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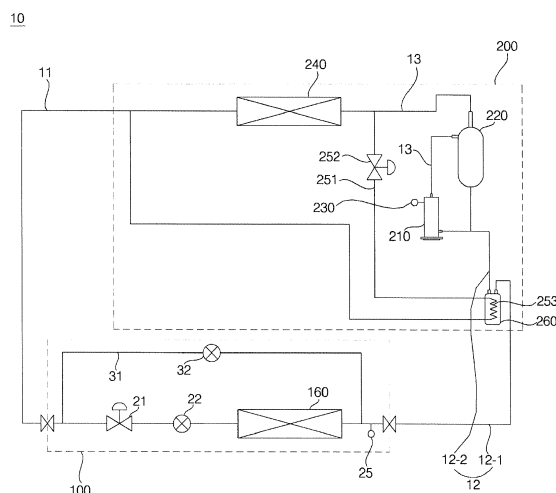
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(54) **AIR CONDITIONER**

(57) Disclosed is an air conditioner (10) including a compressor (210), which compresses and discharges a refrigerant, a condenser (240), which condenses the refrigerant compressed in the compressor, an expansion device (22), which expands the refrigerant condensed in the condenser, an evaporator (160), which evaporates the refrigerant expanded in the expansion device, performs heat exchange between the refrigerant and indoor air, and discharges the evaporated refrigerant to the compressor, a bypass unit (31,32), which guides some of the

refrigerant discharged from the condenser to an outlet end of the evaporator, a heat exchange unit (253,260), which performs heat exchange between some of the refrigerant discharged from the compressor and the refrigerant to be suctioned into the compressor, and a control unit (300), which controls overall operation of the air conditioner. The control unit controls the bypass unit so as to bypass the refrigerant, discharged from the condenser, to the outlet end of the evaporator upon an oil collection operation.

FIG. 1



Description

[0001] The present invention relates to an air conditioner.

[0002] Generally, an air conditioner is an apparatus that cools a room or a given space using a refrigeration cycle including a compressor, a condenser, an expansion device, and an evaporator.

[0003] Such an air conditioner is utilized as an apparatus that cools a showcase, which is configured to display frozen and refrigerated products. That is, the evaporator of the air conditioner is disposed in the showcase, and the condenser is disposed in an outdoor area.

[0004] A conventional air conditioner has a need to prevent the exhaustion of refrigerating machine oil inside the compressor by appropriately collecting the refrigerating machine oil, which has been discharged from the compressor along with refrigerant, into the compressor, in order to secure the reliability of the compressor.

[0005] The refrigerating machine oil used in the air conditioner generally increases in viscosity as the temperature thereof decreases. In the evaporator used in the showcase, the temperature of the refrigerant remains within a range of about -40°C to -5°C.

[0006] Accordingly, the oil undergoes an excessive increase in viscosity and deterioration in flow-ability in a gas pipe that interconnects the outlet end of the evaporator and the suction end of the compressor. The refrigerating machine oil may stay in the gas pipe, and thus may not be collected into the compressor, which results in deterioration in the reliability of the compressor.

[0007] In addition, although the gas pipe between the evaporator and the compressor normally ranges from tens of meters to hundreds of meters in length, the refrigerating machine oil staying in the gas pipe may limit the length of the gas pipe upon installation.

[0008] As illustrated in FIG. 10, most of the refrigerating machine oil that is not collected into the compressor stays in the gas pipe.

[0009] It is an object of the present invention to provide an air conditioner, which has an increased length of gas pipe, thereby achieving innovative installation freedom, increased efficiency, and increased compressor reliability. This object is achieved with an air conditioner as specified in the claims.

[0010] The objects of the present invention are not limited to the effects as mentioned above, and other unmentioned objects will be clearly understood by those skilled in the art from the following claims.

[0011] In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of an air conditioner including a compressor configured to compress and discharge a refrigerant, a condenser configured to condense the refrigerant compressed in the compressor, an expansion device configured to expand the refrigerant condensed in the condenser, an evaporator configured to evaporate the refrigerant expanded in the expansion device, to per-

form heat exchange between the refrigerant and indoor air, and to discharge the evaporated refrigerant to the compressor, a bypass unit configured to guide some of the refrigerant discharged from the condenser to an outlet end of the evaporator, a heat exchange unit configured to perform heat exchange between some of the refrigerant discharged from the compressor and the refrigerant to be suctioned into the compressor, and a control unit configured to control overall operation of the air conditioner, wherein the control unit controls the bypass unit so as to bypass the refrigerant, discharged from the condenser, to the outlet end of the evaporator upon an oil collection operation.

[0012] Details of other embodiments are included in the detailed description and the drawings.

[0013] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

FIG. 1 is a circuit diagram schematically illustrating a refrigeration cycle of an air conditioner according to an embodiment of the present invention;

FIG. 2 is a block diagram of the air conditioner according to the embodiment of the present invention;

FIG. 3 is a view illustrating an accumulator according to the embodiment of the present invention;

FIG. 4 is a perspective view illustrating a showcase according to an embodiment of the present invention;

FIG. 5 is a cross-sectional view of the showcase illustrated in FIG. 4;

FIG. 6 is a view illustrating the flow of refrigerant upon normal operation of the air conditioner according to the embodiment of the present invention;

FIG. 7 is a view illustrating the flow of refrigerant upon an oil collection operation of the air conditioner according to the embodiment of the present invention;

FIG. 8 is a flowchart illustrating a method of controlling the air conditioner according to an embodiment of the present invention;

FIG. 9 is a flowchart illustrating a method of controlling the air conditioner according to another embodiment of the present invention; and

FIG. 10 is a view illustrating the amount of oil remaining in respective elements in the air conditioner according to a comparative example.

[0014] Advantages and features of the present invention and methods for achieving those of the present invention will become apparent upon referring to embodiments described later in detail with reference to the attached drawings. However, embodiments are not limited to the embodiments disclosed hereinafter and may be embodied in different ways. The embodiments are provided for perfection of disclosure and for informing persons skilled in this field of art of the scope of the present invention. The same reference numerals may refer to the

same elements throughout the specification.

[0015] Spatially-relative terms such as "below", "beneath", "lower", "above", or "upper" may be used herein to describe one element's relationship to another element as illustrated in the Figures. It will be understood that spatially-relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. For example, if the device in one of the figures is turned over, elements described as "below" or "beneath" other elements would then be oriented "above" the other elements. The exemplary terms "below" or "beneath" can, therefore, encompass both an orientation of above and below. Since the device may be oriented in another direction, the spatially-relative terms may be interpreted in accordance with the orientation of the device.

[0016] The terminology used in the present disclosure is for the purpose of describing particular embodiments only and is not intended to limit the disclosure. As used in the disclosure and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0017] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0018] In the drawings, the thickness or size of each layer is exaggerated, omitted, or schematically illustrated for convenience of description and clarity. Also, the size or area of each constituent element does not entirely reflect the actual size thereof.

[0019] Hereinafter, exemplary embodiments of the present invention will be described with reference to the accompanying drawings.

[0020] FIG. 1 is a circuit diagram schematically illustrating a refrigeration cycle of an air conditioner according to an embodiment of the present invention, and FIG. 2 is a block diagram of the air conditioner according to the embodiment of the present invention.

[0021] Referring to FIGs. 1 and 2, the air conditioner according to the embodiment of the present invention, designated by reference numeral 10, includes a compressor 210, which compresses and discharges refrigerant, a condenser 240, which condenses the refrigerant compressed in the compressor 210, an expansion device

22, which expands the refrigerant condensed in the condenser 240, an evaporator 160, which evaporates the refrigerant expanded in the expansion device 22, performs heat exchange between the refrigerant and indoor air, and discharges the evaporated refrigerant to the compressor 210, a bypass unit, which bypasses some of the refrigerant discharged from the condenser 240 to the outlet end of the evaporator 160, and a control unit 300, which controls the overall operation of the air conditioner.

[0022] The air conditioner 10 of the embodiment may further include an accumulator 260, which prevents liquid-phase refrigerant, among the refrigerant to be introduced into the compressor 210, from being introduced into the compressor 210, and a heat exchange unit, which performs heat exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210.

[0023] The air conditioner 10 includes an outdoor unit 200 disposed in an outdoor area and an indoor unit 100 disposed in an indoor area, and the outdoor unit 200 and the indoor unit 100 are connected to each other. The outdoor unit 200 includes the compressor 210, the condenser 240, and the heat exchange unit. The indoor unit 100 includes the evaporator 160 and the expansion device 22.

[0024] The compressor 210 is installed in the outdoor unit 200 and serves to compress introduced low-temperature and low-pressure refrigerant into high-temperature and high-pressure refrigerant and discharge the compressed refrigerant. Various structures may be applied to the compressor 210. For example, the compressor 210 may be a reciprocating compressor 210 using a cylinder and a piston, a scroll compressor 210 using a pivoting scroll and a fixed scroll, or an inverter compressor 210 that adjusts the amount of compression of refrigerant depending on the operating frequency.

[0025] In some embodiments, one compressor or a plurality of compressors 210 may be provided. In the present embodiment, one compressor 210 is provided.

[0026] The compressor 210 is connected to the evaporator 160 and the condenser 240. Specifically, the compressor 210 includes an inlet port 211, into which the refrigerant evaporated in the evaporator 160 is introduced upon normal operation (a freezing operation) or into which a mixture of the bypassed refrigerant and the refrigerant evaporated in the evaporator is introduced upon an oil collection operation, and an outlet port 212, from which the compressed refrigerant is discharged to the condenser 240.

[0027] The compressor 210 is connected to the condenser 240 via a connection pipe 13, and is connected to the evaporator 160 via a gas pipe 12. The inlet port 211 of the compressor 210 is connected to the gas pipe 12, and the outlet port 212 in the compressor 210 is connected to the connection pipe 13.

[0028] An oil separator 220 is installed on the connection pipe 13 and serves to separate oil from the refrigerant discharged from the compressor 210 so as to collect the

oil into the compressor 210.

[0029] In the embodiment, the air conditioner further includes an oil level sensor 230, which senses the level of oil inside the compressor 210. The oil level sensor 230 senses the amount of oil inside the compressor 210 and provides oil amount information to the control unit 300.

[0030] The condenser 240 is disposed in the outdoor unit 200, which is disposed in an outdoor area, and serves to perform heat exchange between the refrigerant passing through the condenser 240 and outdoor air. The condenser 240 condenses the refrigerant upon a cooling operation.

[0031] The condenser 240 is connected to the compressor 210, the expansion device 22, and the evaporator 160. Upon a cooling operation, the refrigerant, which has been compressed in the compressor 210 and has passed through the discharge port 212 in the compressor 210, is introduced into the condenser 240 so as to be condensed in the condenser 240, and thereafter moves to the expansion device 22.

[0032] The condenser 240 is connected to the evaporator 160 via a liquid pipe 11. The liquid pipe 11 is provided with the expansion device 22, which expands the refrigerant. The expansion device 22 includes an electronic-type expansion valve, or a temperature-type expansion valve. The expansion device 22 may be provided in the indoor unit 100 or in the outdoor unit 200. Generally, the expansion device 22 is provided in the indoor unit 100, and the outdoor unit 200 and the indoor unit 100 are manufactured by separate manufacturers and are not in communication with each other. The expansion device 22 may include a temperature-type expansion valve. The opening rate of the temperature-type expansion valve is automatically adjusted according to the measured temperature of the refrigerant. The expansion device 22 serves to expand the refrigerant introduced thereto.

[0033] The evaporator 160 is disposed in the indoor unit 100, which is disposed in an indoor area, and serves to perform heat exchange between the refrigerant passing through the evaporator 160 and indoor air. The evaporator 160 evaporates the refrigerant upon a cooling operation.

[0034] The evaporator 160 is connected to the condenser 240, the expansion device 22, and the compressor 210. Upon a cooling operation, the refrigerant expanded in the expansion device 22 is introduced into the evaporator 160 so as to evaporate therein, and thereafter moves to the compressor 210. The evaporator 160 is connected to the compressor 210 via the gas pipe 12. The refrigerant evaporated in the evaporator 160 is introduced into the compressor 210 via the gas pipe 12.

[0035] The evaporator 160 may be provided in the indoor unit 100 as described above. For example, the indoor unit 100 may take the form of a showcase that displays products and is opened to the outside. A detailed structure of the showcase will be described later. The indoor unit 100 includes a showcase valve 21, which controls the introduction of the refrigerant from the condenser

240 into the evaporator 160. The showcase valve 21 is disposed on the liquid pipe 11 and is opened or closed to adjust the flow of refrigerant.

[0036] When the refrigerant evaporated in the evaporator 160 is suctioned into the compressor 210, the circulation cycle of refrigerant is completed. The accumulator 260 is installed on the gas pipe 12 to prevent liquid-phase refrigerant, among the refrigerant to be introduced into the compressor 210, from being introduced into the compressor 210.

[0037] Specifically, the gas pipe 12 includes a first gas pipe 12-1, which interconnects the accumulator 260 and the evaporator 160, and a second gas pipe 12-2, which interconnects the accumulator 260 and the input port 211 of the compressor 210.

[0038] The gas pipe 12 is provided with a discharge temperature sensor 25, which measures the temperature of refrigerant discharged from the evaporator 160. The discharge temperature sensor 25 provides temperature information regarding the temperature of refrigerant discharged from the evaporator 160 to the control unit 300. The discharge temperature sensor 25 may be disposed on the gas pipe 12 at a position close to the evaporator 160. That is, the discharge temperature sensor 25 is disposed on the first gas pipe 12-1 at a position close to the evaporator 160.

[0039] In particular, when the gas pipe 12 is long and the reduction in pressure ranges from 20% to 80% between one end of the gas pipe 12 close to the evaporator 160 and the other end of the gas pipe 12 close to the compressor 210, this causes refrigerating machine oil to stay in the gas pipe 12.

[0040] The bypass unit guides some of the refrigerant discharged from the condenser 240 to the outlet end of the evaporator 160. That is, the bypass unit bypasses some of the refrigerant discharged from the condenser 240 to the evaporator 160. The bypass unit is closed upon a cooling operation (normal operation), but supplies some of the high-temperature and high-pressure refrigerant discharged from the condenser 240 to the gas pipe 12, which is the outlet end of the evaporator 160, upon an oil collection operation. The high-temperature and high-pressure refrigerant, supplied to the gas pipe 12 by the bypass unit, changes the refrigerant in the gas pipe 12 into two-phase refrigerant, and increases the temperature of the refrigerant in the gas pipe 12. Thereby, the oil in the gas pipe 12 increases in temperature and solubility, but decreases in viscosity. Accordingly, the oil, which has a high viscosity and remains in the gas pipe 12, decreases in viscosity during normal operation, thereby being easily collected into the compressor 210 by the pressure of refrigerant. This consequently increases the reliability of the compressor 210.

[0041] The bypass unit includes the liquid pipe 11, which interconnects the condenser 240 and the expansion device 22, a bypass pipe 31, which interconnects the liquid pipe 11 and the gas pipe 12 that interconnects the evaporator 160 and the compressor 210, and a con-

trol valve 32, which is disposed on the bypass pipe 31 to adjust the flow of refrigerant.

[0042] The bypass pipe 31 bypasses some of the refrigerant condensed in the condenser 240 to the outlet end of the evaporator 160. One side of the bypass pipe 31 is connected to the liquid pipe 11 and the other side of the bypass pipe 31 is connected to the gas pipe 12.

[0043] In order to efficiently collect the oil staying in the gas pipe 12, the position at which the bypass pipe 31 is connected to the gas pipe 12 is important. In consideration of the length of the pipe and the efficiency, the bypass pipe 31 may be connected to the gas pipe 12 at a position between the compressor 210 and the evaporator 160 and closer to the evaporator 160 than to the compressor 210. The bypass pipe 31 is connected to the gas pipe 12 at a position close to the evaporator 160. Specifically, the other side of the bypass pipe 31 is connected to the first gas pipe 12-1.

[0044] In order to increase the convenience of installation, the bypass pipe 31 is disposed inside the indoor unit 110. Specifically, when the indoor unit 100 takes the form of a showcase, one end of the bypass pipe 31 is connected to the liquid pipe 11 between the showcase valve 21 and the condenser 240.

[0045] The control valve 32 adjusts the flow of refrigerant in the bypass pipe 31. The control valve 32 includes a solenoid valve or an electronic expansion valve. The control valve 32 may be an electronic valve, the opening rate of which may be adjusted to various values. The opening rate of the control valve 32 is adjusted by a control signal from the control unit 300. When the opening rate of the control valve 32 is adjusted, the air conditioner of the embodiment may perform an oil collection operation during a cooling operation (normal operation), or may stop the cooling operation and perform only the oil collection operation.

[0046] The refrigerant introduced into the bypass pipe 31 changes the refrigerant in the gas pipe 12 into two-phase refrigerant. Thus, the two-phase refrigerant in the gas pipe 12 is introduced into the accumulator 260 and accelerates the accumulation of liquid-phase refrigerant in the accumulator 260. Thereby, the refrigerant discharged from the accumulator 260 to the compressor 210 includes liquid-phase refrigerant and causes damage to the compressor 210.

[0047] In order to prevent damage to the compressor 210 as described above, the heat exchange unit of the embodiment performs heat exchange between some of the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210, thereby preventing damage to the compressor 210.

[0048] The heat exchange unit may include a heat exchanger 253, which performs heat exchange between some of the refrigerant discharged from the compressor 210 and the refrigerant stored in the accumulator 260, a regulation valve 252, which regulates the flow of refrigerant to be supplied to the heat exchanger 253, and a hot gas pipe 251, which interconnects the heat exchanger

253 and the liquid pipe 11.

[0049] The hot gas pipe 251 supplies some of the refrigerant discharged from the compressor 210 to the heat exchanger 253. The hot gas pipe 251 collects the refrigerant, having undergone heat exchange in the heat exchanger 253, into the liquid pipe 11. Specifically, the hot gas pipe 251 includes a first hot gas pipe 251 and a second hot gas pipe 251.

[0050] The first hot gas pipe 251 connects the connection pipe 13 to one side of the heat exchanger 253 so as to supply the high-temperature and high-pressure refrigerant to the heat exchanger 253. The second hot gas pipe 251 connects the liquid pipe 11 to the other side of the heat exchanger 253 so as to collect the refrigerant, having undergone heat exchange in the heat exchanger 253, into the liquid pipe 11.

[0051] The heat exchanger 253 performs heat exchange between some of the refrigerant discharged from the compressor 210 and the refrigerant stored in the accumulator 260. The heat exchanger 253 supplies heat to the accumulator 260, thereby preventing the accumulation of liquid-phase refrigerant and preventing the liquid-phase refrigerant from being supplied to the compressor 210. The refrigerant inside the heat exchanger 253 may undergo heat exchange via indirect heat transfer, rather than being mixed with the refrigerant inside the accumulator 260.

[0052] In particular, referring to FIG. 3, for example, the accumulator 260 is disposed inside the heat exchanger 253, to which the refrigerant compressed in the compressor 210 moves upon an oil collection operation. That is, the heat exchanger 253 takes the form of a coil that surrounds the outer surface of the accumulator 260. The accumulator 260 is connected to the first gas pipe 12-1, into which a mixture of the refrigerant evaporated in the evaporator 160 and the refrigerant that bypasses the evaporator 160 is introduced, and the second gas pipe 12-2, to which the refrigerant discharged from the accumulator 260 moves.

[0053] The regulation valve 252 regulates the flow of refrigerant to be supplied to the heat exchanger 253. The regulation valve 252 is disposed on the first hot gas pipe 251, and regulates the flow of refrigerant compressed in the compressor 210. The regulation valve 252 may include a solenoid valve or an electronic expansion valve. The regulation valve 252 is closed upon normal operation, and is opened upon an oil collection operation.

[0054] The control unit 300 controls the overall operation of the air conditioner. The control unit 300 may include, for example, a processing device that can perform logic judgment and a memory.

[0055] The control unit 300 controls the air conditioner in a normal operation state or an oil collection operation state based on various pieces of information sensed in the air conditioner. The control unit 300 may perform normal operation or stop the normal operation during an oil collection operation.

[0056] The control unit 300 determines an oil collection

operation when the amount of oil in the compressor 210 is insufficient, and starts the oil collection operation. Specifically, the control unit 300 executes an oil collection operation when the oil level input from the oil level sensor 230 is lower than a reference oil level, and executes normal operation when the oil level input from the oil level sensor 230 is higher than the reference oil level.

[0057] The control unit 300 may determine to perform an oil collection operation when the temperature of the gas pipe 12 is low, and may start the oil collection operation when the discharge temperature value input from the discharge temperature sensor 25 is lower than a reference discharge temperature value, and executes normal operation when the discharge temperature value input from the discharge temperature sensor 25 is higher than the reference discharge temperature value.

[0058] Upon an oil collection operation, the control unit 300 controls the bypass unit so as to bypass the refrigerant discharged from the condenser 240 to the outlet end of the evaporator 160. Here, the outlet end of the evaporator 160 means the position on the gas pipe 12 that is close to the evaporator 160.

[0059] Specifically, upon normal operation, the control unit 300 drives the compressor 210 so as to supply cold air to the showcase. Upon an oil collection operation, the control unit 300 drives the compressor 210 and opens the control valve 32 so as to supply high-temperature and high-pressure refrigerant to the gas pipe 12. The control unit 300 may adjust the opening rate and the opening time of the control valve 32 upon the oil collection operation. Upon the oil collection operation, the control unit 300 may open the showcase valve 210 so as to supply the refrigerant to the evaporator 160, or may close the showcase valve 210 so as to supply no refrigerant to the evaporator 160.

[0060] Upon the oil collection operation, the control unit 300 controls the heat exchange unit so as to perform heat exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210. Specifically, the control unit 300 opens the regulation valve 252 so as to perform heat exchange between the high-temperature and high-pressure refrigerant discharged from the compressor 210 and the accumulator 260 upon the oil collection operation.

[0061] Hereinafter, the structure of the showcase according to an embodiment will be described with reference to FIGs. 4 and 5.

[0062] The showcase according to the embodiment of the present invention includes a case 100, which defines a storage compartment 110 in which articles are stored and has an open front side, an upper discharge hole 121, which is formed in the front end of the upper surface of the case 100 so that cold air is discharged downward therefrom, a plurality of shelves 111, which is disposed inside the case 100 to support the stored articles thereon, and a shelf fan 189, which is disposed on the front end of at least one shelf 111 among the shelves 111 and

serves to suction the cold air discharged from the upper discharge hole 121 and to discharge the suctioned cold air downward.

[0063] The case 100 substantially takes the form of a hexahedron having an open front side in order to define the storage compartment 110. The case 100 includes an outer case 101, which forms the external appearance of the showcase, and an inner case 103, which is disposed inside the outer case 101 so as to define the storage compartment 110. The storage compartment 110 has a substantially hexahedral shape having an open front side.

[0064] The outer case 101 forms the external appearance of the showcase. The outer case 101 may substantially take the form of a hexahedron, the front side of which is partially open. In some embodiments, the outer case 101 may have a lateral side, a part of which is open.

[0065] The inner case 103 is disposed inside the outer case 101. The inner case 103 substantially takes the form of a hexahedron having an open front side, similar to the outer case 101. In some embodiments, the inner case 103 may have a lateral side, part of which is open. The inner case 103 defines the storage compartment 110 in which articles are accommodated. Cold air moves between the outer case 101 and the inner case 103 and inside the inner case 103 to keep the articles stored in the storage compartment 110 in a frozen or refrigerated state.

[0066] The shelves 111 are disposed in the storage compartment 110, which is the inside of the inner case 103. Various articles may be seated on the upper surface of each shelf 111. These shelves 111 are fixed to the rear surface of the inner case 103, and horizontally extend toward the open front side of the inner case 103. The shelves 111 may be arranged in the vertical direction so as to vertically divide the storage compartment 110.

[0067] A plurality of rear discharge holes 123 is formed in the rear surface of the inner case 103 so that cold air is discharged therefrom. The rear discharge holes 123 are vertically or horizontally spaced apart from one another. The rear discharge holes 123 may be arranged respectively between the shelves 111. The rear discharge holes 123 discharge cold air, which has been cooled via heat exchange with the refrigerant in the evaporator 160, as will be described later, forwards. The rear discharge holes 123, formed in the rear surface of the inner case 103, discharge the cold air to the open front side of the inner case 103. The cold air discharged from the rear discharge holes 123 horizontally move along the respective shelves 111 so as to keep the articles on the shelves 111 in a frozen or refrigerated state.

[0068] The upper discharge hole 121 is formed in the front end of the upper surface of the inner case 103 so that cold air is discharged therefrom. The upper discharge hole 121 is elongated in the left-and-right direction in the front end of the upper surface of the case 103. The upper discharge hole 121 may be disposed further forward than the front ends of the remaining shelves 111

having no shelf fan 189.

[0069] The upper discharge hole 121 downwardly discharges the cold air, which has been cooled via heat exchange with the refrigerant in the evaporator 160 as will be described later. The cold air discharged from the upper discharge hole 121 is accelerated by the shelf fan 189, and thereafter is suctioned to a cold air suction hole 130, which will be described later.

[0070] The upper discharge hole 121 causes the discharged cold air to move downward along the front side of the storage compartment 110. The cold air discharged from the upper discharge hole 121 serves as an air curtain that prevents outside air from being introduced into the storage compartment 110. The cold air discharged from the upper discharge hole 121 may vertically move, and in some embodiments, may move at an acute angle relative to the vertical direction.

[0071] The shelf fan 189 is disposed on the front end of at least one shelf 111 among the shelves 111. The shelf fan 189 may be disposed on the middle shelf 111 among the shelves 111. In some embodiments, when a plurality of shelf fans 189 is provided, the shelf fans 189 may be arranged at the same interval between the upper discharge hole 121 and the cold air suction hole 130.

[0072] The shelf fan 189 suctiones the cold air discharged from the upper discharge hole 121 and discharges the cold air downward. The shelf fan 189 may be a sirocco fan that is elongated in the left-and-right direction. The shelf fan 189 accelerates and downwardly discharges the cold air discharged from the upper discharge hole 121, and the cold air discharged from the shelf fan 189 is suctioned into the cold air suction hole 130.

[0073] The shelf fan 189 is disposed so as to protrude further forward than the front ends of the shelves 111 having no shelf fan 189. The shelf fan 189 may be disposed below the upper discharge hole 121. The shelf fan 189 may be disposed on the imaginary line that interconnects the upper discharge hole 121 and the cold air suction hole 130.

[0074] The shelf fan 189 is supported by a shelf fan housing 180. The shelf fan housing 180 is formed on the front end of the shelf 111 on which the shelf fan 189 is disposed. The shelf fan housing 180 may be integrally formed with the shelf 111 on which the shelf fan 189 is disposed, or may be separately formed so as to be coupled to the shelf 111. The shelf fan housing 180 protrudes further forward than the front ends of the shelves 111 having no shelf fan 189.

[0075] A shelf suction hole 181 is formed in the top side of the shelf fan housing 180 so that the cold air discharged from the upper discharge hole 121 is suctioned into the shelf suction hole 181. The shelf suction hole 181 may be disposed below the upper discharge hole 121. A shelf discharge hole 182 is formed in the bottom side of the shelf fan housing 180 so that the cold air suctioned into the shelf suction hole 181 is discharged from the shelf discharge hole 182. The shelf discharge hole 182 discharges the cold air downward. The shelf dis-

charge hole 182 may be disposed above the cold air suction hole 130.

[0076] The shelf fan 189 is provided inside the shelf fan housing 180. The shelf fan housing 180 rotatably supports the shelf fan 189. A shelf fan motor 188 is provided inside the shelf fan housing 180 and serves to rotate the shelf fan 189.

[0077] The cold air suction hole 130 is formed in the lower surface of the inner case 103 so that the cold air is suctioned into the cold air suction hole 130. The cold air suction hole 130 may be elongated in the left-and-right direction in the lower surface of the inner case 103. The cold air suction hole 130 may be disposed below the shelf fan 189. The cold air suction hole 130 may be disposed below the shelf discharge hole 182 in the shelf fan housing 180.

[0078] After the cold air discharged from the upper discharge hole 121 is suctioned into the shelf suction hole 181, and then is discharged from the shelf discharge hole 182 by the shelf fan 189, the cold air is suctioned into the cold air suction hole 130. The cold air suction hole 130 further suctiones the cold air discharged from the rear discharge holes 123. The cold air suctioned into the cold air suction hole 130 moves to a lower flow path 141, which is formed below the inner case 103.

[0079] The lower flow path 141 is formed below the lower surface of the inner case 103. The lower flow path 141 is formed between the lower surface of the inner case 103 and the lower surface of the outer case 101. The lower flow path 141 is in communication with the cold air suction hole 130. A blowing fan 150 is provided inside the lower flow path 141.

[0080] The blowing fan 150 is disposed inside the lower flow path 141, which is formed below the lower surface of the inner case 103. The blowing fan 150 is rotatably disposed between the lower surface of the inner case 103 and the lower surface of the outer case 101. The blowing fan 150 creates the flow of cold air so that the cold air is suctioned into the cold air suction hole 130. The blowing fan 150 creates the flow of cold air so as to cause the cold air to be discharged to the rear discharge holes 123 and the upper discharge hole 121.

[0081] The lower flow path 141 is connected to a rear flow path 143. The rear flow path 143 is formed between the rear surface of the inner case 103 and the rear surface of the outer case 101. The cold air, which has been suctioned into the cold air suction hole 130 and moved in the lower flow path 141, is made to rise along the rear flow path 143 by the blowing fan 150.

[0082] The rear flow path 143 is in communication with the rear discharge holes 123. The cold air moving in the rear flow path 143 is distributed to the respective rear discharge holes 123 so as to be discharged therefrom.

[0083] The evaporator 160 is disposed inside the rear flow path 143 to cool the cold air. The refrigerant, which moves in the evaporator 160, undergoes heat exchange with the cold air, which moves in the rear flow path 143. The refrigerant, which has been compressed in the com-

pressor 210, condensed in the condenser 240, and thereafter expanded in the expansion device 22, evaporates in the evaporator 160 via heat exchange with the cold air. The refrigerant, which moves in the evaporator 160, evaporates upon receiving heat from the cold air, and the cold air is cooled.

[0084] The rear flow path 143 is connected to an upper flow path 145. The upper flow path 145 is formed above the upper surface of the inner case 103. The upper flow path 145 is formed between the upper surface of the inner case 103 and the upper surface of the outer case 101. The upper flow path 145 is in communication with the upper discharge hole 121. The cold air moved to the upper flow path 145 through the rear flow path 143 is discharged through the upper discharge hole 121.

[0085] The operation of the showcase according to the present invention having the above-described configuration will be described below.

[0086] When the blowing fan 150 is driven, the cold air inside the storage compartment 110 is suctioned into the lower flow path 141 through the cold air suction hole 130. The cold air moved to the lower flow path 141 is made to rise along the rear flow path 143 by the blowing fan 150.

[0087] The cold air moved to the rear flow path 143 is cooled via heat exchange in the evaporator 160. The cold air cooled in the evaporator 160 rises along the rear flow path 143 so that some of the cold air is discharged through the rear discharge holes 123. The cold air discharged from the rear discharge holes 123 horizontally moves along the respective shelves 111 so as to keep the articles placed on the shelves 111 in a frozen or refrigerated state. The cold air, discharged from the rear discharge holes 123 and moved along the respective shelves 111, moves downward to thereby be suctioned into the cold air suction hole 130.

[0088] The cold air, which has risen along the rear flow path 143 and has moved to the upper flow path 145, is discharged through the upper discharge hole 121. The cold air discharged from the upper discharge hole 121 is suctioned into the shelf suction hole 181 in the shelf fan housing 180 and discharged from the shelf discharge hole 182 by the driving of the shelf fan 189. The cold air discharged from the shelf discharge hole 182 is accelerated by the shelf fan 189 so as to be discharged from the shelf discharge hole 182, and thereafter is suctioned into the cold air suction hole 130.

[0089] The cold air, which has been discharged through the upper discharge hole 121, accelerated by the shelf fan 189, and thereafter suctioned into the cold air suction hole 130, forms an air curtain on the front side of the storage compartment 110. The air curtain formed by the cold air prevents outdoor air from being introduced into the storage compartment 110. In addition, the air curtain prevents the cold air discharged from the rear discharge holes 123 from leaking to the outside of the storage compartment 110.

[0090] The operation of the air conditioner according to the present invention having the above-described con-

figuration will be described below.

[0091] FIG. 6 is a view illustrating the flow of refrigerant upon normal operation of the air conditioner according to the embodiment of the present invention.

[0092] Hereinafter, normal operation (cooling operation) of the air conditioner 100 according to the embodiment of the present invention will be described with reference to FIG. 6.

[0093] The refrigerant compressed in the compressor 210 is discharged from the outlet port 212 and moves to the connection pipe 13. The refrigerant, discharged from the outlet port 212 and moved to the connection pipe 13, moves to the condenser 240. At this time, the regulation valve 252 is closed to prevent the refrigerant compressed in the compressor 210 from moving to the heat exchanger 253.

[0094] The refrigerant moved from the connection pipe 13 to the condenser 240 is condensed in the condenser 240 via heat exchange with outdoor air. The refrigerant condensed in the condenser 240 moves to the expansion device 22 by way of the liquid pipe 11. The expansion device 22 expands the introduced refrigerant. The opening rate of the expansion device 22 is automatically adjusted according to the temperature of the refrigerant.

[0095] The refrigerant moved to the expansion device 22 expands and moves to the evaporator 160. The refrigerant moved to the evaporator 160 evaporates in the evaporator 160 via heat exchange with indoor air. The refrigerant cools the showcase while undergoing heat exchange in the evaporator 160.

[0096] The refrigerant evaporated in the evaporator 160 moves to the gas pipe 12. The refrigerant moved to the gas pipe 12 is introduced into the compressor 210 by way of the accumulator 260.

[0097] FIG. 7 is a view illustrating the flow of refrigerant upon an oil collection operation of the air conditioner according to the embodiment of the present invention.

[0098] Hereinafter, an oil collection operation of the air conditioner 100 according to the embodiment of the present invention will be described with reference to FIG. 7.

[0099] The refrigerant compressed in the compressor 210 is discharged from the outlet port 212 and moves to the connection pipe 13. Some of the refrigerant, discharged from the outlet port 212 and moved to the connection pipe 13, moves to the condenser 240. The remaining refrigerant, discharged from the outlet port 212 and moved to the connection pipe 13, moves to the heat exchanger 253 through the opened regulation valve 252. The refrigerant moved to the heat exchanger 253 undergoes heat exchange with the refrigerant in the accumulator 260, which reduces the accumulation of liquid-phase refrigerant in the accumulator 260.

[0100] The refrigerant moved from the connection pipe 13 to the condenser 240 is condensed in the condenser 240 via heat exchange with outdoor air. The refrigerant condensed in the condenser 240 moves to the liquid pipe 11. Some of the refrigerant moved from the condenser

240 to the liquid pipe 11 moves to the expansion device 22. The opening rate of the expansion device 22 is automatically adjusted according to the temperature of the refrigerant. The refrigerant moved to the expansion device 22 expands and moves to the evaporator 160. The refrigerant moved to the evaporator 160 evaporates in the evaporator 160 via heat exchange with indoor air. The refrigerant cools the showcase while undergoing heat exchange in the evaporator 160.

[0101] The remaining refrigerant moved from the condenser 240 to the liquid pipe 11 moves to the bypass pipe 31 through the opened control valve 32 and is introduced into the gas pipe 12 that is close to the evaporator 160. The refrigerant introduced through the bypass pipe 31 increases the temperature of the gas pipe 12 and changes the refrigerant in the gas pipe 12 into two-phase refrigerant, thereby lowering the viscosity of the oil in the gas pipe 12 and increasing the flow-ability of the oil.

[0102] Both the refrigerant evaporated in the evaporator 160 and the refrigerant bypassed to the bypass pipe 31 move to the gas pipe 12. The refrigerant moved to the gas pipe 12 is introduced into the compressor 210 by way of the accumulator 260. The refrigerant in the accumulator 260 undergoes heat exchange with the heat exchanger 253 as described above.

[0103] FIG. 8 is a flowchart illustrating a method of controlling the air conditioner according to an embodiment of the present invention.

[0104] Referring to FIG. 8, the method of controlling the air conditioner according to the embodiment of the present invention includes determining to perform an oil collection operation when the amount of oil in the compressor 210 is insufficient, and starting the oil collection operation.

[0105] Specifically, the control unit 300 determines whether to execute the oil collection operation or normal operation by comparing the oil level input from the oil level sensor 230 with a reference oil level (S10).

[0106] The control unit 300 executes the oil collection operation when the oil level input from the oil level sensor 230 is lower than the reference oil level (S20), and executes the normal operation when the oil level input from the oil level sensor 230 is higher than the reference oil level (S30).

[0107] Upon the oil collection operation, the control unit 300 controls the bypass unit so as to bypass the refrigerant discharged from the condenser 240 to the outlet end of the evaporator 160. Specifically, upon the oil collection operation, the control unit 300 drives the compressor 210 and opens the control valve 32 so as to supply high-temperature and high-pressure refrigerant to the gas pipe 12 (S21). The control unit 300 may adjust the opening rate and the opening time of the control valve 32 during the oil collection operation. Upon the oil collection operation, the control unit 300 may open the showcase valve 210 so as to supply the refrigerant to the evaporator 160, or may close the showcase valve 210 so as to supply no refrigerant to the evaporator 160.

[0108] Upon the oil collection operation, the control unit 300 controls the heat exchange unit so as to perform heat exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210. Specifically, the control unit 300 opens the regulation valve 252 so as to perform heat exchange between the high-temperature and high-pressure refrigerant discharged from the compressor 210 and the accumulator 260 upon the oil collection operation (S22).

[0109] Upon the normal operation, the control unit 300 controls the bypass unit such that no refrigerant discharged from the condenser 240 is bypassed to the outlet end of the evaporator 160. Upon the normal operation, the control unit 300 drives the compressor 210 and closes the control valve 32 (S31), and opens the showcase valve 210 so as to supply the refrigerant into the evaporator 160.

[0110] Upon the normal operation, the control unit 300 controls the heat exchange unit so as not to perform no exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210. Specifically, the control unit 300 closes the regulation valve 252 upon the normal operation (S32).

[0111] FIG. 9 is a flowchart illustrating a method of controlling the air conditioner according to another embodiment of the present invention.

[0112] Referring to FIG. 9, the method of controlling the air conditioner according to the embodiment of the present invention may include determining an oil collection operation when the temperature of the gas pipe 12 is low, and starting the oil collection operation.

[0113] Specifically, the control unit 300 determines whether to execute the oil collection operation or normal operation by comparing the discharge temperature value input from the discharge temperature sensor 25 with a reference discharge temperature value (S40).

[0114] The control unit 300 executes the oil collection operation when the discharge temperature value input from the discharge temperature sensor 25 is lower than the reference discharge temperature value (S20), and executes the normal operation when the discharge temperature value input from the discharge temperature sensor 25 is higher than the reference discharge temperature value (S30).

[0115] Upon the oil collection operation, the control unit 300 controls the bypass unit so as to bypass the refrigerant discharged from the condenser 240 to the outlet end of the evaporator 160. Specifically, upon the oil collection operation, the control unit 300 drives the compressor 210 and opens the control valve 32 so as to supply high-temperature and high-pressure refrigerant to the gas pipe 12 (S21). The control unit 300 may adjust the opening rate and the opening time of the control valve 32 during the oil collection operation. Upon the oil collection operation, the control unit 300 may open the showcase valve 210 so as to supply the refrigerant to the evap-

orator 160, or may close the showcase valve 210 so as to supply no refrigerant to the evaporator 160.

[0116] Upon the oil collection operation, the control unit 300 controls the heat exchange unit so as to perform heat exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210. Specifically, the control unit 300 opens the regulation valve 252 so as to perform heat exchange between the high-temperature and high-pressure refrigerant discharged from the compressor 210 and the accumulator 260 upon the oil collection operation (S22).

[0117] Upon the normal operation, the control unit 300 controls the bypass unit such that no refrigerant discharged from the condenser 240 is bypassed to the outlet end of the evaporator 160. Upon the normal operation, the control unit 300 drives the compressor 210 and closes the control valve 32 (S31), and opens the showcase valve 210 so as to supply the refrigerant into the evaporator 160.

[0118] Upon the normal operation, the control unit 300 controls the heat exchange unit so as to not perform heat exchange between the refrigerant discharged from the compressor 210 and the refrigerant to be suctioned into the compressor 210. Specifically, the control unit 300 closes the regulation valve 252 upon the normal operation (S32).

[0119] As is apparent from the above description, the embodiments are advantageous in terms of the rapid collection of oil remaining in a gas pipe upon normal operation.

[0120] The embodiments are advantageous in terms of the increased reliability of a compressor owing to the rapid collection of oil remaining in the gas pipe.

[0121] The embodiments are advantageous in terms of an increased length of gas pipe and the increased installation freedom of the air conditioner because the amount of oil remaining in the gas pipe is reduced.

[0122] The embodiments are advantageous in terms of the prevention of damage to the compressor upon an oil collection operation.

Claims

1. An air conditioner comprising:

a compressor (210) configured to compress and discharge a refrigerant;
a condenser (240) configured to condense the refrigerant compressed in the compressor (210);
an expansion device (22) configured to expand the refrigerant condensed in the condenser (240);
an evaporator (160) configured to evaporate the refrigerant expanded in the expansion device (22), to perform heat exchange between the re-

frigerant and indoor air, and to discharge the evaporated refrigerant to the compressor (210);
a bypass unit configured to guide some of the refrigerant discharged from the condenser (240) to an outlet end of the evaporator (160);
a heat exchange unit configured to perform heat exchange between some of the refrigerant discharged from the compressor (210) and the refrigerant to be suctioned into the compressor (210); and
a control unit (300) configured to control overall operation of the air conditioner, wherein the control unit (300) is configured to control the bypass unit so as to bypass the refrigerant, discharged from the condenser (240), to the outlet end of the evaporator (160) upon an oil collection operation.

2. The air conditioner according to claim 1, wherein the bypass unit includes:

a liquid pipe (11) configured to interconnect the condenser (240) and the expansion device (22);
a bypass pipe (31) configured to interconnect the liquid pipe (11) and a gas pipe (12) that interconnects the evaporator (160) and the compressor (210); and
a control valve (32) disposed on the bypass pipe (31) to adjust a flow of the refrigerant.

3. The air conditioner according to claim 2, wherein the control valve (32) includes an electronic expansion valve.

4. The air conditioner according to claim 2, or 3, wherein the bypass pipe (31) is connected to the gas pipe (12) at a position between the compressor (210) and the evaporator (160) and closer to the evaporator (160) than to the compressor (210).

5. The air conditioner according to claim 2, or 3, wherein the bypass pipe (31) is connected to a position of the gas pipe that is close to the evaporator (160).

6. The air conditioner according to claim 1, wherein the control unit (300) is configured to control the heat exchange unit so as to perform heat exchange between the refrigerant discharged from the compressor (210) and the refrigerant to be suctioned into the compressor (210) upon the oil collection operation.

7. The air conditioner according to claim 6, further comprising an accumulator (260) disposed on a gas pipe (12) that interconnects the evaporator (160) and the compressor (210) to prevent liquid-phase refrigerant, among the refrigerant to be introduced into the compressor (210), from being introduced into the compressor (210).

8. The air conditioner according to claim 7, wherein the heat exchange unit includes:

a heat exchanger (253) configured to perform heat exchange between some of the refrigerant discharged from the compressor (210) and the refrigerant stored in the accumulator (260); and a regulation valve (252) configured to regulate a flow of the refrigerant to be supplied to the heat exchanger (253).

9. The air conditioner according to claim 8, wherein the bypass unit includes:

a liquid pipe (11) configured to interconnect the condenser (240) and the expansion device (22); a bypass pipe (32) configured to interconnect the liquid pipe (11) and the gas pipe (12); and a control valve (32) disposed on the bypass pipe (32) to adjust a flow of the refrigerant.

10. The air conditioner according to claim 9, further comprising an oil level sensor (230) configured to sense a level of oil in the compressor (210).

11. The air conditioner according to claim 10, wherein the control unit (300) is configured to execute the oil collection operation when an oil level input from the oil level sensor (230) is lower than a reference oil level.

12. The air conditioner according to claim 11, wherein the control unit (300) is configured to open the control valve (32) and the regulation valve (252) upon the oil collection operation.

13. The air conditioner according to claim 9, further comprising a discharge temperature sensor (25) configured to measure a temperature of the refrigerant discharged from the evaporator (160).

14. The air conditioner according to claim 13, wherein the control unit (300) is configured to execute the oil collection operation when a discharge temperature value input from the discharge temperature sensor (25) is lower than a reference discharge temperature value.

15. The air conditioner according to claim 14, wherein the control unit (300) is configured to open the control valve (32) and the regulation valve (252) upon the oil collection operation.

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FIG. 1

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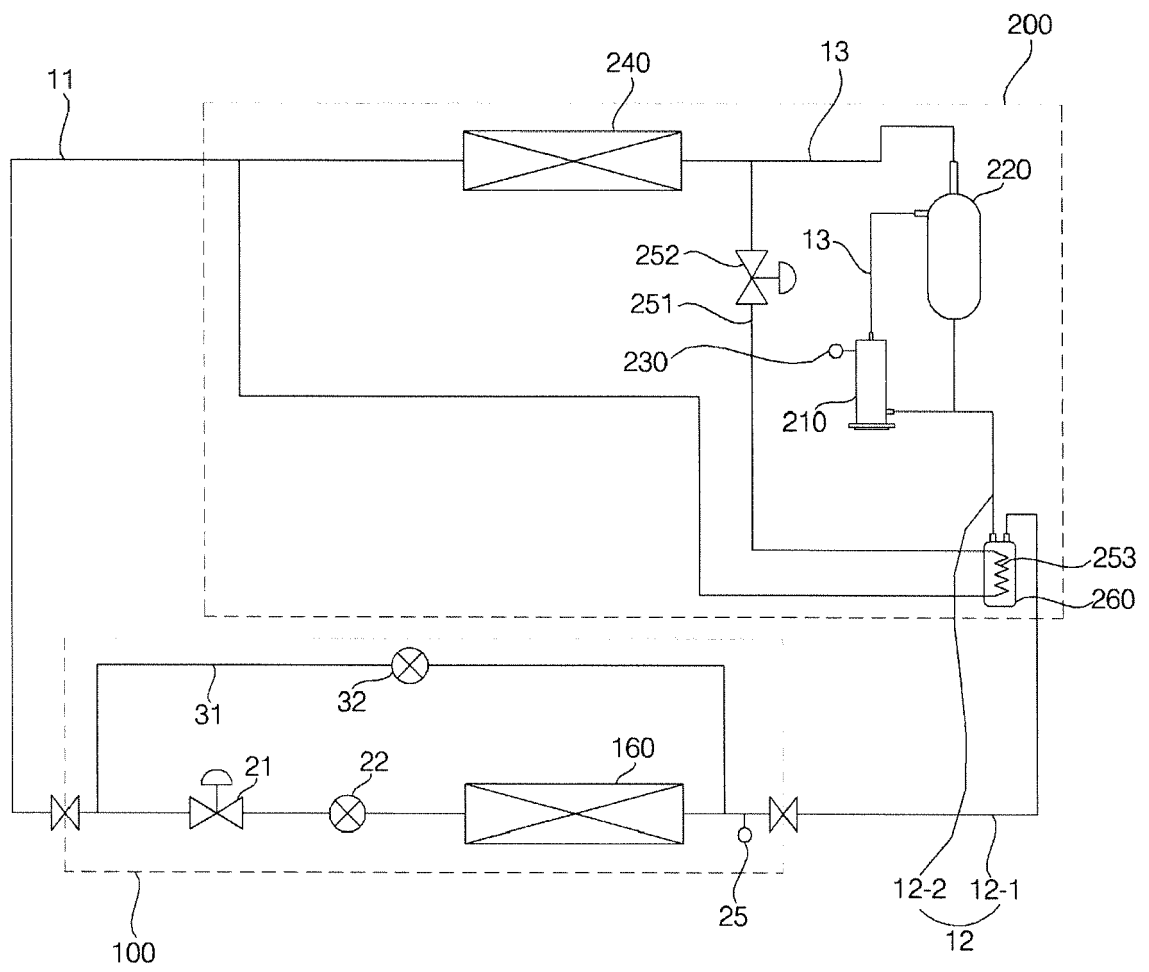


FIG. 2

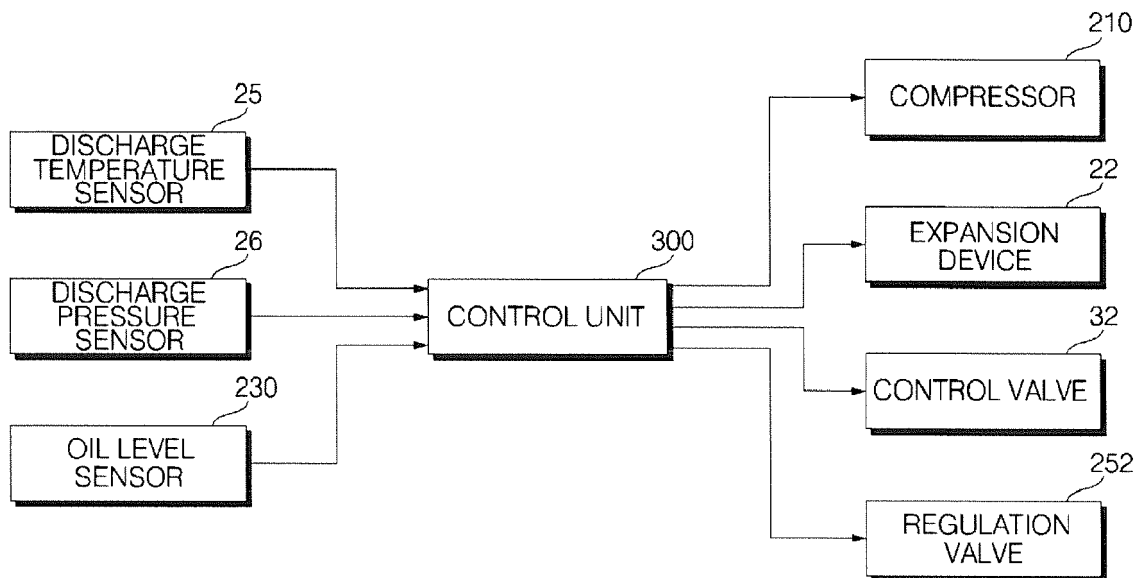


FIG. 3

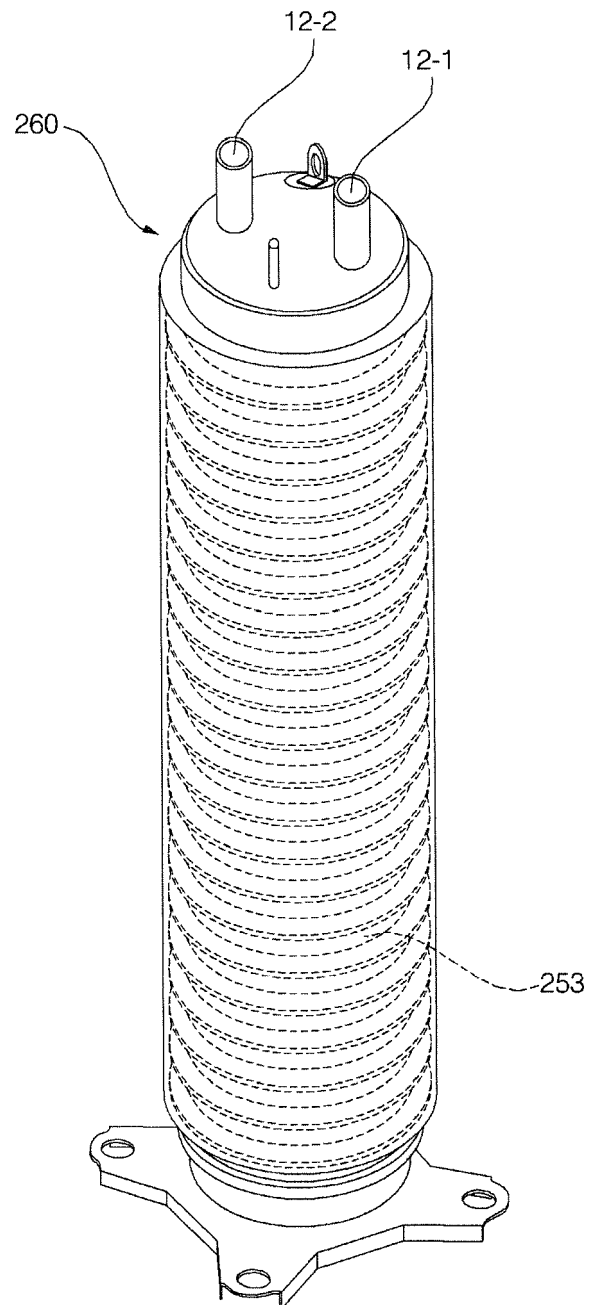


FIG. 4

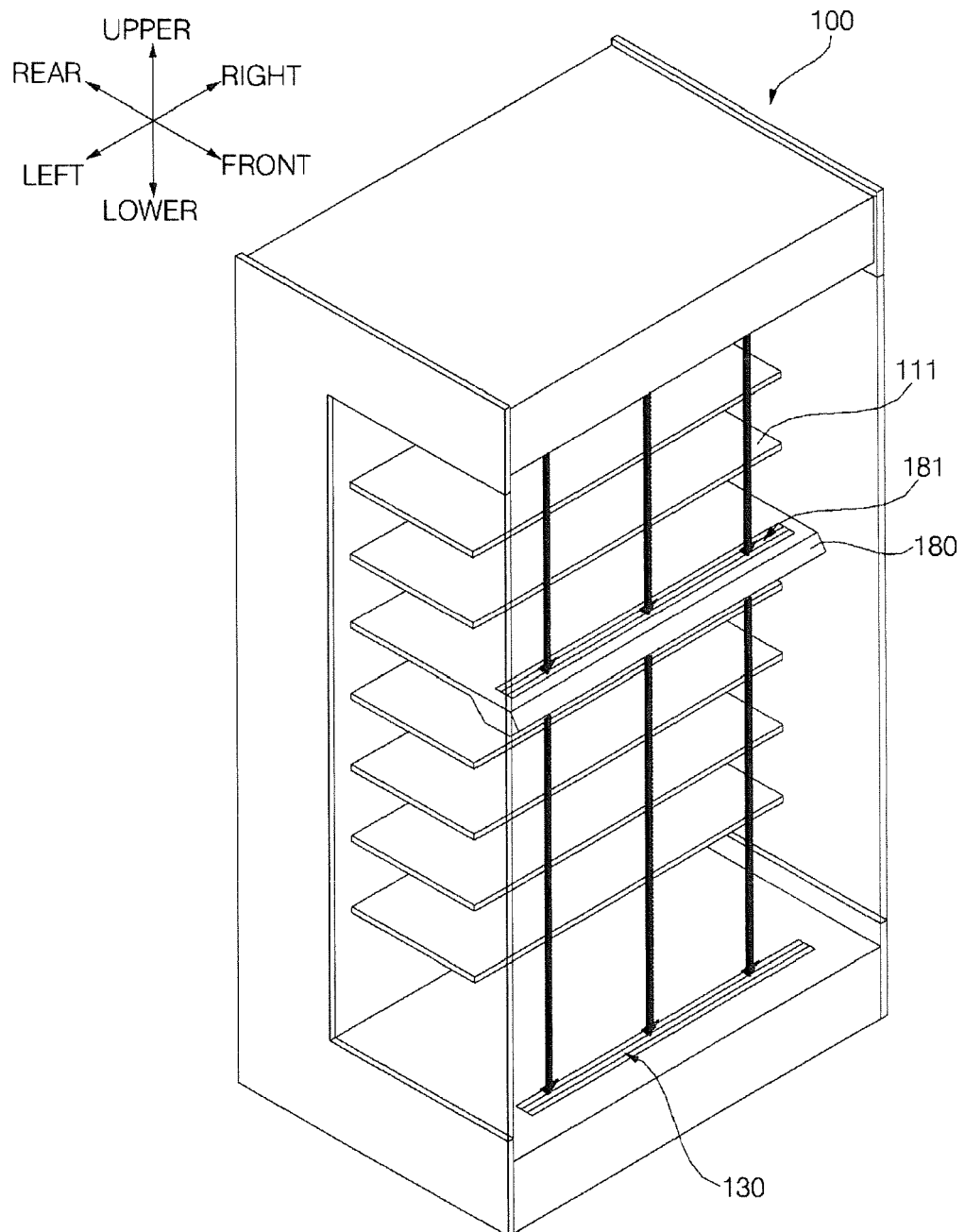


FIG. 5

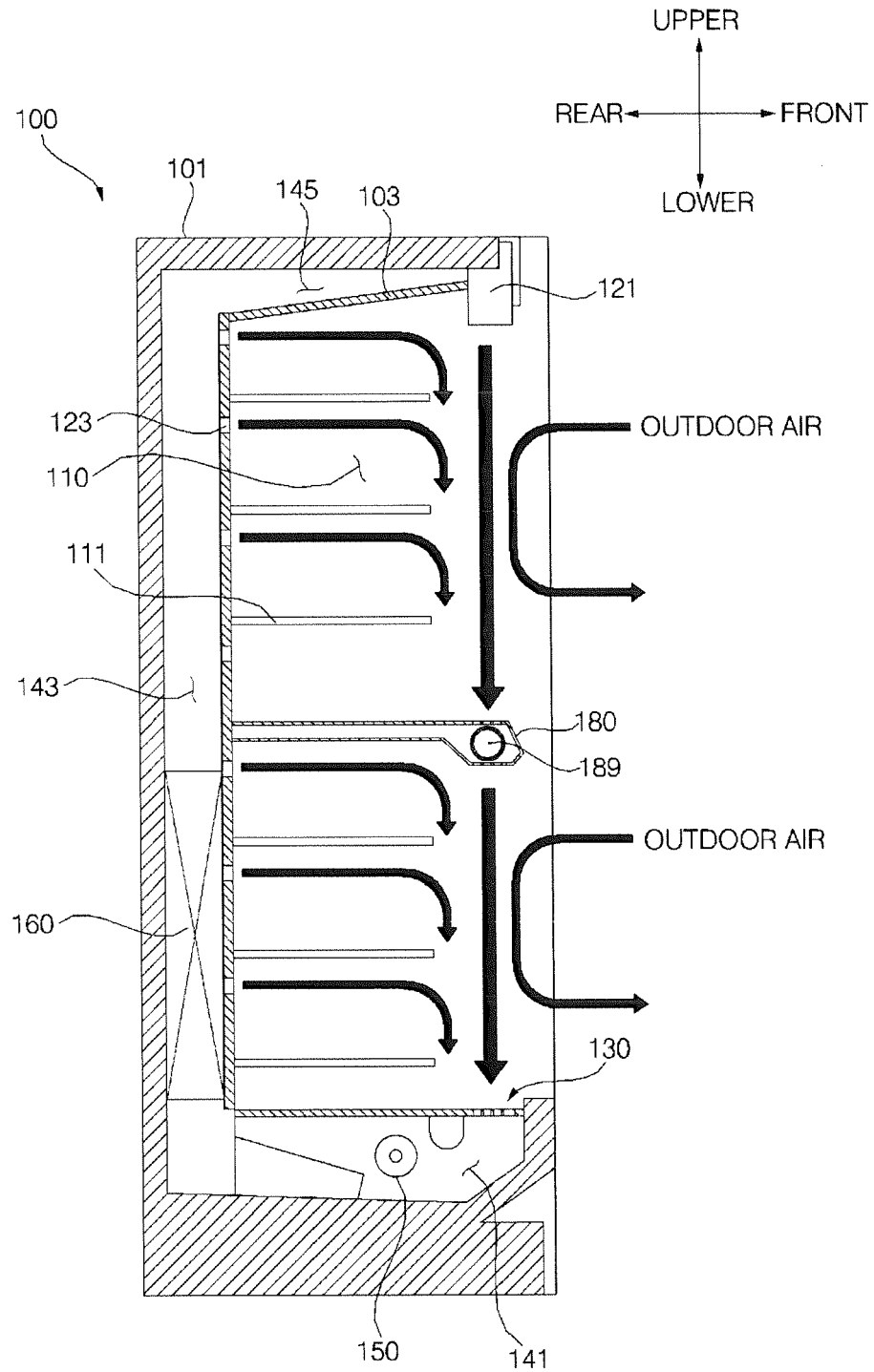


FIG. 6

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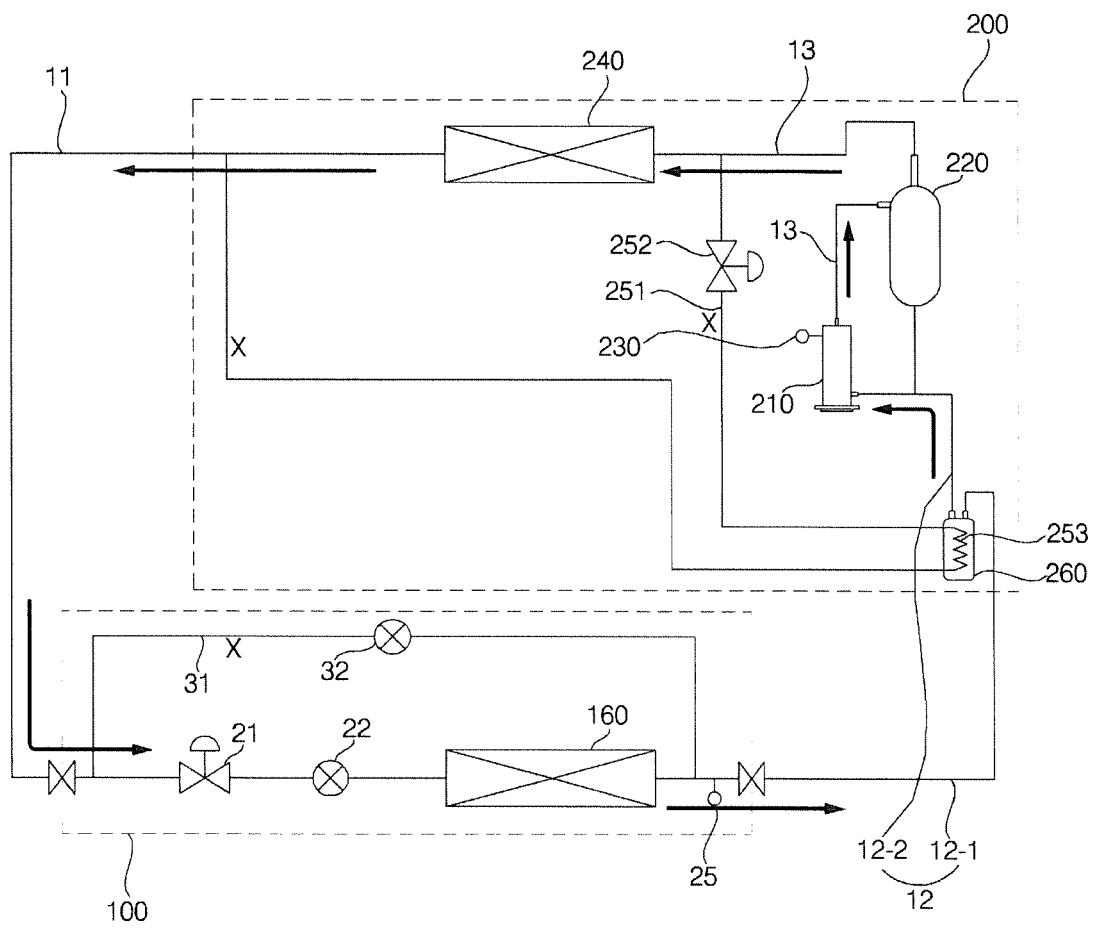


FIG. 7

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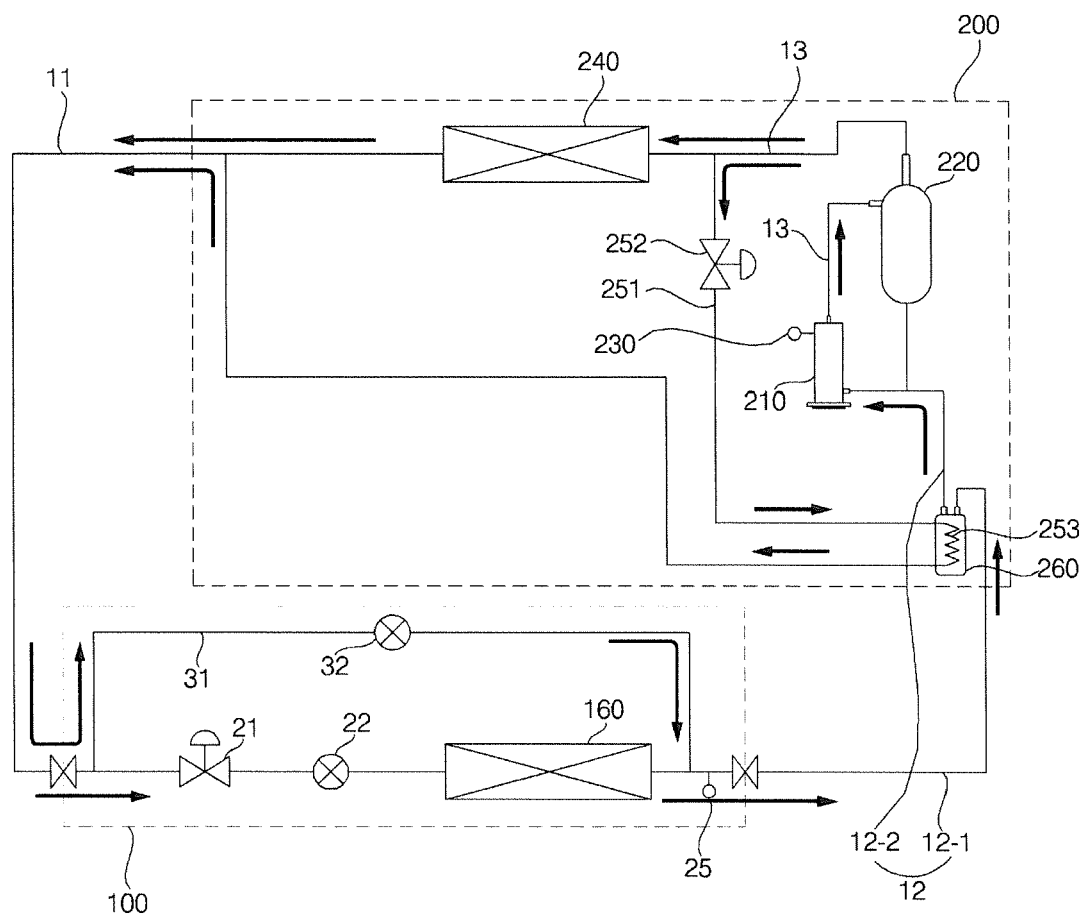


FIG. 8

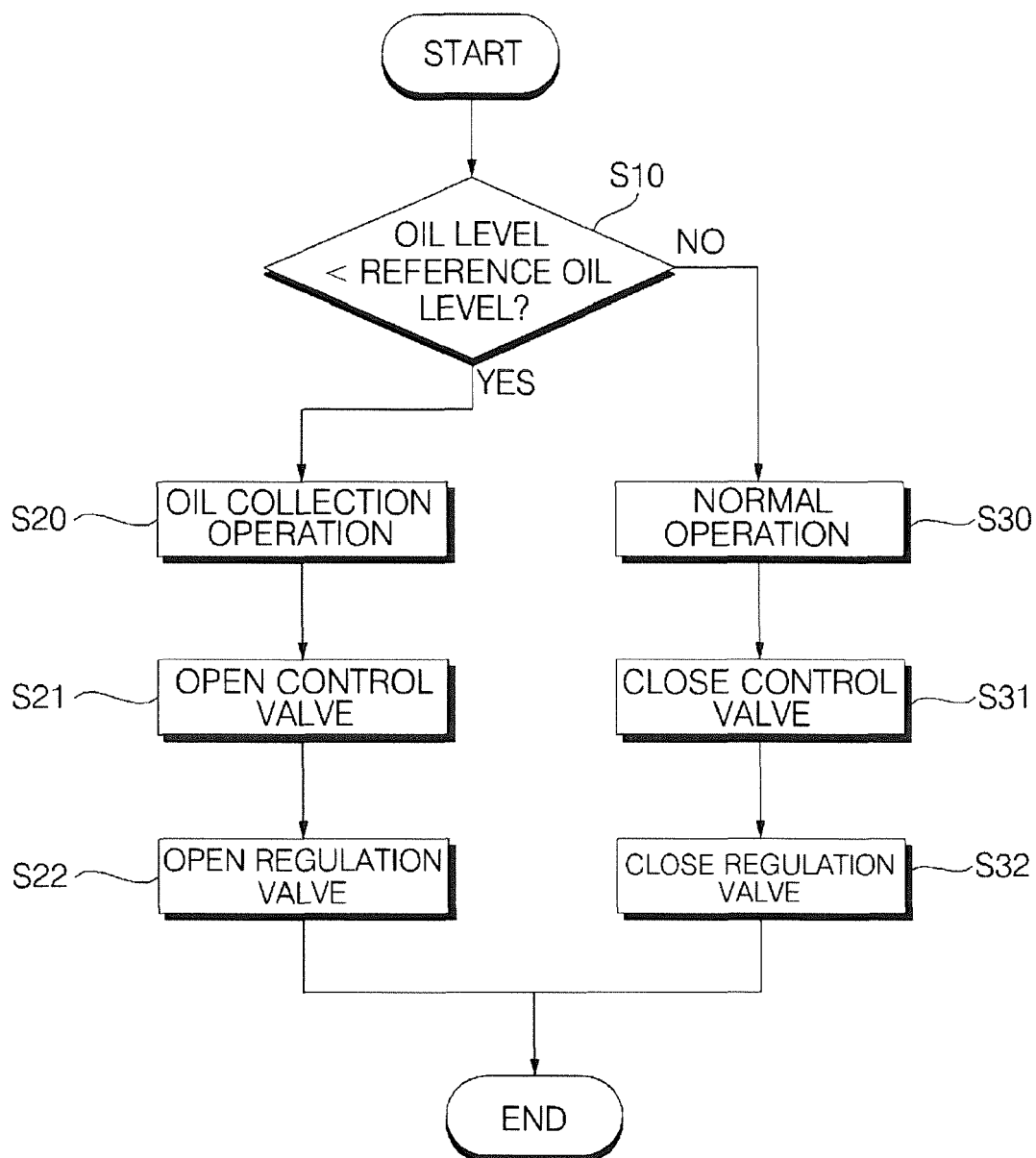


FIG. 9

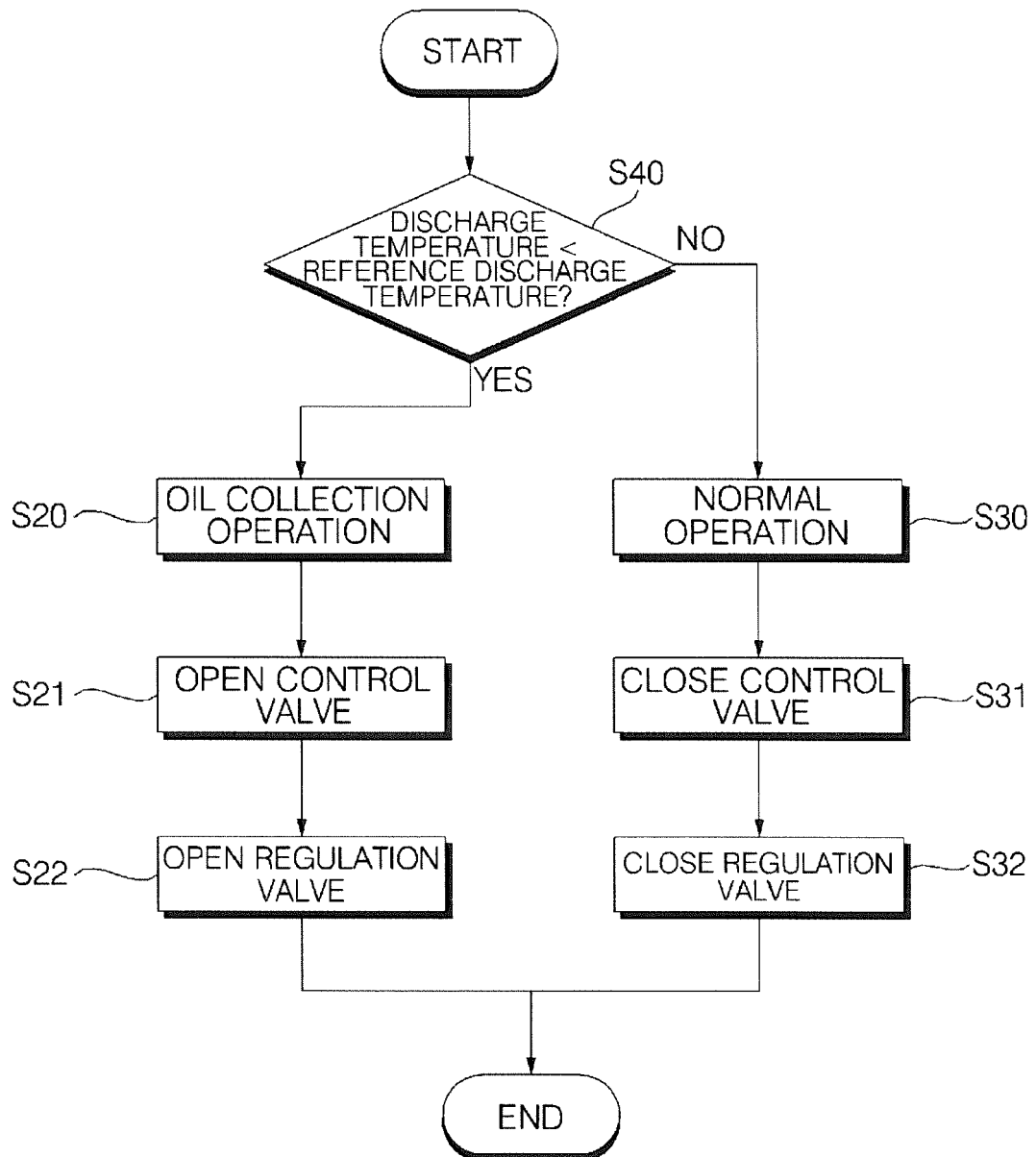
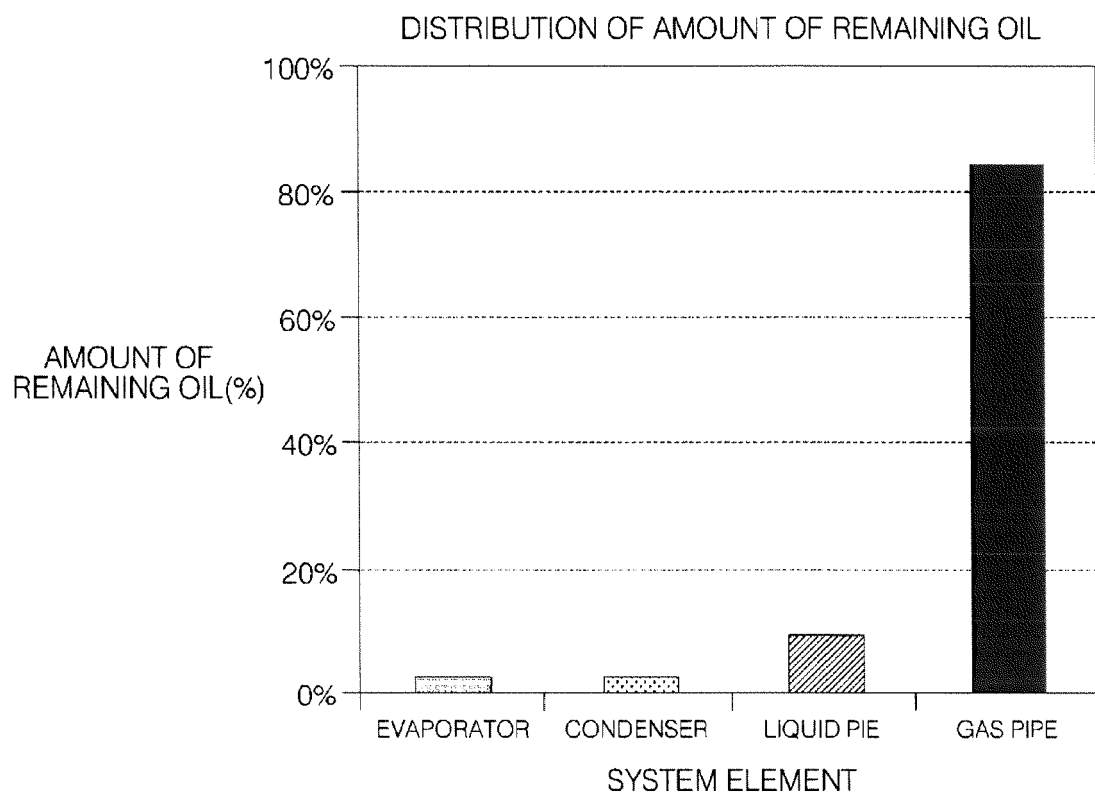


FIG. 10





EUROPEAN SEARCH REPORT

 Application Number
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Place of search Munich		Date of completion of the search 14 June 2017	Examiner Weisser, Meinrad
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