medium that passes through the intermediate heat exchanger 25a and the intermediate heat exchanger 25b suddenly changes. The sudden temperature change causes a pressure variation to occur on the refrigerant side, which may become a factor of inducing pressure anomaly.

[0100] Furthermore, regarding switching of the operation of the indoor units 3, at the time when an indoor unit 3 that has been performing a cooling operation is switched to perform a heating operation, a cooled heat medium that has been supplied to the indoor unit 3 and a heated heat medium that has been supplied to an indoor unit 3 that has been performing a heating operation are mixed together. Thus, a similar phenomenon occurs.

[0101] When some of the indoor units 3 being in operation are to stop, merely separating the heat medium having the same temperature by closing down the heat medium flow control devices 34. Accordingly, although a load variation for the amount corresponding to the stopped indoor units 3 occurs, it is predicted that the variation does not reach the degree of variation which occurs at the time when an indoor unit 3 is activated or performs switching of operation.

[0102] The above-mentioned pressure variation may occur in all the operation modes. It can be considered that the degree of influence increases in the order of the heating only operation mode, the mixed operation mode (the heating main operation mode, the cooling main operation mode), and the cooling only operation mode.

[0103] Here, the case where it is assumed that the heat medium temperature at the time of a heating operation is between 35 degrees C and 50 degrees C and the heat medium temperature at the time of a cooling operation is between 5 degrees C and 15 degrees C will be considered. In the heating only operation mode, since the temperature of the heat medium remaining in the pipes 5 of the stopped indoor units 3 reduces to a value corresponding to the outdoor temperature, the temperature difference of heat medium to be mixed together is about 50 degrees C at the largest in the case where the outdoor temperature is 0 degrees C or lower. In the mixed operation mode, when switching of the operation mode of the indoor units 3 is assumed, the temperature difference of heat medium to be mixed together is about 45 degrees C at the largest, on the basis of the temperature difference between the heat medium at the time of a heating operation and the heat medium at the time of a cooling operation. In the cooling only operation mode, when the outdoor temperature is about 35 degrees C at the highest, the temperature difference of heat medium to be mixed together is about 30 degrees C at the largest.

[0104] Here, regarding the mixed operation mode, an example of switching of the operation mode between heating and cooling has been explained. However, in the case where a stopped indoor unit 3 is activated, a result similar to the case of the heating only operation mode or the cooling only operation mode is obtained. Furthermore, the outdoor temperature represents the ambient temperature of a space in which the pipes 5 are installed, and the temperature of a space that is different from a space above the ceiling or the like (the space 8 illustrated in Fig. 1) and an indoor space (the indoor space 7 illustrated in Fig. 1) is assumed as the outdoor temperature.

[0105] In the air-conditioning apparatus 100, suppression of a pressure variation on the refrigerant side is achieved by the method described below. More specifically, the pressure variation suppressing operation is performed in such a manner that the pressure variation of the heat-source side refrigerant can be reduced by causing the heat medium to circulate in an indoor unit 3 that is scheduled to start operation and adjusting the opening degree of the corresponding heat medium flow control device 34 on the basis of the refrigerant pressure of the refrigerant pipe 4 (pressure detected by the pressure sensor 41) and the heat medium temperature of the pipe 5 connected to the indoor unit 3 that is scheduled to start operation (temperature detected by the corresponding temperature sensor 37). The pressure variation suppressing operation is performed at the time when switching of the operation mode is performed or when a stopped indoor unit 3 is activated. Although the state in which two pressure sensors 41 are installed is illustrated as an ex-

ample in the drawing, two pressure sensors are not necessarily provided.

[0106] Fig. 7 is a flowchart illustrating an example of the flow of the process of a pressure variation suppressing operation performed by the air-conditioning apparatus 100. With reference to Fig. 7, the example of the flow of the process of the pressure variation suppressing operation on a heat-source-side refrigerant side performed by the air-conditioning apparatus 100 will be explained. Here, the case where a pressure variation suppressing operation is performed at the time when the use-side heat exchanger 35b is newly activated in order to perform a heating operation while the use-side heat exchanger 35a is performing a heating operation will be explained. That is, the use-side heat exchanger 35b of the indoor unit 3b is a target for a pressure variation suppressing operation.

[0107] The controller 50 configures a heating heat medium circuit that causes the heat medium to circulate in the use-side heat exchanger 35b, which is a target for a pressure variation suppressing operation, when the pressure variation suppressing operation starts. That is, the controller 50 determines the use-side heat exchanger 35b as a target for the pressure variation suppressing operation, and configures the heating heat medium circuit that causes the heat medium to circulate in the use-side heat exchanger 35b.

[0108] More specifically, the controller 50 slightly opens the heat medium flow control device 34b (step S101), and switches the first heat medium flow switching device 32b and the second heat medium flow switching device 33b to the heating side (steps S102 and S103). Here, setting the opening degree of the heat medium flow control device 34b to be slightly opened means that the opening degree is set to the minimum opening degree (a first opening degree) at which the heat medium can flow. Setting the opening degree of the heat medium flow control device 34b to the minimum opening degree allows the heat medium remaining in the use-side heat exchanger 35b and the pipe 5 to circulate. Here, heating of the heat medium may be performed by either the intermediate heat exchanger 25a or the intermediate heat exchanger 25b.

[0109] After allowing the remaining heat medium to circulate, the controller 50 compares the pressure difference Pa between before and after the indoor unit 3b is activated (pressure difference detected by the pressure sensor 41) with a predetermined specific pressure P0 (step S104). When Pa is lower than P0 (step S104; YES), the controller 50 increases the opening degree of the heat medium flow control device 34b (to a second opening degree) (step S105). Meanwhile, when Pa is equal to P0 or higher (step S104; NO), the controller 50 keeps the opening degree of the heat medium flow control device 34b the minimum opening degree. That is, the controller 50 controls the opening degree of the heat medium flow control device 34 on the basis of Pa, and reduces the pressure variation on the heat-source side refrigerant side to the minimum.

[0110] Then, the controller 50 compares the heat medium temperature Ta at the pipe 5 connected to the use-side heat exchanger 35b in the newly activated indoor unit 3b (temperature detected by the temperature sensor 37b) with a predetermined specific temperature TO (step S106). When Ta is lower than TO (step S106; YES), the process returns to step S104 to continue to perform the process. Meanwhile, when Ta is equal to or higher than TO (step S106; NO), the controller 50 determines that a further pressure variation suppressing operation is not required, and terminates the pressure variation suppressing operation. Accordingly, the series of processing is terminated.

[0111] Here, in order not to greatly affect over the control of the expansion device 26, P0 is desirably set within a range up to, for example, about 6 kgf/cm^2, and more preferably, set to about 1 kgf/cm^2. Accordingly, highly-accurate suppression of a high-pressure variation for the heat-source side refrigerant that avoids the pressure variation at the time of a normal operation can be achieved. Furthermore, T0 may be set to, for example, a value similar to the heat medium return temperature at the use-side heat exchanger 35a during heating (temperature detected by the temperature sensor 37a). By setting the target temperature (TO) of the heat medium not to be higher than the heat medium return temperature at the use-side heat exchanger 35a during heating, excessive heating of the heat medium can be suppressed, and the start-up time of the newly activated indoor unit 3b can be shortened.

[0112] As described above, with the air-conditioning apparatus 100, by performing the control processing mentioned above, a pressure variation on the refrigerant side can be suppressed at the time when a heating operation of the indoor unit 3b starts. Thus, with the air-conditioning apparatus 100, system construction with high reliability without occurrence of pressure anomaly at the time of starting a heating operation can be achieved. Furthermore, with the air-conditioning apparatus 100, owing to the control processing mentioned above, a reduction in the air-outlet temperature at the indoor unit 3a that is performing a heating operation can be prevented, and an effect of not losing the comfort of a user can also be achieved. Although pressure variation suppression on the refrigerant side at the time when the indoor unit 3b starts a heating operation has been explained with reference to Fig. 7, pressure variation suppression on the refrigerant side at the time when the indoor unit 3b that is performing a cooling operation in the mixed mode is switched to perform a heating operation can be similarly dealt with.

[0113] Fig. 8 is a flowchart illustrating a different example of the flow of the process of a pressure variation suppressing operation performed by the air-conditioning apparatus 100. The different example of the flow of the process of the pressure variation suppressing operation on the heat-source side refrigerant side performed by the

air-conditioning apparatus 100 will be explained with reference to Fig. 8. Here, the case where a pressure variation suppressing operation is performed when the use-side heat exchanger 35b is newly activated in order to perform a cooling operation while the use-side heat exchanger 35a is performing a cooling operation will be explained. That is, the use-side heat exchanger 35b of the indoor unit 3b is a target for a pressure variation suppressing operation. Since steps S201 to S205 illustrated in Fig. 8 are similar to steps S101 to S105 illustrated in Fig. 7, the explanation of steps S201 to S205 will be omitted.

[0114] In step S206, the controller 50 compares the heat medium temperature Ta at the pipe 5 connected to the use-side heat exchanger 35b of the newly activated indoor unit 3b (temperature detected by the temperature sensor 37b) with a predetermined specific temperature T10. When Ta is higher than T10 (step S206; YES), the process returns to step S204 to continue to perform the process. Meanwhile, when Ta is lower than or equal to T10 (step S206; NO), the controller 50 determines that a further pressure variation suppressing operation is not required, and terminates the pressure variation suppressing operation. Accordingly, the series of processing is terminated.

[0115] Here, in order not to greatly affect the control of the expansion device 26, P0 is desirably set within a range up to, for example, about 6 kgf/cm^2, and more preferably, set to about 1 kgf/cm^2. Accordingly, highly-accurate suppression of a high-pressure variation for the heat-source side refrigerant that avoids the pressure variation at the time of a normal operation can be achieved. Furthermore, T10 may be set to, for example, a value similar to the heat medium return temperature at the use-side heat exchanger 35a during cooling (temperature detected by the temperature sensor 37a). By setting the target temperature of the heat medium (T10) not to be lower than the heat medium return temperature of the use-side heat exchanger 35a during cooling, excessive cooling of the heat medium can be suppressed, and the start-up time of the newly activated indoor unit 3b can be shortened.

[0116] As described above, the air-conditioning apparatus 100 can suppress a pressure variation on the refrigerant side, by performing the control processing mentioned above, at the time when a cooling operation of the indoor unit 3b starts. Thus, the air-conditioning apparatus 100 not only prevents pressure anomaly from occurring at the time when a heating operation starts but also prevents pressure anomaly on the refrigerant side from occurring even at the time of starting a cooling operation owing to execution of activation of the indoor unit 3, or switching of the operation mode while managing the refrigerant pressure of the refrigerant circuit A. Accordingly, system construction with high reliability without occurrence of pressure anomaly on the refrigerant side even at the time of starting a cooling operation can be achieved. Furthermore, with the air-conditioning apparatus 100, owing to the control processing mentioned above, a reduction in the air-outlet temperature at the indoor unit 3a that is performing a cooling operation can be prevented, and an effect of not losing the comfort of a user can also be achieved. Although pressure variation suppression on the refrigerant side at the time when the indoor unit 3b starts a cooling operation has been explained with reference to Fig. 8, pressure variation suppression on the refrigerant side at the time when the indoor unit 3b that is performing a heating operation in the mixed mode is switched to perform a cooling operation can be similarly dealt with.

[Method for increasing opening degree of heat medium flow control device 34]

[0117] Fig. 9 is an explanatory diagram for explaining a method for increasing the opening degree of the heat medium flow control devices 34. A method for increasing the opening degree of the heat medium flow control devices 34 performed by the air-conditioning apparatus 100, and more specifically, a method for increasing the opening degree when the opening degree is increased from a first opening degree to a second opening degree will be explained with reference to Fig. 9. In Fig. 9, six patterns of the method for increasing the opening degree of the heat medium flow control devices 34 are illustrated in a table format. Although any of the patterns illustrated in Fig. 9 may be adopted as the method for increasing the opening degree of the heat medium flow control devices 34, the pattern may be determined comprehensively based on the control structure, the influence on the system, the time to termination of a pressure variation suppressing operation, the possibility of a large variation, and the like.

(First pattern)

[0118] A first pattern is a fixed opening degree control pattern in which the speed is focused on. The first pattern is summarized in that the opening degree is fixed constant at the timing when the opening degree of the heat medium flow control devices 34 is increased and the same opening degree is maintained until a pressure variation suppressing operation ends. Regarding the details of the first pattern, the fixed opening degree of the heat medium flow control devices 34 is set to be relatively large. The first pattern has an effect in that the control structure is simple, the influence on the system is large, the time to the termination of a pressure variation suppressing operation is short, and the possibility of the occurrence of a large pressure variation is high.

(Second pattern)

[0119] A second pattern is a fixed opening degree control pattern in which the influence on the system is focused on. The second pattern is summarized in that, sim-

ilar to the first pattern, the opening degree is fixed constant at the timing when the opening degree of the heat medium flow control devices 34 is increased and the same opening degree is maintained until the termination of a pressure variation suppressing operation. However, regarding the details of the second pattern, the fixed opening degree of the heat medium flow control devices 34 is set to be relatively small. The second pattern has an effect in that the control structure is simple, the influence on the system is small, the time to the termination of a pressure variation suppressing operation is long, and the possibility of the occurrence of a large pressure variation is low.

(Third pattern)

[0120] A third pattern is an inching opening degree control pattern in which the speed is focused on. The third pattern is summarized in that the opening degree is increased by a certain opening degree at the timing when the opening degree of the heat medium flow control devices 34 is increased. Regarding the details of the third pattern, the inching width of the heat medium flow control devices 34 is set to be relatively large. The third pattern has an effect in that the control structure is at an intermediate level, the influence on the system is large, the time to the termination of a pressure variation suppressing operation is short, and the possibility of the occurrence of a large pressure variation is high.

(Fourth pattern)

[0121] A fourth pattern is an inching opening degree control pattern in which the influence on the system is focused on. The fourth pattern is summarized in that, similar to the third pattern, the opening degree is increased by a certain opening degree at the timing when the opening degree of the heat medium flow control devices 34 is increased. However, regarding the details of the fourth pattern, the inching width of the heat medium flow control devices 34 is set to be relatively small. The fourth pattern has an effect in that the control structure is at the intermediate level, the influence on the system is small, the time to the termination of a pressure variation suppressing operation is long, and the possibility of the occurrence of a large pressure variation is low.

(Fifth pattern)

[0122] A fifth pattern is a target opening degree control pattern in which the speed is focused on. The fifth pattern is based on the start of a heating operation of the indoor unit 3b when TO is used as the reference temperature. The fifth pattern is summarized in that the opening degree of the heat medium flow control devices 34 is determined on the basis of the difference between the reference temperature and a detected temperature and the target opening degree is determined at the timing when the opening degree of the heat medium flow control devices 34 is increased. Regarding the details of the fifth pattern, first, the amount of the increase of the opening degree is determined using a conversion formula $\Delta pulse = f(Am - A1)$ for converting the opening area of the heat medium flow control devices 34 into the pulse number. Here, Am represents the target opening area, and A1 represents the current opening area. In addition, based on the relationship $Am = A1 \times \Delta T1 / \Delta Tm$, $(Am - A1) = (\Delta T1 / \Delta Tm - 1) \times A1$ can be expressed. Here, ΔTm represents the target temperature difference (> 0 degrees C) from the reference temperature T0, and ΔT represents (reference temperature (target temperature) TO - detected temperature Ta). The fifth pattern has an effect in that the control structure is complicated, the influence on the system is at the intermediate level, the time to the termination of a pressure variation suppressing operation is short, and the possibility of the occurrence of a large pressure variation is high. Here, for a cooling operation starting pattern for the indoor unit 3b, the reference temperature is represented by T10, and the details of the formula of ΔT are opposite (ΔT = (detected temperature Ta - reference temperature (target temperature) T10).

(Sixth pattern)

[0123] A sixth pattern is a target opening degree control pattern in which the influence on the system is focused on. The sixth pattern is summarized in that, similar to the fifth pattern, the opening degree of the heat medium flow control devices 34 is determined on the basis of the difference between the reference temperature and the detected temperature, and the target opening degree is determined at the timing when the opening degree of the heat medium flow control devices 34 is increased. However, regarding the details of the sixth pattern, the amount of the increase of the opening degree is determined in inverse-proportion to the difference between a target temperature difference and the current temperature difference from the reference temperature. As a formula, $\Delta pulse = f(Am - A1) / (\Delta T1 - \Delta Tm)$ is expressed. The sixth pattern has an effect in that the control structure is complicated, the influence on the system is small, the time to the termination of a pressure variation suppressing operation is at the intermediate level, and the possibility of the occurrence of a large pressure variation is low.

Embodiment 2

[0124] Fig. 10 is a flowchart illustrating an example of the flow of the process of a pressure variation suppressing operation performed by an air-conditioning apparatus according to Embodiment 2 of the present invention. The example of the flow of the process of the pressure variation suppressing operation on the heat-source side refrigerant side performed by the air-conditioning apparatus according to Embodiment 2 will be explained with reference to Fig. 10. In Embodiment 2, differences from

Embodiment 1 described above will be mainly explained, and the same parts as those in Embodiment 1 will be assigned with the same reference signs. Furthermore, the circuit configuration and operation modes of the air-conditioning apparatus according to Embodiment 2 are similar to those in the air-conditioning apparatus 100 according to Embodiment 1.

[0125] In Embodiment 1, the case where a pressure variation suppressing operation using the heat medium flow control devices 34 is performed on the basis of the refrigerant pressure of the refrigerant pipes 4 (pressure detected by the pressure sensors 41) has been explained as an example. Whereas, in Embodiment 2, the case where a pressure variation suppressing operation using the heat medium flow control devices 34 is performed not on the basis of the refrigerant pressure of the refrigerant pipes 4 (pressure detected by the pressure sensors 41) but on the basis of the heat medium temperature that has been flowing in the pipes 5 (temperature detected by the temperature sensors 37) will be explained as an example.

[0126] More specifically, the pressure variation suppressing operation for the air-conditioning apparatus according to Embodiment 2 is performed in such a manner that a pressure variation of a heat-source side refrigerant is suppressed by causing a heat medium to circulate in an indoor unit 3 that is scheduled to start operation and adjusting the opening degree of a corresponding heat medium flow control device 34 on the basis of the heat medium temperature of a pipe 5 connected to the operating indoor unit 3 (temperature detected by a corresponding temperature sensor 37). The pressure variation suppressing operation is performed at the time when switching of an operation mode is performed or when a stopped indoor unit 3 is activated.

[0127] Here, the case where a pressure variation suppressing operation is performed when the use-side heat exchanger 35b is newly activated in order to perform a heating operation while the use-side heat exchanger 35a is performing a heating operation will be explained. That is, the use-side heat exchanger 35b of the indoor unit 3b is a target for a pressure variation suppressing operation. The controller 50 configures a heating heat medium circuit that causes a heart medium to circulate in the use-side heat exchanger 35b, which is a target for a pressure variation suppressing operation, when the pressure variation suppressing operation starts. That is, the controller 50 determines the use-side heat exchanger 35b as a target for a pressure variation suppressing operation, and configures the heating heat medium circuit that causes the heat medium to circulate in the use-side heat exchanger 35b.

[0128] More specifically, the controller 50 slightly opens the heat medium flow control device 34b (step S301), and switches the first heat medium flow switching device 32b and the second heat medium flow switching device 33b to the heating side (steps S302 and S303). Here, setting the opening degree of the heat medium flow control device 34b to be slightly opened means that the opening degree is set to the minimum opening degree (the first opening degree) at which the heat medium can flow. Setting the opening degree of the heat medium flow control device 34b to the minimum opening degree allows the heat medium remaining in the use-side heat exchanger 35b and the pipe 5 to circulate. Here, heating of the heat medium may be performed by any of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b.

[0129] After allowing the remaining heat medium to circulate, the controller 50 compares the temperature difference Tb of heat medium flowing in the pipe 5 connected to the indoor unit 3a that is performing a heating operation before and after the indoor unit 3b is activated (the difference between heat medium temperatures detected by the temperature sensor 37) with a predetermined specific temperature T1 (step S304). When Tb is lower than T1 (step S304; YES), the controller 50 increases the opening degree of the heat medium flow control device 34b (to the second opening degree) (step S305). Meanwhile, when Tb is equal to or higher than T1 (step S304; NO), the controller 50 keeps the opening degree of the heat medium flow control device 34b the minimum opening degree. That is, the controller 50 controls the opening degree of the heat medium flow control device 34 on the basis of Tb, and reduces the pressure variation on the heat-source side refrigerant side to the minimum.

[0130] Then, the controller 50 compares the heat medium temperature Ta at the pipe 5 connected to the use-side heat exchanger 35b of the newly activated indoor unit 3b (temperature detected by the temperature sensor 37b) with a predetermined specific temperature TO (step S306). When Ta is lower than TO (step S306; YES), the controller 50 returns to step S304 to continue to perform the process. Meanwhile, when Ta is equal to or higher than TO (step S306; NO), the controller 50 determines that a further pressure variation suppressing operation is not required, and terminates the pressure variation suppressing operation. Accordingly, the series of processing is terminated.

[0131] Here, in order not to greatly affect the control of the expansion device 26, T1 is desirably set within a range up to, for example, about 10 degrees C, and more preferably, set to about 1.5 degrees C. Accordingly, highly-accurate suppression of a high-pressure variation for a refrigerant that avoids a temperature variation at the time of a normal operation can be achieved. Furthermore, TO may be set to, for example, a value similar to the heat medium return temperature at the use-side heat exchanger 35a during heating (temperature detected by the temperature sensor 37a). By setting the target temperature (TO) of the heat medium not to be higher than the heat medium return temperature at the use-side heat exchanger 35a during heating, excessive heating of the heat medium can be suppressed, and the start-up time of the newly activated indoor unit 3b can be shortened.

[0132] As described above, the air-conditioning appa-

ratus according to Embodiment 2, by performing the control processing mentioned above, a pressure variation on the refrigerant side can be suppressed at the time when a heating operation of the indoor unit 3b starts. In other words, the air-conditioning apparatus according to Embodiment 2 executes activation of the indoor unit 3, or switching of the operation mode while managing the refrigerant pressure of the refrigerant circuit A. Accordingly, system construction with high reliability without occurrence of pressure anomaly on the refrigerant side can be achieved. Furthermore, in the air-conditioning apparatus according to Embodiment 2, the control processing mentioned above prevents a reduction in the air-outlet temperature at the indoor unit 3a that is performing a heating operation, and therefore, an effect of not losing the comfort of a user can be achieved. Although pressure variation suppression on the refrigerant side at the time when the indoor unit 3b starts a heating operation has been explained with reference to Fig. 10, pressure variation suppression on the refrigerant side at the time when the indoor unit 3b starts a cooling operation can be dealt with by changing the relationship of step S306 to the relationship of step S206 illustrated in Fig. 8.

Embodiment 3

[0133] Fig. 11 is a flowchart illustrating an example of the flow of the process of a pressure variation suppressing operation performed by an air-conditioning apparatus according to Embodiment 3 of the present invention. The example of the flow of the pressure variation suppressing operation on the heat-source side refrigerant side performed by the air-conditioning apparatus according to Embodiment 3 will be explained with reference to Fig. 11. In Embodiment 3, differences from Embodiment 1 described above will be mainly explained, and the same parts as those in Embodiment 1 will be assigned with the same reference signs. Furthermore, the circuit configuration and operation modes of the air-conditioning apparatus according to Embodiment 3 are similar to those of the air-conditioning apparatus 100 according to Embodiment 1.

[0134] In Embodiment 1, the case where a pressure variation suppressing operation using the heat medium flow control devices 34 is performed on the basis of the refrigerant pressure of the refrigerant pipes 4 (pressure detected by the pressure sensors 41) has been explained as an example. Whereas, in Embodiment 3, the case where a pressure variation suppressing operation using the heat medium flow control devices 34 is performed not on the basis of the refrigerant pressure of the refrigerant pipes 4 (pressure detected by the pressure sensors 41) but on the basis of the unit capacity of an additionally activated indoor unit 3 will be explained as an example. Here, a pressure variation suppressing operation is performed at the time when switching of an operation mode is performed or a stopped indoor unit 3 is activated.

[0135] Here, the case where a pressure variation suppressing operation is performed at the time when the use-side heat exchanger 35b is newly activated in order to perform a heating operation while the use-side heat exchanger 35a is performing a heating operation will be explained. That is, the use-side heat exchanger 35b of the indoor unit 3b is a target for a pressure variation suppressing operation. The controller 50 configures a heating heat medium circuit that causes a heat medium to circulate in the use-side heat exchanger 35b, which is a target for a pressure variation suppressing operation, when the pressure variation suppressing operation starts. That is, the controller 50 determines the use-side heat exchanger 35b as a target for a pressure variation suppressing operation, and configures the heating heat medium circuit that causes the heat medium to circulate in the use-side heat exchanger 35b.

[0136] More specifically, the controller 50 slightly opens the heat medium flow control device 34b (step S401), and switches the first heat medium flow switching device 32b and the second heat medium flow switching device 33b to the heating side (steps S402 and S403). Here, setting the opening degree of the heat medium flow control device 34b to be slightly opened means that the opening degree is set to the minimum opening degree (the first opening degree) at which the heat medium can flow. Setting the opening degree of the heat medium flow control device 34b to the minimum opening degree allows the heat medium remaining in the use-side heat exchanger 35b and the pipe 5 to circulate. Here, heating of the heat medium may be performed by any of the intermediate heat exchanger 25a and the intermediate heat exchanger 25b.

[0137] The controller 50 compares the heat medium temperature Ta at the pipe 5 connected to the use-side heat exchanger 35b of the newly activated indoor unit 3b (temperature detected by the temperature sensor 37b) with a predetermined specific temperature TO (step S404). When Ta is lower than TO (step S404; YES), the controller 50 increases the opening degree of the heat medium flow control device 34b (to the second opening degree) and fixes the opening degree, in proportion to the capacity of the newly activated indoor unit 3b (step S405). Meanwhile, when Ta is equal to or higher than TO (step S404; NO), the controller 50 determines that a further pressure variation suppressing operation is not required, and terminates the pressure variation suppressing operation. Accordingly, the series of processing is terminated.

[0138] Here, regarding the fixed opening degree of a heat medium flow control device 34, for example, the opening degree at which a pressure variation on the refrigerant side can be suppressed may be deducted on the basis of the ratio of the capacity of an operating indoor unit 3 to the capacity of an indoor unit to be activated. Then, the opening degree of the heat medium flow control device 34 may be determined on the basis of the capacity ratio of the operating indoor unit 3/the indoor unit 3 to be activated. Furthermore, TO may be set to a value similar

to the heat medium return temperature at the use-side heat exchanger 35a during heating (temperature detected by the temperature sensor 37a). By setting the target temperature (TO) of the heat medium not to be higher than the heat medium return temperature at the use-side heat exchanger 35a during heating, excessive heating of the heat medium can be suppressed, and the start-up time of the newly activated indoor unit 3b can be shortened.

[0139] As described above, the air-conditioning apparatus according to Embodiment 3, by performing the control processing mentioned above, a pressure variation on the refrigerant side can be suppressed at the time when a heating operation of the indoor unit 3b starts. Thus, the air-conditioning apparatus according to Embodiment 3 executes activation of the indoor unit 3, or switching of the operation mode while managing the refrigerant pressure of the refrigerant circuit A. Accordingly, system construction with high reliability without occurrence of pressure anomaly on the refrigerant side can be achieved. Furthermore, with the air-conditioning apparatus according to Embodiment 3, owing to the control processing mentioned above, a reduction in the air-outlet temperature at the indoor unit 3a that is performing a heating operation can be prevented, and an effect of not losing the comfort of a user can also be achieved. Although pressure variation suppression on the refrigerant side at the time when the indoor unit 3b starts a heating operation has been explained with reference to Fig. 11, pressure variation suppression on the refrigerant side at the time when the indoor unit 3b performs a cooling operation can be dealt with by changing the relationship of step S404 into the relationship of step S206 illustrated in Fig. 8.

[0140] As described above, embodiments of the present invention have been individually explained. However, combining the features of the embodiments together is not denied.

[0141] Although the heat medium flow control devices 34 are used as means for adjusting the flow rate of the heat medium in Embodiments 1 to 3, the flow rate of the heat medium may be adjusted by directly inputting a control instruction to the pumps 31. Furthermore, although the second refrigerant flow switching devices 28 are illustrated as if they are four-way valves. However, the second refrigerant flow switching devices 28 are not necessarily four-way valves. The second refrigerant flow switching devices 28 may each include a plurality of two-way passage switching valves or three-way passage switching valves so that a refrigerant flows in the same manner as in the case where the second refrigerant flow switching devices 28 each includes a four-way valve.

[0142] Furthermore, it is needless to mention that the same applies to the case where only one use-side heat exchanger 35 and one heat medium flow control device 34 are connected. Furthermore, obviously, there is no problem in that as the intermediate heat exchangers 25 and the expansion devices 26, a plurality of devices that perform the same operations are provided. Furthermore, although the case where the heat medium flow control devices 34 are built in the relay unit 2 has been explained as an example, the heat medium flow control devices 34 are not necessarily built in the relay unit 2. The heat medium flow control devices 34 may be built in the indoor units 3 or may be configured independent of the relay unit 2 and the indoor units 3.

[0143] As a heat medium, for example, brine (antifreeze), water, a liquid mixture of brine and water, a liquid mixture of water and an additive having a high anticorrosive effect, or the like may be used. Thus, in the air-conditioning apparatus 100, even if a heat medium leaks through the indoor units 3 to the indoor space 7, since a highly safe material is used for a heat medium, the use of the highly safe material contributes to improvement in the safety.

[0144] In the embodiments described above, the case where the air-conditioning apparatus 100 includes the accumulator 19 has been explained as an example. However, the accumulator 19 is not necessarily provided. Furthermore, in general, an air-sending device is often mounted in each of the heat-source-side heat exchanger 12 and the use-side heat exchangers 35 so that condensation or evaporation is promoted by air sending. However, an air-sending device is not necessarily mounted in each of the heat-source-side heat exchanger 12 and the use-side heat exchangers 35. For example, panel heaters or the like that use radiation may be used as the use-side heat exchangers 35, and a device of a water cooled type that transports heat with water or antifreeze may be used as the heat-source-side heat exchanger 12. That is, devices of any type may be used as the heat-source-side heat exchanger 12 and the use-side heat exchangers 35 as long as they have a configuration capable of transferring or removing heat.

[0145] In the embodiments described above, the case where four use-side heat exchangers 35 are provided has been explained as an example. However, the number of use-side heat exchangers 35 is not particularly limited. Furthermore, the case where two intermediate heat exchangers, the intermediate heat exchanger 25a and the intermediate heat exchanger 25b, are provided has been explained as an example. However, obviously, the two intermediate heat exchangers are not necessarily provided. Any number of intermediate heat exchangers can be provided as long as they are configured to be capable of cooling and/or heating a heat medium. Furthermore, the number of each of the pump 31a and the pump 31b to be provided is not necessarily limited to one. A plurality of small-capacity pumps may be arranged in parallel to one another.

[0146] Furthermore, with the air-conditioning apparatuses according to Embodiments 1 to 3, not only can the safety be improved without causing the heat-source side refrigerant to circulate in the indoor units 3 or circulate near the indoor units 3, but system construction with high reliability can also be achieved, which ensures the im-

provement in the energy efficiency. Furthermore, with the air-conditioning apparatuses according to Embodiments 1 to 3, since the length of the pipes 5 can be shortened, energy saving can be achieved. Furthermore, with the air-conditioning apparatus according to Embodiments 1 to 3, the number of connecting pipes (refrigerant pipes 4, pipes 5) between the outdoor unit 1 and the relay unit 2 or the indoor units 3 can be reduced, thus improving the workability.

Reference Signs List

[0147] 1 outdoor unit, 2 relay unit, 3 indoor unit, 3a indoor unit, 3b indoor unit, 3c indoor unit, 3d indoor unit, 4 refrigerant pipe, 4a refrigerant connecting pipe, 4b refrigerant connecting pipe, 5 pipe, 6 outdoor space, 7 indoor space, 8 space, 9 structure, 10 compressor, 11 first refrigerant flow switching device, 12 heat-source-side heat exchanger, 13a check valve, 13b check valve, 13c check valve, 13d check valve, 19 accumulator, 20 bypass pipe, 25 intermediate heat exchanger, 25a intermediate heat exchanger, 25b intermediate heat exchanger, 26 expansion device, 26a expansion device, 26b expansion device, 27 opening/closing device, 28 second refrigerant flow switching device, 28a second refrigerant flow switching device, 28b second refrigerant flow switching device, 29 opening/closing device, 31 pump, 31a pump, 31b pump, 32 first heat medium flow switching device, 32a first heat medium flow switching device, 32b first heat medium flow switching device, 32c first heat medium flow switching device, 32d first heat medium flow switching device, 33 second heat medium flow switching device, 33a second heat medium flow switching device, 33b second heat medium flow switching device, 33c second heat medium flow switching device, 33d second heat medium flow switching device, 34 heat medium flow control device, 34a heat medium flow control device, 34b heat medium flow control device, 34c heat medium flow control device, 34d heat medium flow control device, 35 use-side heat exchanger, 35a use-side heat exchanger, 35b use-side heat exchanger, 35c use-side heat exchanger, 35d use-side heat exchanger, 37 temperature sensor, 37a temperature sensor, 37b temperature sensor, 37c temperature sensor, 37d temperature sensor,, 41 pressure sensor, 41a pressure sensor, 41b pressure sensor, 50 controller, 100 air-conditioning apparatus, A refrigerant circuit, B heat medium circuit

Claims

1. An air-conditioning apparatus (100) comprising:

a refrigerant circuit (A) in which a compressor (10), a heat-source-side heat exchanger (12), a plurality of expansion devices (26), refrigerant-side flows of a plurality of intermediate heat exchangers (25), and a plurality of refrigerant flow switching devices (28) that perform switching of circulation paths are connected with refrigerant pipes (4), through which a heat-source-side refrigerant circulates pressure sensors (41) that detect the pressure of the heat-source side refrigerant in the refrigerant pipes (4);

a heat medium circuit (B) in which pumps (31), a plurality of use-side heat exchangers (35), heat medium flow control devices (34), and heat-medium-side flows of the intermediate heat exchangers (25) are connected with heat medium pipes (5), through which a heat medium circulates; and

a controller (50) that controls an opening degree of at least one of the heat medium flow control devices (34) to adjust a flow rate of the heat medium,

wherein, the controller (50) performs a pressure variation suppressing operation for suppressing a refrigerant pressure variation on a side of the refrigerant circuit (A) by controlling the at least one of the heat medium flow control devices (34) to have a first opening degree so as to allow a certain amount of heat medium to flow through at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35), before the at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35) starts operation or performs switching of an operation mode; and

characterized in that the controller (50),

after controlling the at least one heat medium flow control devices (34) to have the first opening degree,

compares a preset predetermined pressure with a pressure difference between a pressure of the heat-source side refrigerant before the at least one of the heat medium flow control devices (34) is set to have the first opening degree and a pressure of the heat-source side refrigerant after the at least one of the heat medium flow control devices (34) is set to have the first opening degree, and

when the pressure difference is smaller than the predetermined pressure, the controller (50) controls the at least one of the heat medium flow control devices (34) whose opening degree has been controlled to the first opening degree to have a second opening degree that is greater than the first opening degree.

2. The air-conditioning apparatus (100) of claim 1, wherein the predetermined pressure is set within a range up to 6 kgf/cm^2 (5.88 bar).

3. An air-conditioning apparatus (100) comprising:

a refrigerant circuit (A) in which a compressor

(10), a heat-source-side heat exchanger (12), a plurality of expansion devices (26), refrigerant-side flows of a plurality of intermediate heat exchangers (25), and a plurality of refrigerant flow switching devices (28) that perform switching of circulation paths are connected with refrigerant pipes (4), through which a heat-source-side refrigerant circulates;
a heat medium circuit (B) in which pumps (31), a plurality of use-side heat exchangers (35), heat medium flow control devices (34), and heat-medium-side flows of the intermediate heat exchangers (25) are connected with heat medium pipes (5), through which a heat medium circulates; and
temperature sensors (37) that detect the temperature of the heat medium in the heat medium pipe (5) on the return side of the use-side heat-exchangers (35);
a controller (50) that controls an opening degree of at least one of the heat medium flow control devices (34) to adjust a flow rate of the heat medium,
wherein, the controller (50) performs a pressure variation suppressing operation for suppressing a refrigerant pressure variation on a side of the refrigerant circuit (A) by controlling the at least one of the heat medium flow control devices (34) to have a first opening degree so as to allow a certain amount of heat medium to flow through at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35), before the at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35) starts operation or performs switching of an operation mode; and
characterized in that the controller (50),
after controlling the at least one of the heat medium flow control devices (34) to have the first opening degree,
compares a preset predetermined temperature with a temperature difference between a temperature of the heat medium before the at least one of the heat medium flow control devices (34) is set to have the first opening degree and a temperature of the heat medium after the at least one of the heat medium flow control devices (34) is set to have the first opening degree and
when the temperature difference is lower than the predetermined temperature, controls the at least one of the heat medium flow control devices (34) whose opening degree has been controlled to the first opening degree to have a second opening degree that is greater than the first opening degree.

4. The air-conditioning apparatus (100) of claim 3, wherein the predetermined temperature is set within a range up to 10 degrees C.

5. The air-conditioning apparatus (100) of any one of claims 1 or 2, wherein,
the controller (50),
when the pressure difference is equal to or greater than the predetermined pressure or after the at least one of the heat medium flow control devices (34) is set to have the second opening degree,
compares a preset predetermined temperature with a temperature of the heat medium circulating in the at least one of the use-side heat exchangers (35) to which the corresponding heat medium flow control device (34) whose opening degree has been controlled to the second opening degree is connected, and
terminates the pressure variation suppressing operation in respective cases where the temperature of the heat medium is equal to or higher than the predetermined temperature at a time when the at least one of the use-side heat exchangers (35) being in operation of the plurality of the use-side heat exchangers (35) is performing a heating operation and where the temperature of the heat medium is lower than or equal to the predetermined temperature at a time when the at least one of the use-side heat exchangers (35) being in operation of the plurality of the use-side heat exchangers (35) is performing a cooling operation.

6. An air-conditioning apparatus (100) comprising:

a refrigerant circuit (A) in which a compressor (10), a heat-source-side heat exchanger (12), a plurality of expansion devices (26), refrigerant-side flows of a plurality of intermediate heat exchangers (25), and a plurality of refrigerant flow switching devices (28) that perform switching of circulation paths are connected with refrigerant pipes (4), through which a heat-source-side refrigerant circulates;
a heat medium circuit (B) in which pumps (31), a plurality of use-side heat exchangers (35), heat medium flow control devices (34), and heat-medium-side flows of the intermediate heat exchangers (25) are connected with heat medium pipes (5), through which a heat medium circulates; and
temperature sensors (37) that detect the temperature of the heat medium in the heat medium pipe (5) on the return side of the use-side heat-exchangers (35);
a controller (50) that controls an opening degree of at least one of the heat medium flow control devices (34) to adjust a flow rate of the heat medium,
wherein, the controller (50) performs a pressure variation suppressing operation for suppressing

a refrigerant pressure variation on a side of the refrigerant circuit (A) by controlling the at least one of the heat medium flow control devices (34) to have a first opening degree so as to allow a certain amount of heat medium to flow through at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35), before the at least one of the use-side heat exchangers (35) of the plurality of the use-side heat exchangers (35) starts operation or performs switching of an operation mode; and
characterized in that the controller (50),
when a temperature of the heat medium circulating in the at least one of the use-side heat exchangers (35) to which the corresponding heat medium flow control device (34) whose opening degree has been controlled to the first opening degree is connected is lower than a preset predetermined temperature,
controls the at least one of the heat medium flow control devices (34) whose opening degree has been controlled to the first opening degree to have a second opening degree that is greater than the first opening degree, in proportion to a capacity of an indoor unit (3) including the at least one of the use-side heat exchangers (35) to which the corresponding heat medium flow control device (34) whose opening degree has been controlled to the first opening degree is connected.

7. The air-conditioning apparatus (100) of claim 6, wherein,
the controller (50),
compares the preset predetermined temperature with the temperature of the heat medium circulating in the at least one of the use-side heat exchangers (35) to which the corresponding heat medium flow control device (34) whose opening degree has been controlled to the first opening degree is connected, and
terminates the pressure variation suppressing operation in respective cases where the temperature of the heat medium is equal to or higher than the predetermined temperature at a time when the at least one of the use-side heat exchangers (35) being in operation of the plurality of he use-side heat exchangers (35) is performing a heating operation and where the temperature of the heat medium is lower than or equal to the predetermined temperature at a time when the at least one of the use-side heat exchangers (35) being in operation of the plurality of the use-side heat exchangers (35) is performing a cooling operation.

8. The air-conditioning apparatus (100) of claim 1, 3, or 6, wherein the controller (50) fixes the opening degree of the at least one of the heat medium flow control devices (34) to the second opening degree.

9. The air-conditioning apparatus (100) of claim 1, 3, or 6, wherein the controller (50) increases the opening degree of the at least one of the heat medium flow control devices (34) by a certain opening degree to the second opening degree.

10. The air-conditioning apparatus (100) of claim 3 or 6, wherein the controller (50) determines a target opening degree of the second opening degree by calculation based on the predetermined temperature and the temperature difference.

Patentansprüche

1. Klimaanlage (100), umfassend:

einen Kältemittelkreislauf (A), in dem ein Verdichter (10), ein wärmequellenseitiger Wärmetauscher (12), eine Vielzahl von Expansionseinrichtungen (26), kältemittelseitige Strömungen einer Vielzahl von Zwischenwärmetauschern (25) und eine Vielzahl von Kältemittelströmungsschalteinrichtungen (28), die Schalten von Zirkulationspfaden durchführen, mittels Kältemittelleitungen (4) verbunden sind, durch die ein wärmequellenseitiges Kältemittel zirkuliert, Drucksensoren (41), die den Druck des wärmequellenseitigen Kältemittels in den Kältemittelleitungen (4) erfassen;
einen Wärmemediumkreislauf (B), in dem Pumpen (31), eine Vielzahl von nutzungsseitigen Wärmetauschern (35), Wärmemediumströmungssteuerungseinrichtungen (34) und wärmemediumseitige Strömungen der Zwischenwärmetauscher (25) mittels Wärmemediumleitungen (5) verbunden sind, durch die ein Wärmemedium zirkuliert, und
eine Steuerungseinheit (50), die einen Öffnungsgrad von zumindest einer der Wärmemediumströmungssteuerungseinrichtungen (34) steuert, um eine Strömungsrate des Wärmemediums anzupassen,
wobei die Steuerungseinheit (50) einen Druckvariation-Unterdrückungsbetrieb zum Unterdrücken einer Kältemitteldruckvariation auf einer Seite des Kältemittelkreislaufs (A) durchführt durch Steuern der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34), um einen ersten Öffnungsgrad aufzuweisen, um einer bestimmten Menge an Wärmemedium zu ermöglichen, durch zumindest einen der nutzungsseitigen Wärmetauscher (35) der Vielzahl von nutzungsseitigen Wärmetauschern (35) zu strömen, bevor der zumindest eine der nutzungsseitigen Wärmetauscher (35)

der Vielzahl von nutzungsseitigen Wärmetauschern (35) Betrieb startet oder Schalten eines Betriebsmodus durchführt; und

dadurch gekennzeichnet, dass die Steuerungseinheit (50),

nach Steuern der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34), um den ersten Öffnungsgrad aufzuweisen,

einen voreingestellten vorherbestimmten Druck zu vergleichen mit einer Druckdifferenz zwischen einem Druck des wärmequellenseitigen Kältemittels, bevor die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34) eingestellt ist, um den ersten Öffnungsgrad aufzuweisen, und einem Druck des wärmequellenseitigen Kältemittels, nachdem die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34) eingestellt ist, um den ersten Öffnungsgrad aufzuweisen, und

wenn die Druckdifferenz kleiner ist als der vorherbestimmte Druck, die Steuerungseinheit (50) die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34), deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, steuert, um einen zweiten Öffnungsgrad aufzuweisen, der größer ist als der erste Öffnungsgrad.

2. Klimaanlage (100) nach Anspruch 1, wobei der vorherbestimmte Druck in einem Bereich von bis zu 6 kgf/cm (5,88 bar) eingestellt ist.

3. Klimaanlage (100), umfassend:

einen Kältemittelkreislauf (A), in dem ein Verdichter (10), ein wärmequellenseitiger Wärmetauscher (12), eine Vielzahl von Expansionseinrichtungen (26), kältemittelseitige Strömungen einer Vielzahl von Zwischenwärmetauschern (25) und eine Vielzahl von Kältemittelströmungsschalteinrichtungen (28), die Schalten von Zirkulationspfaden durchführen, mittels Kältemittelleitungen (4) verbunden sind, durch die ein wärmequellenseitiges Kältemittel zirkuliert;

einen Wärmemediumkreislauf (B), in dem Pumpen (31), eine Vielzahl von nutzungsseitigen Wärmetauschern (35), Wärmemediumströmungssteuerungseinrichtungen (34) und wärmemediumseitige Strömungen der Zwischenwärmetauscher (25) mittels Wärmemediumleitungen (5) verbunden sind, durch die ein Wärmemedium zirkuliert; und Temperatursensoren (37), die die Temperatur des Wärmemediums in der Wärmemediumleitung (5) auf der Rückführungsseite der nutzungsseitigen Wärmetauscher (35) erfassen;

eine Steuerungseinheit (50), die einen Öffnungsgrad von zumindest einer der Wärmemediumströmungssteuerungseinrichtungen (34) steuert, um eine Strömungsrate des Wärmemediums anzupassen,

wobei die Steuerungseinheit (50) einen Druckvariation-Unterdrückungsbetrieb zum Unterdrücken einer Kältemitteldruckvariation auf einer Seite des Kältemittelkreislaufs (A) durchführt durch Steuern der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34), um einen ersten Öffnungsgrad aufzuweisen, um einer bestimmten Menge an Wärmemedium zu ermöglichen, durch zumindest einen der nutzungsseitigen Wärmetauscher (35) der Vielzahl von nutzungsseitigen Wärmetauschern (35) zu strömen, bevor der zumindest eine der nutzungsseitigen Wärmetauscher (35) der Vielzahl von nutzungsseitigen Wärmetauschern (35) Betrieb startet oder Schalten eines Betriebsmodus durchführt; und

dadurch gekennzeichnet, dass die Steuerungseinheit (50),

nach Steuern der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34), um den ersten Öffnungsgrad aufzuweisen,

eine voreingestellte vorherbestimmte Temperatur vergleicht mit einer Temperaturdifferenz zwischen einer Temperatur des Wärmemediums, bevor die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34) eingestellt ist, um den ersten Öffnungsgrad aufzuweisen, und einer Temperatur des Wärmemediums, nachdem die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34) eingestellt ist, um den ersten Öffnungsgrad aufzuweisen, und

wenn die Temperaturdifferenz geringer ist als die vorherbestimmte Temperatur, die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34), deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, steuert, um einen zweiten Öffnungsgrad aufzuweisen, der größer ist als der erste Öffnungsgrad.

4. Klimaanlage (100) nach Anspruch 3, wobei die vorherbestimmte Temperatur in einem Bereich von bis zu 10 Grad Celsius eingestellt ist.

5. Klimaanlage (100) nach einem der Ansprüche 1 oder 2, wobei die Steuerungseinheit (50),

wenn die Druckdifferenz gleich ist wie oder größer ist als der vorherbestimmte Druck oder nachdem die zumindest eine der Wärmemediumströmungssteuerungseinrich-

tungen (34) eingestellt ist, um den zweiten Öffnungsgrad aufzuweisen,
eine voreingestellte vorherbestimmte Temperatur vergleicht mit einer Temperatur des Wärmemediums, zirkulierend in dem zumindest einen der nutzungsseitigen Wärmetauscher (35), mit dem die entsprechende Wärmemediumströmungssteuerungseinrichtung (34), deren Öffnungsgrad auf den zweiten Öffnungsgrad gesteuert wurde, verbunden ist, und
den Druckvariation-Unterdrückungsbetrieb beendet in jeweiligen Fällen, in denen die Temperatur des Wärmemediums gleich ist wie oder höher ist als die vorherbestimmte Temperatur zu einem Zeitpunkt, zu dem der zumindest eine der nutzungsseitigen Wärmetauscher (35), der in Betrieb ist, der Vielzahl der nutzungsseitigen Wärmetauscher (35), einen Erwärmungsbetrieb durchführt, und in denen die Temperatur des Wärmemediums niedriger ist als oder gleich ist wie die vorherbestimmte Temperatur zu einem Zeitpunkt ist, zu dem der zumindest eine der nutzungsseitigen Wärmetauscher (35), der in Betrieb ist, der Vielzahl der nutzungsseitigen Wärmetauscher (35), einen Kühlungsbetrieb durchführt.

6. Klimaanlage (100), umfassend:

einen Kältemittelkreislauf (A), in dem ein Verdichter (10), ein wärmequellenseitiger Wärmetauscher (12), eine Vielzahl von Expansionseinrichtungen (26), kältemittelseitige Strömungen einer Vielzahl von Zwischenwärmetauschern (25) und eine Vielzahl von Kältemittelströmungsschalteinrichtungen (28), die Schalten von Zirkulationspfaden durchführen, mittels Kältemittelleitungen (4) verbunden sind, durch die ein wärmequellenseitiges Kältemittel zirkuliert;
einen Wärmemediumkreislauf (B), in dem Pumpen (31), eine Vielzahl von nutzungsseitigen Wärmetauschern (35), Wärmemediumströmungssteuerungseinrichtungen (34) und wärmemediumseitige Strömungen der Zwischenwärmetauscher (25) mittels Wärmemediumleitungen (5) verbunden sind, durch die ein Wärmemedium zirkuliert; und Temperatursensoren (37), die die Temperatur des Wärmemediums in der Wärmemediumleitung (5) auf der Rückführungsseite der nutzungsseitigen Wärmetauscher (35) erfassen;
eine Steuerungseinheit (50), die einen Öffnungsgrad von zumindest einer der Wärmemediumströmungssteuerungseinrichtungen (34) steuert, um eine Strömungsrate des Wärmemediums anzupassen,
wobei die Steuerungseinheit (50) einen Druckvariation-Unterdrückungsbetrieb zum Unterdrücken einer Kältemitteldruckvariation auf einer Seite des Kältemittelkreislaufs (A) durchführt durch Steuern der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34), um einen ersten Öffnungsgrad aufzuweisen, um einer bestimmten Menge an Wärmemedium zu ermöglichen, durch zumindest einen der nutzungsseitigen Wärmetauscher (35) der Vielzahl von nutzungsseitigen Wärmetauschern (35) zu strömen, bevor der zumindest eine der nutzungsseitigen Wärmetauscher (35) der Vielzahl von nutzungsseitigen Wärmetauschern (35) Betrieb startet oder Schalten eines Betriebsmodus durchführt; und
dadurch gekennzeichnet, dass die Steuerungseinheit (50),
wenn eine Temperatur des Wärmemediums, zirkulierend in dem zumindest einen der nutzungsseitigen Wärmetauscher (35), mit dem die entsprechende Wärmemediumströmungssteuerungseinrichtung (34) verbunden ist, deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, niedriger ist als eine voreingestellte vorherbestimmte Temperatur,
die zumindest eine der Wärmemediumströmungssteuerungseinrichtungen (34), deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, steuert, um einen zweiten Öffnungsgrad aufzuweisen, der größer ist als der erste Öffnungsgrad, proportional zu einer Kapazität einer Inneneinheit (3), die den zumindest einen der nutzungsseitigen Wärmetauscher (35) umfasst, mit dem die entsprechende Wärmemediumströmungssteuerungseinrichtung (34), deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, verbunden ist.

7. Klimaanlage (100) nach Anspruch 6, wobei,

die Steuerungseinheit (50),
die voreingestellte vorherbestimmte Temperatur vergleicht mit der Temperatur des Wärmemediums, zirkulierend in dem zumindest einen der nutzungsseitigen Wärmetauscher (35), mit dem die entsprechende Wärmemediumströmungssteuerungseinrichtung (34), deren Öffnungsgrad auf den ersten Öffnungsgrad gesteuert wurde, verbunden ist, und
den Druckvariation-Unterdrückungsbetrieb beendet in jeweiligen Fällen, in denen die Temperatur des Wärmemediums gleich ist wie oder höher ist als die vorherbestimmte Temperatur zu einem Zeitpunkt, zu dem der zumindest eine der nutzungsseitigen Wärmetauscher (35), der in Betrieb ist, der Vielzahl der nutzungsseitigen Wärmetauscher (35), einen Erwärmungsbetrieb durchführt, und in denen die Temperatur des Wärmemediums niedriger ist als oder gleich ist

wie die vorherbestimmte Temperatur zu einem Zeitpunkt, zu dem der zumindest eine der nutzungsseitigen Wärmetauscher (35), der in Betrieb ist, der Vielzahl der nutzungsseitigen Wärmetauscher (35), einen Kühlungsbetrieb durchführt.

8. Klimaanlage (100) nach Anspruch 1, 3 oder 6, wobei die Steuerungseinheit (50) den Öffnungsgrad der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34) auf den zweiten Öffnungsgrad festlegt.

9. Klimaanlage (100) nach Anspruch 1, 3 oder 6, wobei die Steuerungseinheit (50) den Öffnungsgrad der zumindest einen der Wärmemediumströmungssteuerungseinrichtungen (34) um einen bestimmten Öffnungsgrad auf den zweiten Öffnungsgrad erhöht.

10. Klimaanlage (100) nach Anspruch 3 oder 6, wobei die Steuerungseinheit (50) einen Zielöffnungsgrad des zweiten Öffnungsgrades bestimmt durch Berechnung auf Grundlage der vorherbestimmten Temperatur und der Temperaturdifferenz.

Revendications

1. Appareil de climatisation (100) comprenant :

un circuit de fluide frigorigène (A) dans lequel un compresseur (10), un échangeur de chaleur du côté source de chaleur (12), une pluralité de dispositifs d'expansion (26), des flux du côté fluide frigorigène d'une pluralité d'échangeurs de chaleur intermédiaires (25), et une pluralité de dispositifs de commutation du flux du fluide frigorigène (28) qui exécutent une commutation des chemins de circulation, sont connectés par des canalisations de fluide frigorigène (4), à travers lesquelles circule un fluide frigorigène du côté source de chaleur ; des capteurs de pression (41) qui détectent la pression du fluide frigorigène du côté source de chaleur dans les canalisations de fluide frigorigène (4) ;
un circuit de milieu thermique (B) dans lequel des pompes (31), une pluralité d'échangeurs de chaleur du côté utilisation (35), des dispositifs de commande du flux du milieu thermique (34), et des flux du côté milieu thermique des échangeurs de chaleur intermédiaires (25), sont connectés par des canalisations de milieu thermique (5), à travers lesquelles circule un milieu thermique ; et
un contrôleur (50) qui commande le degré d'ouverture de l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin de régler le débit du milieu thermique,
où, le contrôleur (50) exécute une opération de suppression d'une variation de pression, consistant à supprimer une variation de pression du fluide frigorigène d'un côté du circuit de fluide frigorigène (A), en commandant l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin qu'il présente un premier degré d'ouverture de façon à permettre à une certaine quantité de milieu thermique de circuler à travers l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35), avant que l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35) ne commence à fonctionner ou n'exécute une commutation d'un mode de fonctionnement ; et
caractérisé en ce que le contrôleur (50),
après avoir commandé l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin qu'il présente le premier degré d'ouverture,
compare une pression prédéterminée préréglée à une différence de pression entre la pression du fluide frigorigène du côté source de chaleur avant que l'un au moins des dispositifs de commande du flux du milieu thermique (34) ne soit réglé afin qu'il présente le premier degré d'ouverture, et la pression du fluide frigorigène du côté source de chaleur après que l'un au moins des dispositifs de commande du flux du milieu thermique (34) ait été réglé afin qu'il présente le premier degré d'ouverture, et
lorsque la différence de pression est inférieure à la pression prédéterminée, le contrôleur (50) commande l'un au moins des dispositifs de commande du flux du milieu thermique (34) dont le degré d'ouverture à été commandé au premier degré d'ouverture, afin qu'il présente un second degré d'ouverture qui est supérieur au premier degré d'ouverture.

2. Appareil de climatisation (100) selon la revendication 1, où la pression prédéterminée est réglée à l'intérieur d'une plage qui peut atteindre 6 kgf/cm^2 (5,88 bars).

3. Appareil de climatisation (100) comprenant :

un circuit de fluide frigorigène (A) dans lequel un compresseur (10), un échangeur de chaleur du côté source de chaleur (12), une pluralité de dispositifs d'expansion (26), des flux du côté fluide frigorigène d'une pluralité d'échangeurs de chaleur intermédiaires (25), et une pluralité de dispositifs de commutation du flux de fluide frigorigène (28) qui exécutent une commutation des chemins de circulation, sont connectés par

des canalisations de fluide frigorigène (4), à travers lesquelles circule un fluide frigorigène du côté source de chaleur ;
un circuit de milieu thermique (B) dans lequel des pompes (31), une pluralité d'échangeurs de chaleur du côté utilisation (35), des dispositifs de commande du flux du milieu thermique (34), et des flux du côté milieu thermique des échangeurs de chaleur intermédiaires (25), sont connectés par des canalisations de milieu thermique (5), à travers lesquelles circule un milieu thermique ; et des capteurs de température (37) qui détectent la température du milieu thermique dans la canalisation de milieu thermique (5) du côté retour des échangeurs de chaleur du côté utilisation (35) ;
un contrôleur (50) qui commande le degré d'ouverture de l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin de régler le débit du milieu thermique,
où, le contrôleur (50) exécute une opération de suppression d'une variation de pression, consistant à supprimer une variation de pression du fluide frigorigène d'un côté du circuit de fluide frigorigène (A), en commandant l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin qu'il présente un premier degré d'ouverture de façon à permettre à une certaine quantité de milieu thermique de circuler à travers l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35), avant que l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35) ne commence à fonctionner ou n'exécute une commutation d'un mode de fonctionnement ; et
caractérisé en ce que le contrôleur (50),
après avoir commandé l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin qu'il présente le premier degré d'ouverture,
compare une température prédéterminée préréglée à une différence de température entre la température du milieu thermique avant que l'un au moins des dispositifs de commande du flux du milieu thermique (34) ne soit réglé afin qu'il présente le premier degré d'ouverture, et la température du milieu thermique après que l'un au moins des dispositifs de commande du flux du milieu thermique (34) ait été réglé afin qu'il présente le premier degré d'ouverture, et
lorsque la différence de température est inférieure à la température prédéterminée, commande l'un au moins des dispositifs de commande du flux du milieu thermique (34) dont le degré d'ouverture à été commandé au premier degré d'ouverture, afin qu'il présente un second degré d'ouverture qui est supérieur au premier degré d'ouverture.

4. Appareil de climatisation (100) selon la revendication 3, où la température prédéterminée est réglée à l'intérieur d'une plage qui peut atteindre 10 °C.

5. Appareil de climatisation (100) selon la revendication 1 ou 2, où, le contrôleur (50),

lorsque la différence de pression est égale ou supérieure à la pression prédéterminée ou après que l'un au moins des dispositifs de commande du flux du milieu thermique (34) ait été réglé pour présenter le second degré d'ouverture,
compare une température prédéterminée préréglée à la température du milieu thermique qui circule dans l'un au moins des échangeurs de chaleur du côté utilisation (35) auquel est connecté le dispositif de commande du flux du milieu thermique correspondant (34) dont le degré d'ouverture à été commandé afin qu'il présente le second degré d'ouverture, et
met fin à l'opération de suppression d'une variation de pression dans des cas respectifs où la température du milieu thermique est égale ou supérieure à la température prédéterminée à un moment où l'un au moins des échangeurs de chaleur du côté utilisation (35) en service de la pluralité d'échangeurs de chaleur du côté utilisation (35), exécute un fonctionnement en chauffage, et où la température du milieu thermique est égale ou inférieure à la température prédéterminée à un moment où l'un au moins des échangeurs de chaleur du côté utilisation (35) en service de la pluralité d'échangeurs de chaleur du côté utilisation (35) exécute un fonctionnement en refroidissement.

6. Appareil de climatisation (100) comprenant :

un circuit de fluide frigorigène (A) dans lequel un compresseur (10), un échangeur de chaleur du côté source de chaleur (12), une pluralité de dispositifs d'expansion (26), des flux du côté fluide frigorigène d'une pluralité d'échangeurs de chaleur intermédiaires (25), et une pluralité de dispositifs de commutation du flux de fluide frigorigène (28) qui exécutent une commutation des chemins de circulation, sont connectés par des canalisations de fluide frigorigène (4), à travers lesquelles circule un fluide frigorigène du côté source de chaleur ;
un circuit de milieu thermique (B) dans lequel des pompes (31), une pluralité d'échangeurs de chaleur du côté utilisation (35), des dispositifs de commande du flux du milieu thermique (34),

et des flux du côté milieu thermique des échangeurs de chaleur intermédiaires (25), sont connectés par des canalisations de milieu thermique (5), à travers lesquelles circule un milieu thermique ; et des capteurs de température (37) qui détectent la température du milieu thermique dans la canalisation de milieu thermique (5) du côté retour des échangeurs de chaleur du côté utilisation (35) ;
un contrôleur (50) qui commande le degré d'ouverture de l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin de régler le débit du milieu thermique,
où, le contrôleur (50) exécute une opération de suppression d'une variation de pression, consistant à supprimer une variation de pression du fluide frigorigène d'un côté du circuit de fluide frigorigène (A), en commandant l'un au moins des dispositifs de commande du flux du milieu thermique (34) afin qu'il présente un premier degré d'ouverture de façon à permettre à une certaine quantité de milieu thermique de circuler à travers l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35), avant que l'un au moins des échangeurs de chaleur du côté utilisation (35) de la pluralité d'échangeurs de chaleur du côté utilisation (35) ne commence à fonctionner ou n'exécute une commutation d'un mode de fonctionnement ; et
caractérisé en ce que le contrôleur (50),
lorsque la température du milieu thermique qui circule dans l'un au moins des échangeurs de chaleur du côté utilisation (35) auquel est connecté le dispositif de commande du flux du milieu thermique correspondant (34) dont le degré d'ouverture à été commandé afin qu'il présente le premier degré d'ouverture, est inférieure à une température prédéterminée préréglée,
commande l'un au moins des dispositifs de commande du flux du milieu thermique (34) dont le degré d'ouverture à été commandé au premier degré d'ouverture, afin qu'il présente un second degré d'ouverture qui est supérieur au premier degré d'ouverture, proportionnellement à la capacité d'une unité intérieure (3) comprenant l'un au moins des échangeurs de chaleur du côté utilisation (35) auquel est connecté le dispositif de commande du flux du milieu thermique correspondant (34) dont le degré d'ouverture à été commandé au premier degré d'ouverture.

7. Appareil de climatisation (100) selon la revendication 6, où,

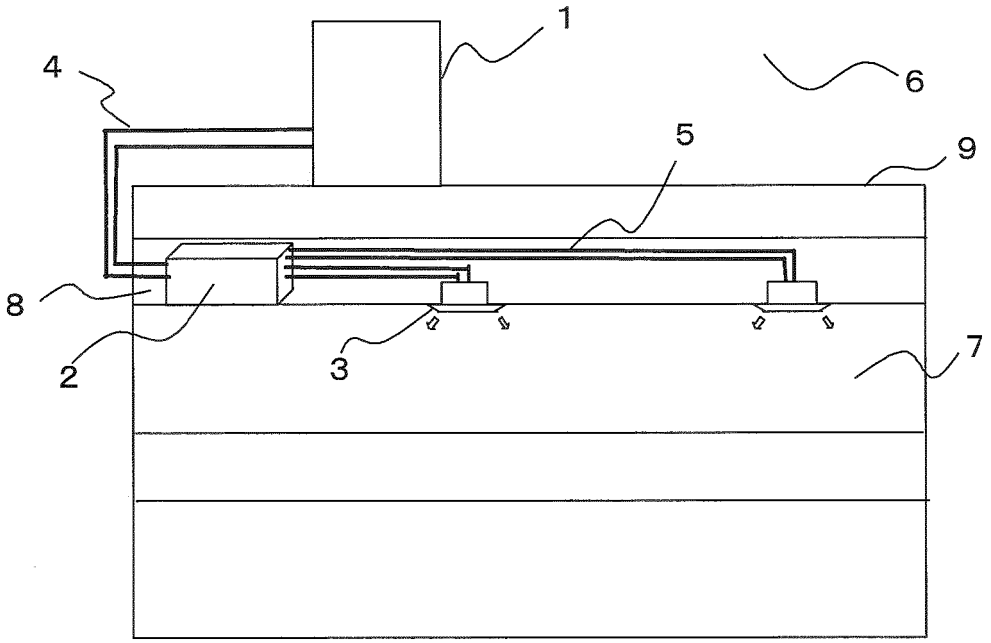
le contrôleur (50),
compare la température prédéterminée préréglée à la température du milieu thermique qui circule dans l'un au moins des échangeurs de chaleur du côté utilisation (35) auquel est connecté le dispositif de commande du flux du milieu thermique correspondant (34) dont le degré d'ouverture à été commandé afin qu'il présente le premier degré d'ouverture, et
met fin à l'opération de suppression d'une variation de pression dans des cas respectifs où la température du milieu thermique est égale ou supérieure à la température prédéterminée à un moment où l'un au moins des échangeurs de chaleur du côté utilisation (35) en service de la pluralité d'échangeurs de chaleur du côté utilisation (35), exécute un fonctionnement en chauffage, et où la température du milieu thermique est égale ou inférieure à la température prédéterminée à un moment où l'un au moins des échangeurs de chaleur du côté utilisation (35) en service de la pluralité d'échangeurs de chaleur du côté utilisation (35) exécute un fonctionnement en refroidissement.

8. Appareil de climatisation (100) selon la revendication 1, 3, ou 6, où le contrôleur (50) fixe le degré d'ouverture de l'un au moins des dispositifs de commande du flux du milieu thermique (34) au second degré d'ouverture.

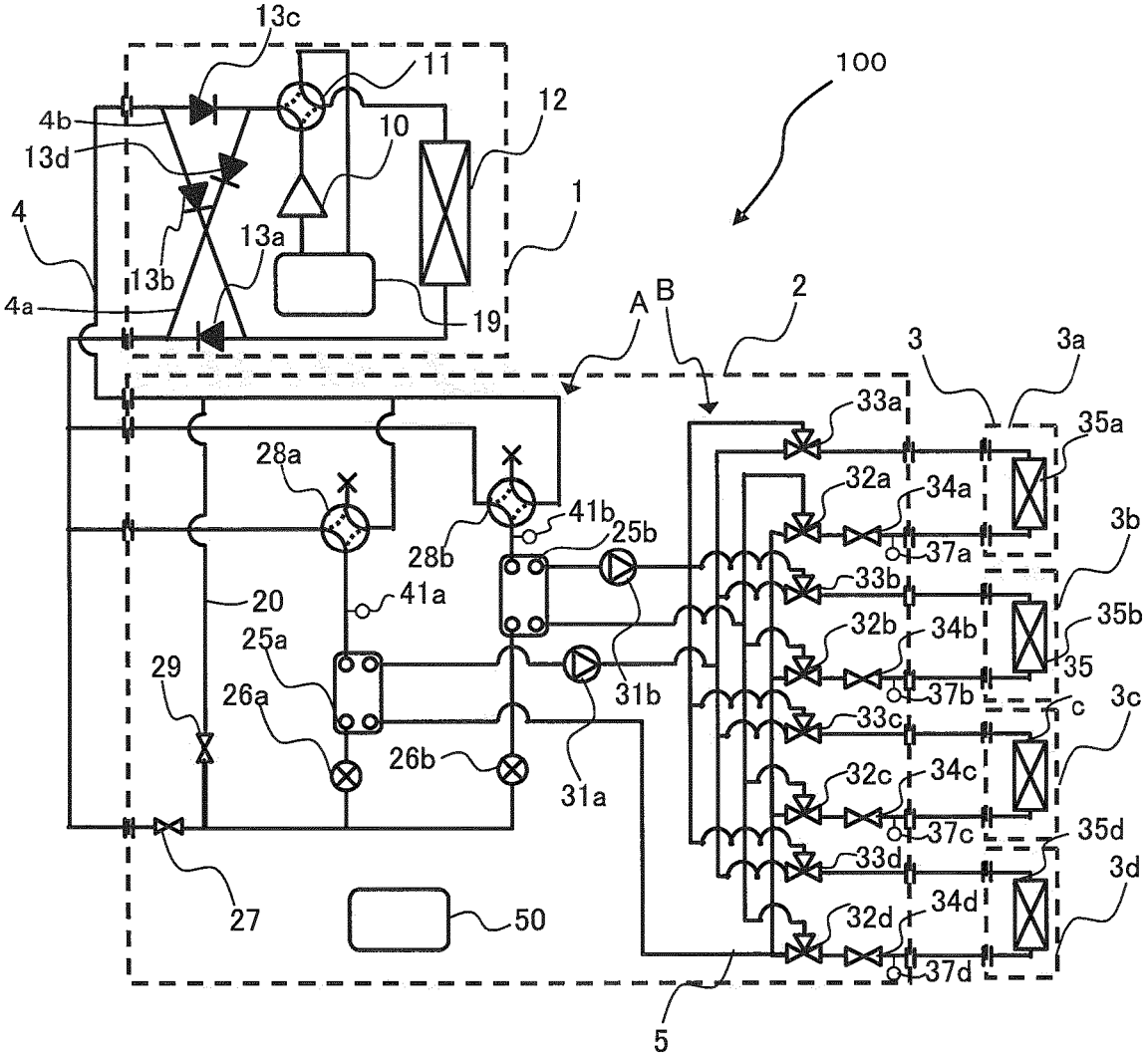
9. Appareil de climatisation (100) selon la revendication 1, 3, ou 6, où le contrôleur (50) augmente d'un certain degré d'ouverture le degré d'ouverture de l'un au moins des dispositifs de commande du flux du milieu thermique (34), jusqu'au second degré d'ouverture.

10. Appareil de climatisation (100) selon la revendication 3 ou 6, où le contrôleur (50) détermine un degré d'ouverture cible du second degré d'ouverture grâce à un calcul basé sur la température prédéterminée et sur la différence de température.

F I G. 1



F I G. 2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4b
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13d
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13b
4a
19
A
B
2
3
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35a
28a
32a
34a
41b
25b
3b
28b
37a
33b
20
41a
35b
32b
34b
25a
35
29
31b
37b
c
3c
26a
33c
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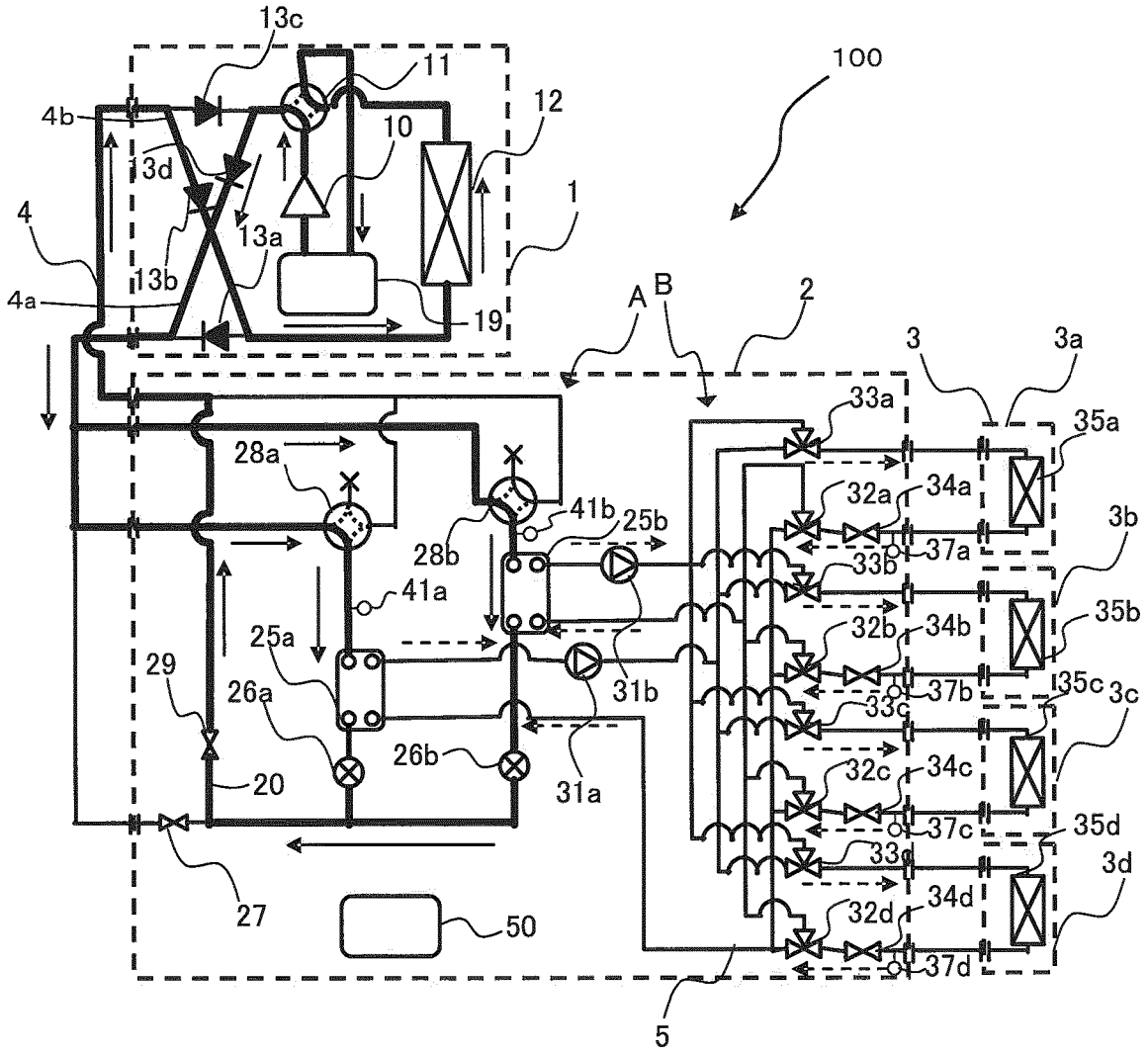
3d
27
50
32d
34d
37d
5

F I G. 3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4b
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13a
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19
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B
2
3
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35a
28a
32a
34a
41b
25b
3b
28b
37a
33b
41a
35b
25a
32b
34b
29
31b
37b
35c
3c
26a
33c
26b
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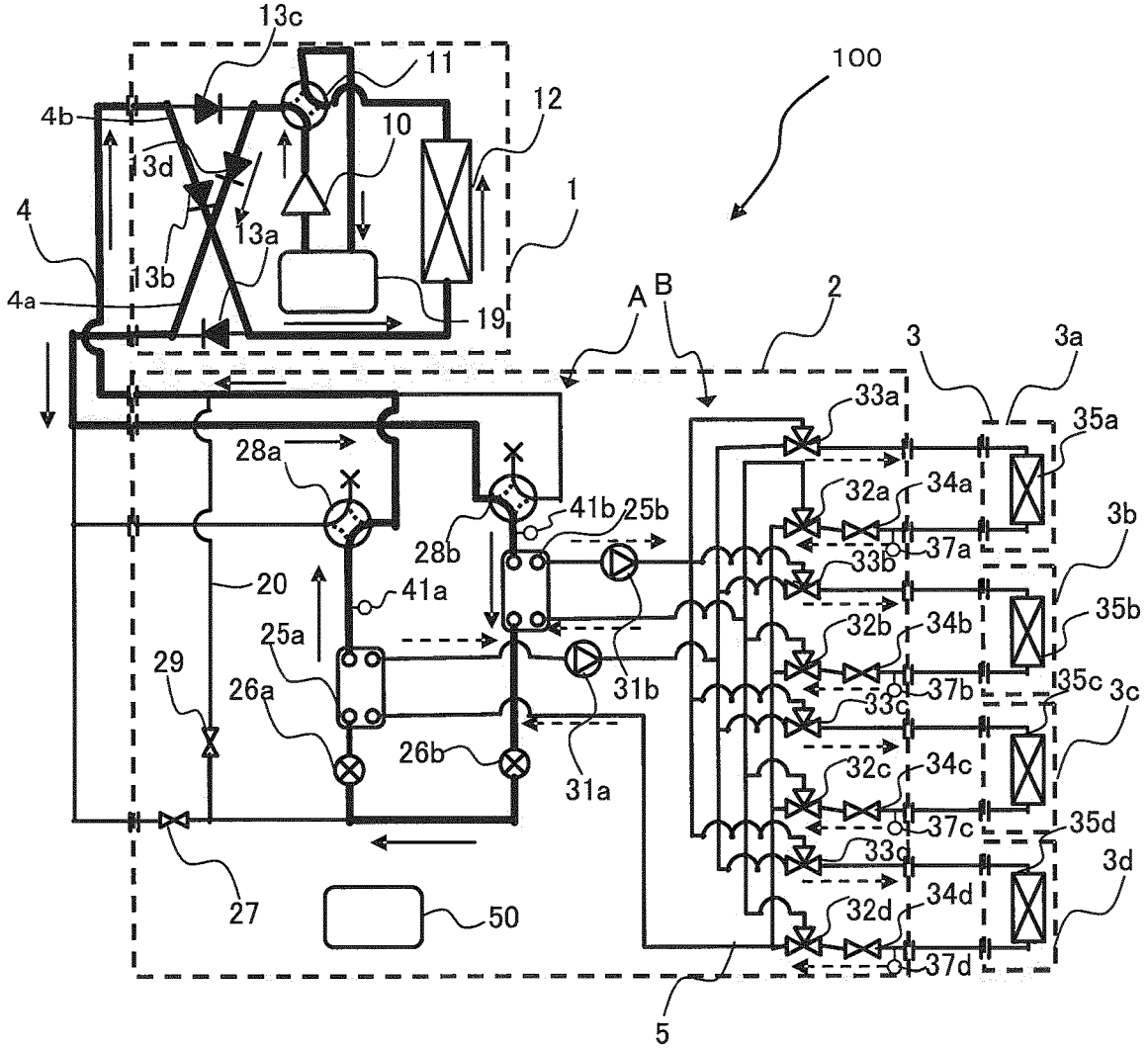
31a
37c
35d
33d
3d
34d
27
32d
50
37d
5

F I G. 4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32a
34a
41b
25b
28b
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41a
35b
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34b
29
26a
31b
37b
35c
33c
3c
26b
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31a
37c
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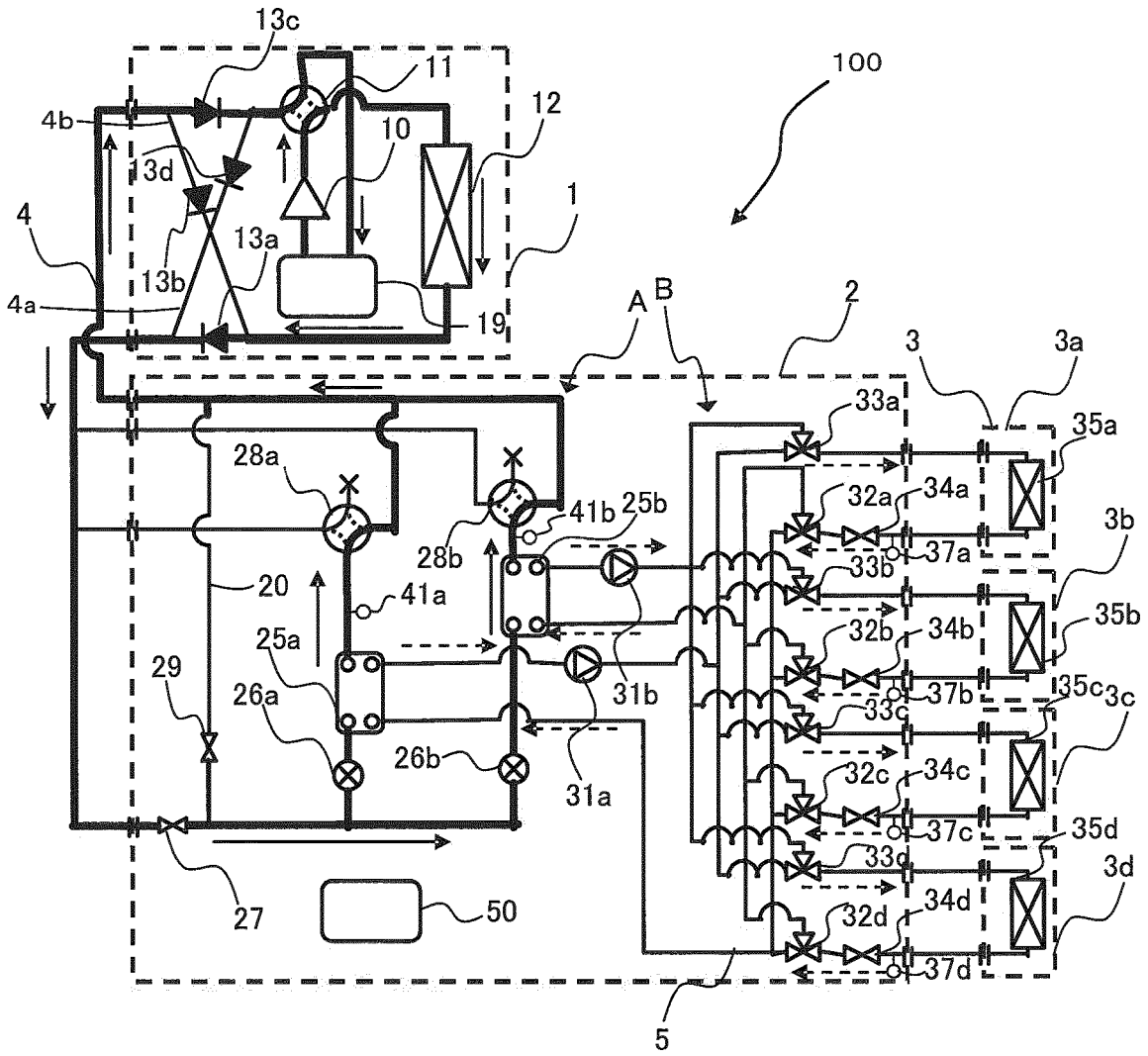
33d
3d
27
50
32d
34d
37d
5

F I G. 5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26a
31b
37b
35c
3c
33c
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37c
35d
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3d
27
50
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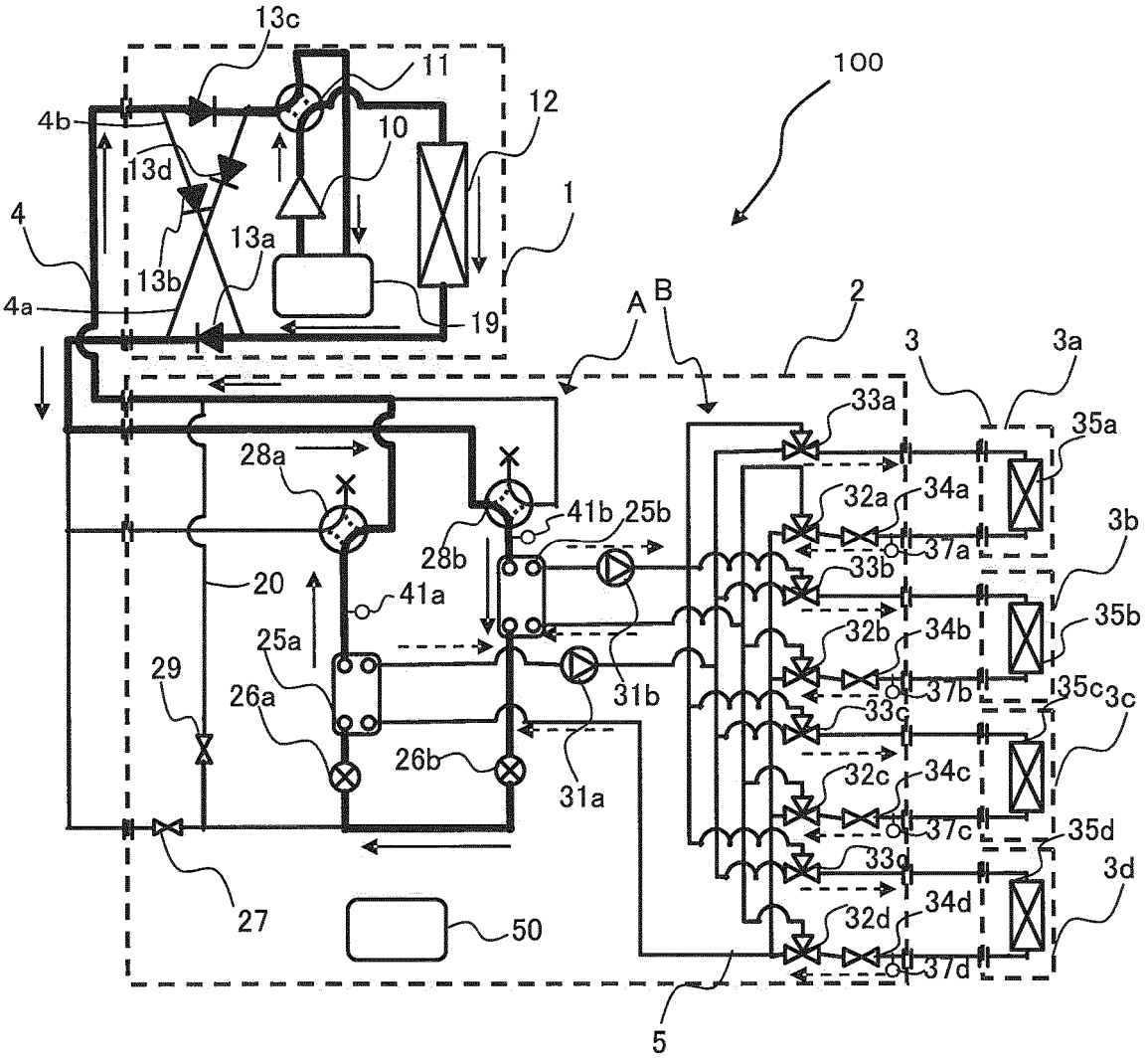
32d
37d
5

F I G. 6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3c
26a
31b
33c
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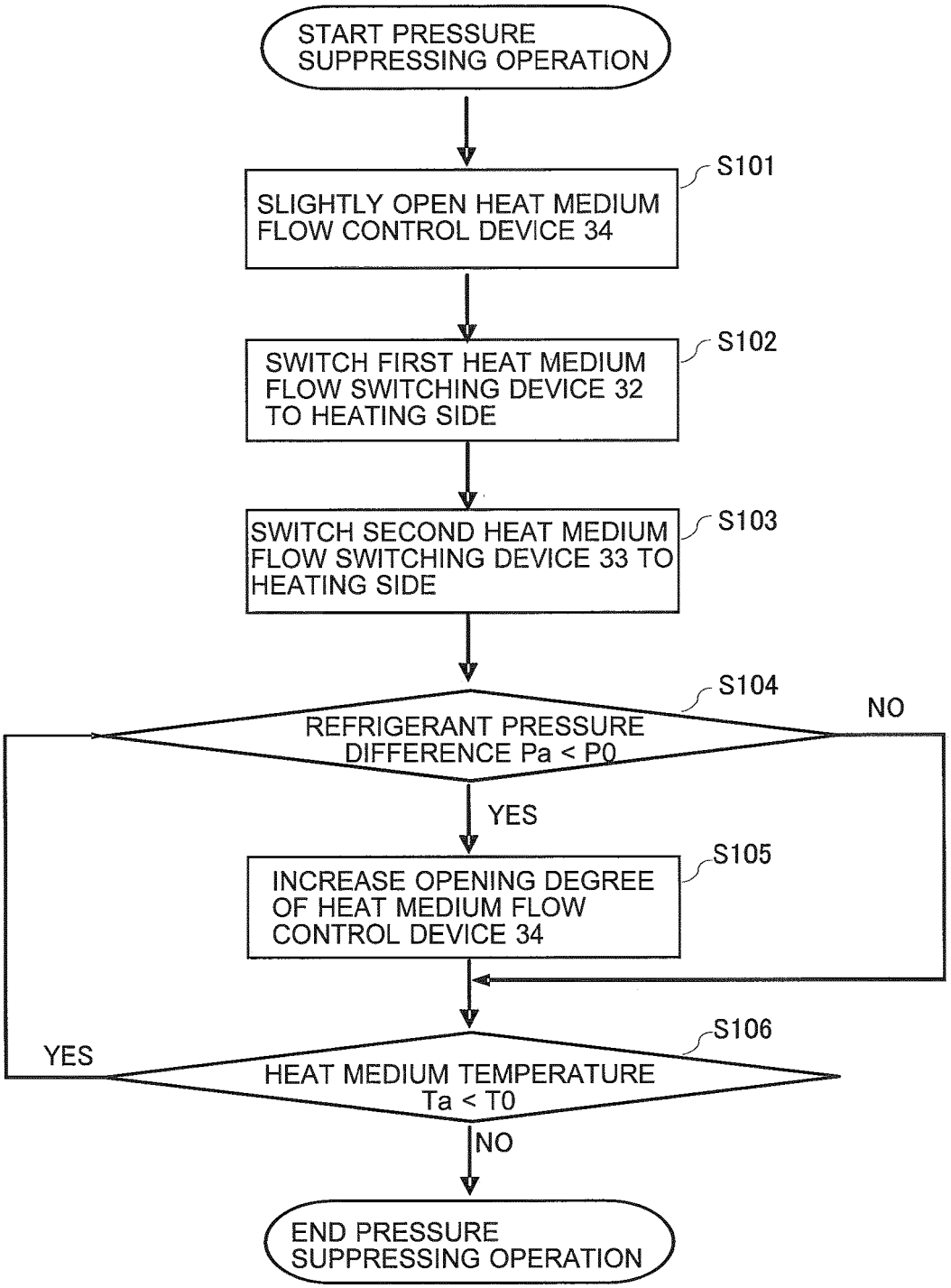
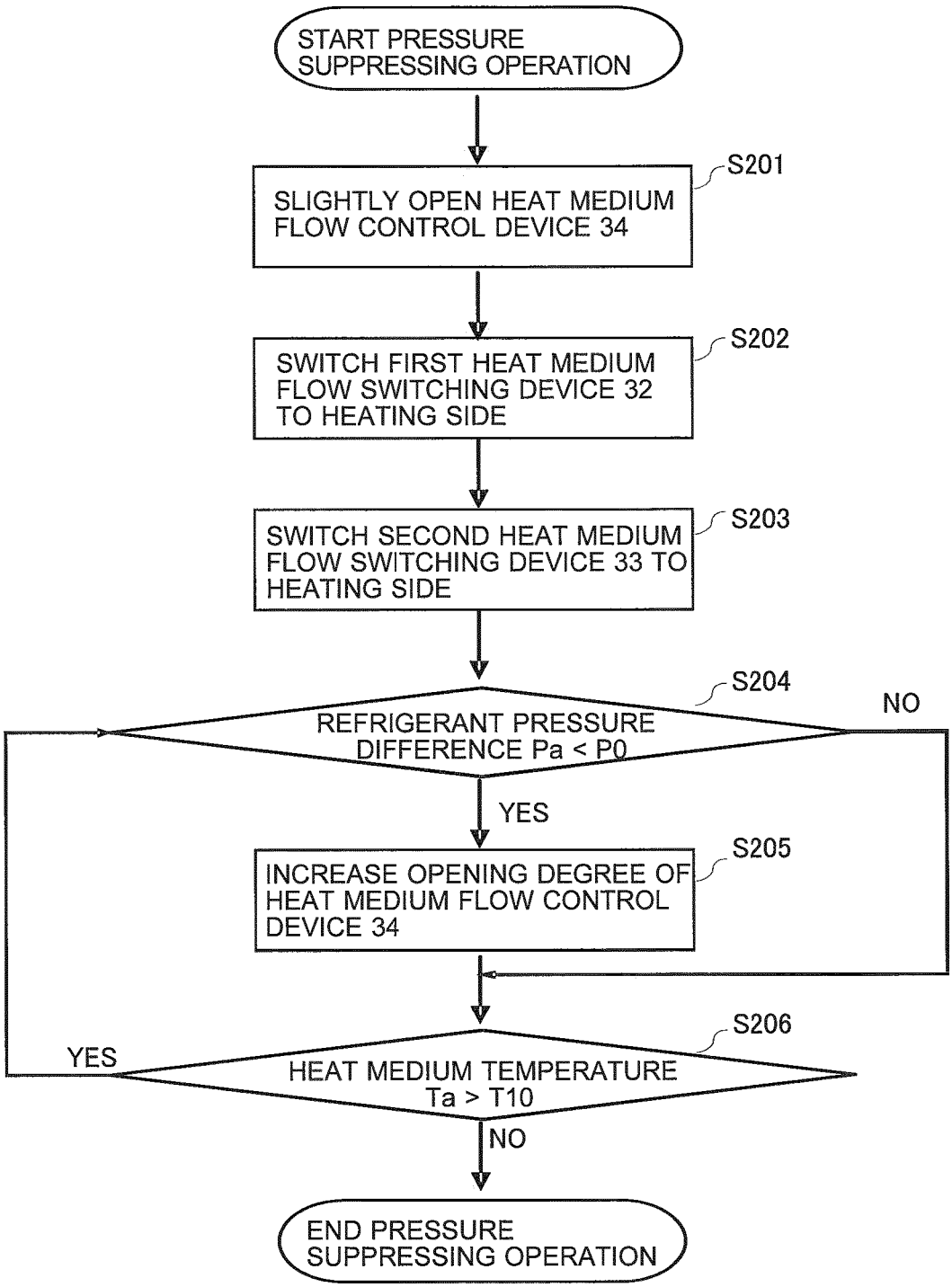
34d
27
50
32d
37d
5

F I G. 7


START PRESSURE SUPPRESSING OPERATION
S101
SLIGHTLY OPEN HEAT MEDIUM FLOW CONTROL DEVICE 34
S102
SWITCH FIRST HEAT MEDIUM FLOW SWITCHING DEVICE 32 TO HEATING SIDE
S103
SWITCH SECOND HEAT MEDIUM FLOW SWITCHING DEVICE 33 TO HEATING SIDE
S104
REFRIGERANT PRESSURE DIFFERENCE Pa < P0
NO
YES
S105
INCREASE OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE 34
S106
YES
HEAT MEDIUM TEMPERATURE Ta < T0
NO
END PRESSURE SUPPRESSING OPERATION

F I G. 8

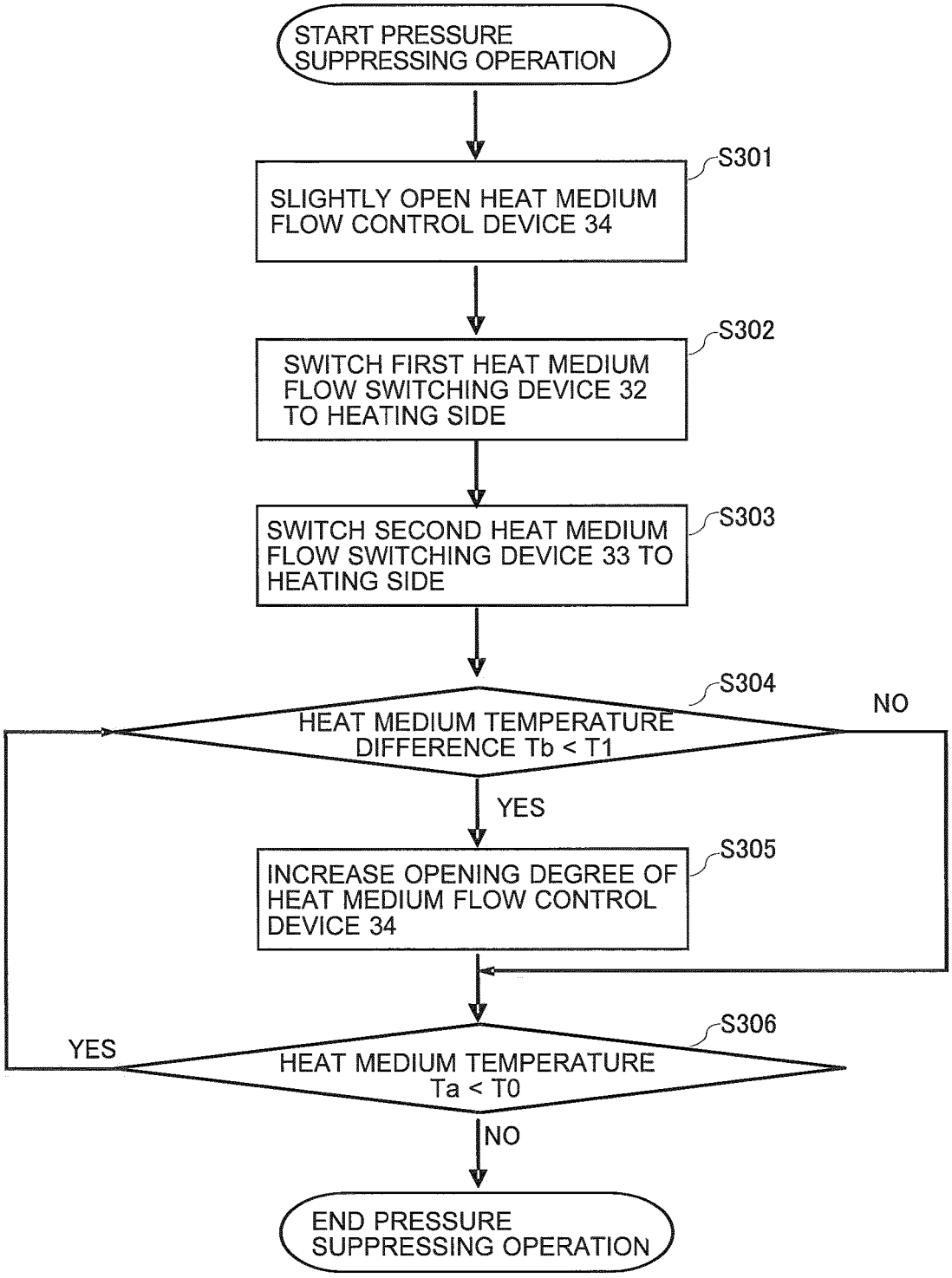

START PRESSURE SUPPRESSING OPERATION
S201
SLIGHTLY OPEN HEAT MEDIUM FLOW CONTROL DEVICE 34
S202
SWITCH FIRST HEAT MEDIUM FLOW SWITCHING DEVICE 32 TO HEATING SIDE
S203
SWITCH SECOND HEAT MEDIUM FLOW SWITCHING DEVICE 33 TO HEATING SIDE
S204
REFRIGERANT PRESSURE DIFFERENCE Pa < P0
NO
YES
S205
INCREASE OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE 34
S206
YES
HEAT MEDIUM TEMPERATURE Ta > T10
NO
END PRESSURE SUPPRESSING OPERATION

F I G. 9

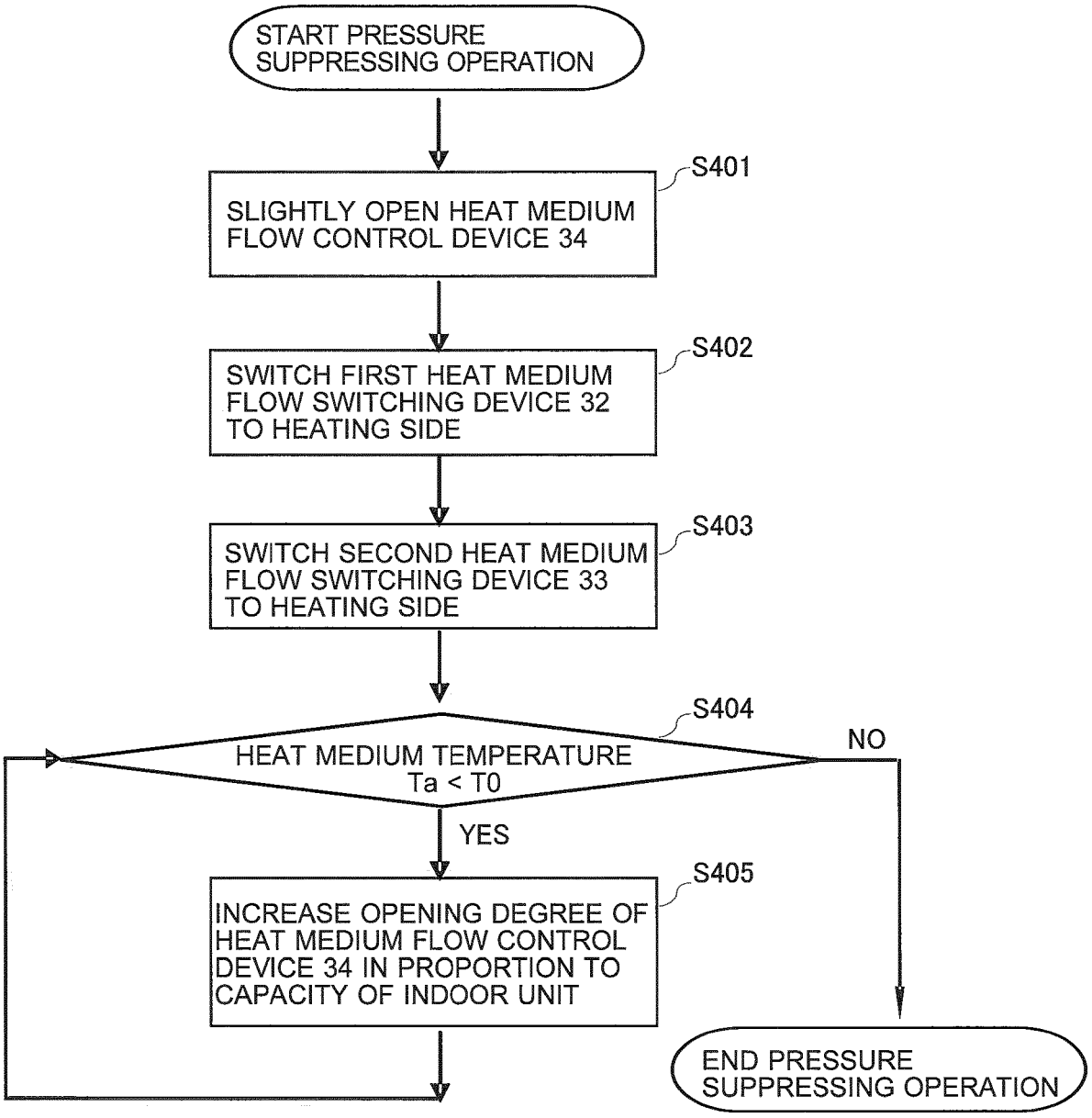
METHOD FOR INCREASING OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE

No.	MEANS	OPERATION		EFFECTS			
		SUMMARY	DETAILS	CONTROL STRUCTURE	INFLUENCE ON SYSTEM	TIME TO TERMINATION OF PRESSURE VARIATION SUPPRESSING OPERATION	POSSIBILITY OF OCCURRENCE OF LARGE PRESSURE FLUCTUATION
1	FIXED OPENING DEGREE CONTROL 1 (FOCUSED ON SPEED)	FIX OPENING DEGREE CONSTANT AT TIMING WHEN OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE IS INCREASED	LARGE FIXED OPENING DEGREE	O(SIMPLE)	× (LARGE)	O(SHORT)	× (LARGE)
2	FIXED OPENING DEGREE CONTROL 2 (FOCUSED ON INFLUENCE ON SYSTEM)	KEEP SAME OPENING DEGREE UNTIL TERMINATION PRESSURE VARIATION SUPPRESSING OPERATION	SMALL FIXED OPENING DEGREE	O(SIMPLE)	O(SMALL)	× (LONG)	O(SMALL)
3	INCHING OPENING DEGREE CONTROL 1 (FOCUSED ON SPEED)	INCREASE OPENING DEGREE BY A CERTAIN OPENING DEGREE AT TIMING WHEN OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE IS INCREASED	LARGE INCHING WIDTH	△(MEDIUM)	× (LARGE)	O(SHORT)	× (LARGE)
4	INCHING OPENING DEGREE CONTROL 2 (FOCUSED ON INFLUENCE ON SYSTEM)		SMALL INCHING WIDTH	△(MEDIUM)	O(SMALL)	× (LONG)	O(SMALL)
5	TARGET OPENING DEGREE CONTROL 1 (FOCUSED ON SPEED)	DETERMINE OPENING DEGREE OF HEAT MEDIUM FLOW DEVICE ON THE BASIS OF DIFFERENCE BETWEEN REFERENCE TEMPE-RATURE AND DETECTED TEMPERATURE DETERMINE TARGET OPENING DEGREE AT TIMING WHEN OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE IS INCREASED	Δpulse=f(Am- A1) DETERMINE AMOUNT OF INCREASE OF OPENING DEGREE BY USING CONVERSION FORMULA (f(x) FOR CONVERTING OPENING AREA OF FLOW CONTROL DEVICE INTO PULSE NUMBER. RELATIONSHIP OF "Am - A1" IS AS FOLLOWS. Am: TARGET OPENING AREA. A1: CURRENT OPENING AREA ΔTm = TARGET TEMPERATURE DIFFERENCE (> 0 DEGREES C) FROM REFERENCE TEMPERATURE T0 ΔT = REFERENCE TEMPERATURE T0 - DETECTED TEMPERATURE Ta BASED ON RELATIONSHIP OF Am =A1 × ΔT1/ΔTm, Am - A1 = (ΔT1/ΔTm-1) × A1 CAN BE REPRESENTED.	× (COMPLI-CATED)	△(MEDIUM)	O(SHORT)	× (LARGE)
6	TARGET OPENING DEGREE CONTROL 2 (FOCUSED ON INFLUENCE ON SYSTEM)		Δpulse=f(Am- A1)/ (ΔT1/ΔTm) DETERMINE AMOUNT OF INCREASE OF OPENING DEGREE IN INVERSE PROPORTION TO DIFFERENCE BETWEEN TARGET TEMPERATURE DIFFERENCE AND CURRENT TEMPERATURE DIFFERENCE FROM REFERENCE TEMPERATURE	× (COMPLI-CATED)	O(SMALL)	△(MEDIUM)	O(SMALL)

F I G. 1 0


START PRESSURE SUPPRESSING OPERATION
S301
SLIGHTLY OPEN HEAT MEDIUM FLOW CONTROL DEVICE 34
S302
SWITCH FIRST HEAT MEDIUM FLOW SWITCHING DEVICE 32 TO HEATING SIDE
S303
SWITCH SECOND HEAT MEDIUM FLOW SWITCHING DEVICE 33 TO HEATING SIDE
S304
HEAT MEDIUM TEMPERATURE DIFFERENCE Tb < T1
NO
YES
S305
INCREASE OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE 34
S306
YES
HEAT MEDIUM TEMPERATURE Ta < T0
NO
END PRESSURE SUPPRESSING OPERATION

F I G. 1 1


START PRESSURE SUPPRESSING OPERATION
S401
SLIGHTLY OPEN HEAT MEDIUM FLOW CONTROL DEVICE 34
S402
SWITCH FIRST HEAT MEDIUM FLOW SWITCHING DEVICE 32 TO HEATING SIDE
S403
SWITCH SECOND HEAT MEDIUM FLOW SWITCHING DEVICE 33 TO HEATING SIDE
S404
HEAT MEDIUM TEMPERATURE Ta < T0
NO
YES
S405
INCREASE OPENING DEGREE OF HEAT MEDIUM FLOW CONTROL DEVICE 34 IN PROPORTION TO CAPACITY OF INDOOR UNIT
END PRESSURE SUPPRESSING OPERATION

REFERENCES CITED IN THE DESCRIPTION

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