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Remarks:
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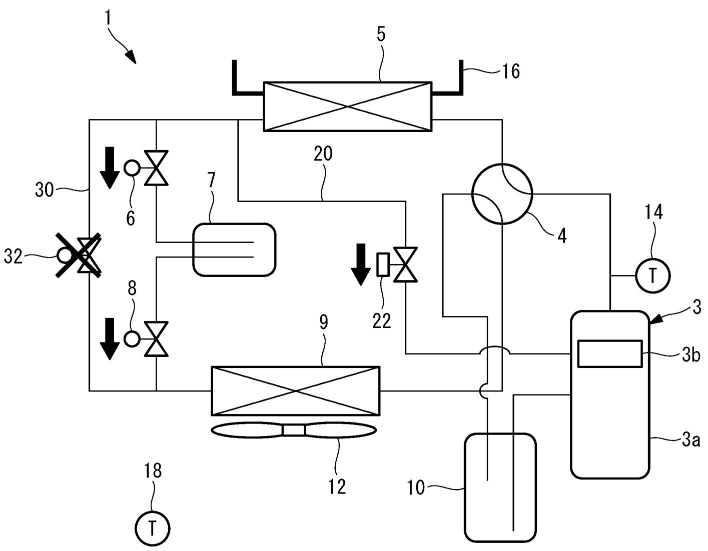
(54) HEAT SOURCE UNIT AND CONTROL METHOD THEREFOR

(57) A heat source device includes: a compressor (3) that compresses a refrigerant; a heat exchanger (5) configured to perform heat exchange between a refrigerant and a heat medium; an air heat exchanger (9) that performs heat exchange between a refrigerant and air; a liquid bypass pipe (20) to guide a liquid refrigerant to an intake side of the compressor; a first and a second expansion valves (6,8); and a receiver (7) to store a refrigerant between the first and the second expansion valves. The device further comprises a selector valve (4) to selectively guide the refrigerant during heating or cooling; a parallel refrigerant pipe (30) provided with a third expansion valve (32); and a control unit controlling the expansion valves..

FIG. 3



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Description

[Technical Field]

[0001] The present disclosure relates to a heat source device and a control method thereof suitable for use in a heat pump chiller or the like, for example.

[Background Art]

[0002] Heat pump chillers are used as one of heat source devices for industrial use or the like. When a heat pump chiller is used in a heating operation to supply hot water, a lower ambient temperature particularly tends to cause a high pressure ratio and a higher temperature of a refrigerant discharged from a compressor. When a low-boiling refrigerant such as R32 is used as a low global warming potential (GWP) refrigerant, the refrigerant discharge temperature will be much higher. Since a higher refrigerant discharge temperature makes it difficult to use conventional components that have been used for refrigerants which are not a low-boiling refrigerant, it is required to reduce the refrigerant discharge temperature.

[0003] Patent Literature 1 discloses that a part of a refrigerant guided from an indoor unit is expanded by a throttle device to a gas-liquid two-phase, this two-phase refrigerant is supplied to the refrigerant intake side of a compressor, and thereby the refrigerant discharge temperature is reduced.

[Citation List]

[Patent Literature]

[0004] [PTL 1]
Japanese Patent No. 6005255.

[Summary of Invention]

[Technical Problem]

[0005] In Patent Literature 1, however, since a refrigerant in a gas-liquid two-phase is used as a cooling refrigerant, the specific volume of the refrigerant becomes larger than that of a liquid refrigerant, and this results in a larger diameter of a pipe. This is an obstacle not only to improvement of piping arrangement but also to a cost reduction.

[0006] When a cooling operation in addition to a heating operation is performed by a heat pump, since a required amount of a refrigerant differs for each operation, there is a problem of an excessive refrigerant in use.

[0007] In Patent Literature 1, a throttle device is provided in a pipe that guides a gas-liquid two-phase refrigerant used for cooling, and the opening of the throttle device is controlled. However, it is complicated to perform opening control of the throttle device in addition to expansion valve control of the main refrigerant circuit.

[0008] The present disclosure has been made in view of such circumstances and intends to provide a heat source device and a control method thereof that can reduce the diameter of a pipe used for supplying a cooling refrigerant to be guided to the intake side of a compressor.

[0009] Further, the present disclosure intends to provide a heat source device and a control method thereof that can reduce the amount of a used refrigerant even with a heat source device that performs a heating operation and a cooling operation.

[0010] Further, the present disclosure intends to provide a heat source device and a control method thereof that can supply a cooling refrigerant to the intake side of a compressor by using simple control.

[Solution to Problem]

[0011] A heat source device according to one aspect of the present disclosure includes: a compressor configured to compress a refrigerant; a heat medium heat exchanger configured to perform heat exchange between a refrigerant and a heat medium; an expansion valve configured to expand a refrigerant; an air heat exchanger configured to perform heat exchange between a refrigerant and air; and a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the expansion valve.

[0012] A control method of a heat source device according to one aspect of the present disclosure is a control method of a heat source device including a compressor configured to compress a refrigerant, a heat medium heat exchanger configured to perform heat exchange between a refrigerant and a heat medium, an expansion valve configured to expand a refrigerant, an air heat exchanger configured to perform heat exchange between a refrigerant and air, a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the expansion valve, a liquid bypass valve provided in the liquid bypass pipe, and a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium, and the control method includes: controlling the liquid bypass valve from a closed position to an open position when the heating operation is performed and when an air temperature around the air heat exchanger becomes a predetermined value or lower.

[Advantageous Effects of Invention]

[0013] It is possible to reduce the diameter of a pipe used for supplying a cooling refrigerant to be guided to the intake side of a compressor.

[0014] The amount of a used refrigerant can be reduced even with a heat source device that performs a heating operation and a cooling operation.

[0015] A cooling refrigerant can be supplied to the intake side of a compressor by using simple control.

[Brief Description of Drawings]

[0016]

[Fig. 1]
Fig. 1 is a schematic configuration diagram illustrating a refrigerant circuit during a heating operation according to a first embodiment of the present disclosure.
[Fig. 2]
Fig. 2 is a schematic configuration diagram illustrating the refrigerant circuit during a cooling operation according to the first embodiment of the present disclosure.
[Fig. 3]
Fig. 3 is a schematic configuration diagram illustrating a refrigerant circuit during a heating operation according to a second embodiment of the present disclosure.
[Fig. 4]
Fig. 4 is a schematic configuration diagram illustrating the refrigerant circuit during a cooling operation according to the second embodiment of the present disclosure.
[Fig. 5]
Fig. 5 is a graph illustrating a p-h diagram of a refrigerant circuit according to a third embodiment of the present disclosure.
[Fig. 6]
Fig. 6 is a schematic configuration diagram illustrating a refrigerant circuit illustrating a modified example of the third embodiment of the present disclosure.

[Description of Embodiments]

[0017] Each embodiment according to the present disclosure will be described below with reference to the drawings.

[First Embodiment]

[0018] A first embodiment of the present disclosure will be described below with reference to Fig. 1 and Fig. 2.

[0019] Fig. 1 and Fig. 2 illustrate a refrigerant circuit configuration of a chiller (heat source device) 1 of the present embodiment. The chiller 1 can perform a heating operation and a cooling operation by switching a four-way valve (selector valve) 4 provided on the discharge side of the compressor 3. The heating operation is an operation to heat water (heat medium) in a water heat exchanger (heat medium heat exchanger) 5, and the cooling operation is an operation to cool water in the water heat exchanger 5. Fig. 1 illustrates a refrigerant circuit when the heating operation is performed, and Fig. 2 illustrates the refrigerant circuit when the cooling operation is performed.

[0020] In the chiller 1, for example, R32 is used as a refrigerant. The R32 is a low-boiling refrigerant, which is a low global warming potential (GWP) refrigerant. Other refrigerants may be used instead of the R32.

[0021] The chiller 1 has the compressor 3 that compresses a refrigerant, the four-way valve 4, the water heat exchanger 5, a first expansion valve 6, a receiver 7, a second expansion valve 8, an air heat exchanger 9, and an accumulator 10. The compressor 3, the four-way valve 4, the water heat exchanger 5, the first expansion valve 6, the receiver 7, the second expansion valve 8, the air heat exchanger 9, and the accumulator 10 are connected to each other via refrigerant pipes, and thereby a refrigerant circuit that performs a refrigeration cycle is formed.

[0022] The compressor 3 is a scroll compressor or a rotary compressor, for example, and a compression mechanism 3b such as a scroll compression mechanism or a rotary compression mechanism is provided inside a housing 3a of the compressor 3. A compression mechanism 3b is driven by an electric motor (not illustrated). The electric motor has an invertor device, and the rotational rate thereof may be changed to any value in accordance with an instruction from a control unit (not illustrated).

[0023] A discharge temperature sensor 14 that measures the discharge temperature of a refrigerant is provided on the discharge side of the compressor 3. The output of the discharge temperature sensor 14 is transmitted to the control unit.

[0024] The four-way valve 4 is switched so that a refrigerant discharged from the compressor 3 is guided to the water heat exchanger 5 during a heating operation (Fig. 1) and is switched so that a refrigerant discharged from the compressor 3 is guided to the air heat exchanger 9 during a cooling operation (Fig. 2). The control of the four-way valve 4 is performed by a control unit (not illustrated).

[0025] The water heat exchanger 5 operates as a condenser during a heating operation (Fig. 1) and operates as an evaporator during a cooling operation (Fig. 2). A water pipe 16 that circulates water to and from an external load is connected to the water heat exchanger 5. In the water heat exchanger 5, heat exchange is performed between water guided from the water pipe 16 and a refrigerant.

[0026] The first expansion valve 6 expands a refrigerant condensed and liquified by the water heat exchanger 5 when operating as a condenser as with Fig. 1. The opening of the first expansion valve 6 is controlled by the control unit.

[0027] The second expansion valve 8 expands a refrigerant condensed and liquified by the air heat exchanger 9 when operating as a condenser as with Fig. 2. The opening of the second expansion valve 8 is controlled by the control unit.

[0028] The receiver 7 is a container provided between the first expansion valve 6 and the second expansion valve 8 and configured to temporarily store a part of a refrigerant expanded by the first expansion valve 6 or the second expansion valve 8. The capacity (size) of the receiver 7 is determined in accordance with an amount of a refrigerant circulating in the refrigerant circuit.

[0029] The air heat exchanger 9 operates as an evaporator during a heating operation (Fig. 1) and operates as a condenser during a cooling operation (Fig. 2). In the air heat exchanger 9, heat exchange is performed between a refrigerant and air. Air is delivered from a fan 12 to the air heat exchanger 9.

[0030] The accumulator 10 is a container provided in upstream of the compressor 3, that is, on the refrigerant intake side and configured to temporarily store a refrigerant evaporated by the air heat exchanger 9 or the water heat exchanger 5.

[0031] The upstream end of a liquid bypass pipe 20 is connected between the water heat exchanger 5 and the first expansion valve 6. The downstream end of the liquid bypass pipe 20 is connected to the intake side of the compression mechanism 3b of the compressor 3. A part of a liquid refrigerant guided from the water heat exchanger 5 operating as a condenser during a heating operation is guided to the compression mechanism 3b via a liquid bypass valve 22. That is, the liquid bypass valve 22 bypasses the first expansion valve 6, the receiver 7, the second expansion valve 8, the air heat exchanger 9, and the accumulator 10.

[0032] The liquid bypass valve 22 is provided in an intermediate position of the liquid bypass pipe 20. The liquid bypass valve 22 is an on-off valve such as an electromagnetic valve, and the on-off operation thereof is performed by the control unit.

[0033] An ambient temperature sensor 18 is provided inside the casing of the chiller 1 or near the chiller 1. The ambient temperature is measured by the ambient temperature sensor. The ambient temperature measured by the ambient temperature sensor 18 represents a temperature of air guided to the air heat exchanger 9 by the fan 12. The output of the ambient temperature sensor 18 is transmitted to the control unit.

[0034] The control unit is formed of a central processing unit (CPU), a random access memory (RAM), a read only memory (ROM), a computer readable storage medium, and the like, for example. Further, a series of processes for implementing various functions are stored in a storage medium or the like in a form of a program as an example, and various functions are implemented when the CPU loads the program into the RAM or the like and performs information processing and computation. For a program, a form of being installed in advance in the ROM or other storage media, a form of being provided in a state of being stored in a computer readable storage medium, a form of being delivered via a wired or wireless communication connection, or the like may be applied to the program. The computer readable storage medium may be a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like.

[0035] Next, the operation of the chiller 1 configured as above will be described.

<Heating operation: Fig. 1>

[0036] When water is heated by the water heat exchanger 5, the four-way valve 4 is switched as illustrated in Fig. 1, and thereby a high-pressure gas refrigerant discharged from the compressor 3 is guided to the water heat exchanger 5. In the water heat exchanger 5, heat exchange with water guided from the water pipe 16 causes the refrigerant to condense. Water is heated by latent heat occurring when the refrigerant condenses. The heated water is guided to the external load via the water pipe 16.

[0037] The liquid refrigerant condensed by the water heat exchanger 5 is guided to the first expansion valve 6 and expanded. The expanded refrigerant is guided to the receiver 7, and a part of the refrigerant is stored in the receiver 7 as an excessive refrigerant. The refrigerant taken out of the receiver 7 is guided to the air heat exchanger 9 via the second expansion valve 8.

[0038] In the air heat exchanger 9, heat exchange with air guided by the fan 12 causes the refrigerant to evaporate. The refrigerant evaporating from the air heat exchanger 9 is guided to the accumulator 10 through the four-way valve 4. The gas refrigerant guided from the accumulator 10 is guided to the intake side of the compressor 3 and is again compressed by the compression mechanism 3b.

[0039] The control unit controls the liquid bypass valve 22, which is provided in the liquid bypass pipe 20, from a closed position to an open position when the ambient temperature measured by the ambient temperature sensor 18 falls to a low ambient temperature that is a predetermined value or lower (for example, 0 □ or lower or -5 □ or lower). Accordingly, a part of a liquid refrigerant guided from the water heat exchanger 5 is guided to the intake side of the compression mechanism 3b of the compressor 3 via the liquid bypass pipe 20. The liquid refrigerant is supplied to the intake side of the compression mechanism 3b in such a way, and thereby the discharge temperature of the refrigerant discharged from the compressor 3 is reduced.

[0040] Closing and opening of the liquid bypass valve 22 may be controlled by using a temperature measured by the discharge temperature sensor 14 or a pressure ratio of the compressor 3 in addition to a temperature measured by the ambient temperature sensor 18 or instead of a temperature measured by the ambient temperature sensor 18. For example, when the measurement value of the discharge temperature sensor 14 reaches a temperature corresponding to a case where the temperature of water heated by the water heat exchanger 5 is 50 □ and/or when the pressure ratio of the compressor 3 rises to 4.5 or higher, the liquid bypass valve 22 is controlled from a closed position to an open position.

<Cooling operation: Fig. 2>

[0041] When water is cooled by the water heat exchanger 5, the four-way valve 4 is switched as illustrated in Fig. 2, and thereby a high-pressure gas refrigerant discharged from the compressor 3 is guided to the air heat exchanger 9. In the air heat exchanger 9, heat exchange with air guided by the fan 12 causes the refrigerant to condense.

[0042] The liquid refrigerant condensed by the air heat exchanger 9 is guided to the second expansion valve 8 and expanded. The expanded refrigerant is guided to the receiver 7, and a part of the refrigerant is stored in the receiver 7. The refrigerant taken out of the receiver 7 is guided to the water heat exchanger 5 via the first expansion valve 6.

[0043] In the water heat exchanger 5, heat exchange with water guided from the water pipe 16 causes the refrigerant to evaporate. The water cooled by the evaporation latent heat of the refrigerant is guided to the external load via the water pipe 16.

[0044] The refrigerant evaporated by the water heat exchanger 5 is guided to the accumulator 10 through the four-way valve 4. The gas refrigerant guided from the accumulator 10 is guided to the intake side of the compressor 3 and again compressed by the compression mechanism 3b.

[0045] The control unit leaves the liquid bypass valve 22 closed during a cooling operation. That is, the liquid bypass pipe 20 is not used during the cooling operation.

[0046] According to the present embodiment, the following effects and advantages are achieved.

[0047] A liquid refrigerant is guided to the intake side of the compression mechanism 3b through the liquid bypass pipe 20, and thereby the temperature of the refrigerant discharged from the compressor 3 can be reduced. This enables an operation at a high pressure ratio and an expanded range of use of the chiller 1.

[0048] Since a liquid refrigerant flows in the liquid bypass pipe 20, the opening diameter (the pipe inner diameter) can be smaller than that for a two-phase refrigerant mixed with a gas refrigerant. This can reduce the cost and facilitates piping arrangement of the pipe.

[0049] The upstream end of the liquid bypass pipe 20 is provided between the water heat exchanger 5 and the first expansion valve 6. Accordingly, a refrigerant before expanded can be reliably guided as a liquid medium to the compressor 3.

[0050] Since a part of the liquid refrigerant is bypassed to the compressor 3 by the liquid bypass pipe 20, this enables a reduced capacity (size) of the receiver 7 provided between the first expansion valve 6 and the second expansion valve 8. This enables space saving and cost reduction.

[0051] During a heating operation and at a low ambient temperature at which the ambient temperature is a predetermined value or lower, the pressure ratio may be high (for example, 4.5 or higher), and the temperature of the refrigerant discharged from the compressor 3 may rise to a high temperature. Accordingly, in a case of such a condition, the liquid bypass valve 22 is opened to guide the liquid refrigerant to the intake side of the compression mechanism 3b.

[Second Embodiment]

[0052] Next, a second embodiment of the present disclosure will be described with reference to Fig. 3 and Fig. 4. Since the present embodiment has the same basic configuration as the first embodiment, only the configuration added to the first embodiment will be described below.

[0053] As illustrated in Fig. 3 and Fig. 4, a parallel refrigerant pipe 30 branched from a part between the upstream end of the liquid bypass pipe 20 and the first expansion valve 6 and branched from a part between the second expansion valve 8 and the air heat exchanger 9 is provided. The parallel refrigerant pipe 30 is provided in parallel to the first expansion valve 6, the receiver 7, and the second expansion valve 8. Accordingly, the parallel refrigerant pipe 30 connects the water heat exchanger 5 and the air heat exchanger 9 to each other while bypassing the first expansion valve 6, the receiver 7, and the second expansion valve 8.

[0054] A third expansion valve 32 is provided in the parallel refrigerant pipe 30. The opening of the third expansion valve is controlled by the control unit.

[0055] Next, the operation of chiller 1 configured as above will be described.

<Heating operation: Fig. 3>

[0056] During a heating operation, the third expansion valve 32 is fully closed in accordance with an instruction from the control unit. Therefore, since the parallel refrigerant pipe 30 is not used during a heating operation, the same operation as that of Fig. 1 in the first embodiment takes place during the heating operation. At a low ambient temperature, the liquid bypass valve 22 is opened in the same manner as in the first embodiment to reduce the refrigerant discharge temperature by using a liquid refrigerant.

<Cooling operation: Fig. 4>

[0057] During a cooling operation, the first expansion valve 6 and the second expansion valve 8 are fully closed in accordance with an instruction from the control unit so that no refrigerant flows to the receiver 7. The liquid bypass valve 22 is also fully closed, and the liquid bypass pipe 20 is not used. Therefore, all the liquid refrigerant guided from the air heat exchanger 9 is guided to the parallel refrigerant pipe 30 and expanded by the third expansion valve 32 whose opening is controlled by the control unit. The refrigerant expanded by the third expansion valve 32 is guided to the water heat exchanger 5. Since the subsequent operation is the same as that of Fig. 2 in the first embodiment, the description thereof will be omitted.

[0058] The chiller 1 of the present embodiment achieves the following effects and advantages.

[0059] The parallel refrigerant pipe 30 is provided in parallel to the first expansion valve 6, the receiver 7, and the second expansion valve 8. Further, during a heating operation, the third expansion valve 32 is closed so that the refrigerant flows to the first expansion valve 6 side. Accordingly, an excessive refrigerant can be stored in the receiver 7 during the heating operation.

[0060] At a low ambient temperature, a part of the liquid refrigerant can be guided to the compressor 3 to bypass the receiver 7 by using the liquid bypass pipe 20. This can reduce the capacity of the receiver 7.

[0061] On the other hand, during a cooling operation, the third expansion valve 32 is opened so that the refrigerant flows in the parallel refrigerant pipe 30 and no refrigerant flows to the second expansion valve 8 side. This makes it possible to use a required refrigerant neither too much nor too little without storing the refrigerant in the receiver 7 during the cooling operation.

[0062] As set forth, a necessary and sufficient amount of a refrigerant can be selected even with the chiller 1 that performs a heating operation and a cooling operation, and the amount of a used refrigerant can thus be reduced.

[0063] When the parallel refrigerant pipe 30 is used during a cooling operation, a refrigerant is expanded by the third expansion valve 32, and the expansion can be performed by a single expansion valve. Therefore, with use of only the third expansion valve 32 in the parallel refrigerant pipe 30, an insufficient opening diameter of the expansion valve can be avoided when the high-low differential pressure (the refrigerant differential pressure between the water heat exchanger 5 and the air heat exchanger 9) is relatively lower than a case where two of the first expansion valve 6 and the second expansion valve 8 are used for expansion.

[Third Embodiment]

[0064] Next, a third embodiment of the present disclosure will be described.

[0065] In the chiller 1 of the present embodiment, since the configuration of the first embodiment and the second embodiment illustrated in Fig. 1 to Fig. 4 can be used, the description thereof will be omitted.

[0066] The control unit of the present embodiment controls the opening of the first expansion valve 6 during the heating operation illustrated in Fig. 1 and Fig. 3 so that the temperature of a refrigerant discharged from the compressor 3 becomes a predetermined value or lower. Specifically, when the measurement value of the discharge temperature sensor 14 exceeds a predetermined value, the opening of the first expansion valve 6 is reduced in the closing direction. Herein, the predetermined value means a measurement temperature at the discharge temperature sensor 14 corresponding to a case where the temperature of water heated by the water heat exchanger 5 is 50 □ or a temperature lower by several degrees Celsius than the measurement temperature, for example.

[0067] The opening of the first expansion valve 6 is reduced, thereby, the amount of refrigerant circulation is reduced, the condensing capacity of the water heat exchanger 5 is increased, the liquid phase rate of the refrigerant is increased, and the amount of the liquid refrigerant guided to the compressor 3 through the liquid bypass pipe 20 is increased. The amount of the liquid refrigerant guided to the intake side of the compressor 3 then increases, and thereby the discharge gas temperature decreases.

[0068] The above process is illustrated in a p (pressure)-h (specific enthalpy) diagram of Fig. 5. As illustrated in Fig. 5, the first expansion valve 6 is throttled, thereby, the specific enthalpy moves from point C2 of HL2 to point C1 of HL1, and the degree of excessive cooling increases. The refrigerant (point L1) having the increased degree of excessive cooling and the increased amount of the liquid refrigerant reaches point A (specific enthalpy HA) that is the intake position of the compressor 3 via the liquid bypass pipe 20, merges at the intake side of the compression mechanism 3b with a refrigerant expanded up to point D1 by the first expansion valve 6 and evaporated by the air heat exchanger 9, and reaches point S1 (specific enthalpy HS1). The refrigerant compressed by the compression mechanism 3b is then at a high temperature and a high pressure and reaches point B1.

[0069] On the other hand, a refrigerant before the opening of the first expansion valve 6 is reduced moves from point C2 and merges at point S2 (specific enthalpy HS2) via point D2 and point L2. The refrigerant compressed by the compression mechanism 3b then reaches point B2.

[0070] As is clear from comparison between point B1 and point B2, it is found that point B1 at which the opening of the first expansion valve 6 is reduced has a lower temperature and a lower discharge temperature than point B2.

[0071] As described above, by reducing the opening of the first expansion valve 6, it is possible to increase the degree of excessive cooling and reduce the discharge temperature without controlling the opening of the liquid bypass valve 22.

[0072] The effects and advantages of the present embodiment are as follows.

[0073] The opening of the first expansion valve 6 is controlled, and thereby the temperature of a refrigerant discharged from the compressor 3 is controlled to be a predetermined value or lower. Accordingly, it is possible to employ an on-off valve (electromagnetic valve) where only opening/closing of the valve takes place as the liquid bypass valve 22 rather than employing a regulator valve having a variable valve opening, and this enables cost reduction. Further, since adjustment of the opening of the liquid bypass valve 22 is unnecessary, the control can be simplified.

[0074] The present embodiment can be modified as with Fig. 6.

[0075] Fig. 6 corresponds to Fig. 1, however, the position of the upstream end of the liquid bypass pipe 20 differs. The remaining configuration is the same as that of Fig. 1. In the present modified example, the upstream end of the liquid bypass pipe 20 is connected between the first expansion valve 6 and the receiver 7. Even with such a configuration, the discharge refrigerant temperature can be controlled by the first expansion valve 6 as with the present embodiment described above.

[0076] The heat source device and the control method thereof described above in each embodiment are understood as follows, for example.

[0077] The heat source device (1) according to one aspect of the present disclosure includes: a compressor (3) configured to compress a refrigerant; a heat medium heat exchanger (5) configured to perform heat exchange between a refrigerant and a heat medium; an expansion valve (6) configured to expand a refrigerant,; an air heat exchanger (9) configured to perform heat exchange between a refrigerant and air; and a liquid bypass pipe (20) configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the expansion valve.

[0078] The liquid refrigerant is guided to the intake side of the compressor through the liquid bypass pipe, and thereby the temperature of the refrigerant discharged from the compressor can be reduced. This enables an operation at a high pressure ratio and an expanded range of use of the heat source device.

[0079] Since a liquid refrigerant flows in the liquid bypass pipe, the opening diameter (the pipe inner diameter) can be smaller than that for a two-phase refrigerant mixed with a gas refrigerant. This can reduce the cost and facilitates piping arrangement of the pipe.

[0080] Furthermore, in the heat source device according to one aspect of the present disclosure, the expansion valve includes a first expansion valve provided on the heat medium heat exchanger side and a second expansion valve (8) provided on the air heat exchanger side, the upstream end of the liquid bypass pipe is connected between the heat medium heat exchanger and the first expansion valve, and a receiver (7) configured to store a refrigerant is provided between the first expansion valve and the second expansion valve.

[0081] The upstream end of the liquid bypass pipe is provided between the heat medium heat exchanger and the first expansion valve. Accordingly, the refrigerant before expanded can be reliably guided as a liquid medium to the compressor.

[0082] Since a part of the liquid refrigerant is bypassed to the compressor by the liquid bypass pipe, this enables a reduced capacity of the receiver provided between the first expansion valve and the second expansion valve. This enables space saving and cost reduction.

[0083] Furthermore, the heat source device according to one aspect of the present disclosure includes: a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium; a liquid bypass valve (22) provided in the liquid bypass pipe; and a control unit configured to control the liquid bypass valve from a closed position to an open position when the heating operation is performed and when an air temperature around the air heat exchanger becomes a predetermined value or lower.

[0084] When a heating operation is performed and when the air temperature around the air heat exchanger becomes a predetermined value (for example, 0 □) or lower, the pressure ratio may be high (for example, 4.5 or higher), and the temperature of the refrigerant discharged from the compressor may rise to a high temperature. Accordingly, in a case of such a condition, the liquid bypass valve is opened to guide the liquid refrigerant to the intake side of the compressor.

[0085] Furthermore, the heat source device according to one aspect of the present disclosure includes: a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium; a parallel refrigerant pipe (30) provided in parallel to the first expansion valve, the receiver, and the second expansion valve and connecting the heat medium heat exchanger and the air heat exchanger to each other; a third expansion valve (32) provided in the parallel refrigerant pipe; and a control unit configured to close the third expansion valve and control an opening of the first expansion valve and/or the second expansion valve so that a refrigerant flows to the first expansion valve side during the heating operation and configured to open the third expansion valve and control an opening of the first expansion valve and/or the second expansion valve so that a refrigerant does not flow to the second expansion valve side during the cooling operation.

[0086] The parallel refrigerant pipe is provided in parallel to the first expansion valve, the receiver, and the second expansion valve. Further, during a heating operation, the third expansion valve is closed so that the refrigerant flows to the first expansion valve side. Accordingly, an excessive refrigerant can be stored in the receiver during the heating operation. On the other hands, during a cooling operation, the third expansion valve is opened so that the refrigerant flows in the parallel refrigerant pipe and no refrigerant flows to the second expansion valve side. This makes it possible to use a required refrigerant neither too much nor too little without storing the refrigerant in the receiver during the cooling operation.

[0087] As set forth, a necessary and sufficient amount of a refrigerant can be selected even with the heat source device that performs a heating operation and a cooling operation, and the amount of a used refrigerant can be reduced.

[0088] When the parallel refrigerant pipe is used during a cooling operation, a refrigerant is expanded by the third expansion valve, and the expansion can be performed by a single expansion valve. Therefore, with use of only the third expansion valve in the parallel refrigerant pipe, an insufficient opening diameter of the expansion valve can be avoided when the high-low differential pressure (the refrigerant differential pressure between the heat medium heat exchanger and the air heat exchanger) is relatively lower than a case where two of the first expansion valve and the second expansion valve are used for expansion.

[0089] Furthermore, the heat source device according to one aspect of the present disclosure includes: a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium; a liquid bypass valve provided in the liquid bypass pipe and being an on-off valve; and a control unit configured to control an opening of the first expansion valve during the heating operation so that a temperature of a refrigerant discharged from the compressor becomes a predetermined value or lower.

[0090] The opening of the first expansion valve is controlled, and thereby the temperature of a refrigerant discharged from the compressor is controlled to be a predetermined value or lower. Accordingly, it is possible to employ an on-off valve where only opening/closing of the valve takes place as the liquid bypass valve rather than employing a regulator valve having a variable valve opening, and this enables cost reduction. Further, since adjustment of the opening of the liquid bypass valve is unnecessary, the control can be simplified.

[0091] A control method of a heat source device according to one aspect of the present disclosure is a control method of a heat source device including a compressor configured to compress a refrigerant, a heat medium heat exchanger configured to perform heat exchange between a refrigerant and a heat medium, an expansion valve configured to expand a refrigerant, an air heat exchanger configured to perform heat exchange between a refrigerant and air, a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the expansion valve, a liquid bypass valve provided in the liquid bypass pipe and a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium, and the control method includes: controlling the liquid bypass valve from a closed position to an open position when the heating operation is performed and when an air temperature around the air heat exchanger becomes a predetermined value or lower.

[0092] A control method of a heat source device according to one aspect of the present disclosure is a control method of a heat source device including a compressor configured to compress a refrigerant, a heat medium heat exchanger configured to perform heat exchange between a refrigerant and a heat medium, an air heat exchanger configured to perform heat exchange between a refrigerant and air, a first expansion valve provided on the heat medium heat exchanger side, a second expansion valve provided on the air heat exchanger side, a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the first expansion valve, a liquid bypass valve provided in the liquid bypass pipe, a receiver provided between the first expansion valve and the second expansion valve and configured to store a refrigerant, a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium, a parallel refrigerant pipe provided in parallel to the first expansion valve, the receiver, and the second expansion valve and connecting the heat medium heat exchanger and the air heat exchanger to each other, and a third expansion valve provided in the parallel refrigerant pipe, and the control method includes: during the heating operation, closing the third expansion valve and controlling an opening of the first expansion valve and/or the second expansion valve so that a refrigerant flows to the first expansion valve side; and during the cooling operation, opening the third expansion valve and controlling an opening of the first expansion valve and/or the second expansion valve so that a refrigerant does not flow to the second expansion valve side.

[0093] A control method of a heat source device according to one aspect of the present disclosure is a control method of a heat source device including a compressor configured to compress a refrigerant, a heat medium heat exchanger configured to perform heat exchange between a refrigerant and a heat medium, an air heat exchanger configured to perform heat exchange between a refrigerant and air, a first expansion valve provided on the heat medium heat exchanger side, a second expansion valve provided on the air heat exchanger side, a liquid bypass pipe configured to guide a liquid refrigerant to an intake side of the compressor, an upstream end of the liquid bypass pipe being connected between the heat medium heat exchanger and the first expansion valve, a liquid bypass valve provided in the liquid bypass pipe, a receiver provided between the first expansion valve and the second expansion valve and configured to store a refrigerant, and a selector valve configured to guide a refrigerant discharged from the compressor to the heat medium heat exchanger during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor to the air heat exchanger during a cooling operation for cooling the heat medium, and the control method includes: controlling an opening of the first expansion valve during the heating operation so that a temperature of a refrigerant discharged from the compressor becomes a predetermined value or lower.

[Reference Signs List]

[0094]

1	chiller (heat source device)
3	compressor
3a	housing
3b	compression mechanism
4	four-way valve (selector valve)
5	water heat exchanger (heat medium heat exchanger)
6	first expansion valve
7	receiver
8	second expansion valve
9	air heat exchanger
10	accumulator
12	fan
14	discharge temperature sensor
16	water pipe
18	ambient temperature sensor
20	liquid bypass pipe
22	liquid bypass valve
30	parallel refrigerant pipe
32	third expansion valve

Claims

1. A heat source device (1) comprising:

a compressor (3) configured to compress a refrigerant;
a heat medium heat exchanger (5) configured to perform heat exchange between a refrigerant and a heat medium;
an air heat exchanger (9) configured to perform heat exchange between a refrigerant and air; and
a liquid bypass pipe (20) configured to guide a liquid refrigerant to an intake side of the compressor (3),
characterized in that it comprises a first and a second expansion valve (6,8) configured to expand a refrigerant, the first expansion valve (6) being provided on the heat medium heat exchanger (5) side and the second expansion valve (8) being provided on the air heat exchanger (9) side,
in that the upstream end of the liquid bypass pipe (20) is connected between the heat medium heat exchanger (5) and the first expansion valve (6),
in that a receiver (7) configured to store a refrigerant is provided between the first expansion valve (6) and the second expansion valve (8), and
in that it further comprises:

a selector valve (4) configured to guide a refrigerant discharged from the compressor (3) to the heat medium heat exchanger (3) during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor (3) to the air heat exchanger (9) during a cooling operation for cooling the heat medium;
a parallel refrigerant pipe (30) provided in parallel to the first expansion valve (6), the receiver (7), and the second expansion valve (8) and connecting the heat medium heat exchanger (3) and the air heat exchanger (9) to each other;
a third expansion valve (32) provided in the parallel refrigerant pipe (30); and
a control unit configured to close the third expansion valve (32) and control an opening of the first expansion valve (6) and/or the second expansion valve (8) so that a refrigerant flows to the first expansion valve (6) side during the heating operation and configured to open the third expansion valve (32) and control an opening of the first expansion valve (6) and/or the second expansion valve (8) so that a refrigerant does not flow to the second expansion valve (8) side during the cooling operation..

2. The heat source device (1) according to claim 1 fur-

ther comprising:
a liquid bypass valve (22) provided in the liquid bypass pipe (20) and being an on-off valve,
wherein the control unit is configured to control an opening of the first expansion valve (6) during the heating operation so that a temperature of a refrigerant discharged from the compressor (3) becomes a predetermined value or lower.

3. A control method of a heat source device (1) comprising

a compressor (3) configured to compress a refrigerant,
a heat medium heat exchanger (5) configured to perform heat exchange between a refrigerant and a heat medium,
an air heat exchanger (9) configured to perform heat exchange between a refrigerant and air,
a first expansion valve (6) provided on the heat medium heat exchanger (5) side,
a second expansion valve (8) provided on the air heat exchanger (9) side,
a liquid bypass pipe (20) configured to guide a liquid refrigerant to an intake side of the compressor (3), an upstream end of the liquid bypass pipe (20) being connected between the heat medium heat exchanger (5) and the first expansion valve (6),
a liquid bypass valve (22) provided in the liquid bypass pipe (20),
a receiver (7) provided between the first expansion valve (6) and the second expansion valve (8) and configured to store a refrigerant,
a selector valve (4) configured to guide a refrigerant discharged from the compressor (3) to the heat medium heat exchanger (5) during a heating operation for heating the heat medium and guide a refrigerant discharged from the compressor (3) to the air heat exchanger (9) during a cooling operation for cooling the heat medium,
a parallel refrigerant pipe (30) provided in parallel to the first expansion valve (6), the receiver (7), and the second expansion valve (8) and connecting the heat medium heat exchanger (5) and the air heat exchanger (9) to each other, and
a third expansion valve (32) provided in the parallel refrigerant pipe (30),
the control method comprising:
during the heating operation, closing the third expansion valve (32) and controlling an opening of the first expansion valve (6) and/or the second expansion valve (8) so that a refrigerant flows to the first expansion valve (6) side; and during the cooling operation, opening the third expansion valve (32) and controlling an opening of the first expansion valve (6) and/or the second expansion valve (8) so that a refrigerant does not flow to the second expansion valve (8) side.

FIG. 1

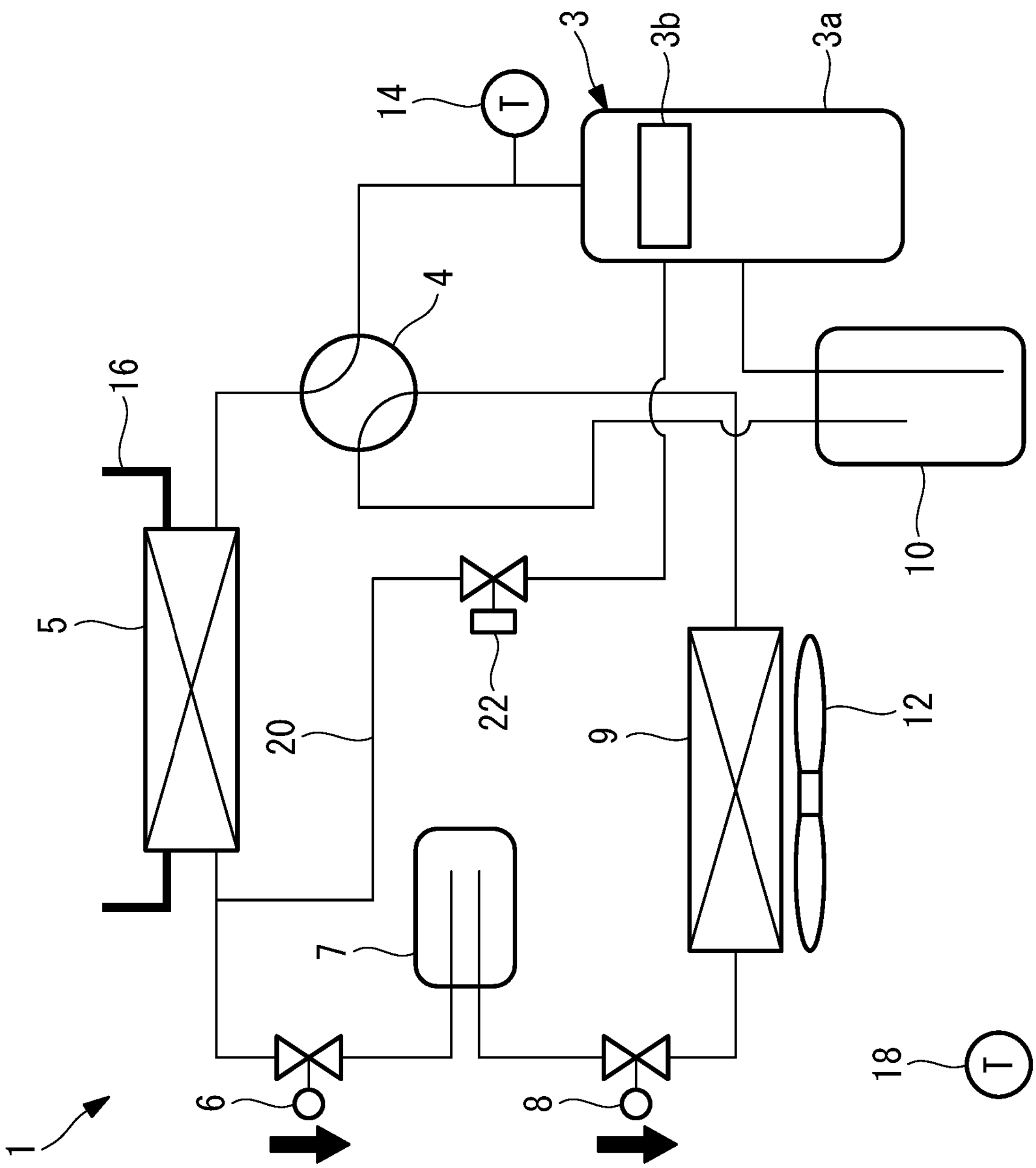


FIG. 2

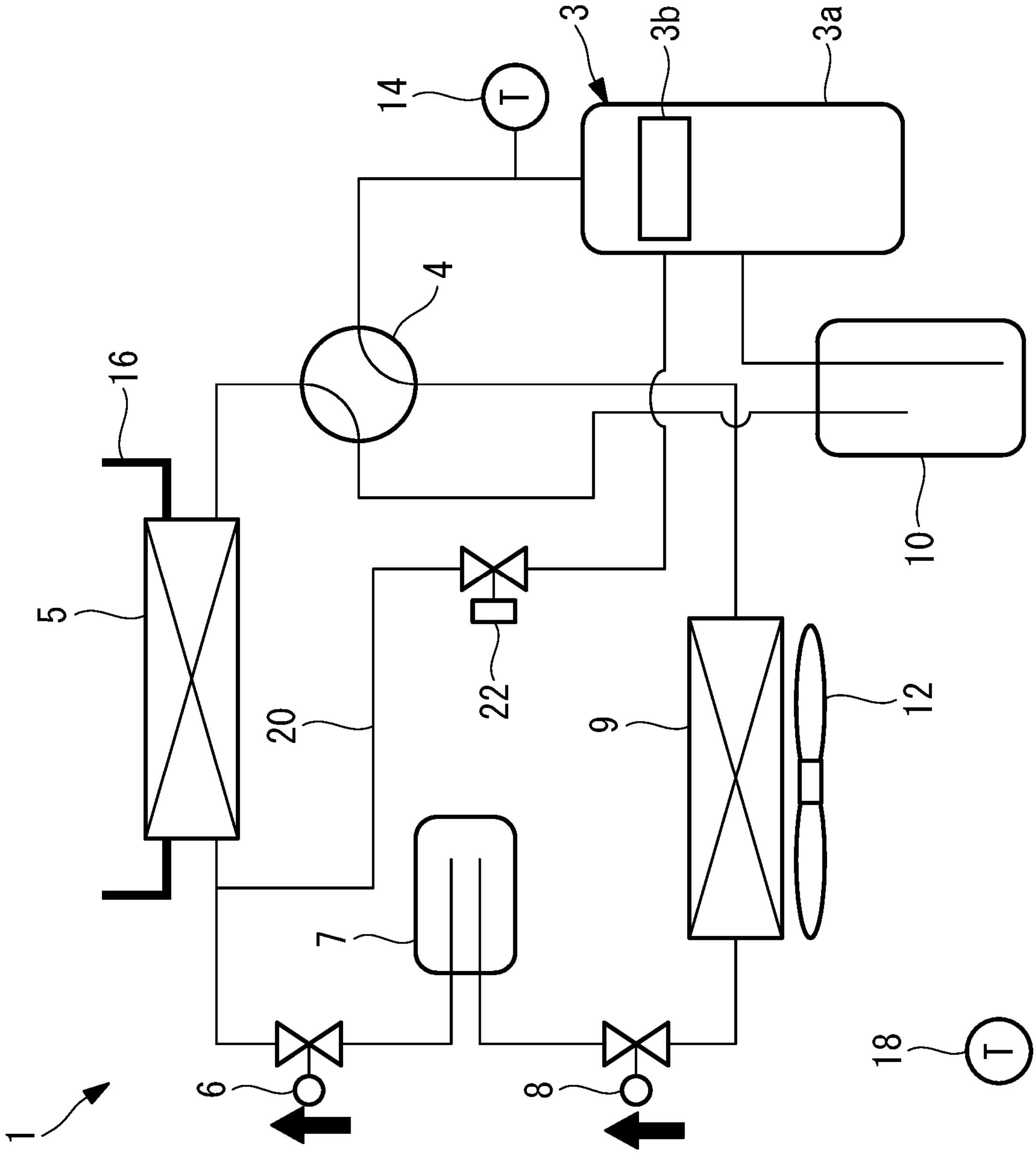


FIG. 3

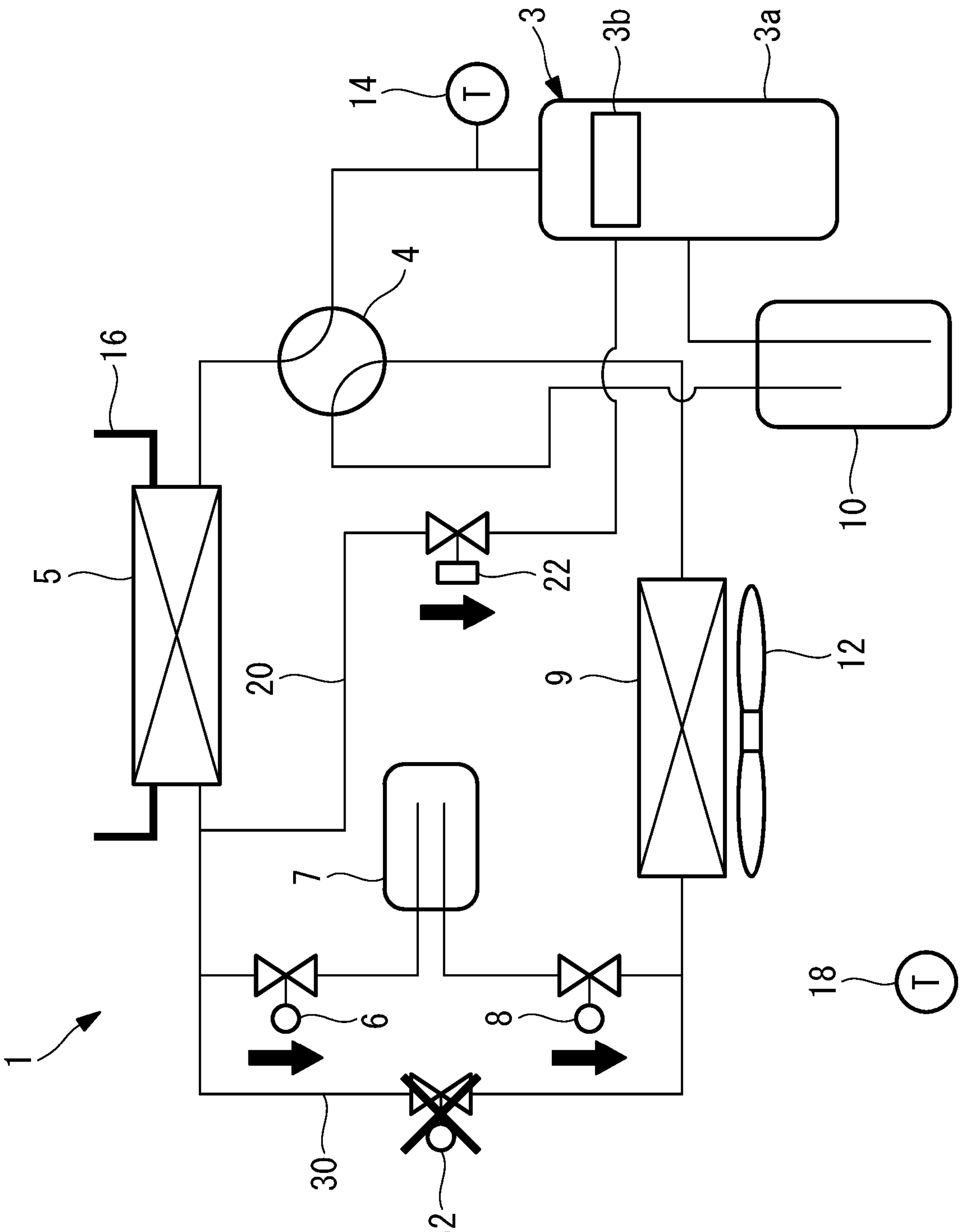


FIG. 4

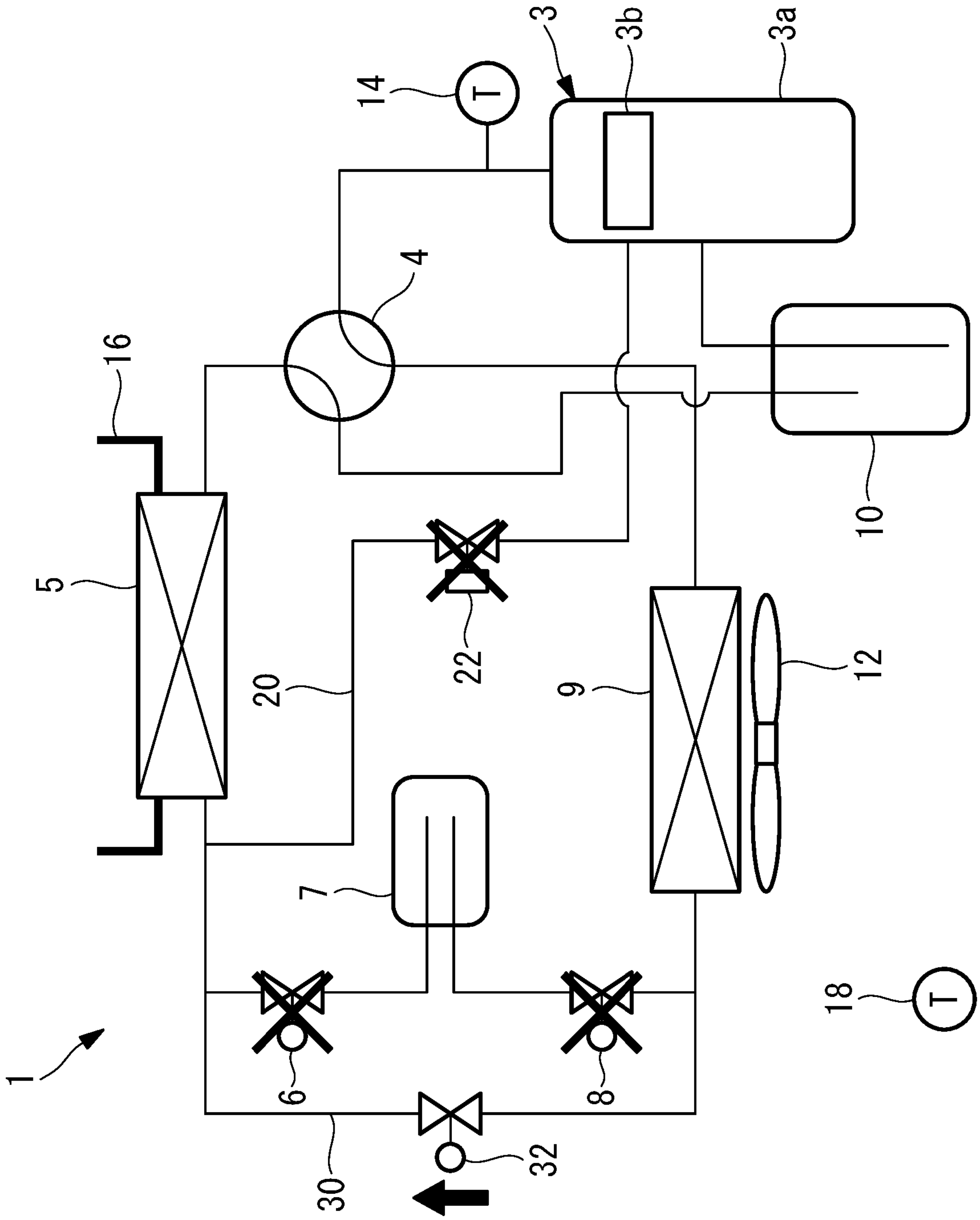


FIG. 5

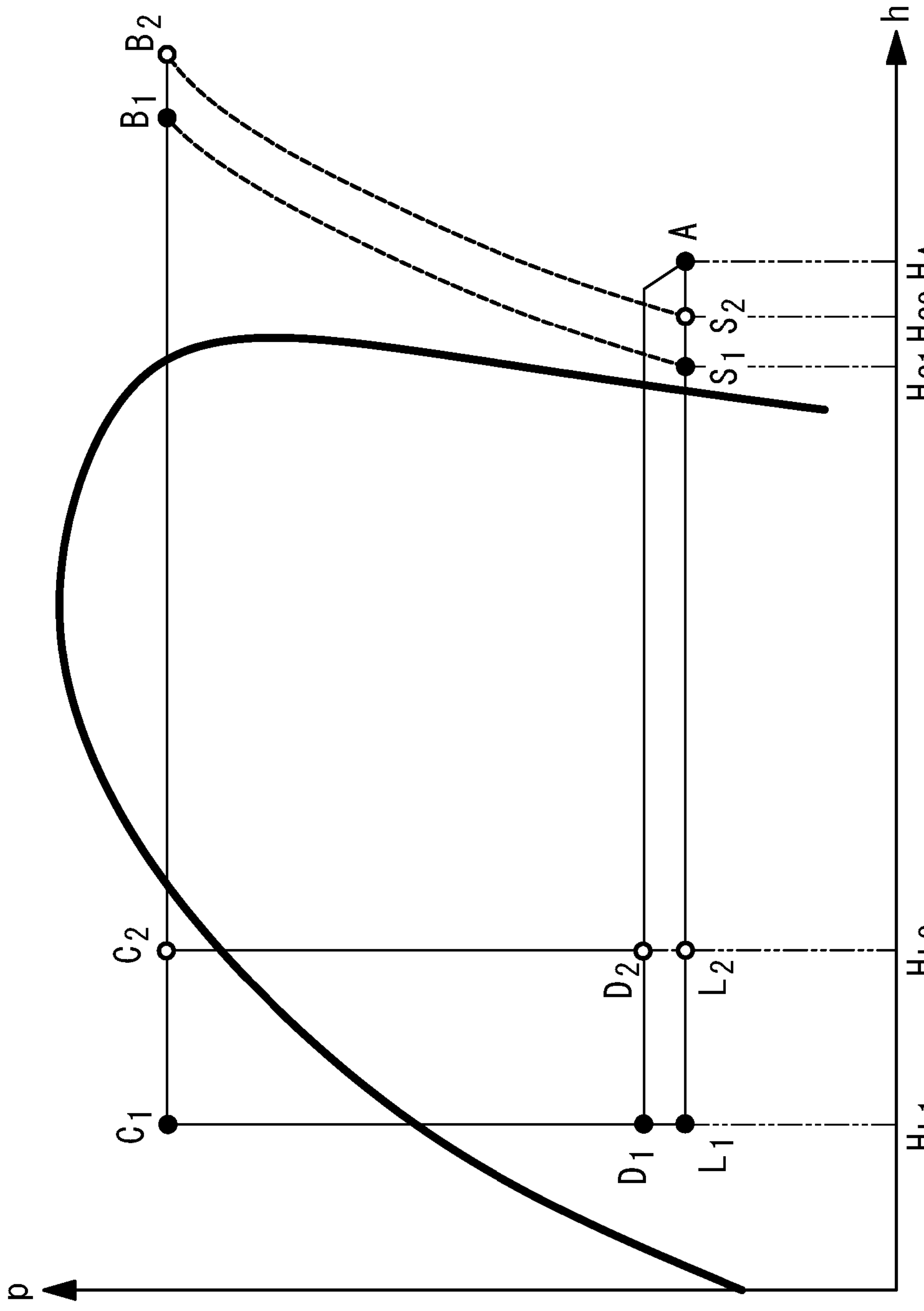
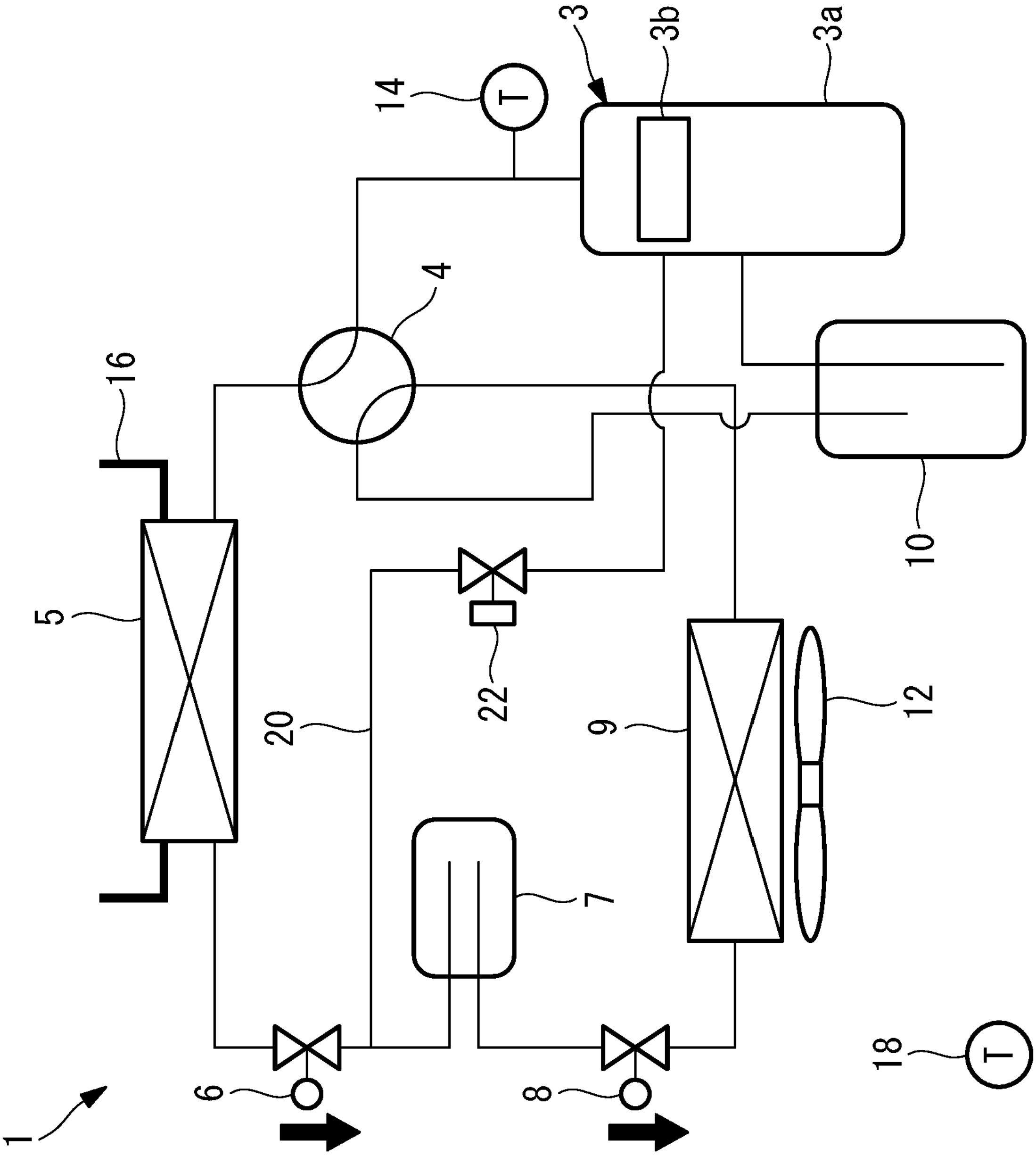


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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