



## Description

### BACKGROUND

#### 1. Field

[0001] The present disclosure relates to a heat supplier, and more particularly, to a heat supplier that heats or cools water flowing into an indoor space by using a refrigerant discharged from a compressor.

#### 2. Description of the Related Art

[0002] A heat supplier is a device that supplies heating or cooling energy to water flowing into an indoor space.

[0003] Such a heat supplier may have a structure that includes a compressor, a first heat exchanger for heat exchange between air and refrigerant, and a second heat exchanger for heat exchange between water supplied to an indoor space and refrigerant. In other words, the heat supplier may use air-to-water heat pump (AWHP) that uses refrigerant to exchange heat between air and water. The water flowing through the second heat exchanger may receive heating or cooling energy of the refrigerant to be supplied to the indoor space.

[0004] The heat supplier may be mainly operated in a heating operation mode in which refrigerant at a high pressure is delivered to the second heat exchanger. However, depending on the condition, the heat supplier may be operated in a cooling operation mode in which liquid refrigerant is delivered to the second heat exchanger.

[0005] A capacity difference occurs between the first heat exchanger, which performs heat exchange between air and refrigerant, and the second heat exchanger, which performs heat exchange between water and refrigerant. In general, the capacity of the first heat exchanger is greater than the capacity of the second heat exchanger. This may cause a difference in the flow rate of the refrigerant between when the heat supplier is operated in the heating operation mode and when the heat supplier is operated in the cooling operation mode.

[0006] In addition, the heat supplier may be configured such a liquid pipe connecting the first heat supplier and the second heat supplier may be provided with one expansion valve and a supercooling device for improving heat exchange performance. When the refrigerant that has passed through the supercooling device passes through the expansion valve, it is advantageous in terms of heat exchange performance. However, when one expansion valve and the supercooling device are provided, performance can be improved only in one of the heating operation mode or the cooling operation mode.

[0007] Korean Laid-Open Patent Publication No. 10-2022-0043958 A also discloses a structure in which one expansion device and one supercooling device are disposed at a liquid pipe.

### SUMMARY

[0008] It is an objective of the present disclosure to provide a heat supplier that can achieve the performance during cooling operation.

[0009] It is another objective of the present disclosure to provide a heat supplier that can control the refrigerant flow rate that varies depending on cooling operation and heating operation modes.

10 [0010] The objectives of the present disclosure are not limited to the objectives described above, and other objectives not stated herein will be clearly understood by those skilled in the art from the following description.

[0011] According to an aspect of the subject matter described in this application, a heat supplier includes a compressor configured to compress a refrigerant; a first heat exchanger configured to exchange heat between air and the refrigerant; a second heat exchanger configured to exchange heat between water and the refrigerant; a switching valve to direct the refrigerant discharged from the compressor into the first heat exchanger or the second heat exchanger; a third heat exchanger configured to exchange heat between refrigerant flowing through a liquid pipe, which connects the first heat exchanger and the second heat exchanger, and refrigerant branched from the liquid pipe and expanded; a first expansion valve configured to expand refrigerant flowing from the third heat exchanger to the first heat exchanger; and a second expansion valve configured to expand refrigerant flowing from the third heat exchanger to the second heat exchanger. The first expansion valve and the second expansion valve may be selectively opened and closed according to a direction of the refrigerant flowing through the third heat exchanger. Accordingly, the refrigerant that has passed through the third heat exchanger may flow through the first expansion valve or the second expansion valve.

[0012] The liquid pipe may include: a first liquid pipe at which the third heat exchanger and the first expansion valve are disposed; a second liquid pipe at which the second expansion valve is disposed; and a bypass pipe to connect a first side and a second side of the first liquid pipe. The second liquid pipe and the bypass pipe may be connected in parallel to the first liquid pipe at different positions.

[0013] The first liquid pipe may be provided with a first check valve to direct refrigerant flowing through the bypass pipe into the third heat exchanger. Accordingly, the refrigerant that has bypassed the first expansion valve may flow into the second expansion valve through the third heat exchanger.

[0014] The first expansion valve and the third heat exchanger may be disposed at the first liquid pipe positioned between two ends of the second bypass pipe, and the third heat exchanger and the first check valve may be disposed at the first liquid pipe positioned between two ends of the second liquid pipe. Accordingly, the refrigerant flowing out from the bypass pipe may flow in one

direction.

**[0015]** The first check valve may cause the refrigerant to flow into the third heat exchanger, thereby allowing the refrigerant flowing out from the bypass pipe to flow into the third heat exchanger.

**[0016]** The bypass pipe may be provided with a second check valve to direct refrigerant flowing through the first heat exchanger into the third heat exchanger. Accordingly, the refrigerant flowing into the third heat exchanger along the first liquid pipe may be prevented from flowing into the bypass pipe.

**[0017]** The bypass pipe may be connected to the first liquid pipe so as to bypass the first expansion valve and the third heat exchanger. Accordingly, the refrigerant flowing out from the first heat exchanger may flow by passing through the first expansion valve.

**[0018]** The second liquid pipe may be connected in parallel to the first liquid pipe so as to bypass the third heat exchanger and the first check valve. Accordingly, the refrigerant flowing through the third heat exchanger may flow into the second liquid pipe to pass through the second expansion valve.

**[0019]** The heat supplier may further include: a branch pipe branched from the liquid pipe to allow refrigerant to flow into the third heat exchanger; and a third expansion valve disposed on the branch pipe and configured to expand refrigerant flowing therethrough. Accordingly, the temperature of the refrigerant flowing through the liquid pipe may be reduced.

**[0020]** The branch pipe may be branched from the liquid pipe at a position between the third heat exchanger and the first expansion valve.

**[0021]** The refrigerant flowing into the third heat exchanger through the branch pipe may be supplied to the compressor.

**[0022]** A size of an aperture of the second expansion valve may be greater than a size of an aperture of the first expansion valve. Accordingly, the amount of refrigerant flowing from the first heat exchanger to the second heat exchanger may be increased.

**[0023]** The heat supplier may be operated in a heating operation mode in which the refrigerant discharged from the compressor is delivered into the second heat exchanger. The second expansion valve may be closed in the heating operation mode, such that the refrigerant flowing from the second heat exchanger to the first heat exchanger may pass through the third heat exchanger and then pass through the first expansion valve. Accordingly, the refrigerant flowing through the liquid pipe in the heating mode may be cooled while passing through the third heat exchanger and then pass through the first expansion valve.

**[0024]** The heat supplier may be operated in a cooling operation mode in which the refrigerant discharged from the compressor is transferred into the first heat exchanger. The first expansion valve may be closed in the cooling operation mode, such that the refrigerant flowing from the first heat exchanger to the second heat exchanger

may pass through the third heat exchanger and then pass through the second expansion valve. Accordingly, the refrigerant flowing through the liquid pipe in the heating mode may be cooled while passing through the third heat exchanger and then pass through the second expansion valve.

**[0025]** The liquid pipe may include: a first liquid pipe at which the third heat exchanger and the first expansion valve are disposed; and a second liquid pipe at which the second expansion valve is disposed; a bypass pipe to connect a first side and a second side of the first liquid pipe. The first expansion valve may be closed in the cooling operation mode, such that the refrigerant flowing from the first heat exchanger to the second heat exchanger may flow into the third heat exchanger through the bypass pipe, and the refrigerant flowing out from the third heat exchanger may flow through the second liquid pipe. Accordingly, the refrigerant flowing through the liquid pipe in the cooling mode may be expanded while passing through the third heat exchanger and then pass through the second expansion valve.

**[0026]** The first expansion valve may be disposed between the first heat exchanger and the third heat exchanger, and the second expansion valve may be disposed between the second heat exchanger and the third heat exchanger. The heat supplier may further include: a first bypass pipe to bypass the first expansion valve, a second bypass pipe to bypass the second expansion valve; a first bypass valve disposed at the first bypass pipe; and a second bypass valve disposed at the second bypass pipe.

**[0027]** The first expansion valve and the first bypass valve may be selectively opened, and the second expansion valve and the second bypass valve may be selectively opened. Accordingly, the refrigerant that has passed through the third heat exchanger may pass through the first expansion valve or the second expansion valve.

**[0028]** Details of other embodiments are included in the detailed description and the accompanying drawings.

**[0029]** A heat supplier according to the present disclosure has one or more of the following effects.

**[0030]** First, regardless of the flow direction of refrigerant flowing through a liquid pipe, as the refrigerant passes through a first expansion valve or a second expansion valve through a third heat exchanger, it is possible to increase heat exchange performance.

**[0031]** Second, as the first expansion valve and the second expansion valve have different aperture sizes, it is possible to regulate the flow rate of refrigerant flowing from the first heat exchanger to the second heat exchanger and the flow rate of refrigerant flowing from the second heat exchanger to the first heat exchanger.

**[0032]** The effects of the present disclosure are not limited to the effects described above, and other effects not mentioned will be clearly understood by those skilled in the art from the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

### [0033]

FIG. 1 is a system diagram of a heat supplier according to a first embodiment of the present disclosure. FIG. 2 is a diagram for explaining a refrigerant flow in a heating mode of the heat supplier of the FIG. 1. FIG. 3 is a diagram for explaining a refrigerant flow in a cooling mode of the heat supplier of the FIG. 1. FIG. 4 is a system diagram of a heat supplier according to a comparative example of the present disclosure. FIG. 5 illustrates a comparison of cooling performance of a heat supplier according to the present disclosure and a heat supplier according to a comparative example of the present disclosure. FIG. 6 is a flowchart illustrating a method of controlling a heat supplier of the present disclosure. FIG. 7 is a system diagram of a heat supplier according to a second embodiment of the present disclosure.

## DETAILED DESCRIPTION

[0034] The above and other aspects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings. Exemplary embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the exemplary embodiments to those skilled in the art. The same reference numerals are used throughout the drawings to designate the same or similar components.

[0035] Hereinafter, a heat supplier according to embodiments of the present disclosure will be described with reference to the accompanying drawings.

[0036] The heat supplier herein may provide heating or cooling to an indoor space. The heat supplier may supply a high pressure refrigerant or a low pressure refrigerant to a second heat exchanger 24 (see FIG. 1) described later, so as to supply heating or cooling energy to water flowing into the indoor space.

[0037] With reference to FIG. 1, components provided in an outdoor unit of the heat supplier will be described below.

[0038] The heat supplier includes a compressor 10 to compress refrigerant, a first heat exchanger 20 for heat exchange between the refrigerant discharged from the compressor 10 and air, a second heat exchanger 24 for heat exchange between the refrigerant discharged from the compressor 10 and water, and a switching valve 12 to direct the refrigerant discharged from the compressor 10

into the first heat exchanger 20 or the second heat exchanger 24. The heat supplier further includes a heat exchanger fan 22 to cause air to flow into the first heat exchanger 20.

[0039] The first heat exchanger 20 exchanges heat between air and refrigerant. Referring to FIG. 1, the first heat exchanger 20 may include a plurality of branch refrigerant tubes 21a, a heat exchanger header 21b that connects one side (or a first side) of each of the plurality of branch refrigerant tubes 21a and a liquid pipe 30 described later, and a manifold 21c that connects the other side (or a second side) of each of the plurality of branch refrigerant tubes 21a and a gas pipe 18b.

[0040] The heat exchanger fan 22 may cause an air flow into the first heat exchanger 20. Thus, as the heat exchanger fan 22 operates, it greatly increases the air flow rate, causing the refrigerant flowing in the first heat exchanger 20 to undergo a phase change.

[0041] The second heat exchanger 24 exchanges heat between water and refrigerant. The second heat exchanger 24 may be a plate type heat exchanger. The heat exchanger 24 is provided with a flow path in which water flows and a flow path in which refrigerant flows. The refrigerant flowing in the second heat exchanger 24 may exchange heat with water, causing the refrigerant to undergo a phase change.

[0042] Water introduced into the second heat exchanger 24 may be moved by a pump (not shown) disposed at one side.

[0043] The switching valve 12 may direct the flow of refrigerant discharged from the compressor 10 into the first heat exchanger 20 or the second heat exchanger 24. When an operation mode of the heat supplier is switched, the switching valve 12 may change a flow direction of the refrigerant discharged from the compressor 10.

[0044] The heat supplier includes an accumulator 14 that separates the refrigerant flowing to the compressor 10 into a liquid refrigerant and a gaseous refrigerant so as to supply the gaseous refrigerant to the compressor 10. The heat supplier includes a muffler 16 to reduce noise of the refrigerant discharged from the compressor 10.

[0045] The heat supplier includes the liquid pipe 30 that connects the first heat exchanger 20 and the second heat exchanger 24.

[0046] The heat supplier includes a third heat exchanger 44 that is disposed at the liquid pipe 30 to exchange heat between the refrigerant flowing through the liquid pipe 30 and the refrigerant branched from the liquid pipe 30 and expanded. The refrigerant branched from the liquid pipe 30 and expanded may pass through the third heat exchanger 44 and then flow into the compressor 10. The heat supplier includes a branch pipe 38 branched from the liquid pipe 30 so that the refrigerant flows into the third heat exchanger 44, and a third expansion valve 46 disposed on the branch pipe 38 and configured to expand the refrigerant flowing therethrough.

[0047] The heat supplier includes a first expansion valve 40 to expand the refrigerant flowing from the third

heat exchanger 44 to the first heat exchanger 20. The heat exchanger includes a second expansion valve 42 to expand the refrigerant flowing from the third heat exchanger 44 to the second heat exchanger 24.

**[0048]** The liquid pipe 30 includes a first liquid pipe 32 at which the third heat exchanger 44 and the first expansion valve 40 are disposed, and a second liquid pipe 34 at which the second expansion valve 42 is disposed. The liquid pipe 30 includes a bypass pipe 36 that connects one side (or a first side) of the first liquid pipe 32 and the other side (or a second side) of the first liquid pipe 32. The third heat exchanger 44 and the first expansion valve 40 are disposed between points of the first liquid pipe 32 where both ends of the first liquid pipe 32 are connected to the bypass pipe 36.

**[0049]** The first liquid pipe 32 connects the first heat exchanger 20 and the second heat exchanger 24. The third heat exchanger 44 is disposed at the first liquid pipe 32. The first expansion valve 40 is disposed at the first liquid pipe 32. The branch pipe 38 is branched from one side of the first liquid pipe 32. The branch pipe 38 is branched from the first liquid pipe 32 between the third heat exchanger 44 and the first expansion valve 40.

**[0050]** The first liquid pipe 32 is provided with a first check valve 50 to direct the flow of refrigerant from the second heat exchanger 24 to the first heat exchanger 20. The first check valve 50 is disposed between the second heat exchanger 24 and the third heat exchanger 44.

**[0051]** Both ends of the second liquid pipe 34 are connected to the first liquid pipe 32. The third heat exchanger 44 is disposed between points of the first liquid pipe 32 where both ends of the second liquid pipe 34 are connected. The first check valve 50 is disposed between points of the first liquid pipe 30 where both ends of the second liquid pipe 34 are connected.

**[0052]** One end (of a first end) of the second liquid pipe 34 is connected to the first liquid pipe 32 between the first expansion valve 40 and the third heat exchanger 44. The other end (or a second end) of the second liquid pipe 34 is connected to the first liquid pipe 32 between the second heat exchanger 24 and the third heat exchanger 44. The other end of the second liquid pipe 34 is connected to the first liquid pipe 32 between the second heat exchanger 24 and the first check valve 50. Accordingly, the refrigerant flowing between the third heat exchanger 44 and the first expansion valve 40 may flow into the second liquid pipe 34 and then pass through the second expansion valve 42 to flow into the second heat exchanger 24.

**[0053]** Both ends of the bypass pipe 36 are connected to the first liquid pipe 32. One end (of a first end) of the bypass pipe 36 is connected to the first liquid pipe 32 between the first expansion valve 40 and the first heat exchanger 20. The other end of the second liquid pipe 34 is connected to the first liquid pipe 32 between the first check valve 50 and the third heat exchanger 44. Accordingly, the refrigerant flowing through the bypass pipe 36 may bypass the first expansion valve 40.

**[0054]** The bypass pipe 36 may be provided with a

second check valve 44 to direct the refrigerant flowing in the first heat exchanger 20 into the third heat exchanger 44.

**[0055]** The heat supplier may include a high pressure pipe 18a through which the refrigerant discharged from the compressor 10 flows, a first gas pipe 18b that connects the switching valve 12 and the first heat exchanger 20, and a second gas pipe 18c that connects the switching valve 12 and the second heat exchanger 24.

**[0056]** Hereinafter, the flow of refrigerant in a heating operation mode (HM) and a cooling operation mode (CM) of the heat supplier and the configuration of the components will be described with reference to FIGS. 2 and 3.

**[0057]** The heat supplier according to the present disclosure may be operated in a heating operation mode HM and a cooling operation mode CM.

**[0058]** The heating operation mode HM is an operation method that heats water flowing through the second heat exchanger 24a by transferring refrigerant at a high pressure to the second heat exchanger 24. The cooling operation mode CM is an operation method that cools water flowing through the second heat exchanger 24 by transferring refrigerant at a high pressure to the first heat exchanger 20.

**[0059]** Referring to FIG. 2, in the heating operation mode HM, the switching valve 12 directs the refrigerant discharged from the compressor 10 to the second heat exchanger 24. In the heating operation mode HM, the first expansion valve 40 is adjusted to expand the refrigerant flowing through the liquid pipe 30. In the heating operation mode HM, the second expansion valve 42 is adjusted so that the refrigerant does not flow to the second liquid pipe 34.

**[0060]** In the heating operation mode HM, the first heat exchanger 20 serves as an evaporator. In the heating operation mode HM, the second heat exchanger 24 serves as a condenser.

**[0061]** Referring to FIG. 2, the refrigerant discharged from the compressor 10 may flow into the second heat exchanger 24 to heat water. The refrigerant flowing out from the second heat exchanger 24 flows along the first liquid pipe 32. The refrigerant flowing along the first liquid pipe 32 may pass through the third heat exchanger 44, and then may be expanded while passing through the first expansion valve 40. The refrigerant that has passed through the first expansion valve 40 may flow into the first heat exchanger 20, thereby exchanging heat with air.

**[0062]** The refrigerant flowing out from the first heat exchanger 20 may flow through the switching valve 12, into the accumulator 14 and to flow into the compressor 10.

**[0063]** That is, in the heating operation mode HM, the refrigerant may heat the water flowing through the second heat exchanger 24. In addition, the refrigerant that has passed through the third heat exchanger 44 may flow into the first expansion valve 40. As the second expansion valve 42 closes the second liquid pipe 34, no refrigerant flows into the second liquid pipe 34. Further, due

to the second check valve 52, the refrigerant flowing through the first liquid pipe 32 does not flow into the bypass pipe 36.

**[0064]** Referring to FIG. 3, in the cooling operation mode CM, the switching valve 12 directs the refrigerant discharged from the compressor 10 into the first heat exchanger 20. In the cooling operation mode CM, the second expansion valve 42 is adjusted to expand the refrigerant flowing through the liquid pipe 30. In the cooling operation mode CM, the first expansion valve 40 is adjusted so that the refrigerant does not flow to the first liquid pipe 32.

**[0065]** In the cooling operation mode CM, the first heat exchanger 20 serves as a condenser. In the cooling operation mode CM, the second heat exchanger 24 serves as an evaporator.

**[0066]** Referring to FIG. 3, the refrigerant discharged from the compressor 10 may flow into the first heat exchanger to heat air, and may cool water flowing through the second heat exchanger 24. The refrigerant flowing out from the first heat exchanger 20 flows along the bypass pipe 36.

**[0067]** The refrigerant flowing along the bypass pipe 36 flows into the third heat exchanger 44 to exchange heat and then flows into the second liquid pipe 34. The refrigerant flowing along the second liquid pipe 34 may be expanded while passing through the second expansion valve 42. The refrigerant that has passed through the second expansion valve 42 flows into the second heat exchanger 24, thereby exchanging heat with water.

**[0068]** The refrigerant flowing out from the second heat exchanger 24 may flow through the switching valve 12, into the accumulator 14 and to flow into the compressor 10.

**[0069]** That is, in the cooling operation mode CM, the refrigerant may cool water flowing through the second heat exchanger 24. In addition, the refrigerant that has passed through the third heat exchanger 44 may flow into the second expansion valve 42. As the first expansion valve 40 closes the first liquid pipe 32, no refrigerant flows into the first liquid pipe 32. Further, due to the first check valve 50, the refrigerant flowing through the bypass pipe 36 may flow toward the third heat exchanger 44.

**[0070]** FIG. 4 is a diagram illustrating a heat supplier with a conventional structure. In the following description, a difference from FIG. 1 will be mainly discussed. The heat supplier of FIG. 4 includes only one expansion valve 41. That is, a component corresponding to the second expansion valve 32 of the present disclosure is not provided. In addition, the heat supplier of FIG. 4 does not include components corresponding to the second liquid pipe 34, the bypass pipe 36, the first check valve 50, and the second check valve 53 of the present disclosure.

**[0071]** Thus, as for the heat supplier of FIG. 4, in the heating operation mode HM, the refrigerant that has passed through a third heat exchanger 44 may be supplied to a first heat exchanger 20 through the expansion valve 41, whereas in the cooling operation mode CM, the

refrigerant expanded by the expansion valve 41 passes through the third heat exchanger 44.

**[0072]** Referring to FIG. 5, it can be seen that the present disclosure exhibits improved cooling performance in the cooling operation mode CM. Referring to FIG. 5, as for the heat supplier of the present disclosure, as the refrigerant flowing from the first heat exchanger 20 to the second heat exchanger 24 passes through the third heat exchanger 44 and then flows into the second expansion valve 42, it is possible to increase the degree of supercooling of the liquid refrigerant introduced into the second expansion valve 42.

**[0073]** Referring to FIG. 5, in the case of the conventional heat supplier (see B in FIG. 5), since the refrigerant flowing from the first heat exchanger 20 to the second heat exchanger 24 passes through the expansion valve 41 and then flows into the third heat exchanger 44, the degree of supercooling of the refrigerant introduced into the expansion valve 41 is not enhanced.

**[0074]** Referring to FIG. 5, in the case of the heat supplier of the present disclosure (see A in FIG. 5), as the liquid refrigerant discharged from the first heat exchanger 20 passes through the third heat exchanger 44 and is delivered to the second expansion valve 43, it is possible to further increase the degree of supercooling of the liquid refrigerant. In addition, the second expansion valve 42 that expands the refrigerant flowing from the first heat exchanger 20 to the second heat exchanger 24 and the first expansion valve 40 that expands the refrigerant flowing from the second heat exchanger 24 to the first heat exchanger 20 may have different sizes from each other. That is, as the separate size and control of the second expansion valve 42 reduces a pressure loss at an inlet of the second expansion valve 42, the low pressure increases slightly, thereby allowing the degree of suction superheat of the compressor 10 to be optimally maintained.

<Control>

**[0075]** Hereinafter, a method of controlling a heat supplier of the present disclosure will be described with reference to FIG. 6.

**[0076]** When an operation is started, a mode is selected (s100), and the compressor 10 is operated (s200).

**[0077]** Here, at step s100, a cooling operation mode CM or a heating operation mode HM may be selected. The mode may be selected by a user.

**[0078]** At step s200, the compressor 10 may be operated so as to compress and discharge a refrigerant. Step s100 and Step s200 may be performed in reversed order or may be performed simultaneously. At step s200, the pump (not shown) may also be operated to allow water passing through the second heat exchanger 24 to flow.

**[0079]** Next, the switching valve 12 is adjusted (s300). The switching valve 12 may change the direction of flow of the refrigerant discharged from the compressor 10 based on the selected mode. In the cooling operation

mode CM, the switching valve 12 may be adjusted so that the refrigerant discharged from the compressor 10 flows into the first heat exchanger 20. In the heating operation mode HM, the switching valve 12 may be adjusted so that the refrigerant discharged from the compressor 10 flows into the second heat exchanger 24.

**[0080]** The switching valve 12 may maintain the direction of flow of the refrigerant unless the operation mode is switched.

**[0081]** Thereafter, in order to regulate the flow of refrigerant flowing through the liquid pipe 30, the first expansion valve 40 and the second expansion valve 42 are adjusted (s400).

**[0082]** The first expansion valve 40 is closed in the cooling operation mode CM. The second expansion valve 42 is closed in the heating operation mode HM.

**[0083]** The second expansion valve 42 may be adjusted in the cooling operation mode CM. In the cooling operation mode CM, the second expansion valve 42 is adjusted to control the degree of discharge superheat.

**[0084]** The first expansion valve 40 may be adjusted in the heating operation mode HM. In the heating operation mode HM, the first expansion valve 40 may be adjusted to control the degree of discharge superheat.

**[0085]** Here, the degree of discharge superheat may refer to the temperature of refrigerant discharged from the compressor.

**[0086]** Thereafter, whether an entry condition for controlling the third expansion valve 46 is satisfied may be determined (s500).

**[0087]** Whether the entry condition for controlling the third expansion valve 46 is satisfied may be determined based on the operational stability of the heat supplier in which the compressor 10 is driven. In one implementation, whether condensation temperature is greater than or equal to a first set temperature is determined. Based on the condensation temperature being greater than or equal to the first set temperature, it may be determined that the entry condition for controlling the third expansion valve 46 is satisfied. In another implementation, whether the degree of discharge superheat of the compressor 10 is greater than or equal to a second set temperature is determined. Based on the degree of discharge superheat of the compressor 10 being greater than or equal to the second set temperature, it may be determined that the entry condition for controlling the third expansion valve 46 is satisfied.

**[0088]** When it is determined that the entry condition for controlling the third expansion valve 46 is satisfied, the third expansion valve 46 is adjusted (s600).

**[0089]** At step s600, the first expansion valve 40 or the second expansion valve 42 may also be adjusted. At step s600, the first expansion valve 40 or the second expansion valve 42, namely, a valve that is not closed may be controlled together.

**[0090]** That is, in the cooling operation mode CM, the second expansion valve 42 may be adjusted together with the third expansion valve 46. In the heating operation

mode HM, the first expansion valve 40 may be adjusted together with the third expansion valve 46.

**[0091]** In the cooling operation mode CM, the third expansion valve 46 is adjusted to control the degree of discharge superheat. The size of an aperture of the third expansion valve 46 may be adjusted to regulate the amount of refrigerant flowing to the compressor 10, thereby controlling the degree of discharge superheat.

**[0092]** Also, in the cooling operation mode CM, the second expansion valve 42 is adjusted to control the degree of suction superheat. Here, the degree of suction superheat may refer to the temperature of refrigerant sucked into the compressor. The second expansion valve 42 may adjust the flow rate of refrigerant sucked into the compressor 10 to thereby control the degree of suction superheat.

**[0093]** In the heating operation mode HM, the third expansion valve 46 is adjusted to control the degree of discharge superheat. Also, in the heating operation mode HM, the first expansion valve 40 may be adjusted to control the degree of supercooling at an outlet of the second heat exchanger 24, which serves as a condenser.

**[0094]** Here, controlling the degree of supercooling at the outlet of the second heat exchanger 24 may mean that the flow rate of the refrigerant flowing from the second heat exchanger 24 to the first heat exchanger 22 is adjusted to control the temperature of the refrigerant flowing through the second heat exchanger 22.

**[0095]** Hereinafter, a heat supplier according to another embodiment of the present disclosure will be described with reference to FIG. 7. Components different from those of the heat supplier of FIG. 1 will be mainly described.

**[0096]** The heat supplier of FIG. 7 is configured such that a first expansion valve 40, a second expansion valve 42, and a third heat exchanger 44 are disposed at one liquid pipe 30. In addition, the heat supplier includes a first bypass pipe 60 to bypass the first expansion valve 40, a second bypass pipe 62 to bypass the second expansion valve 42, a first bypass valve 64 disposed at the first bypass pipe 60, and a second bypass valve 66 disposed at the second bypass valve 62.

**[0097]** The heat supplier includes a branch pipe 38 branched from the liquid pipe 30 to allow the refrigerant to flow into the third heat exchanger 44, and a third expansion valve 46 disposed on the branch pipe 38 and configured to expand the refrigerant flowing there-through.

**[0098]** The first expansion valve 40 is disposed between the first heat exchanger 20 and the third heat exchanger 44. The first expansion valve 40 is closed in the cooling operation mode CM and is opened in the heating operation mode HM.

**[0099]** The second expansion valve 42 is disposed between the second heat exchanger 24 and the third heat exchanger 44. The second expansion valve 42 is opened in the cooling operation mode CM and is closed in the heating operation mode HM.

**[0100]** The first expansion valve 40 and the first bypass valve 64 may be selectively opened. That is, the first bypass valve 64 is closed when the first expansion valve 40 is opened. The first bypass valve 64 is opened when the first expansion valve 40 is closed.

**[0101]** When taking a look at the valve opening and closing according to the operation mode, the first expansion valve 40 is closed and the first bypass valve 64 is opened in the cooling operation mode CM. Also, the first expansion valve 40 is opened and the first bypass valve 64 is closed in the heating operation mode HM.

**[0102]** The second expansion valve 42 and the second bypass valve 66 may be selectively opened. That is, the second bypass valve 66 is closed when the second expansion valve 42 is opened. The second bypass valve 66 is opened when the second expansion valve 42 is closed.

**[0103]** When taking a look at the valve opening and closing according to the operation mode, the second expansion valve 42 is opened and the second bypass valve 66 is closed in the cooling operation mode CM. Also, the second expansion valve 42 is closed and the second bypass valve 66 is opened in the heating operation mode HM.

**[0104]** When taking a look at the flow of refrigerant in the cooling operation mode CM, the refrigerant discharged from the compressor 10 flows into the first heat exchanger 20 through a switching valve 12. The refrigerant that has passed through the first heat exchanger 20 flows into the third heat exchanger 44 through the first bypass pipe 60. In this case, a part of the refrigerant may pass through the third expansion valve 46 and the third heat exchanger 44 through the branch pipe 38 and then flow into the compressor 10.

**[0105]** The refrigerant that has passed through the third heat exchanger 44 may be expanded by the second expansion valve 42 to flow into the second heat exchanger 24, thereby cooling the water flowing through the second heat exchanger 24. Then, the refrigerant discharged from the second heat exchanger 24 flows into the compressor 10.

**[0106]** When taking a look at the flow of refrigerant in the heating operation mode HM, the refrigerant discharged from the compressor 10 flows into the second heat exchanger 24 through the switching valve 12. The second heat exchanger 24 may heat water flowing therein.

**[0107]** The refrigerant that has passed through the second heat exchanger 24 flows into the third heat exchanger 44 through the second bypass pipe 62. Here, a part of the refrigerant may pass through the third expansion valve 46 and the third heat exchanger 44 through the branch pipe 38 and then flow into the compressor 10.

**[0108]** The refrigerant that has passed through the third heat exchanger 44 is expanded by the first expansion valve 40 to flow into the first heat exchanger 20. Then, the refrigerant discharged from the first heat exchanger 20 flows into the compressor 10.

**[0109]** Even in the case of the heat supplier according to FIG. 7, regardless of the operation mode, the refrigerant flowing through the liquid pipe 30 may be made to pass through the third heat exchanger 44 and then pass through the expansion valve 40, 42. That is, when the refrigerant flows from the first heat exchanger 20 to the second heat exchanger 24, the refrigerant that has passed through the third heat exchanger 44 may pass through the second expansion valve 42. When the refrigerant flows from the second heat exchanger 24 to the first heat exchanger 20, the refrigerant that has passed through the third heat exchanger 44 may pass through the first expansion valve 40.

**[0110]** It will be apparent that, although the preferred embodiments have been shown and described above, the present disclosure is not limited to the above-described specific embodiments, and various modifications and variations can be made by those skilled in the art without departing from the scope of the appended claims. Thus, it is intended that the modifications and variations should not be understood independently of the technical spirit or prospect of the present disclosure.

## Claims

### 1. A heat supplier comprising:

a compressor configured to compress a refrigerant;  
 a first heat exchanger configured to exchange heat between air and the refrigerant;  
 a second heat exchanger configured to exchange heat between water and the refrigerant;  
 a switching valve to direct the refrigerant discharged from the compressor into the first heat exchanger or the second heat exchanger;  
 a third heat exchanger configured to exchange heat between refrigerant flowing through a liquid pipe, which connects the first heat exchanger and the second heat exchanger, and refrigerant branched from the liquid pipe and expanded;  
 a first expansion valve configured to expand refrigerant flowing from the third heat exchanger to the first heat exchanger; and  
 a second expansion valve configured to expand refrigerant flowing from the third heat exchanger to the second heat exchanger,  
 wherein the first expansion valve and the second expansion valve are selectively opened and closed according to a direction of the refrigerant flowing through the third heat exchanger.

### 2. The heat supplier of claim 1, wherein the liquid pipe comprises:

a first liquid pipe at which the third heat exchanger and the first expansion valve are disposed;



- a second liquid pipe at which the second expansion valve is disposed; and  
 a bypass pipe to connect a first side and a second side of the first liquid pipe, and  
 wherein the second liquid pipe and the bypass pipe are connected in parallel to the first liquid pipe at different positions.
3. The heat supplier of claim 2, wherein the first liquid pipe is provided with a first check valve to direct refrigerant flowing through the bypass pipe into the third heat exchanger.
  4. The heat supplier of claim 3, wherein the first expansion valve and the third heat exchanger are disposed at the first liquid pipe positioned between two ends of the second bypass pipe, and  
 wherein the third heat exchanger and the first check valve are disposed at the first liquid pipe positioned between two ends of the second liquid pipe.
  5. The heat supplier of claim 4, wherein the first check valve causes the refrigerant to flow into the third heat exchanger.
  6. The heat supplier of claim 5, wherein the bypass pipe is provided with a second check valve to direct refrigerant flowing through the first heat exchanger into the third heat exchanger.
  7. The heat supplier of any one of claims 3 to 6, wherein the bypass pipe is connected to the first liquid pipe so as to bypass the first expansion valve and the third heat exchanger,  
 wherein the second liquid pipe is connected in parallel to the first liquid pipe so as to bypass the third heat exchanger and the first check valve.
  8. The heat supplier of any one of claims 1 to 7, further comprising:  
 a branch pipe branched from the liquid pipe to allow refrigerant to flow into the third heat exchanger; and  
 a third expansion valve disposed on the branch pipe and configured to expand refrigerant flowing therethrough.
  9. The heat supplier of claim 8, wherein the branch pipe is branched from the liquid pipe at a position between the third heat exchanger and the first expansion valve.
  10. The heat supplier of claim 8 or 9, wherein the refrigerant flowing into the third heat exchanger through the branch pipe is supplied to the compressor.
  11. The heat supplier of any one of claims 1 to 10,  
 wherein a size of an aperture of the second expansion valve is greater than a size of an aperture of the first expansion valve.
  12. The heat supplier of any one of claims 1 to 11, wherein the heat supplier is operated in a heating operation mode in which the refrigerant discharged from the compressor is delivered into the second heat exchanger, and  
 wherein the second expansion valve is closed in the heating operation mode, such that the refrigerant flowing from the second heat exchanger to the first heat exchanger passes through the third heat exchanger and then passes through the first expansion valve.
  13. The heat supplier of any one of claims 1 to 12, wherein the heat supplier is operated in a cooling operation mode in which the refrigerant discharged from the compressor is transferred into the first heat exchanger, and  
 wherein the first expansion valve is closed in the cooling operation mode, such that the refrigerant flowing from the first heat exchanger to the second heat exchanger passes through the third heat exchanger and then passes through the second expansion valve.
  14. The heat supplier of claim 13, wherein the liquid pipe comprises:  
 a first liquid pipe at which the third heat exchanger and the first expansion valve are disposed;  
 a second liquid pipe at which the second expansion valve is disposed; and  
 a bypass pipe to connect a first side and a second side of the first liquid pipe, and  
 wherein the first expansion valve is closed in the cooling operation mode, such that the refrigerant flowing from the first heat exchanger to the second heat exchanger flows into the third heat exchanger through the bypass pipe, and the refrigerant flowing out from the third heat exchanger flows through the second liquid pipe.
  15. The heat supplier of any one of claims 1 to 14, wherein the first expansion valve is disposed between the first heat exchanger and the third heat exchanger,  
 wherein the second expansion valve is disposed between the second heat exchanger and the third heat exchanger, and  
 wherein the heat supplier further comprises:  
 a first bypass pipe to bypass the first expansion valve;  
 a second bypass pipe to bypass the second

expansion valve;  
a first bypass valve disposed at the first  
bypass pipe; and  
a second bypass valve disposed at the  
second bypass pipe, 5  
wherein the first expansion valve and the  
first bypass valve are selectively opened,  
and  
wherein the second expansion valve and  
the second bypass valve are selectively 10  
opened.

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Fig. 1

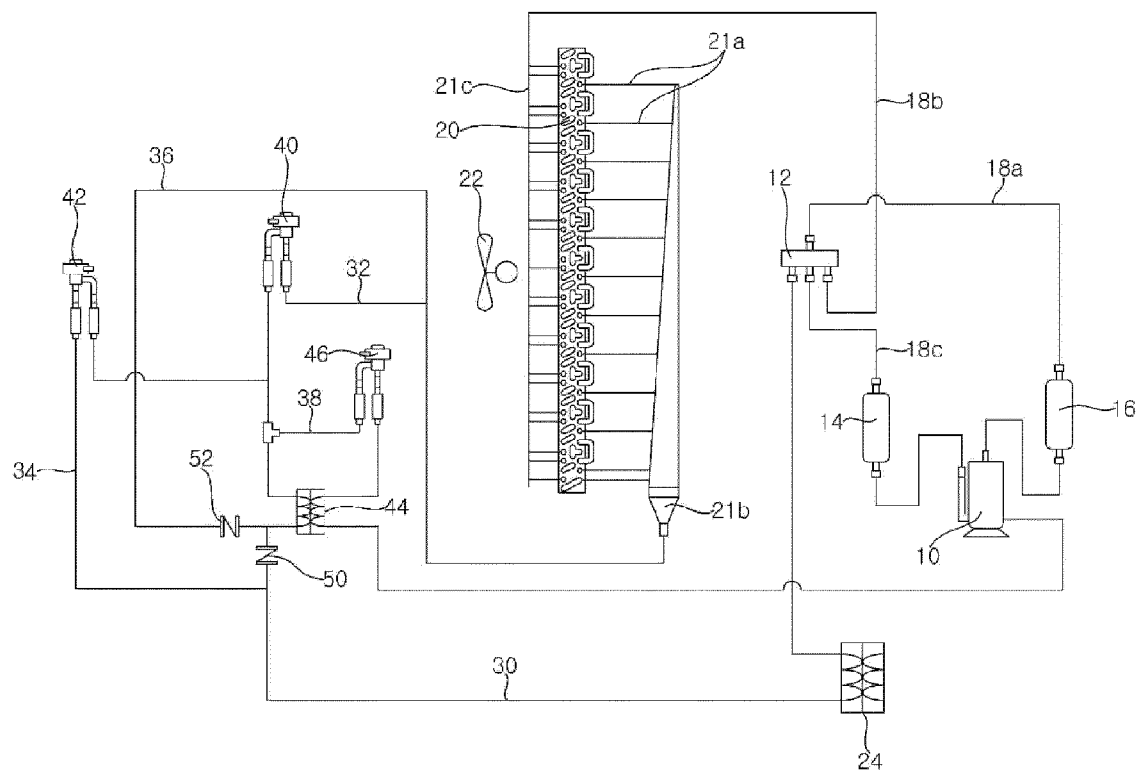


Fig. 2

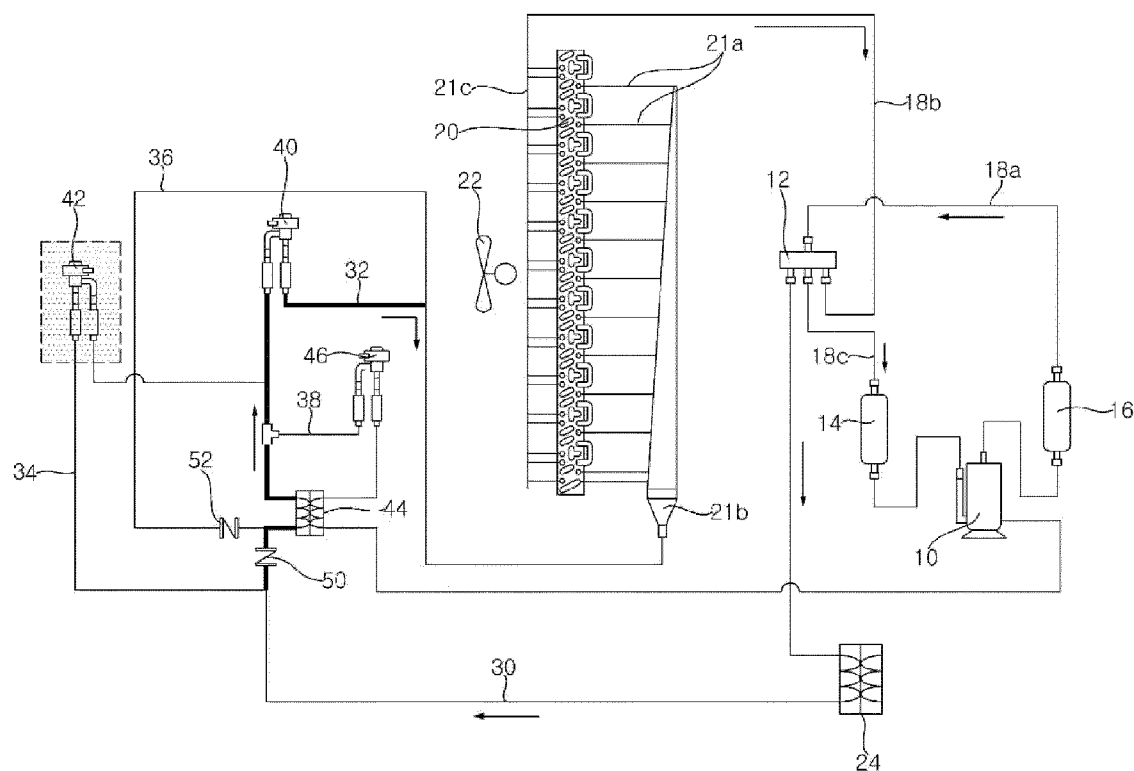


Fig. 3

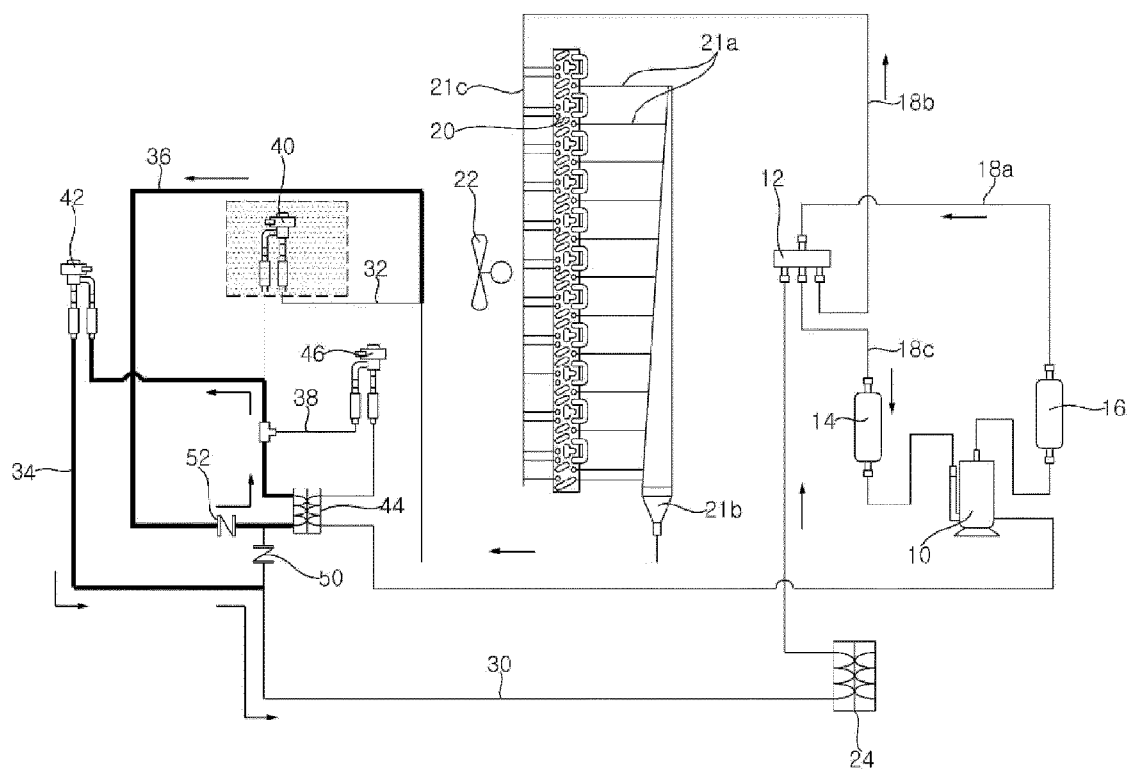


Fig. 4

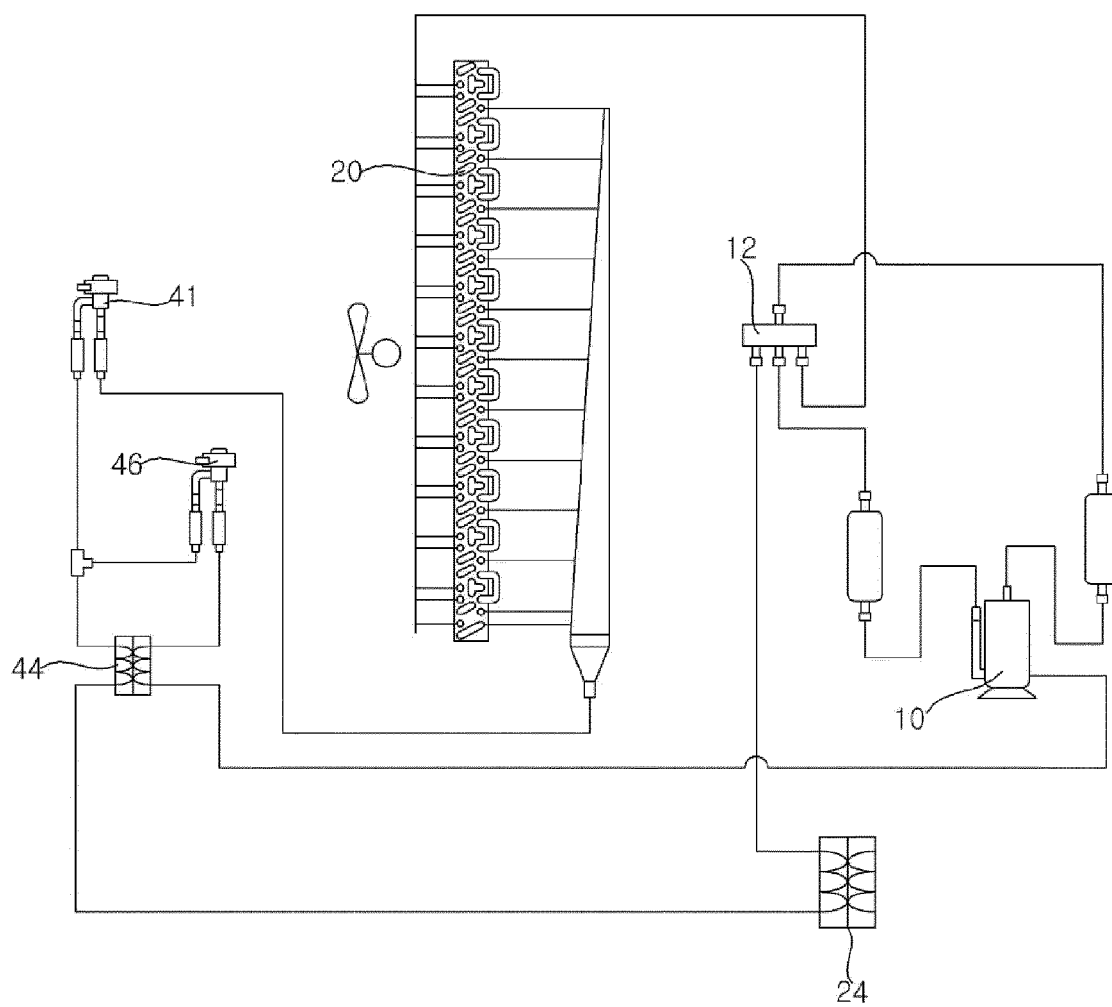


Fig. 5

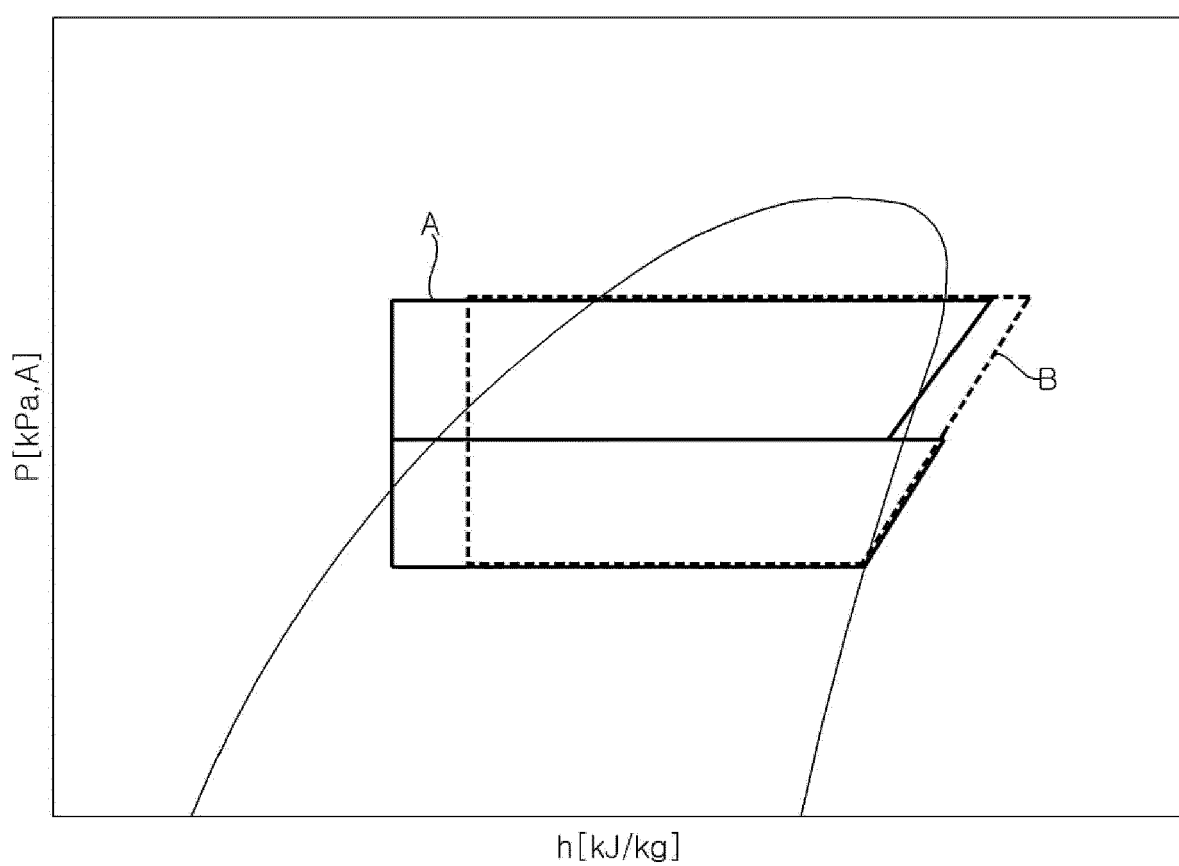


Fig. 6

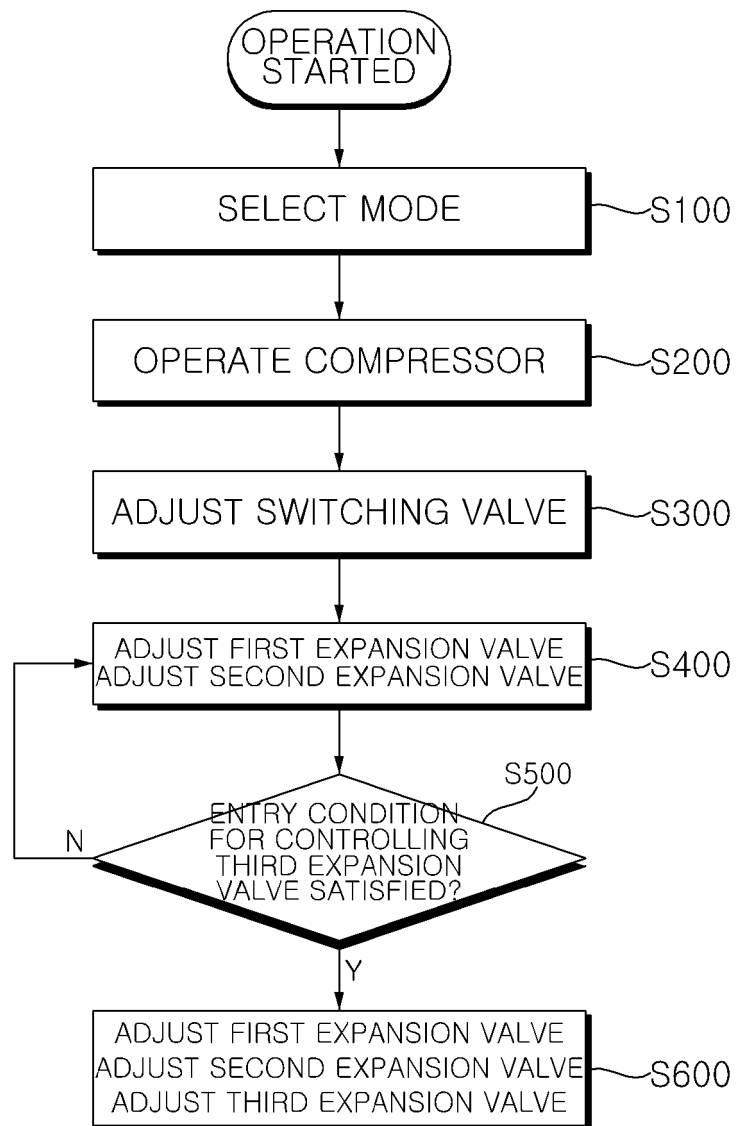
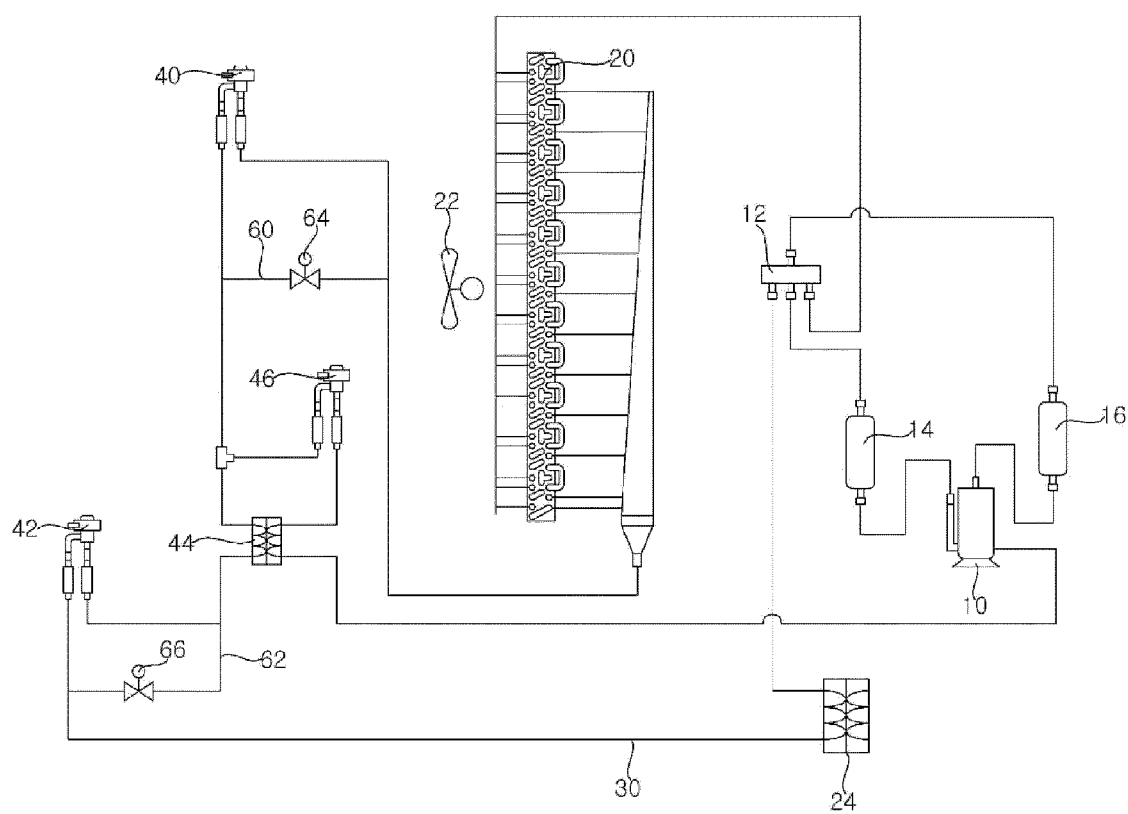




Fig. 7





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Application Number

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| Place of search                                                                                                                                                                                                                                                              |                                                                                                                                                              | Date of completion of the search | Examiner                                                 |
| Munich                                                                                                                                                                                                                                                                       |                                                                                                                                                              | 29 November 2024                 | Gaspar, Ralf                                             |
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| T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                              |                                  |                                                          |

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