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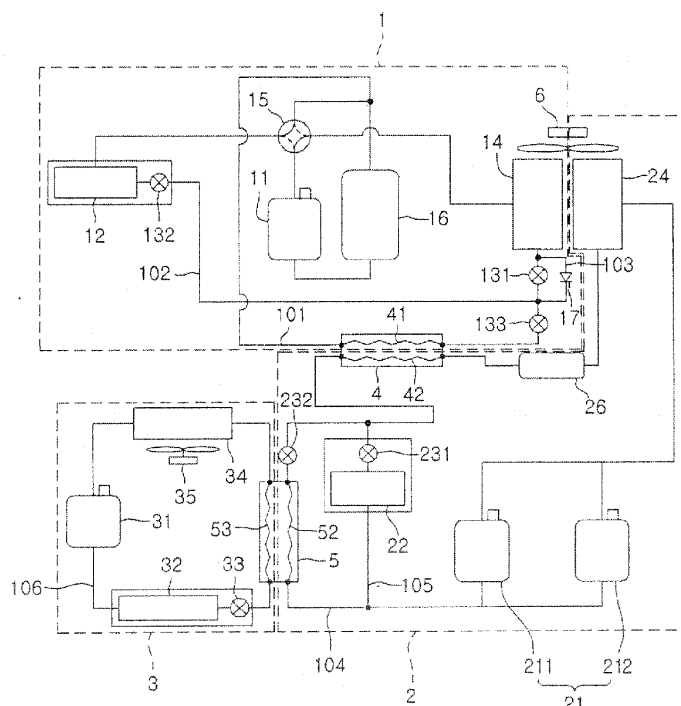
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(54) **Refrigerant system**

(57) A refrigerant system, includes: an air conditioner (1) configured to condition air in a building by using a first refrigerant cycle; a cooler (2) configured to cool air in a storage compartment of the building by using a second refrigerant cycle; and a refrigerant heat exchanger (4)

configured to exchange heat between a refrigerant of the air conditioner and a refrigerant of the cooler, wherein the cooler includes a main compressor (211) and an auxiliary compressor (212) configured to backup the main compressor.

FIG. 1



Description

[0001] Exemplary embodiments of the present invention relate to a refrigerant system performing a refrigerant cycle.

[0002] A refrigerant system of the related art performs a refrigerant cycle of compression, condensation, expansion, and evaporation to heat/cool an indoor space or cool a food in a storage.

[0003] Such a refrigerant system includes a compressor for compressing refrigerant, an indoor heat exchanger where the refrigerant exchanges heat with indoor air, an expander expanding the refrigerant, and an outdoor heat exchanger where the refrigerant exchanges heat with outdoor air. Further, the refrigerant system may include an accumulator for dividing the refrigerant that is introduced to the compressor into liquid refrigerant and vapor refrigerant, a four-way valve configured to change a flow direction of the refrigerant for performing the refrigerant cycle, a fan forcibly moving the indoor air or outdoor air respectively to the indoor heat exchanger or the outdoor heat exchanger, and a motor for rotating the fan.

[0004] When an indoor space is cooled, the indoor heat exchanger functions as an evaporating member, and the outdoor heat exchanger functions as a condensing member. When the indoor space is heated, the indoor heat exchanger functions as a condensing member, and the outdoor heat exchanger functions as an evaporating member. A shift between the heating and cooling of the indoor space is performed by changing the flow direction of the refrigerant with the four-way valve.

[0005] Accordingly, the present invention is directed to a refrigerant system that substantially obviate one or more problems due to limitations and disadvantages of the related art.

[0006] An advantage of the present invention is to continually cool a food or other material, and prevent damage to the food or other material due to a cooling stop.

[0007] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0008] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, a refrigerant system may include: an air conditioner configured to condition air in a building by using a first refrigerant cycle; a cooler configured to cool air in a storage compartment of the building by using a second refrigerant cycle; and a refrigerant heat exchanger configured to exchange heat between a refrigerant of the air conditioner and a refrigerant of the cooler, wherein the cooler includes a main compressor and an auxiliary compressor configured to back-

up the main compressor.

[0009] The refrigerant system may include a breakdown sensor configured to sense a breakdown of the main compressor and a controller configured to control the auxiliary compressor to replace the main compressor if the breakdown sensor senses a breakdown of the main compressor.

[0010] The breakdown sensor may include a current sensor configured to sense a current of the main compressor. The controller may control the auxiliary compressor to replace the main compressor if the current sensed by the current sensor is greater than a reference current. The controller may control the auxiliary compressor to replace the main compressor if the current sensed by the current sensor is less than a reference current.

[0011] The breakdown sensor may include a temperature sensor configured to sense a refrigerant temperature at a discharge side of the main compressor. The controller may control the auxiliary compressor to replace the main compressor if the temperature sensed by the temperature sensor is greater than a reference temperature.

[0012] The refrigerant system may include a breakdown signaler configured to output a breakdown signal if the breakdown sensor senses a breakdown of the main compressor.

[0013] The refrigerant system may include an overload sensor configured to sense an overload of the main compressor and a controller configured to control the auxiliary compressor to supplement the main compressor if the overload sensor senses an overload of the main compressor.

[0014] The overload sensor may include a temperature sensor configured to sense an outdoor temperature. The controller may control the auxiliary compressor to supplement the main compressor if the temperature sensed by the temperature sensor is greater than a reference temperature.

[0015] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0016] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0017] In the drawings:

[0018] FIG. 1 is a schematic view illustrating a refrigerant system.

[0019] FIG. 2 is a schematic view illustrating a flow of refrigerant in the refrigerant system of FIG. 1.

[0020] FIG. 3 is a block diagram illustrating a control signal flow of the refrigerant system of FIG. 1.

[0021] FIG. 4 is a block diagram illustrating another control signal flow of the refrigerant system of FIG. 1.

[0022] FIG. 5 is a flowchart illustrating a method of con-

trolling the refrigerant system according to the control signal flow of FIG. 4.

[0023] FIG. 6 is a schematic view illustrating a flow of the refrigerant when the refrigerant system operates under an overload condition.

[0024] FIG. 7 is a schematic view illustrating a flow of the refrigerant when the main compressor of the refrigerant system is broken.

[0025] FIG. 8 is a block diagram illustrating another control signal flow of a refrigerant system of FIG. 1.

[0026] FIG. 9 is a flowchart illustrating a method of controlling the refrigerant system of FIG. 7.

[0027] Reference will now be made in detail to embodiments of the present invention, examples of which is illustrated in the accompanying drawings.

[0028] FIG. 1 is a schematic view illustrating a refrigerant system.

[0029] Referring to FIG. 1, the refrigerant system may include an air conditioner 1 performing a refrigerant cycle to condition indoor air, and coolers 2 and 3 each performing a refrigerant cycle for cooling a storage compartment. For example, the air conditioner 1 may condition air in a building and coolers 2 and 3 may each cool a storage compartment of the building, such as a storage compartment attached to the building or connected with the building in some manner.

[0030] The coolers 2 and 3 may include a refrigerator (also denoted by 2) for refrigerating, for example, a food, and a freezer (also denoted by 3) for freezing, for example, a food. Refrigerant of the air conditioner 1, refrigerant of the refrigerator 2, and refrigerant of the freezer 3 may flow independently from one another.

[0031] The air conditioner 1 may include: an air conditioner compressor 11 for compressing the refrigerant flowing through the air conditioner 1; an air conditioner outdoor heat exchanger 14 where the refrigerant exchanges heat with outdoor air; air conditioner expanders 131, 132, and 133 for expanding the refrigerant; and an indoor heat exchanger 12 where the refrigerant exchanges heat with indoor air. The air conditioner 1 may include an accumulator 16 for dividing the refrigerant introduced to the air conditioner compressor 11 into vapor refrigerant and liquid refrigerant, and a four-way valve 15 for changing a flow direction of the refrigerant discharged from the air conditioner compressor 11.

[0032] The refrigerator 2 may include: refrigerator compressor 21 for compressing the refrigerant flowing through the refrigerator 2; a refrigerator outdoor heat exchanger 24 where the refrigerant exchanges heat with outdoor air; refrigerator expanders 231 and 232 for expanding the refrigerant; and a refrigerator heat exchanger 22 where the refrigerant exchanges heat with air adjacent to a food. The outdoor air of the refrigerator 2 may be the same as the outdoor air of the air conditioner 1 or may be the indoor air of the air conditioner 1.

[0033] The freezer 3 may include: a freezer compressor 31 for compressing the refrigerant flowing through the freezer 3; a freezer outdoor heat exchanger 34 where

the refrigerant exchanges heat with outdoor air; a fan motor assembly 35 for forcibly moving outdoor air to the freezer outdoor heat exchanger 34; a freezer expander 33 for expanding the refrigerant; and a freezer heat exchanger 32 where the refrigerant exchanges heat with air adjacent to a food. The outdoor air of the freezer 3 may be the same as the outdoor air of the air conditioner 1 or may be the indoor air of the air conditioner 1.

[0034] In other words, each of the refrigerator 2 and the freezer 3 may include: a cooler compressor for compressing the refrigerant flowing through the refrigerator 2 or the freezer 3; a cooler outdoor heat exchanger where the refrigerant exchanges heat with outdoor air; a cooler expander for expanding the refrigerant; and a cooler heat exchanger where the refrigerant exchanges heat with air adjacent to a food. The cooler compressors may include the refrigerator compressor 21 and the freezer compressor 31. The cooler outdoor heat exchangers may include the refrigerator outdoor heat exchanger 24 and the freezer outdoor heat exchanger 34. The cooler expanders may include the refrigerator expanders 231 and 232 and the freezer expander 33. The cooler heat exchangers may include the refrigerator heat exchanger 22 and the freezer heat exchanger 32.

[0035] The air conditioner expanders 131, 132, and 133; the refrigerator expanders 231 and 232; and the freezer expander 33 may be any device such as an electronic valve that can discharge and cut off a refrigerant flow, expand refrigerant, and control a flow rate of refrigerant. The refrigerant system may include a fan motor assembly 6 for forcibly moving outdoor air to the air conditioner outdoor heat exchanger 14 and the refrigerator outdoor heat exchanger 24. When the air conditioner outdoor heat exchanger 14 is adjacent to the refrigerator outdoor heat exchanger 24, the single fan motor assembly 6 may be provided to forcibly move outdoor air to both the air conditioner outdoor heat exchanger 14 and the refrigerator outdoor heat exchanger 24. However, two fan motor assemblies may be provided to correspond respectively to the air conditioner outdoor heat exchanger 14 and the refrigerator outdoor heat exchanger 24, such as when the air conditioner outdoor heat exchanger 14 is spaced a predetermined distance from the refrigerator outdoor heat exchanger 24.

[0036] The refrigerant system may include refrigerant heat exchangers 4 and 5 such that the air conditioner 1 exchanges heat with the refrigerator 2 and the refrigerator 2 exchanges heat with the freezer 3. The refrigerant heat exchangers 4 and 5 may include a first refrigerant heat exchanger (also denoted by 4) where the refrigerant of the air conditioner 1 exchanges heat with the refrigerant of the refrigerator 2, and a second refrigerant heat exchanger (also denoted by 5) where the refrigerant of the refrigerator 2 exchanges heat with the refrigerant of the freezer 3.

[0037] Passages 41 and 42 may be disposed within the first refrigerant heat exchanger 4 such that the refrigerant of the air conditioner 1 and the refrigerant of the

refrigerator 2 independently flow to exchange heat with each other. In addition, passages 51 and 52 may be disposed within the second refrigerant heat exchanger 5 such that the refrigerant of the refrigerator 2 and the refrigerant of the freezer 3 independently flow to exchange heat with each other.

[0038] The first refrigerant heat exchanger 4 may be connected in parallel to the indoor heat exchanger 12 of the air conditioner 1. The air conditioner 1 may further include air conditioner refrigerant pipes 101, 102, and 103 for guiding a flow of the refrigerant of the air conditioner 1. The air conditioner refrigerant pipes 101, 102, and 103 may include: a first refrigerant pipe (also denoted by 101) connecting the air conditioner compressor 11, the air conditioner outdoor heat exchanger 14, and the first refrigerant heat exchanger 4 to one another; a second refrigerant pipe (also denoted by 102) guiding the refrigerant discharged from the air conditioner compressor 11 or the refrigerant discharged from the air conditioner outdoor heat exchanger 14 to the indoor heat exchanger 12; and a bypass pipe (also denoted by 103) connected in parallel to a third expansion valve (also denoted by 131) to be described later. That is, a first end of the second refrigerant pipe 102 may be connected to a first point of the first refrigerant pipe 101 between the air conditioner outdoor heat exchanger 14 and the indoor heat exchanger 12, and a second end of the second refrigerant pipe 102 may be connected to a second point of the first refrigerant pipe 101 between the indoor heat exchanger 12 and the air conditioner compressor 11. A first end of the bypass pipe 103 may be connected to the first refrigerant pipe 101 between the air conditioner outdoor heat exchanger 14 and the third expansion valve 131, and a second end of the bypass pipe 103 may be connected to the first refrigerant pipe 101 between the third expansion valve 131 and the first refrigerant heat exchanger 4.

[0039] The bypass pipe 103 may be provided with a flow limiter 17 that limits a flow direction of the refrigerant flowing through the bypass pipe 103 to a predetermined direction. The flow limiter 17 may prevent the refrigerant flowing from the indoor heat exchanger 12 to the air conditioner outdoor heat exchanger 14 from passing through the bypass pipe 103. Thus, the refrigerant flowing from the indoor heat exchanger 12 to the air conditioner outdoor heat exchanger 14 may pass through the third expansion valve 131. The flow limiter 17 may be any device, for example, such as a check valve that can limit the flow direction of refrigerant to a predetermined direction.

[0040] The air conditioner expanders 131, 132, and 133 may include a first expander (also denoted by 132) installed on the second refrigerant pipe 102 to correspond to an intake side of the indoor heat exchanger 12, a second expander (also denoted by 133) installed on the first refrigerant pipe 101 to correspond to an intake side of the first refrigerant heat exchanger 4, a third expander (also denoted by 131) installed on the first refrigerant pipe 101 adjacent to the air conditioner outdoor

heat exchanger 14. The air conditioner expanders 131, 132, and 133 may adjust the degree of opening of the first and second refrigerant pipes 101 and 102, and may selectively close the first and second refrigerant pipes 101 and 102. The first expander 132 may adjust the amount of the refrigerant introduced to the indoor heat exchanger 12 and selectively cut off the flow of the refrigerant to the indoor heat exchanger 12; and the second expander 133 may adjust the amount of the refrigerant introduced to the first refrigerant heat exchanger 4, and selectively cut off the flow of the refrigerant to the first refrigerant heat exchanger 4. The third expander 131 may expand the refrigerant introduced to the air conditioner outdoor heat exchanger 14 and close the first refrigerant pipe 101 such that the refrigerant discharged from the air conditioner outdoor heat exchanger 14 bypasses the third expander 131.

[0041] Since the first expander 132 may selectively cut off the flow of the refrigerant to the indoor heat exchanger 12, the first expander 132 may be a flow cutoff part.

[0042] The second refrigerant heat exchanger 5 may be connected in parallel to the refrigerator heat exchanger 22 on the refrigerator 2. The refrigerator 2 may further include refrigerator refrigerant pipes 104 and 105 for guiding the refrigerant flowing through the refrigerator 2. The refrigerator refrigerant pipes 104 and 105 may include: a third refrigerant pipe (also denoted by 104) connecting the refrigerator compressor 21, the refrigerator outdoor heat exchanger 24, the first refrigerant heat exchanger 4, and the second refrigerant heat exchanger 5 to one another; and a fourth refrigerant pipe (also denoted by 105) guiding a portion of the refrigerant that is introduced to the second refrigerant heat exchanger 5 to the refrigerator heat exchanger 22. That is, a first end of the fourth refrigerant pipe 105 may be connected to a first point of the third refrigerant pipe 104 between the refrigerator compressor 21 and the second refrigerant heat exchanger 5, and a second end of the fourth refrigerant pipe 105 may be connected to a second point of the third refrigerant pipe 104 between the first refrigerant heat exchanger 4 and the second refrigerant heat exchanger 5.

[0043] In addition, the second refrigerant heat exchanger 5 may be connected in series to the freezer heat exchanger 32 on the freezer 3. The freezer 3 may further include a freezer refrigerant pipe 106 for guiding the refrigerant flowing through the freezer 3. The freezer refrigerant pipe 106 may be sequentially connected to the freezer compressor 31, the freezer outdoor heat exchanger 34, the second refrigerant heat exchanger 5, the freezer expander 33, and the freezer heat exchanger 32.

[0044] In other words, the refrigerator 2 and the freezer 3 may include cooler refrigerant pipes (also denoted by 104, 105, and 106), which guide the refrigerant flowing through the refrigerator 2 and the freezer 3. The cooler refrigerant pipes 104, 105, and 106 may include the refrigerator refrigerant pipes 104 and 105, and the freezer refrigerant pipe 106.

[0045] The refrigerator expanders 231 and 232 may

include a fourth expander (also denoted by 232) installed on the third refrigerant pipe 104 to correspond to an intake side of the second refrigerant heat exchanger 5, and a fifth expander (also denoted by 231) installed on the fourth refrigerant pipe 105 to correspond to an intake side of the refrigerator heat exchanger 22.

[0046] A receiver dryer 26 may be installed between the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4. The refrigerant flowing through the refrigerator refrigerant pipes 104 and 105 may be stored in a liquid state within the receiver dryer 26.

[0047] The refrigerator compressor 21 may include a main compressor 211 and an auxiliary compressor 212 that backups the main compressor 211. The main compressor 211 may be connected in parallel to the auxiliary compressor 212 on the third refrigerant pipe 104.

[0048] Intake sides of the main compressor 211 and the auxiliary compressor 212 may be simultaneously connected to the refrigerator heat exchanger 22 and the second refrigerant heat exchanger 5, and discharged sides of the main compressor 211 and the auxiliary compressor 212 may be simultaneously connected to the refrigerator outdoor heat exchanger 24. Thus, the refrigerant within the third refrigerant pipe 104 may selectively flow through at least one of the main compressor 211 and the auxiliary compressor 212.

[0049] Hereinafter, a flow of refrigerant when a refrigerant system cools an indoor space and storage compartment will be described with reference to the accompanying drawings.

[0050] FIG. 2 is a schematic view illustrating an exemplary flow of refrigerant in the refrigerant system of FIG. 1 when the refrigerant system cools an indoor space.

[0051] Referring to FIG. 2, the refrigerant discharged from the air conditioner compressor 11 to the air conditioner outdoor heat exchanger 14 has a high temperature and a high pressure. At this point, the four-way valve 15 disposed between the air conditioner compressor 11 and the air conditioner outdoor heat exchanger 14 guides the refrigerant, discharged from the air conditioner compressor 11, to the air conditioner outdoor heat exchanger 14.

[0052] While the refrigerant flows through the air conditioner outdoor heat exchanger 14, the refrigerant is condensed and the temperature of the refrigerant decreases by emitting heat to outdoor air. The refrigerant discharged from the air conditioner outdoor heat exchanger 14 passes through the first expander 132 of the air conditioner expanders 131, 132, and 133, and thus, is expanded to a low temperature/low pressure state. At this point, the third expander 131 is maintained in a closed state, and the refrigerant discharged from the air conditioner outdoor heat exchanger 14 is introduced to the first expander 132 through the bypass pipe 103.

[0053] The refrigerant discharged from the first expander 132 is introduced to the indoor heat exchanger 12. While the refrigerant flows through the indoor heat exchanger 12, the refrigerant absorbs heat from indoor air, and thus, is evaporated and the temperature of the

refrigerant increases.

[0054] The refrigerant discharged from the indoor heat exchanger 12 is introduced to the accumulator 16. At this point, the four-way valve 15 disposed between the indoor heat exchanger 12 and the accumulator 16 guides the refrigerant, discharged from the indoor heat exchanger 12, to the accumulator 16.

[0055] While the refrigerant passes through the accumulator 16, liquid refrigerant is separated from the refrigerant, and only vapor refrigerant is introduced again to the air conditioner compressor 11. While the refrigerant passes through the air conditioner compressor 11, the refrigerant is compressed to a high temperature/high pressure state.

[0056] As the refrigerant continually flows as described above, the indoor space may be cooled.

[0057] Next, when refrigerant flows through the refrigerator 2, the refrigerant is discharged in a high temperature/high pressure state from the main compressor 211, and passes through the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4.

[0058] While the refrigerant passes through the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4, the refrigerant is condensed and the temperature of the refrigerant decreases. While the refrigerant flows through the refrigerator outdoor heat exchanger 24, the refrigerant emits heat to outdoor air. In addition, while the refrigerant flows through the first refrigerant heat exchanger 4, the refrigerant of the refrigerator 2 emits heat to the refrigerant of the air conditioner 1. Thus, the refrigerant of the refrigerator 2 is condensed and the temperature of the refrigerant further decreases.

[0059] The refrigerant is cooled when the refrigerant passes through both the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4, and thus, reaches a lower temperature state than when passing through one of the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4. Thus, the refrigerator 2 may have a higher coefficient of performance (COP) when the refrigerant passes through both the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4 than when passing through only the refrigerator outdoor heat exchanger 24.

[0060] The refrigerant discharged from the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4 is introduced to the refrigerator expanders 231 and 232. The refrigerant discharged from the refrigerator outdoor heat exchanger 24 and the first refrigerant heat exchanger 4, is introduced to the fourth and fifth expanders 232 and 231. While the refrigerant passes through the refrigerator expanders 231 and 232, the refrigerant is expanded to a low temperature/low pressure state.

[0061] The refrigerant discharged from the fourth expander 232 is introduced to the second refrigerant heat exchanger 5, and the refrigerant discharged from the fifth expander 231 is introduced to the refrigerator heat exchanger 22. That is, the refrigerant discharged from the

refrigerator expanders 231 and 232 is introduced to the second refrigerant heat exchanger 5 and the refrigerator heat exchanger 22.

[0062] While the refrigerant flows through the second refrigerant heat exchanger 5, the refrigerant of the refrigerator 2 absorbs heat from the refrigerant of the freezer 3, and thus, is evaporated and the temperature of the refrigerant increases. While the refrigerant flows through the refrigerator heat exchanger 22, the refrigerant absorbs heat from air adjacent to the refrigerator heat exchanger 22, and thus, is evaporated and the temperature of the refrigerant increases.

[0063] Then, the refrigerant, discharged from the second refrigerant heat exchanger 5 and the refrigerator heat exchanger 22, flows to the main compressor 211. While the refrigerant passes through the refrigerator compressor 21, the refrigerant is compressed to the high temperature/high pressure state.

[0064] When refrigerant flows through the freezer 3, the refrigerant is discharged in a high temperature/high pressure state from the freezer compressor 31, and is introduced to the freezer outdoor heat exchanger 34. While the refrigerant flows through the freezer outdoor heat exchanger 34, the refrigerant emits heat to outdoor air, and is condensed and the temperature of the refrigerant decreases.

[0065] The refrigerant discharged from the freezer outdoor heat exchanger 34 is introduced to the second refrigerant heat exchanger 5. While the refrigerant flows through the second refrigerant heat exchanger 5, the refrigerant of the freezer 3 emits heat to the refrigerant of the refrigerator 2, and thus, is condensed and the temperature of the refrigerant further decreases.

[0066] At this point, the refrigerant is cooled when the refrigerant passes through both the freezer outdoor heat exchanger 34 and the second refrigerant heat exchanger 5, and thus, reaches a lower temperature state than when passing through one of the freezer outdoor heat exchanger 34 and the second refrigerant heat exchanger 5. Thus, the freezer 3 may have a higher coefficient of performance (COP) when the refrigerant passes through both the freezer outdoor heat exchanger 34 and the second refrigerant heat exchanger 5 than when passing through only the freezer outdoor heat exchanger 34.

[0067] The refrigerant discharged from the second refrigerant heat exchanger 5 is introduced to the freezer expander 33. While the refrigerant passes through the freezer expander 33, the refrigerant is expanded to a low temperature/low pressure state. The refrigerant discharged from the freezer expander 33 is introduced to the freezer heat exchanger 32. While the refrigerant flows through the freezer heat exchanger 32, the refrigerant absorbs heat from air adjacent to the freezer heat exchanger 32, and thus, is evaporated and the temperature of the refrigerant increases.

[0068] Then, the refrigerant discharged from the freezer heat exchanger 32 passes through the freezer compressor 31, and thus, is compressed to the high temper-

ature/high pressure state.

[0069] When the refrigerant system operates in a heating mode, a flow direction of the refrigerant flowing through the second refrigerant pipe 102 of the air conditioner 1 is switched to be opposite to the flow direction of the refrigerant in a cooling mode as described above.

[0070] When the refrigerant system operates in a heating mode, the refrigerant of the air conditioner 1 is discharged from the air conditioner compressor 11, and then, is introduced to the indoor heat exchanger 12. At this point, the four-way valve 15 guides the refrigerant, discharged from the air conditioner compressor 11, to the indoor heat exchanger 12.

[0071] While the refrigerant flows through the indoor heat exchanger 12, the refrigerant emits heat to indoor air, and is condensed to a low temperature/high pressure state. The refrigerant discharged from the indoor heat exchanger 12 is introduced to the third expander 131 of the air conditioner expanders 131, 132, and 133. At this point, since the flow limiter 17 prevents the refrigerant discharged from the indoor heat exchanger 12 from passing through the bypass pipe 103, the refrigerant discharged from the indoor heat exchanger 12 is introduced to the third expander 131. The third expander 131 is maintained in a full open state, and thus, the refrigerant expands substantially in the third expander 131. That is, while the refrigerant passes through the third expander 131, the refrigerant is expanded to a low temperature/low pressure state.

[0072] The refrigerant discharged from the third expander 131 is introduced to the air conditioner outdoor heat exchanger 14. While the refrigerant flows through the air conditioner outdoor heat exchanger 14, the refrigerant absorbs heat from outdoor air, and thus, is evaporated to and the temperature of the refrigerant increases.

[0073] The refrigerant from the air conditioner outdoor heat exchanger 14 is introduced to the accumulator 16, and liquid refrigerant and vapor refrigerant are separated from each other. At this point, the four-way valve 15 guides the refrigerant, discharged from the air conditioner outdoor heat exchanger 14, to the accumulator 16. Then, only the vapor refrigerant separated at the accumulator 16 is introduced to the air conditioner compressor 11, and is compressed again to the high temperature/high pressure state.

[0074] As the refrigerant continually flows as described above, the indoor space can be heated.

[0075] When the refrigerant system operates in the heating mode, the flows of the refrigerant in the refrigerator 2 and the freezer 3 may be the same as those in the cooling mode of the refrigerant system.

[0076] Hereinafter, a configuration and a method for controlling the refrigerant system will be described in detail with reference to the accompanying drawings.

[0077] FIG. 3 is a block diagram illustrating a control signal flow of the refrigerant system of FIG. 1. FIG. 4 is a block diagram illustrating another control signal flow of the refrigerant system of FIG. 1. FIG. 5 is a flowchart

illustrating a method of controlling the refrigerant system according to the control signal flow of FIG. 4. FIG. 6 is a schematic view illustrating a flow of the refrigerant when the refrigerant system operates under an overload condition. FIG. 7 is a schematic view illustrating a flow of the refrigerant when the main compressor of the refrigerant system is broken.

[0078] Referring to FIG. 3, in the control configuration of the refrigerant system, the refrigerant system may further include: a breakdown sensor 61 sensing a breakdown of the main compressor 211; an overload sensor 62 sensing an overload of the main compressor 211; a breakdown signaler 69 outputting a breakdown signal when the main compressor 211 is broken; and a controller 65 controlling the main compressor 211, the auxiliary compressor 212, and the breakdown signaler 69 based on signals received from the breakdown sensor 61 and the overload sensor 62. The breakdown sensor 61, the overload sensor 62, the main compressor 211, the auxiliary compressor 212, the breakdown signaler 69, and the controller 65 may be electrically connected to one another to communicate with each other through electrical signals.

[0079] When the breakdown sensor 61 senses a breakdown of the main compressor 211, the controller 65 controls the auxiliary compressor 212 to replace the main compressor 211 and the breakdown signaler 69 outputs a breakdown signal indicating to the user that a breakdown of the main compressor 211 has occurred.

[0080] When the overload sensor 62 senses an overload of the main compressor 211, the controller 65 controls the auxiliary compressor 212 to supplement the main compressor 211.

[0081] Referring to FIG. 4, in the control configuration of the refrigerant system, the refrigerant system may further include: a current sensor 71 sensing a current of the main compressor 211; an outdoor temperature sensor 72 sensing an outdoor temperature; a breakdown signaler 79 outputting a breakdown signal when the main compressor 211 is broken; and a controller 75 controlling the main compressor 211, the auxiliary compressor 212, and the breakdown signaler 79 based on the current of the main compressor 211 and the outdoor temperature, which are sensed by the current sensor 71 and the outdoor temperature sensor 72. The current sensor 71, the outdoor temperature sensor 72, the main compressor 211, the auxiliary compressor 212, the breakdown signaler 79, and the controller 75 may be electrically connected to one another to communicate with each other through electrical signals.

[0082] Referring to FIG. 5, in the method of controlling the refrigerant system, the refrigerant system starts to operate and an outdoor temperature is sensed in operation S11. The outdoor temperature may be sensed by the outdoor temperature sensor 72.

[0083] When the outdoor temperature is equal to or greater than a reference temperature in operation S12, the controller 75 controls the main compressor 211 and

the auxiliary compressor 212 to simultaneously operate in operation S13. The reference temperature may be the lower limit of the outdoor temperature at which a load is too great for the main compressor 211 to withstand. That is, when the outdoor temperature is equal to or greater than the reference temperature, an overload condition that normal cooling of a food only with the main compressor 211 is difficult is recognized. Thus, to withstand the load that the main compressor 211 cannot withstand, the auxiliary compressor 212 operates to support the main compressor 211.

[0084] A flow of the refrigerant when the main compressor 211 and the auxiliary compressor 212 operate at the same time is illustrated in FIG. 6. That is, the refrigerant discharged from the refrigerator heat exchanger 22 and the second refrigerant heat exchanger 5 simultaneously passes through the main compressor 211 and the auxiliary compressor 212, and then, is introduced to the refrigerator outdoor heat exchanger 24.

[0085] However, when the outdoor temperature is smaller than the reference temperature in operation S12, only the main compressor 211 operates in operation S14.

[0086] Next, a current of the main compressor 211 is sensed in operation S15. The current of the main compressor 211 may be sensed by the current sensor 71.

[0087] When the current of the main compressor 211 sensed by the current sensor 71 is outside a reference range, i.e. greater than a first reference current or less than a second reference current in operation S16, the controller 75 controls the auxiliary compressor 212 to replace the main compressor 211 and operates to output the breakdown signal in operation S17. The breakdown signal can be output by the breakdown signaler 79. That is, when the sensed current is outside the reference range, only the auxiliary compressor 212 operates, and the breakdown signal is output.

[0088] The reference range may be a current range from the main compressor 211 when the main compressor 211 normally operates. The reference range may be a predetermined current range measured when the main compressor 211 normally operates. Thus, when the current of the main compressor 211 is greater than the first reference current, that is, out of a normal current value, the refrigerator heat exchanger 22 is considered to be abnormal. In addition, while the main compressor 211 normally operates, the current from the main compressor 211 has a predetermined value greater than zero. Thus, when the current of the main compressor 211 is less than a second reference range, such as being zero, the main compressor 211 is considered to be abnormal. For example, when an anomaly or a short connection occurs in a motor of the main compressor 211, the current of the main compressor 211 may be zero.

[0089] As a result, when the sensed current is greater than the first reference current or less than a second reference current, the main compressor 211 is considered to be broken, and thus, the auxiliary compressor 212 operates to replace the main compressor 211, so that the

refrigerator 2 can continually cool a food or other material. Since the freshness of a food depends on a storage temperature, when the cooling of the refrigerator 2 is stopped, the quality of a food may be quickly deteriorated. However, since the auxiliary compressor 212 can continually cool a food even when the main compressor 211 is broken, a damage of a food due to a cooling stop can be prevented.

[0090] A flow of the refrigerant when the auxiliary compressor 212 operates to replace the main compressor 211 is illustrated in FIG. 7. That is, the refrigerant discharged from the refrigerator heat exchanger 22 and the second refrigerant heat exchanger 5 passes through only the auxiliary compressor 212, and then, is introduced to the refrigerator outdoor heat exchanger 24.

[0091] Since a breakdown of the main compressor 211 may be sensed based on a current of the main compressor 211, the current sensor 71 may be called a breakdown sensor for sensing a breakdown of the main compressor 211.

[0092] However, when the sensed current is not greater outside the reference range in operation S16, the outdoor temperature is sensed again. That is, when the sensed current is not greater than the reference current or not equal to zero in operation S16, the process that the main compressor 211 and the auxiliary compressor 212 are controlled according to the outdoor temperature, and the process that a current of the main compressor 211 is sensed to determine whether a breakdown occurs are repeated.

[0093] Thus, according to the embodiment, since the auxiliary compressor 212 operates to replace the main compressor 211 when the main compressor 211 is broken, the refrigerator 2 can continually cool a food.

[0094] In addition, under an overload condition that the main compressor 211 cannot withstand, the auxiliary compressor 212 operates together with the main compressor 211, and thus, a refrigeration performance of the refrigerator 2 can be maintained or improved.

[0095] Hereinafter, a configuration and a method for controlling a refrigerant system according to another embodiment will be described in detail with reference to the accompanying drawings. The embodiment is different in that a breakdown of a main compressor is sensed using a refrigerant temperature at the discharge side of the main compressor. Thus, a description of the same configuration as that of the first embodiment will be omitted here.

[0096] FIG. 8 is a block diagram illustrating another control signal flow of a refrigerant system of FIG. 1. FIG. 9 is a flowchart illustrating a method of controlling the refrigerant system of FIG. 7.

[0097] Referring to FIG. 8, in the control configuration of the refrigerant system, the refrigerant system may further include: a refrigerant temperature sensor 81 sensing a discharge side refrigerant temperature of the main compressor 211; an outdoor temperature sensor 82 sensing an outdoor temperature; a breakdown signaler 89 out-

putting a breakdown signal when the main compressor 211 is broken; and a controller 85 controlling the main compressor 211, the auxiliary compressor 212, and the breakdown signaler 89 based on the discharge side refrigerant temperature of the main compressor 211 and the outdoor temperature, which are sensed by the refrigerant temperature sensor 81 and the outdoor temperature sensor 82. The refrigerant temperature sensor 81, the outdoor temperature sensor 82, the main compressor 211, the auxiliary compressor 212, the breakdown signaler 89, and the controller 85 may be electrically connected to one another to communicate with each other through electrical signals.

[0098] Referring to FIG. 9, in the method of controlling the refrigerant system, the refrigerant system starts to operate and an outdoor temperature is sensed in operation S21. The outdoor temperature may be sensed by the outdoor temperature sensor 82.

[0099] When the outdoor temperature is equal to or greater than a reference temperature in operation S22, the controller 85 controls the main compressor 211 and the auxiliary compressor 212 to simultaneously operate in operation S23.

[0100] However, when the outdoor temperature is smaller than the reference temperature in operation S22, only the main compressor 211 operates in operation S24.

[0101] Next, a discharge side refrigerant temperature of the main compressor 211 is sensed in operation S25. The discharge side refrigerant temperature of the main compressor 211 may be sensed by the refrigerant temperature sensor 81.

[0102] When the discharge side refrigerant temperature of the main compressor 211 sensed by the current sensor 81 is greater than the reference temperature in operation S26, the controller 85 controls the auxiliary compressor 212 to replace the main compressor 211 and operates to output the breakdown signal in operation S27. The breakdown signal can be output by the breakdown signaler 89. That is, when the sensed refrigerant temperature is greater than the reference temperature, only the auxiliary compressor 212 operates, and the breakdown signal is output.

[0103] The reference temperature may be an upper limit of the discharge side refrigerant temperature of the main compressor 211 when the main compressor 211 normally operates. The reference temperature may be a predetermined range of the discharge side refrigerant temperature, which can be measured when the main compressor 211 normally operates. Thus, when the discharge side refrigerant temperature of the main compressor 211 is greater than the reference temperature, that is, out of a normal refrigerant temperature, the main compressor 211 is considered to be abnormal. For example, when inner frictional force of the main compressor 211 is increased by a foreign substance attached to the main compressor 211, or by mechanical wear of the main compressor 211, the discharge side refrigerant temperature of the main compressor 211 may increase.

[0104] That is, when the sensed refrigerant temperature is greater than the reference temperature, the main compressor 211 is considered to be broken, and thus, the auxiliary compressor 212 operates to replace the main compressor 211, so that the refrigerator 2 can continually cool a food.

[0105] Since a breakdown of the main compressor 211 may be sensed based on the discharge side refrigerant temperature of the main compressor 211, the refrigerant temperature sensor 81 may be called a breakdown sensor for sensing a breakdown of the main compressor 211.

[0106] However, when the sensed refrigerant temperature is not greater than the reference temperature in operation S26, the outdoor temperature is sensed again. That is, when the sensed refrigerant temperature is not greater than the reference temperature, the process that the main compressor 211 and the auxiliary compressor 212 are controlled according to the outdoor temperature, and the process that the discharge side refrigerant temperature of the main compressor 211 is sensed to determine whether a breakdown occurs are repeated.

[0107] Thus, according to the embodiment, since the auxiliary compressor 212 operates to replace the main compressor 211 when the main compressor 211 is broken, the refrigerator 2 can continually cool a food.

[0108] In addition, under an overload condition that the main compressor 211 cannot withstand, the auxiliary compressor 212 operates together with the main compressor 211, and thus, a refrigeration performance of the refrigerator 2 can be maintained or improved.

[0109] Also, the method of sensing a breakdown of the main compressor 211 based on the current of the main compressor 211, and the method of sensing a breakdown of the main compressor 211 based on the refrigerant temperature of the main compressor 211 may be used together. For example, when the current of the main compressor 211 is outside the reference current range, and/or when the discharge side refrigerant temperature of the main compressor 211 is greater than the reference temperature occurs, the main compressor 211 may be considered to be broken.

[0110] It will be apparent to those skilled in the art that various modifications and variation may be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. A refrigerant system, comprising:

an air conditioner configured to condition air in a building by using a first refrigerant cycle;
a cooler configured to cool air in a storage compartment of the building by using a second re-

frigerant cycle; and

a refrigerant heat exchanger configured to exchange heat between a refrigerant of the air conditioner and a refrigerant of the cooler, wherein the cooler includes a main compressor and an auxiliary compressor configured to back-up the main compressor.

2. The refrigerant system of claim 1, further comprising:

a breakdown sensor configured to sense a breakdown of the main compressor; and
a controller configured to control the auxiliary compressor to replace the main compressor if the breakdown sensor senses a breakdown of the main compressor.

3. The refrigerant system of claim 2, wherein the breakdown sensor includes a current sensor configured to sense a current of the main compressor.

4. The refrigerant system of claim 3, wherein the controller controls the auxiliary compressor to replace the main compressor if the current sensed by the current sensor is greater than a reference current.

5. The refrigerant system of claim 3, wherein the controller controls the auxiliary compressor to replace the main compressor if the current sensed by the current sensor is less than a reference current.

6. The refrigerant system of any of claims 2 to 5, wherein the breakdown sensor includes a temperature sensor configured to sense a refrigerant temperature at a discharge side of the main compressor.

7. The refrigerant system of claim 6, wherein the controller controls the auxiliary compressor to replace the main compressor if the temperature sensed by the temperature sensor is greater than a reference temperature.

8. The refrigerant system of claim 1, further comprising:

a breakdown sensor configured to sense a breakdown of the main compressor; and
a breakdown signaler configured to output a breakdown signal if the breakdown sensor senses a breakdown of the main compressor.

9. The refrigerant system of any of claims 1 to 8, further comprising:

an overload sensor configured to sense an overload of the main compressor;
a controller configured to control the auxiliary compressor to supplement the main compressor if the overload sensor senses an overload

of the main compressor.

10. The refrigerant system of claim 9, wherein the overload sensor includes a temperature sensor configured to sense an outdoor temperature. 5
11. The refrigerant system of claim 10, wherein the controller controls the auxiliary compressor to supplement the main compressor if the temperature sensed by the temperature sensor is greater than a reference temperature. 10
12. A method of operating a refrigerant system according to any of claims 1 to 11. 15

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FIG. 1

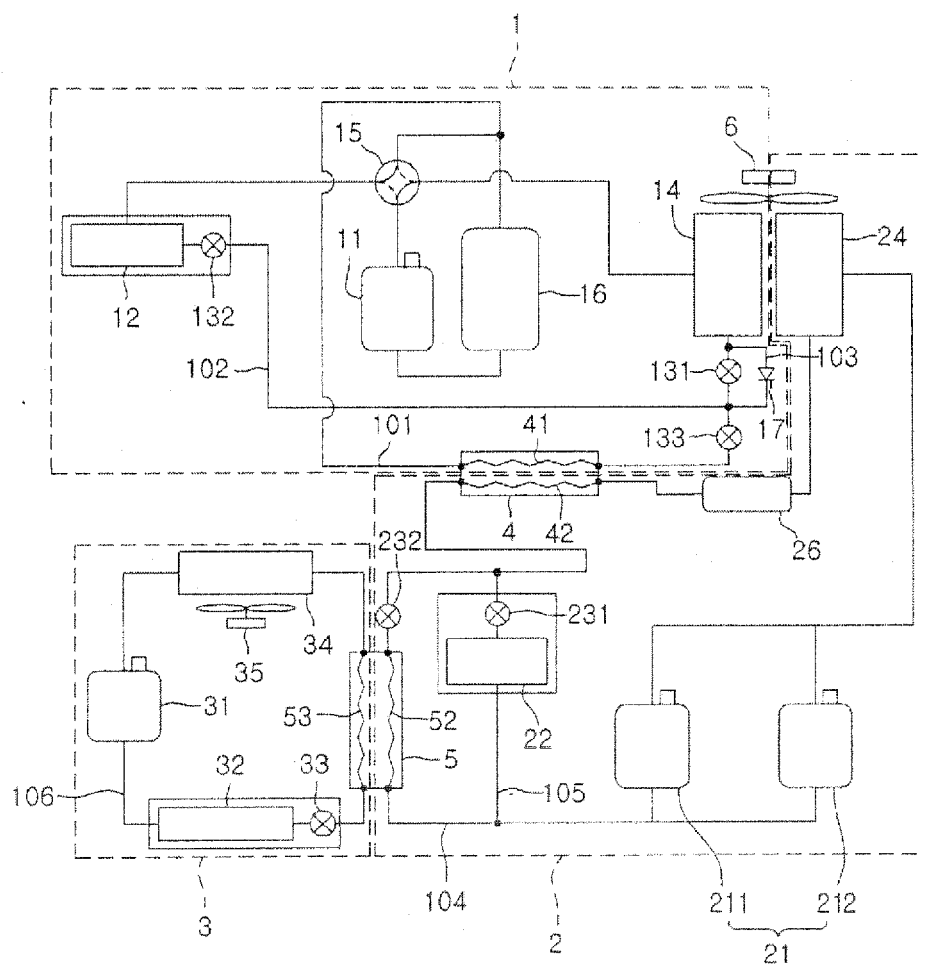


FIG. 2

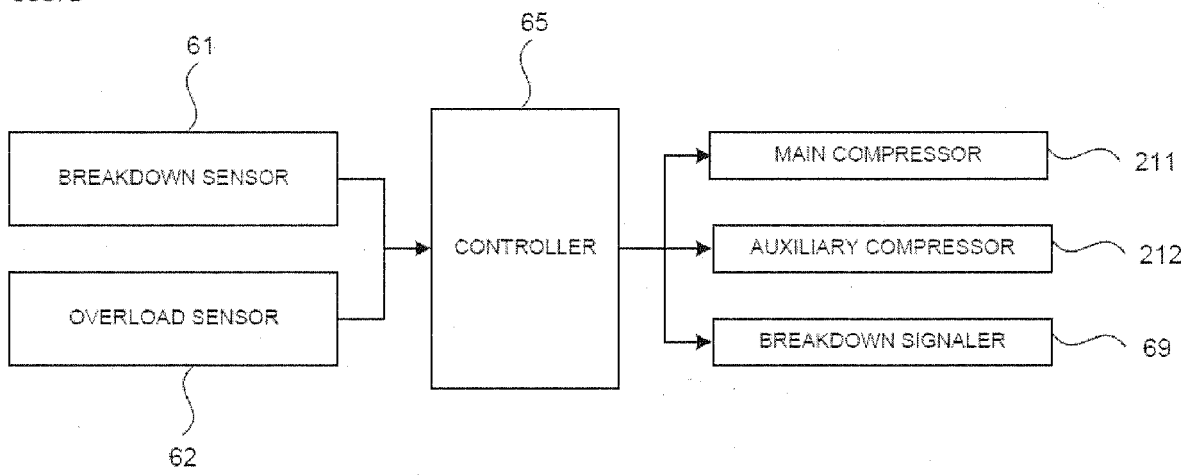


FIG.3

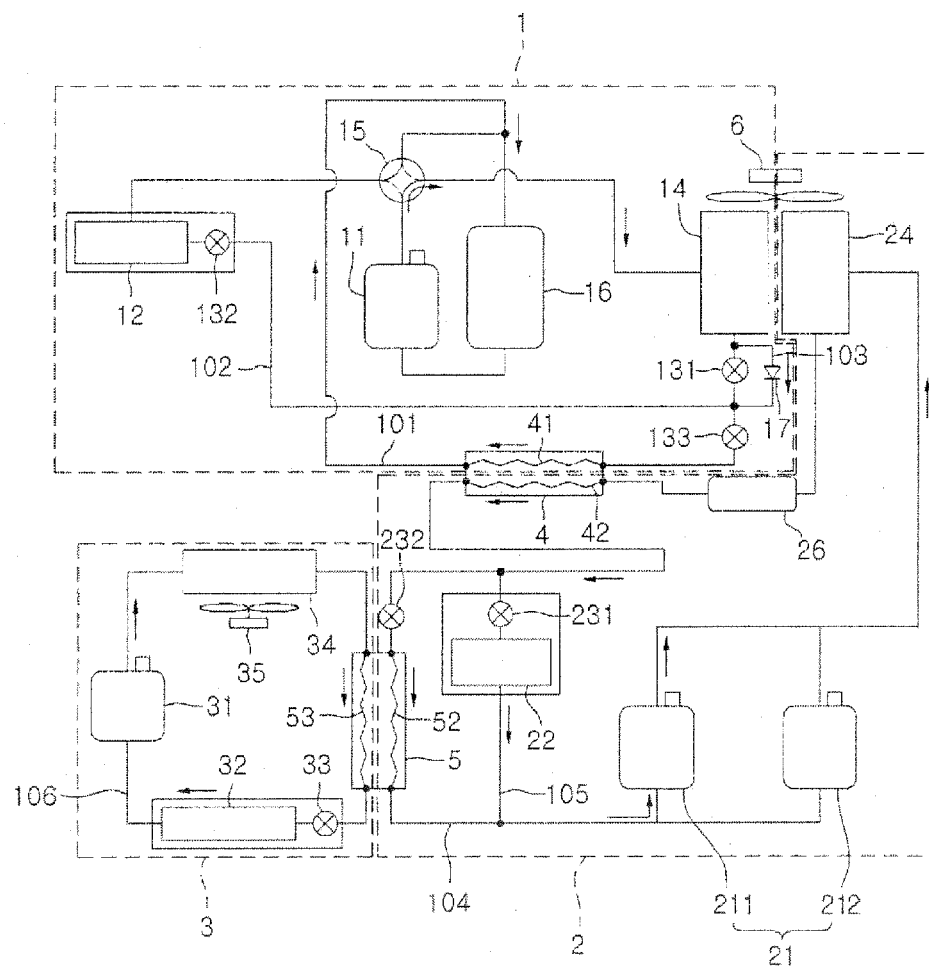


FIG. 4

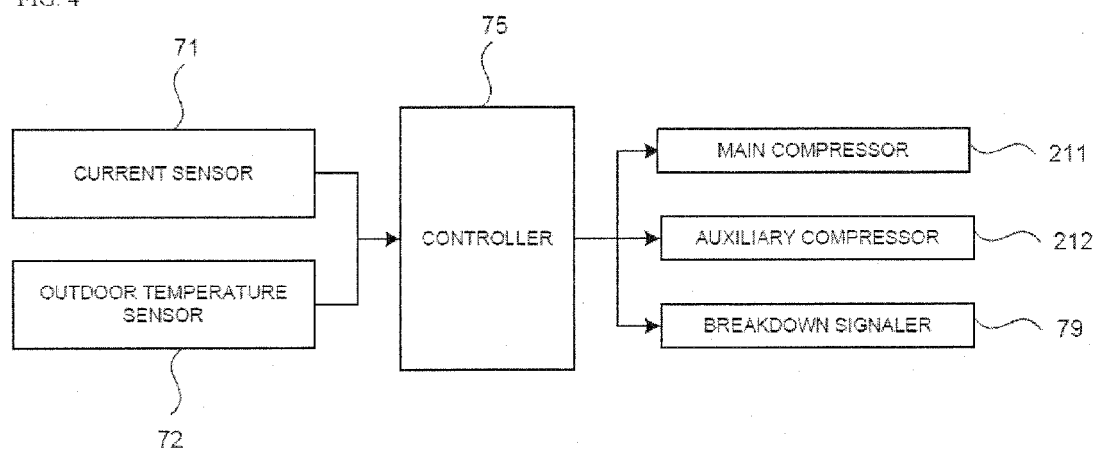


FIG. 5

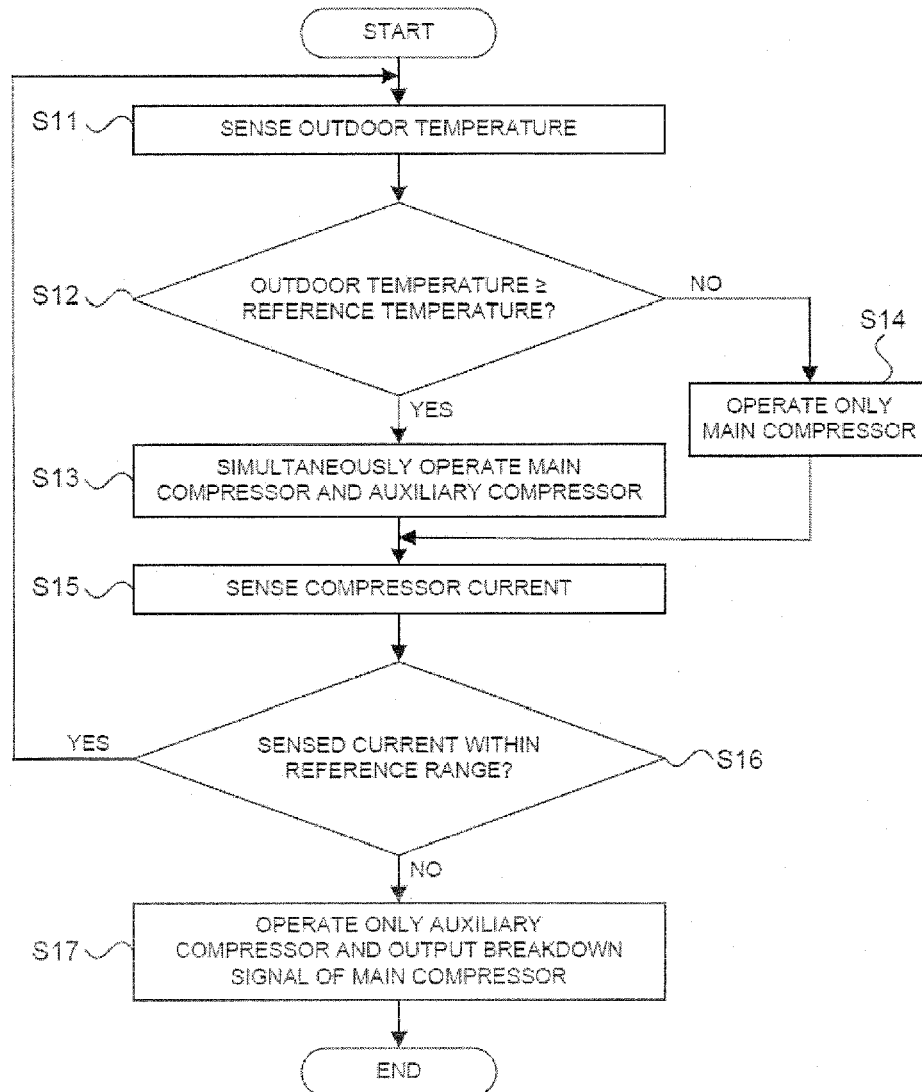


FIG. 6

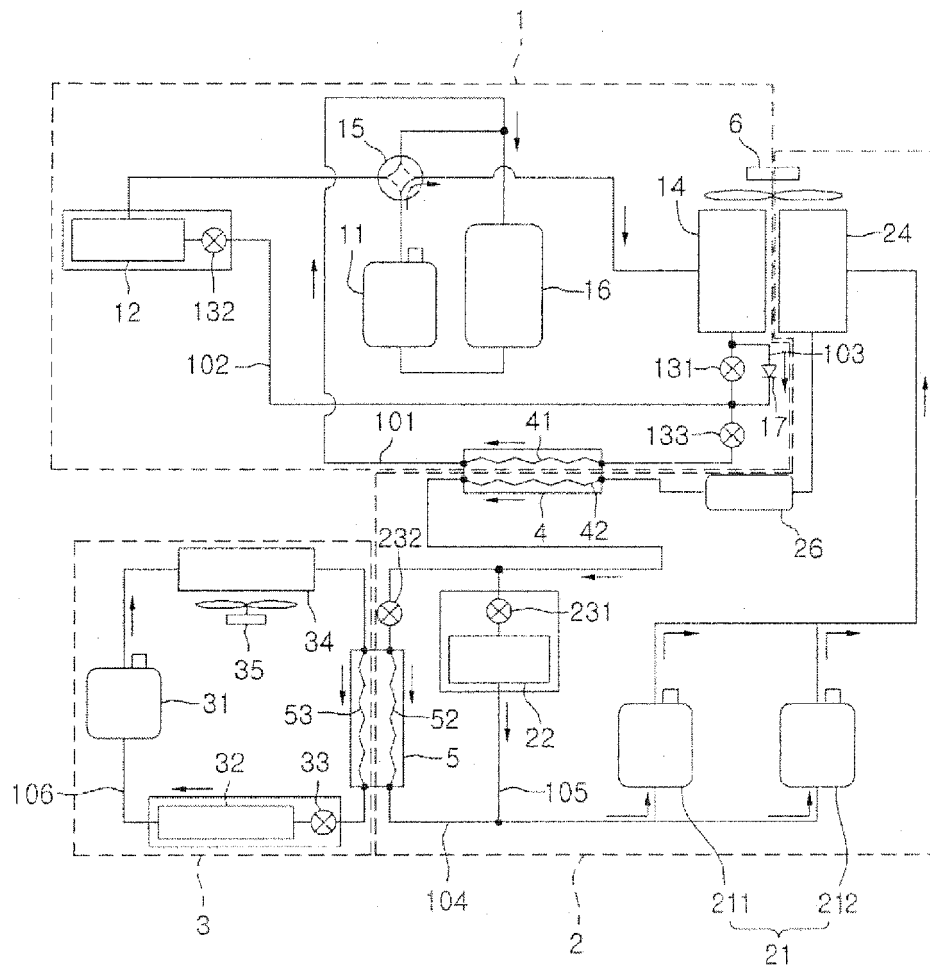


FIG. 7

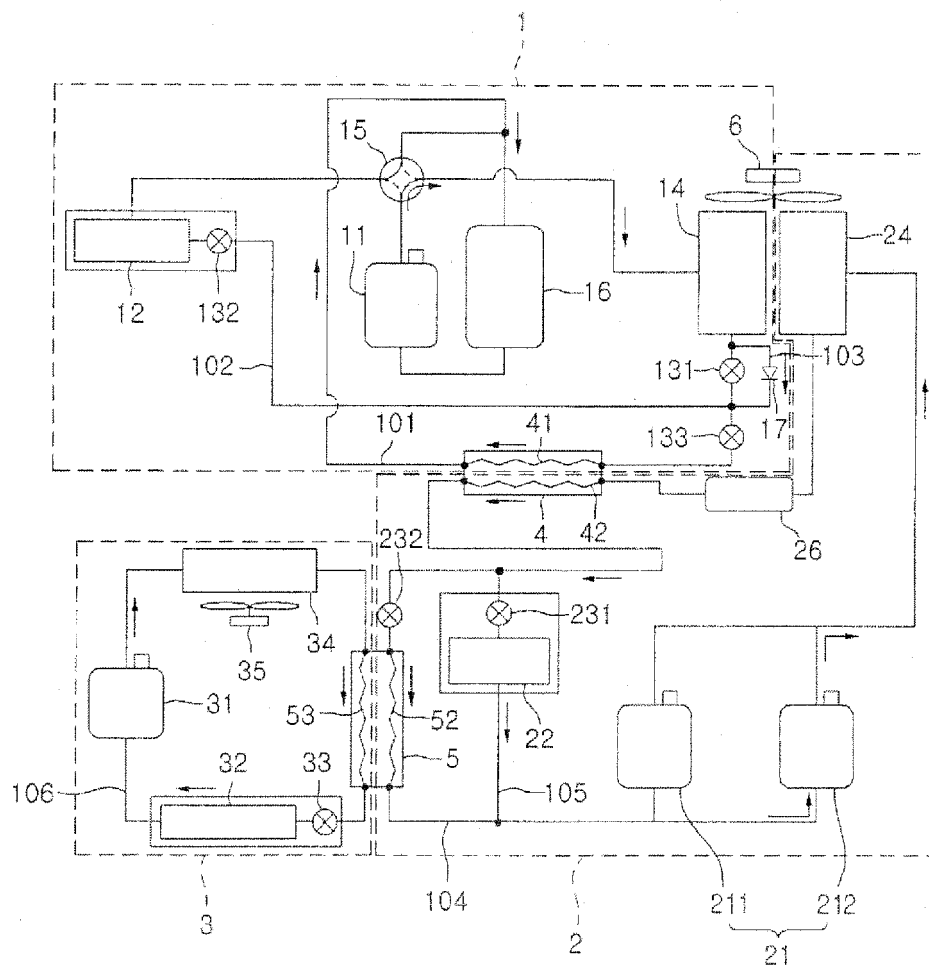


FIG. 8

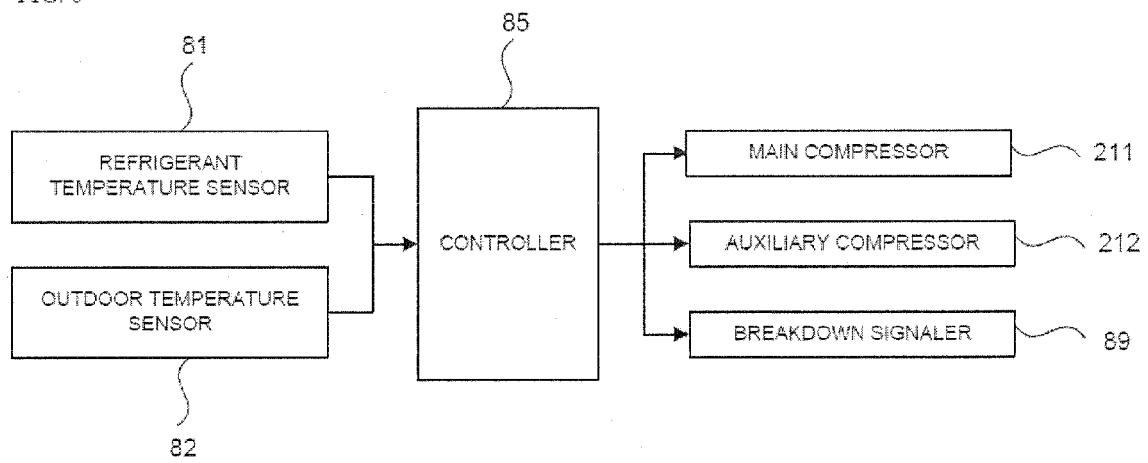


FIG. 9

