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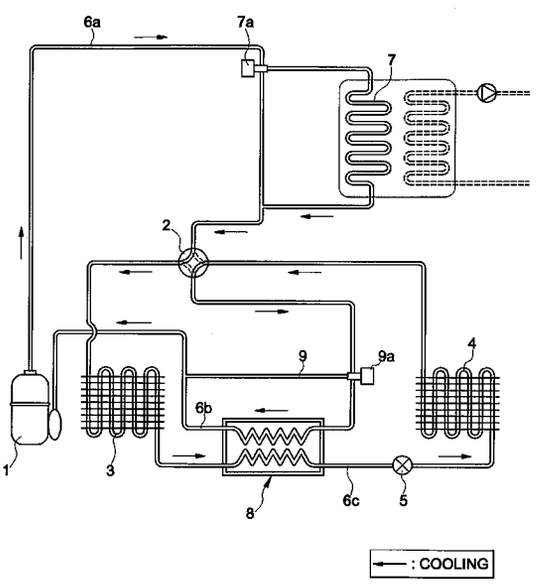
(54) Heating and cooling system

(57) A heating and cooling system for preventing the deterioration of heating efficiency generated due to a subsidiary heat exchanger used to increase cooling efficiency. The heating and cooling system includes a compressor for compressing a refrigerant, an indoor heat exchanger for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger for heat-exchanging the refrigerant with an outdoor air, a four-way valve disposed at an outlet of the compressor for selectively discharging the refrigerant to one of the indoor and outdoor heat exchangers according to heating and cooling modes, an expansion valve for decompressing and expanding the refrigerant, an inlet refrigerant pipe for guiding the refrigerant drawn into the compressor, a subsidiary heat exchanger disposed in the inlet refrigerant pipe for heat-exchanging the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through a connection refrigerant pipe in the cooling mode so as to control the temperature of the refrigerant drawn into the compressor, and a bypass refrigerant pipe for allowing the refrigerant drawn into the compressor to bypass the subsidiary heat exchanger and then to be directed into the compressor. Thereby, the heating and cooling system prevents the deterioration of heating efficiency generated when the refrigerant drawn into the compressor and the refrigerant discharged from the indoor heat exchanger is heat-exchanged in the heating mode.

FIG 1



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Description

[0001] The present invention relates to a heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger, an outdoor heat exchanger, and a subsidiary heat exchanger connected between the indoor and the outdoor heat exchangers.

[0002] Heating and cooling systems generally comprise a compressor for compressing a refrigerant into a high-temperature and high-pressure state, an indoor heat exchanger, an outdoor heat exchanger, an expansion valve for decompressing and expanding the refrigerant, and a four-way valve positioned at an outlet of the compressor for selectively directing the flow of refrigerant to either the indoor or the outdoor heat exchanger dependent on whether the heating or cooling mode is selected.

[0003] The above heating and cooling system further comprises a subsidiary heat exchanger for heat-exchanging the refrigerant discharged from the outdoor heat exchanger with the refrigerant drawn into the compressor when the system is operating in a cooling mode, so that the refrigerant guided into the indoor heat exchanger is cooled and the refrigerant drawn into the compressor is heated, thereby increasing cooling efficiency.

[0004] However, when the system is operating in a heating mode, when the refrigerant passes through the outdoor heat exchanger, it is evaporated and heated by outdoor air, thus being maintained at a relatively high temperature compared to the refrigerant passing from the indoor heat exchanger towards the outdoor heat exchanger. Therefore, when the refrigerant passes through the subsidiary heat exchanger, the high temperature refrigerant from the outdoor heat exchanger is heat-exchanged with the relatively cooler refrigerant from the indoor heat exchanger before it reaches the outdoor heat exchanger, thereby increasing the temperature of the refrigerant just about to pass through the outdoor heat exchanger and so reducing the efficiency of the heating mode.

[0005] Therefore, it is an object of the present invention to provide a heating and cooling system, which substantially alleviates or overcomes the deterioration of heating mode efficiency caused by a subsidiary heat exchanger which is used to increase cooling efficiency.

[0006] Accordingly, a heating and cooling system according to the present invention is characterised by a bypass pipe connected in parallel with the subsidiary heat exchanger operable to allow the refrigerant to flow therethrough and bypass the subsidiary heat exchanger.

[0007] Ina preferred embodiment, a bypass valve is connected to the bypass pipe to selectively direct the flow of refrigerant either through the bypass refrigerant pipe or through the subsidiary heat exchanger. The bypass valve is preferably operable to direct the flow of refrigerant through the subsidiary heat exchanger if the temperature of refrigerant being drawn into the compressor is higher than a predetermined temperature.

[0008] Conveniently, refrigerant flows between the indoor and outdoor heat exchangers through a connection refrigerant pipe and the refrigerant flows back into an inlet of the compressor through an inlet refrigerant pipe, said subsidiary heat exchanger advantageously being operable to heat exchange refrigerant flowing through the connection refrigerant pipe with refrigerant flowing through the inlet refrigerant pipe.

[0009] Preferably, each end of the bypass pipe is respectively connected to the inlet refrigerant pipe either side of the subsidiary heat exchanger, and the bypass valve is connected where one end of the bypass pipe meets the inlet refrigerant pipe.

[0010] In a preferred embodiment, an expansion valve disposed in the connection refrigerant pipe, and preferably, a four-way valve is provided to selectively direct the flow of refrigerant from an outlet of the compressor to either the indoor or the outdoor heat exchanger.

[0011] In accordance with another aspect, the present invention provides a heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger for heat-exchanging the refrigerant with outdoor air, an expansion valve for decompressing and expanding the refrigerant, an inlet refrigerant pipe for guiding the refrigerant drawn into the compressor, a subsidiary heat exchanger disposed in the inlet refrigerant pipe for heat-exchanging the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through a connection refrigerant pipe so as to control the temperature of the refrigerant drawn into the compressor, and a bypass refrigerant pipe for allowing the refrigerant drawn into the compressor to bypass the subsidiary heat exchanger and then to be directed into the compressor.

[0012] A part of the inlet refrigerant pipe and a part of the connection refrigerant pipe for guiding the transfer of the refrigerant between the outdoor and indoor heat exchangers may be disposed in the subsidiary heat exchanger so that the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through the connection refrigerant pipe are heat-exchanged.

[0013] The bypass refrigerant pipe may be provided with both ends respectively connected to positions of the inlet refrigerant pipe disposed at both sides of the subsidiary heat exchanger, and a bypass valve may be disposed at an area, where the inlet refrigerant pipe and the bypass refrigerant pipe are connected, for guiding the refrigerant to one of the subsidiary heat exchanger and the bypass refrigerant pipe.

[0014] The heating and cooling system may further comprise a hot water supply heat exchanger connected in parallel to an outlet refrigerant for guiding the refrigerant discharged from the compressor, and a hot water supply valve for supplying the refrigerant to the hot water

supply heat exchanger in case the heating and cooling system requires hot water.

[0015] In accordance with yet another aspect, the present invention provides a heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger for heat-exchanging the refrigerant with outdoor air, a four-way valve disposed at an outlet of the compressor for selectively discharging the refrigerant to one of the indoor and outdoor heat exchangers according to heating and cooling modes, an expansion valve for decompressing and expanding the refrigerant, an inlet refrigerant pipe for guiding the refrigerant drawn into the compressor, a subsidiary heat exchanger disposed in the inlet refrigerant pipe for heat-exchanging the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through a connection refrigerant pipe in the cooling mode so as to control the temperature of the refrigerant drawn into the compressor, and a bypass refrigerant pipe for allowing the refrigerant drawn into the compressor to bypass the subsidiary heat exchanger and then to be directed into the compressor.

[0016] A part of the inlet refrigerant pipe and a part of the connection refrigerant pipe for guiding the transfer of the refrigerant between the outdoor and indoor heat exchangers may be disposed in the subsidiary heat exchanger so that the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through connection refrigerant pipe are heat-exchanged.

[0017] The bypass refrigerant pipe may be provided with both ends respectively connected to positions of the inlet refrigerant pipe disposed at both sides of the subsidiary heat exchanger, and a bypass valve may be disposed at an area, where the inlet refrigerant pipe and the bypass refrigerant pipe are connected, for guiding the refrigerant to either the subsidiary heat exchanger or the bypass refrigerant pipe.

[0018] The heating and cooling system may further comprise a hot water supply heat exchanger connected in parallel to an outlet refrigerant pipe for guiding the refrigerant discharged from the compressor, and a hot water supply valve for supplying the refrigerant to the hot water supply heat exchanger in case the heating and cooling system requires hot water.

[0019] The bypass valve may guide the refrigerant to the subsidiary heat exchanger in case the temperature of the refrigerant drawn into the compressor in the heating mode is higher than a designated value.

[0020] A preferred embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view illustrating the flow of a refrigerant in a cooling mode of a heating and cooling system in accordance with the present invention;

Figure 2 is a schematic view illustrating the flow of the refrigerant in a heating mode of the heating and cooling system in accordance with the present invention; and

Figure 3 is a schematic view illustrating the flow of the refrigerant, in which heat-exchange is achieved by a subsidiary heat exchanger, in the heating mode of the heating and cooling system in accordance with the present invention.

[0021] Referring now to Figure 1, a heating and cooling system in accordance with the present invention comprises a compressor 1 for compressing a refrigerant into a high-temperature and high-pressure state, a four-way valve 2 disposed at an outlet of the compressor 1 for selectively directing the flow of the refrigerant according to a selected operating mode, i.e. heating or cooling mode, an indoor heat exchanger 4 for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger 3 for heat-exchanging the refrigerant with outdoor air, and an expansion valve 5 for decompressing and expanding the refrigerant. Carbon dioxide (CO_2) is used as the refrigerant in the heating and cooling system of the present invention.

[0022] When the four-way valve 2 is operated to direct the high-temperature and high-pressure refrigerant discharged from the compressor 1 to the outdoor heat exchanger 3, the outdoor heat exchanger 3 serves as a condenser and the indoor heat exchanger 4 serves as an evaporator, thereby causing the heating and cooling system of the present invention to be operated in the cooling mode. On the other hand, when the refrigerant discharged from the compressor 1 is directed to the indoor heat exchanger 4, the indoor heat exchanger 4 serves as a condenser and the outdoor heat exchanger 3 serves as an evaporator, thereby causing the heating and cooling system of the present invention to be operated in the heating mode.

[0023] The above parts of the heating and cooling system constitute a closed circuit through refrigerant pipes 6a, 6b and 6c. The refrigerant pipes 6a, 6b and 6c comprise an outlet refrigerant pipe 6a for guiding the refrigerant discharged from the compressor 1 to the four-way valve 2, an inlet refrigerant pipe 6b for guiding the refrigerant from the four-way valve 2 to the compressor 1 and a connection refrigerant pipe 6c disposed between the outdoor heat exchanger 3 and the indoor heat exchanger 4 for guiding the refrigerant discharged from the outdoor heat exchanger 3 to the indoor heat exchanger 4 and vice versa. The expansion valve 5 is disposed in the connection refrigerant pipe 6c.

[0024] A hot water supply heat exchanger 7 is connected in parallel to the outlet refrigerant pipe 6a for heat-exchanging the refrigerant with supplied water in order to provide hot water, and a hot water supply valve 7a is provided for selectively directing the refrigerant to the hot water supply heat exchanger 7 when required.

[0025] The heating and cooling system of the present invention further comprises a subsidiary heat exchanger

8 operable to heat the refrigerant prior to entering the compressor 1 in the cooling mode, thus improving the cooling efficiency. A part of the inlet refrigerant pipe 6b and a part of the connection refrigerant pipe 6c close to the outdoor heat exchanger 3 are disposed in the subsidiary heat exchanger 8 so that the refrigerants passing therethrough are heat-exchanged. Therefore, in a cooling mode, the refrigerant passing through the inlet refrigerant pipe 6b is heated by the refrigerant passing through the connection refrigerant pipe 6c, and the refrigerant passing through the connection refrigerant pipe 6c is cooled by heat exchange with the refrigerant passing through the inlet refrigerant pipe 6b, before the refrigerant passing through the connection refrigerant pipe 6c is decompressed and expanded by the expansion valve 5.

[0026] The heating and cooling system of the present invention further comprises a bypass refrigerant pipe 9 provided with ends respectively connected to positions of the inlet refrigerant pipe 6b at either side of the subsidiary heat exchanger 8 so as to allow the refrigerant to bypass the subsidiary heat exchanger 8. Heat exchange of the refrigerants by the subsidiary heat exchanger 8 can therefore selectively be performed in the cooling mode and suppressed in the heating mode. A bypass valve 9a is disposed where the inlet refrigerant pipe 6b and the bypass refrigerant pipe 9 are connected, for selectively directing the refrigerant to either the subsidiary heat exchanger 8 or the bypass refrigerant pipe 9, according to whether the cooling or heating mode is selected.

[0027] Accordingly, in the heating mode, the refrigerant drawn into the compressor 1 by the bypass valve 9a does not pass through the subsidiary heat exchanger 8 but is introduced directly into the compressor 1 through the bypass refrigerant pipe 9. Since the refrigerant supplied to the outdoor heat exchanger 3 through the connection refrigerant pipe 6c is expanded by the expansion valve 5 and has a temperature lower than that of outdoor air, it is heated and evaporated by the outdoor air when it passes through the outdoor heat exchanger 3. If it was to then pass through the subsidiary heat exchanger 8 along the inlet refrigerant pipe 6b, it would be cooled again by the refrigerant passing through the connection refrigerant pipe 6c, thereby being converted into a liquid state. However, the above described structure of the bypass refrigerant pipe 9 and bypass valve 9a of the present invention serves to prevent the generation of liquid refrigerant.

[0028] In the heating mode, if the refrigerant being drawn into the compressor 1 has a temperature higher than a predetermined value, the bypass valve 9a directs the flow of refrigerant through the subsidiary heat exchanger 8. This causes the refrigerant to be cooled by heat exchange with the refrigerant passing through the connection refrigerant pipe 6c, thereby preventing the compressor 1 from being overloaded due to excessive pressure generated when the temperature of the refrigerant is higher than the designated value.

[0029] Hereinafter, operation and effects of the above described heating and cooling system of the present invention will be described in detail.

[0030] First, the cooling mode of the heating and cooling system of the present invention will be described. The refrigerant in a high-temperature and high-pressure state is discharged from the compressor 1 and is directed to the outdoor heat exchanger 3 by the four-way valve 2. Accordingly, in the cooling mode, the outdoor heat exchanger 3 serves as a condenser and the indoor heat exchanger 4 serves as an evaporator.

[0031] The refrigerant supplied to the outdoor heat exchanger 3 emits heat so that it is cooled, and it then passes through the expansion valve 5 disposed in the connection refrigerant pipe 6c whereby it is decompressed and expanded. It then flows to the indoor heat exchanger 4 where it is heat-exchanged with indoor air, absorbs heat from the indoor air, and cools an indoor space. The refrigerant is continuously being drawn into the compressor 1 through the four-way valve 2 and the inlet refrigerant pipe 6b.

[0032] In the cooling mode, the bypass valve 9a directs the flow of refrigerant through the subsidiary heat exchanger 8, thus allowing it to be heat exchanged with the refrigerant passing through the connection refrigerant pipe 6c. The refrigerant flowing to the indoor heat exchanger 4 through the connection refrigerant pipe 6c is cooled and the refrigerant flowing to the compressor 1 through the inlet refrigerant pipe 6b is heated, thereby increasing cooling efficiency of the heating and cooling system.

[0033] Next, with reference to Figure 2, the heating mode of the heating and cooling system of the present invention will be described. The refrigerant in the high-temperature and high-pressure state discharged from the compressor 1 is directed to the indoor heat exchanger 4 by the four-way valve 2. Accordingly, in the heating mode, the indoor heat exchanger 4 serves as a condenser and the outdoor heat exchanger 3 serves as an evaporator.

[0034] The refrigerant supplied to the indoor heat exchanger 4 emits heat by being heat-exchanged with the indoor air, thereby heating the indoor space. The refrigerant then flows through the expansion valve 5 where it is decompressed and expanded. It then flows to the outdoor heat exchanger 3 through the connection refrigerant pipe 6c where it absorbs heat through heat exchange with the outdoor air, and is heated. Then, the refrigerant is continuously being drawn into the compressor 1 through the four-way valve 2 and the inlet refrigerant pipe 6b.

[0035] In the heating mode, the bypass valve 9a directs the refrigerant to the bypass refrigerant pipe 9 so that it does not pass through the subsidiary heat exchanger 8 and is directly drawn into the compressor 1, thereby preventing any heat-exchange with the refrigerant passing through the connection refrigerant pipe 6c.

[0036] However, referring now to Figure 3, if the temperature of the refrigerant drawn into the compressor 1 is more than a designated value, the refrigerant passing through the inlet refrigerant pipe 6b is directed to the subsidiary heat exchanger 8 by the bypass valve 9a. The refrigerant passing through the inlet refrigerant pipe 6b is heat-exchanged with the refrigerant passing through the connection refrigerant pipe 6c, thereby being cooled.

[0037] In the heating and cooling system of the present invention, the hot water supply heat exchanger 7 is connected in parallel to the outlet refrigerant pipe 6a. If the heating and cooling system requires hot water, the high-temperature and high-pressure refrigerant discharged from the compressor 1 is supplied to the hot water supply heat exchanger 7, thereby heating water.

[0038] As is apparent from the above description, the present invention provides a heating and cooling system including a bypass refrigerant pipe and a bypass valve operable to allow refrigerant to bypass a subsidiary heat exchanger in a heating mode, thereby preventing the deterioration of heating efficiency that is caused by the subsidiary heat exchanger in the heating mode.

[0039] Furthermore, the system of the present invention is operable to allow the refrigerant passing through an inlet refrigerant pipe to be directed to the subsidiary heat exchanger and cooled by the refrigerant passing through a connection refrigerant pipe, if the refrigerant introduced into a compressor has a temperature higher than a designated value, in order to prevent the compressor from being overloaded.

[0040] Although the preferred embodiment of the invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the claims hereafter.

Claims

1. A heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger, an outdoor heat exchanger, and a subsidiary heat exchanger connected between the indoor and outdoor heat exchangers **characterised by** a bypass pipe connected in parallel with the subsidiary heat exchanger operable to allow the refrigerant to flow therethrough and bypass the subsidiary heat exchanger.

2. A heating and cooling system according to claim 1 wherein a bypass valve is connected to the bypass pipe to selectively direct the flow of refrigerant either through the bypass refrigerant pipe or through the subsidiary heat exchanger.

3. A heating and cooling system according to claim 2 wherein the bypass valve is operable to direct the flow of refrigerant through the subsidiary heat exchanger if the temperature of refrigerant being drawn into the compressor is higher than a predetermined temperature.

4. A heating and cooling system according to claim 2 or claim 3 wherein refrigerant flows between the indoor and outdoor heat exchangers through a connection refrigerant pipe and the refrigerant flows back into an inlet of the compressor through an inlet refrigerant pipe, said subsidiary heat exchanger being operable to heat exchange refrigerant flowing through the connection refrigerant pipe with refrigerant flowing through the inlet refrigerant pipe.

5. A heating and cooling system according to claim 4 wherein each end of the bypass pipe is respectively connected to the inlet refrigerant pipe either side of the subsidiary heat exchanger, and the bypass valve is connected where one end of the bypass pipe meets the inlet refrigerant pipe.

6. A heating and cooling system according to claim 4 or claim 5 including an expansion valve disposed in the connection refrigerant pipe.

7. A heating and cooling system according to any preceding claim further comprising a four-way valve to selectively direct the flow of refrigerant from an outlet of the compressor to either the indoor or the outdoor heat exchanger.

8. A heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger for heat-exchanging the refrigerant with outdoor air, an expansion valve for decompressing and expanding the refrigerant, an inlet refrigeration pipe for guiding the refrigerant drawn into the compressor, a subsidiary heat exchanger disposed in the inlet refrigerant pipe for heat-exchanging the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through a connection refrigerant pipe so as to control the temperature of the refrigerant drawn into the compressor, and a bypass refrigerant pipe for allowing the refrigerant drawn into the compressor to bypass the subsidiary heat exchanger and then to be directed into the compressor.

9. The heating and cooling system according to claim 8 wherein a part of the inlet refrigerant pipe and a part of the connection refrigerant pipe for guiding the transfer of the refrigerant between the outdoor and indoor heat exchangers are disposed in the subsidiary heat exchanger so that the refrigerant passing through the inlet refrigerant pipe and the

refrigerant passing through the connection refrigerant pipe are heat-exchanged.

10. The heating and cooling system according to claim 8 wherein the bypass refrigerant pipe is provided with both ends respectively connected to positions of the inlet refrigerant pipe disposed at both sides of the subsidiary heat exchanger, and a bypass valve is disposed at an area, where the inlet refrigerant pipe and the bypass refrigerant pipe are connected, for guiding the refrigerant to one of the subsidiary heat exchanger and the bypass refrigerant pipe.

11. The heating and cooling system according to claim 8 further comprising a hot water supply heat exchanger connected in parallel to an outlet refrigerant pipe for guiding the refrigerant discharged from the compressor, and a hot water supply valve for supplying the refrigerant to the hot water supply heat exchanger in case the heating and cooling system requires hot water.

12. A heating and cooling system comprising a compressor for compressing a refrigerant, an indoor heat exchanger for heat-exchanging the refrigerant with indoor air, an outdoor heat exchanger for heat-exchanging the refrigerant with outdoor air, a four-way valve disposed at an outlet of the compressor for selectively discharging the refrigerant to one of the indoor and outdoor heat exchangers according to heating and cooling modes, an expansion valve for decompressing and expanding the refrigerant, an inlet refrigerant pipe for guiding the refrigerant drawn into the compressor, a subsidiary heat exchanger disposed in the inlet refrigerant pipe for heat-exchanging the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through a connection refrigerant pipe in the cooling mode so as to control the temperature of the refrigerant drawn into the compressor, and a bypass refrigerant pipe for allowing the refrigerant drawn into the compressor to bypass the subsidiary heat exchanger and then to be directed into the compressor.

13. The heating and cooling system according to claim 12 wherein a part of the inlet refrigerant pipe and a part of the connection refrigerant pipe for guiding the transfer of the refrigerant between the outdoor and indoor heat exchangers are disposed in the subsidiary heat exchanger so that the refrigerant passing through the inlet refrigerant pipe and the refrigerant passing through connection refrigerant pipe are heat-exchanged.

14. The heating and cooling system according to claim 12 wherein the bypass refrigerant pipe is provided with both ends respectively connected to positions of the inlet refrigerant pipe disposed at both sides of the subsidiary heat exchanger, and a bypass valve is disposed at an area, where the inlet refrigerant pipe and the bypass refrigerant pipe are connected, for guiding the refrigerant to one of the subsidiary heat exchanger and the bypass refrigerant pipe.

15. The heating and cooling system according to claim 12 further comprising a hot water supply heat exchanger connected in parallel to an outlet refrigerant pipe for guiding the refrigerant discharged from the compressor, and a hot water supply valve for supplying the refrigerant to the hot water supply heat exchanger in case the heating and cooling system requires hot water.

16. The heating and cooling system according to claim 12 wherein the bypass valve guides the refrigerant to the subsidiary heat exchanger in case that the temperature of the refrigerant drawn into the compressor in the heating mode is higher than a designated value.

FIG 1

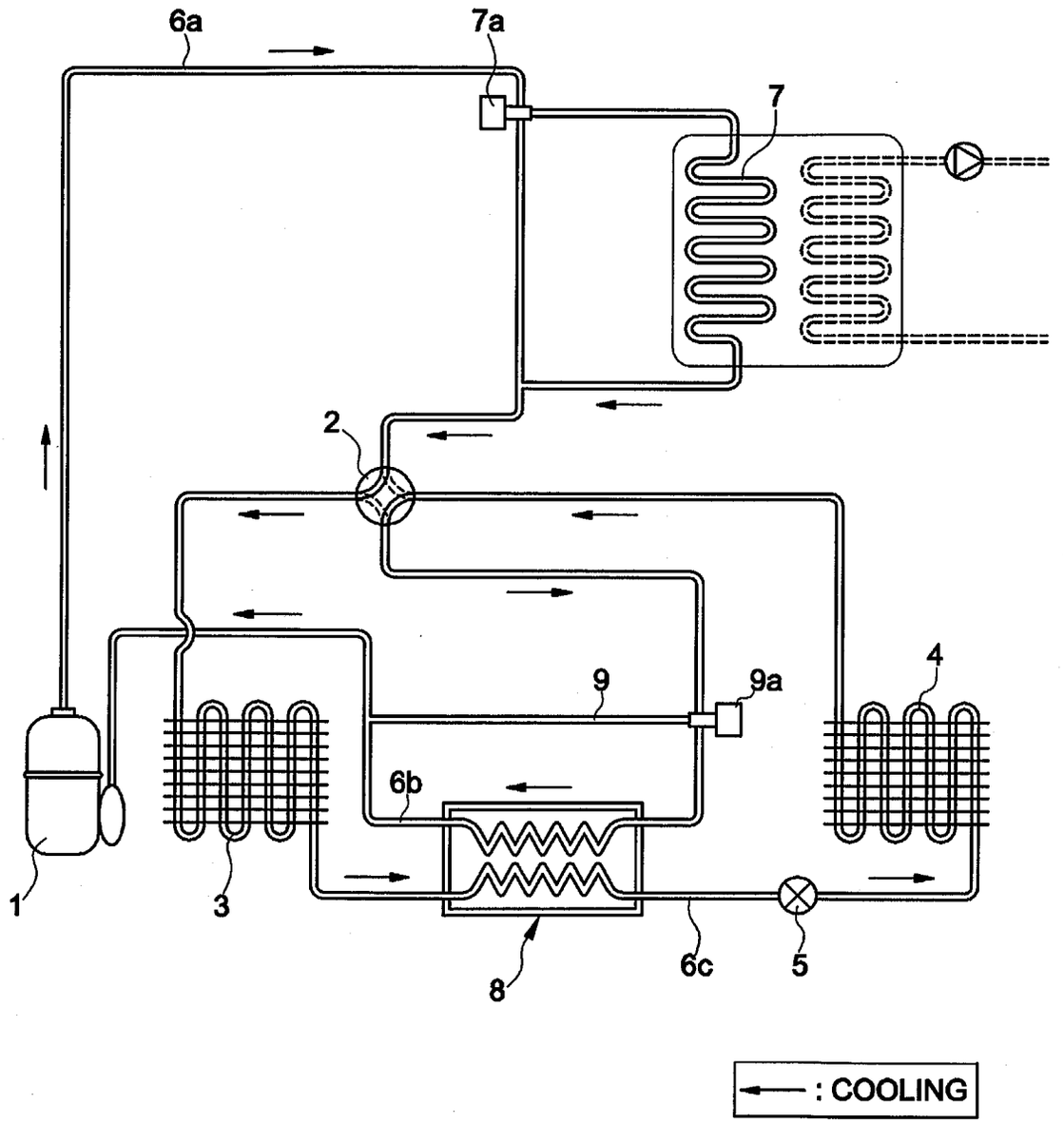

FIG 2

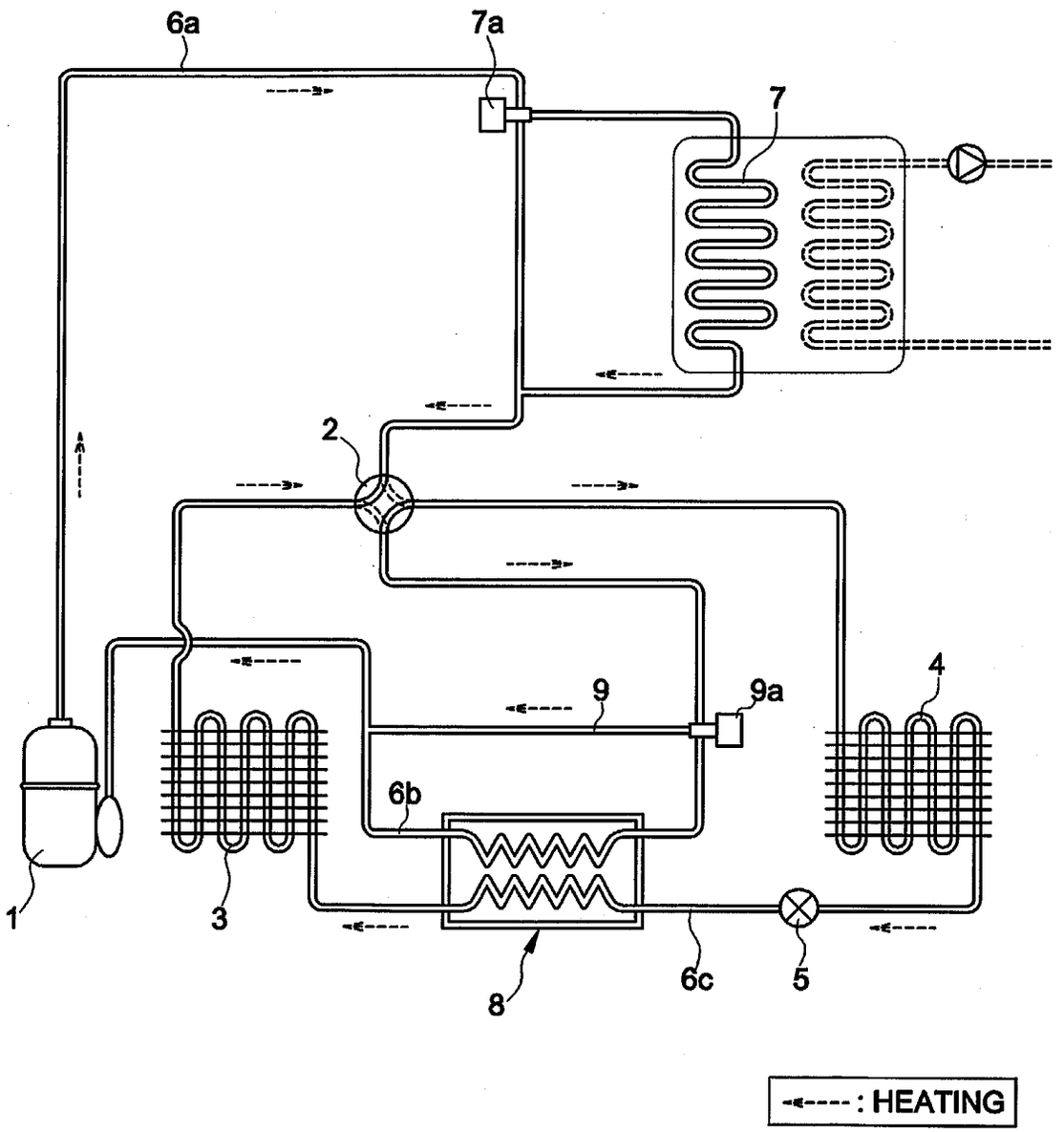

FIG 3