(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 015 793 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.05.2016 Bulletin 2016/18

(51) Int Cl.:
F25B 13/00 *(2006.01)*

(21) Application number: **15191922.2**

(22) Date of filing: **28.10.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **29.10.2014 KR 20140147976**
29.10.2014 KR 20140147977
29.10.2014 KR 20140147978

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(54) AIR CONDITIONER AND METHOD OF CONTROLLING THE SAME

(57) An air conditioner includes a compressor; a flow switching part disposed at an outlet side of the compressor to switch a flow direction of a refrigerant according to whether a cooling operation or heating operation is performed; an outdoor heat exchanger connected to the flow switching part and having a plurality of the refrigerant pipes to guide the refrigerant which heat-exchanges with outdoor air; and a main expansion valve connected to one side of the outdoor heat exchanger. A first inlet/outlet pipe connects the flow switching part to the outdoor heat exchanger; and a second inlet/outlet pipe connects the outdoor heat exchanger to the main expansion valve, where the outdoor heat exchanger includes a header to form a flowing space of the refrigerant and having an upper header and a lower header; a check valve disposed between the upper header and the lower header to guide the refrigerant to flow one way; and a bypass pipe connecting the lower header to the second inlet/outlet pipe and guiding a discharge of a liquid refrigerant located in the lower header, and a bypass pipe valve controlling an amount of the liquid refrigerant flowing through the bypass pipe.

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Description

BACKGROUND

1. Field

[0001] An air conditioner and a method of controlling the same are disclosed herein.

2. Background

[0002] An air conditioner is an apparatus which maintains air in a desired space at a desired temperature. Generally, the air conditioner includes a compressor, a condenser, an expander and an evaporator, and drives a refrigerant cycle by performing a compression process, a condensation process, an expansion process and an evaporation process of a refrigerant, and thus the desired space may be heated or cooled.

[0003] The desired space may be a space according to a place in which the air conditioner is used. For example, when the air conditioner is disposed at home or an office, the desired space may be an indoor space of a house or a building. When the air conditioner is disposed in a vehicle, the desired space may be a passenger compartment.

[0004] When the air conditioner performs a cooling operation, an outdoor heat exchanger provided at an outdoor unit serves as the condenser, and an indoor heat exchanger provided at an indoor unit serves as the evaporator. However, when the air conditioner performs a heating operation, the indoor heat exchanger serves as the condenser, and the outdoor heat exchanger serves as the evaporator.

[0005] FIG. 1 is a view illustrating a structure of a conventional outdoor heat exchanger.

[0006] Referring to FIG. 1, the conventional outdoor heat exchanger 1 includes a plurality of refrigerant pipes 2 which are arranged in a plurality of rows, a coupling plate 3 to which ends of the refrigerant pipes 2 are coupled, and which supports the refrigerant pipes 2, and a header 4 which branches the refrigerant into the refrigerant pipes 2 or combines the refrigerant passed through the refrigerant pipes 2.

[0007] The outdoor heat exchanger 1 further includes a return tube 7 which changes a flow direction of the refrigerant from one refrigerant pipe 2 to another refrigerant pipe. For example, the return tube 7 may change the flow direction of the refrigerant from one refrigerant pipe 2, which is located in a first row of the refrigerant pipes 2 disposed in two rows, to another refrigerant pipe located in a second row.

[0008] The outdoor heat exchanger 1 further includes a plurality of distributors 5 and 6. The plurality of distributors 5 and 6 include a first distributor 5 which branches and introduces the refrigerant into at least a part of the refrigerant pipes among the plurality of refrigerant pipes 2, and a second distributor 6 which branches and introduces the refrigerant into the rest of the plurality of refrigerant pipes 2.

[0009] In the outdoor heat exchanger 1 as described above, opposing flow directions of the refrigerant are respectively formed in the heating and cooling operations.

[0010] For example, when the air conditioner performs the cooling operation, the outdoor heat exchanger 1 serves as the condenser (referring to a solid line arrow).

[0011] Specifically, the high pressure refrigerant compressed in the compressor is introduced into the header 4, branched into the plurality of refrigerant pipes 2, and heat-exchanged with outdoor air while flowing through the refrigerant pipes 2. The heat-exchanged refrigerant is combined at the first and second distributors 5 and 6, and then flows toward the indoor heat exchanger.

[0012] On the other hand, when the air conditioner performs the heating operation, the outdoor heat exchanger 1 serves as the evaporator (referring to a dotted line arrow).

[0013] Specifically, the refrigerant condensed in the indoor heat exchanger may be depressurized while passing through the expander, and then may be introduced into the outdoor heat exchanger 1. The refrigerant is branched into the first and second distributors 5 and 6 at an entrance side of the outdoor heat exchanger 1, and then introduced into the refrigerant pipes 2 through a plurality of branch pipes connected to each distributor.

[0014] At this time, the refrigerant is heat-exchanged with the outdoor air while flowing through the refrigerant pipes 2, and the heat-exchanged refrigerant may be combined at the header 4 and then may flow toward the compressor.

[0015] When the air conditioner performs the cooling operation, the refrigerant passing through the outdoor heat exchanger 1 may be at a high temperature and high pressure gaseous state. At this time, to increase condensation efficiency of the refrigerant, it is advantageous to reduce the number of paths branched to the outdoor heat exchanger 1 and to increase a length of each of the paths.

[0016] That is, by increasing a length of a flow path of the refrigerant, a flow speed of the refrigerant may be increased, and thus a condensing pressure of the refrigerant may be reduced. Therefore, the condensation efficiency, i.e., a phase change rate to a liquid state may be improved.

[0017] However, when the air conditioner performs the heating operation, the refrigerant passing through the outdoor heat exchanger 1 has two phases, a gaseous refrigerant and a liquid refrigerant. At this time, to reduce a pressure loss of the refrigerant, it is advantageous to increase the number of the paths branched to the outdoor heat exchanger 1 and to reduce the length of each of the paths.

[0018] That is, a gaseous refrigerant of the two-phase refrigerant may have a large pressure loss during flow. By reducing the length of the flow path of the refrigerant and increasing the number of the paths, the pressure loss, i.e., an evaporating pressure drop may be prevented, and thus evaporation efficiency may be improved.

[0019] However, according to the structure of the conventional outdoor heat exchanger as illustrated in FIG. 1, when the air conditioner performs the cooling operation and the heating operation, the number of the paths through which the refrigerant is branched to the outdoor heat exchanger and the length of each of the paths are formed equally, and thus there is a problem that the heat exchange efficiency is reduced.

[0020] That is, in the cooling operation, the condensing pressure in the outdoor heat exchanger is increased, and thus the condensation efficiency is degraded. In the heating operation, the evaporating pressure in the outdoor heat exchanger is reduced, and thus the evaporation efficiency is degraded.

SUMMARY

[0021] Therefore, the present disclosure is directed to an air conditioner having an outdoor heat exchanger in which heat exchange efficiency is improved, and a method of controlling the same.

[0022] According to an aspect, there is provided an air conditioner including a compressor; a flow switching part disposed at an outlet side of the compressor to switch a flow direction of a refrigerant according to whether a cooling operation or heating operation is performed; an outdoor heat exchanger connected to the flow switching part and having a plurality of the refrigerant pipes to guide the refrigerant which heat-exchanges with outdoor air; a main expansion valve connected to one side of the outdoor heat exchanger; a first inlet/outlet pipe connecting the flow switching part to the outdoor heat exchanger; and a second inlet/outlet pipe connecting the outdoor heat exchanger to the main expansion valve, wherein the outdoor heat exchanger includes a header to form a flowing space of the refrigerant and having an upper header and a lower header; a check valve disposed between the upper header and the lower header to guide the refrigerant to flow one way; and a bypass pipe connecting the lower header to the second inlet/outlet pipe and to guide a discharge of a liquid refrigerant located in the lower header, and a bypass pipe valve which controls an amount of the liquid refrigerant flowing through the bypass pipe.

[0023] The air conditioner may further include a detector disposed in the refrigerant flowing space of the header to detect the amount of the liquid refrigerant in the lower header.

[0024] The detector may include a liquid level sensor disposed in the refrigerant flowing space of the header to detect a level of the liquid refrigerant introduced into the lower header.

[0025] The liquid level sensor may include a first liquid level sensor disposed at a lower side of the lower header-such that a plurality of liquid level sensors are disposed above the first liquid level sensor.

[0026] The detector may include a temperature sensor disposed in the refrigerant flowing space of the header to detect a temperature of the liquid refrigerant introduced into the lower header.

[0027] The temperature sensor may include a first temperature sensor disposed at a lower side of the lower header such that a second temperature sensor provided above the first temperature sensor.

[0028] When the amount of the liquid refrigerant measured by the detector is more than a set range, the bypass pipe valve may be opened, and thus the refrigerant stored in the outdoor heat exchanger may be discharged from the outdoor heat exchanger, and when the amount of the liquid refrigerant measured by the detector is less than the set range, the bypass pipe valve may be closed.

[0029] The outdoor heat exchanger may further include a first refrigerant pipe connected to the upper header; a connection pipe to guide the refrigerant flowing through the first refrigerant pipe to the lower header; and a refrigerant introduction pipe connecting the lower header to a second refrigerant pipe, and the refrigerant introduction pipe may be higher than the connection pipe.

[0030] The refrigerant introduction pipe may include a lower introduction pipe disposed at a lower side of the lower header such that a plurality of upper introduction pipes is disposed above the lowermost introduction pipe, and a height of the lower introduction pipe may be higher than a height of the connection pipe with respect to a bottom of the outdoor heat exchanger.

[0031] The bypass pipe may extend from a surface of the lower header.

[0032] The bypass pipe valve may include an electronic expansion valve of a degree of opening is controllable.

[0033] The air conditioner may further include first and second distribution pipes branching from the second inlet/outlet pipe; and a first and second distributors connected to the respective first and second distribution pipes to branch and introduce the refrigerant into the plurality of refrigerant pipes.

[0034] The first distributor is connected to the first distribution pipe and in communication with the upper header; and a second distributor is connected to the second distribution pipe and in communication with the lower header.

[0035] The air conditioner may further include a first valve device disposed at the first distribution pipe; and a second valve device disposed at the second distribution pipe.

[0036] The air conditioner may further include a third valve device disposed at the connection pipe.

[0037] According to another aspect, there is provided method of controlling an air conditioner, including driving a cooling operation in an indoor unit; heat-exchanging a refrigerant to be discharged to the indoor unit through an outdoor heat exchanger, and introducing the refrigerant into the outdoor heat exchanger; detecting an amount of a liquid refrigerant introduced into the outdoor heat exchanger through a detector; and controlling a degree of opening of a valve disposed at a bypass pipe to discharge the liquid refrigerant from the outdoor heat exchanger, by a controller based on the detected amount of the liquid refrigerant.

[0038] The controller controls by opening the bypass pipe valve when the amount of the liquid refrigerant detected by the detector is more than a set range, and may close the bypass pipe valve, when the amount of the liquid refrigerant is less than the set range.

[0039] The detector may include a temperature sensor disposed at a refrigerant path of the outdoor heat exchanger to detect a temperature of the refrigerant, and the amount of the liquid refrigerant introduced into the outdoor heat exchanger may be detected through a temperature value of the refrigerant detected by the temperature sensor.

[0040] The temperature sensor may include a first temperature sensor disposed at a lower side of the lower header; and a second temperature sensor disposed above the first temperature sensor.

[0041] The detector may include a liquid level sensor disposed at a refrigerant path of the outdoor heat exchanger to detect a level of the liquid refrigerant, and the amount of the liquid refrigerant introduced into the outdoor heat exchanger may be detected through a level value of the liquid refrigerant detected by the liquid level sensor.

[0042] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] Embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements, and wherein:

FIG. 1 is a view illustrating a conventional outdoor heat exchanger;
FIG. 2 is a view illustrating a structure of an air conditioner according to an embodiment of the present invention;
FIG. 3 is a view illustrating a main structure of an outdoor heat exchanger according to the embodiment of the present invention;
FIG. 4 is an enlarged view of a lower header of the outdoor heat exchanger according to the embodiment of the present invention;
FIG. 5 is a view illustrating a case in which a lowermost introduction pipe is formed lower than a height of a connection pipe;
FIG. 6 is an enlarged view of a lower head having a temperature sensor according to another embodiment of the present invention;
FIG. 7 is a block diagram of the air conditioner according to the embodiment of the present invention;
FIG. 8 is a flowchart of a method of controlling the outdoor heat exchanger according to a first embodiment of the present invention; and
FIG. 9 is a flowchart of a method of controlling the outdoor heat exchanger according to a second embodiment of the present invention.

DETAILED DESCRIPTION

[0044] Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings, wherein like reference numerals may refer to like or corresponding elements throughout the drawings and repeated description thereof may be omitted. In addition, the components may be described interchangeably as "modules" and "parts" in this specification merely for the sake of convenience, and these terms do not have distinct meanings or roles. Also, in the following description, if it is considered that the specific description of the related and well known functions or structures may obscure the gist of the present invention, the specific description may be omitted. Also, the description proposed herein is just a preferable example for the purpose of illustration only, not intended to limit the scope of the invention, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the invention.

[0045] FIG. 2 is a view illustrating a structure of an air conditioner according to an embodiment of the present invention, and FIG. 3 is a view illustrating a main structure of an outdoor heat exchanger according to the embodiment of the present invention.

[0046] Referring to FIG. 2, the air conditioner 10 according to the embodiment of the present invention includes an outdoor unit which is disposed at an outdoor area, and an indoor unit which is disposed at an indoor area. The indoor unit includes an indoor heat exchanger which heat-exchanges with indoor air. FIG. 2 illustrates a structure of the outdoor unit.

[0047] The air conditioner 10 includes a plurality of compressors 110 and 112, and oil separators 120 and 122 which are disposed at outlet sides of the plurality of compressors 110 and 112 to separate oil from a refrigerant discharged from the plurality of compressors 110 and 112.

[0048] The plurality of compressors 110 and 112 include a first compressor 110 and a second compressor 112 which are connected in parallel with each other. A discharge temperature sensor 114 which detects a temperature of the compressed refrigerant may be provided at each of the outlet sides of the first and second compressors 110 and 112.

[0049] The oil separators 120 and 122 include a first oil separator 120 which is disposed at the outlet side of the first compressor 110 and the second oil separator 122 which is disposed at the outlet side of the second compressor 112.

[0050] The air conditioner 10 includes a collection path 116, for collecting oil, from the oil separators 120 and

122 to the compressors 110 and 112. The collection path 116 extends from each of the outlet sides of the first and second oil separators 120 and 122 and then is combined, and the combined path may be connected with pipes located at inlet sides of the first and second compressors 110 and 112.

[0051] A dryer 127 and a capillary 128 may be installed at the collection path 116.

[0052] A high pressure sensor 125 which detects a high pressure of the refrigerant discharged from the compressors 110 and 112, and a flow switching part 130 which guides the refrigerant passing through the high pressure sensor 125 toward an outdoor heat exchanger 200 or the indoor unit are provided at outlet sides of the oil separators 120 and 122. For example, the flow switching part 130 may include a four-way valve.

[0053] When the air conditioner performs a cooling operation, the refrigerant flows into the outdoor heat exchanger 200 from the flow switching part 130. On the other hand, when the air conditioner performs a heating operation, the refrigerant flows from the flow switching part 130 toward an indoor heat exchanger of the indoor unit (not shown).

[0054] When air conditioner performs the cooling operation, the refrigerant condensed in the outdoor heat exchanger 200 passes through a main expansion valve (an electronic expansion valve) 260. At this time, the main expansion valve 260 is completely opened, and thus does not perform a decompression action on the refrigerant. That is, the main expansion valve 260 may be installed at an outlet side of the outdoor heat exchanger 200 based on the cooling operation.

[0055] The refrigerant passing through the main expansion valve 260 passes through a heat sinking panel 265. The heat sinking panel 265 may be provided at an electronic unit in which a heat generating component is provided.

[0056] For example, the heat generating component may include a power module (an intelligent power module (IPM)). It may be understood that the IPM is a module in which a drive circuit and a protection circuit having a self-protecting function of a power device, such as MOSFET and IGBT, are installed.

[0057] The condensed refrigerant contacts the heat sinking panel 265, and cools the heat generating component.

[0058] The air conditioner 10 further includes a supercooling heat exchanger 270 into which the refrigerant passing through the heat sinking panel 265 is introduced, and a supercooling distributor 271 which is provided at an inlet side of the supercooling heat exchanger 270 to branch the refrigerant. The supercooling heat exchanger 270 serves as a middle heat exchanger which heat-exchanges with a first refrigerant circulating in a system after some (a second refrigerant) of the first refrigerant is branched.

[0059] Here, the first refrigerant is a refrigerant which is introduced into the supercooling heat exchanger 270 via the supercooling distributor 271, and may be supercooled by the second refrigerant. The second refrigerant may absorb heat from the first refrigerant.

[0060] The air conditioner 10 includes a supercooling path 273 which is provided at an outlet side of the supercooling heat exchanger 270 to allow the second refrigerant to be branched from the first refrigerant. A supercooling expander 275 which depressurizes the second refrigerant is provided at the supercooling path 273. The supercooling expander 275 may include an electronic expansion valve (EEV).

[0061] The second refrigerant in the supercooling path 273 may be introduced into the supercooling heat exchanger 270, may heat-exchange with the first refrigerant, and then may flow to an inlet side of a gas-liquid separator 280. The air conditioner 10 further includes a super-cooled discharge temperature sensor 276 which detects a temperature of the second refrigerant passed through the supercooling heat exchanger 270.

[0062] The gas-liquid separator 280 is a device which separates and outputs a gaseous refrigerant before the refrigerant is introduced into the compressors 110 and 112. The separated gaseous refrigerant may be introduced into the compressors 110 and 112.

[0063] While a refrigeration cycle is driven, the evaporated refrigerant may be introduced into the gas-liquid separator 280 via the flow switching part 130. At this time, the evaporated refrigerant is combined with the second refrigerant passing through the supercooling heat exchanger 270, and then introduced into the gas-liquid separator 280.

[0064] A suction temperature sensor 282 which detects a temperature of the refrigerant to be suctioned into the compressors 110 and 112 may be provided at an inlet side of the gas-liquid separator 280.

[0065] Meanwhile, the first refrigerant passing through the supercooling heat exchanger 270 may be introduced into the indoor unit through an indoor unit connection pipe 279. The air conditioner 10 further includes a liquid line temperature sensor 278 which is provided at the outlet side of the supercooling heat exchanger 270 to detect a temperature of the first refrigerant passed through the supercooling heat exchanger 270, i.e., a temperature of the supercooled refrigerant.

[0066] Hereinafter, the outdoor heat exchanger 200 and a peripheral structure thereof will be described.

[0067] The air conditioner 10 includes a first inlet/outlet pipe 201a which is connected from the flow switching part 130 to one side of the outdoor heat exchanger 200, and a second inlet/outlet pipe 201 b which is connected from the other side of the outdoor heat exchanger 200 to the main expansion valve 260.

[0068] For example, the first inlet/outlet pipe 201 a may be connected to an upper portion of a header 205, i.e., an upper header 205a, and the second inlet/outlet pipe 201 b may be connected to a lower portion of the header 205, i.e., a lower header 205b.

[0069] When the air conditioner 10 performs the cooling operation, the refrigerant is introduced into the outdoor heat exchanger 200 through the first inlet/outlet pipe 201 a, and also discharged from the outdoor heat exchanger 200 through the second inlet/outlet pipe 201 b.

[0070] On the other hand, when the air conditioner 10 performs the heating operation, the refrigerant is introduced into the outdoor heat exchanger 200 through the second inlet/outlet pipe 201 b, and discharged from the outdoor heat exchanger 200 through the first inlet/outlet pipe 201 a.

[0071] The outdoor heat exchanger 200 includes a refrigerant pipe 202. For example, a plurality of refrigerant pipes 202 may be provided to form two rows in a horizontal direction and a plurality of columns in a vertical direction. The plurality of refrigerant pipes 202 may be disposed to be spaced apart from each other.

[0072] The plurality of refrigerant pipes 202 may be bent and then may extend longitudinally. For example, in FIG. 3, the plurality of refrigerant pipes 202 may be formed to extend toward a rear of the figure and then to extend again toward a front thereof. In this case, the plurality of refrigerant pipes 202 may have a U shape.

[0073] The outdoor heat exchanger 200 further includes a coupling plate 203 which supports the refrigerant pipes 202. The coupling plate 203 includes a first plate 203a which supports one side of the refrigerant pipes 202 having a bent shape, and a second plate 203b which supports the other side thereof. The first and second plates 203a and 203b extend vertically.

[0074] The outdoor heat exchanger 200 further includes a return pipe 204 which is coupled to ends of the plurality of refrigerant pipes 202 to guide the refrigerant flowing in one refrigerant pipe 202 to another refrigerant pipe 202. A plurality of return pipes 204 are provided, and coupled to one side of the first and second plates 203a and 203b.

[0075] The outdoor heat exchanger 200 further includes the header 205 which forms a flow space of the refrigerant. The header 205 may be configured to branch and introduce the refrigerant into the plurality of refrigerant pipes 202 or to combine the refrigerant heat-exchanged at the plurality of refrigerant pipes 202 according to whether the air conditioner 10 performs the cooling operation or the heating operation. The header 205 extends vertically corresponding to an extension direction of the first plate 203a.

[0076] A plurality of refrigerant introduction pipes 232 extend between the header 205 and the first plate 203a. The plurality of refrigerant introduction pipes 232 extend from the header 205, and are connected to the refrigerant pipes 202 which are supported by the first plate 203a. And the plurality of refrigerant introduction pipes 232 may be disposed to be vertically spaced apart from each other.

[0077] When the air conditioner 10 performs the cooling operation, the refrigerant in the header 205 may be introduced into the refrigerant pipes 202 through the plurality of refrigerant introduction pipes 232. On the other hand, when the air conditioner 10 performs the heating operation, the refrigerant in the refrigerant pipes 202 may be introduced into the header 205 through the refrigerant introduction pipes 232.

[0078] The air conditioner 10 further includes a plurality of distributors 210 and 220 which branch and introduce the refrigerant into the outdoor heat exchanger 200 based on the heating operation. The plurality of distributors 210 and 220 include a first distributor 210 and a second distributor 220.

[0079] The air conditioner 10 further includes a first distribution pipe 211 and a second distribution pipe 221 which are branched from the second inlet/outlet pipe 201 b to the respective first and second distributors 210 and 220. The first distribution pipe 211 and the second distribution pipe 221 may extend from a branch part 201c to the respective first and second distributors 210 and 220.

[0080] The air conditioner 10 further includes a first valve device 215 which is installed at the first distribution pipe 211 to control an amount of the refrigerant flowing through the first distribution pipe 211, and a second valve device 225 which is installed at the second distribution pipe 221 to control an amount of the refrigerant flowing through the second distribution pipe 221.

[0081] The first and second valve devices 215 and 225 may be an electronic expansion valve of which an opening degree may be controlled.

[0082] The air conditioner 10 further includes a plurality of capillary tubes 207 which extend from the first and second distributors 210 and 220 to the plurality of refrigerant pipes 202. When the air conditioner 10 performs the heating operation, the refrigerant is branched to the first distributor 210 and the second distributor 220, and flows to the refrigerant pipes 202 through the plurality of capillary tubes 207.

[0083] The air conditioner 10 further includes branch pipes 209 which connect the plurality of capillary tubes 207 with the refrigerant pipes 202. The branch pipe 209 may branch the refrigerant flowing through the capillary tube 207 into two directions, i.e., toward one refrigerant pipe 202 and toward another refrigerant pipe 202. For example, the branch pipe 209 may be a Y-shaped branch pipe. A plurality of branch pipes 209 may be provided corresponding to the number of the plurality of capillary tubes 207.

[0084] When the air conditioner 10 performs the heating operation, the refrigerant introduced into the refrigerant pipes 202 through the plurality of capillary tubes 207 connected to the first distributor 210 is heat-exchanged, and then introduced into the upper header 205a of the header 205. The refrigerant introduced into the refrigerant pipes 202 through the plurality of capillary tubes 207 connected to the second distributor 220 is heat-exchanged, and then introduced into the lower header 205b of the header 205.

[0085] That is, the header 205 includes the upper header 205a which is in communication with the first distributor 210, and the lower header 205b which is in communication with the second distributor 220. In FIG. 3, an imaginary division line ℓ1 which divides the upper header 205a from the lower header 205b is indicated.

[0086] The air conditioner 10 further includes a check valve 240 which is installed between the upper header 205a and the lower header 205b. The check valve 240 allows a flow of the refrigerant from the lower header 205b to the upper header 205a, and restricts the flow of the refrigerant from the upper header 205a to the lower header 205b.

[0087] Therefore, when the air conditioner 10 performs the heating operation, the refrigerant introduced into the refrigerant pipes 202 through the second distributor 220 may be heat-exchanged, may be introduced into the lower header 205b, and may be guided to the upper header 205a by the check valve 240. And the refrigerant introduced into the refrigerant pipes 202 through the first distributor 210 may be heat-exchanged, may be introduced into the upper header 205a, may be combined with the refrigerant introduced from the lower header 205b, and may flow to the first inlet/outlet pipe 201 a.

[0088] The air conditioner 10 further includes a connection pipe 230 which extends from one point of the first distribution pipe 211 to the lower header 205b. A third valve device 235 which controls a flow rate of the refrigerant in the connection pipe 230 may be installed at the connection pipe 230. For example, the third valve device 235 may include a solenoid valve which may be controlled to be switched on/off, or the electronic expansion valve of which the opening degree is allowed.

[0089] When the air conditioner 10 performs the cooling operation, the refrigerant flowing from the first distributor 210 to the first distribution pipe 211 may be introduced into the lower header 205b through the connection pipe 230.

[0090] The air conditioner 10 further includes a bypass pipe 250 which extends from a lower end of the header 205, i.e., a lower end of the lower header 205b to the second inlet/outlet pipe 201 b. When the air conditioner 10 performs the cooling operation, the bypass pipe 250 is formed to divert a liquid refrigerant accumulated at a lower portion of the header 205 to the second inlet/outlet pipe 201 b, i.e., the outlet side of the outdoor heat exchanger 200.

[0091] Hereinafter, a flow of the refrigerant in the air conditioner 10 while the air conditioner 10 performs the heating operation and the cooling operation will be described with reference to FIGS. 2 and 3.

[0092] First, when the air conditioner 10 performs the heating operation, oil is separated from the high temperature and high pressure refrigerant compressed in the first and second compressors 110 and 112, while the refrigerant passes through the first and second oil separators 120 and 122, and the separated oil is returned to the first and second compressors 110 and 112 through the collection path 116. And the refrigerant from which the oil is separated flows toward the indoor unit via the flow switching part 130.

[0093] The refrigerant introduced into the indoor unit is condensed in the indoor heat exchanger, and the condensed refrigerant is introduced into the supercooling heat exchanger 270 through the indoor unit connection pipe 279. At this time, some of the refrigerant may be branched to the supercooling path 273, may be depressurized in the supercooling expander 275, and then may be introduced into the supercooling heat exchanger 270.

[0094] Therefore, the condensed refrigerant and the refrigerant flowing through the supercooling path 273 heat-exchange with each other, and thus the condensed refrigerant may be supercooled.

[0095] The supercooled refrigerant passed through the supercooling heat exchanger 270 may cool the heat generating component of the electronic unit, while passing through the heat sinking panel 265, and may be depressurized in the main expansion valve 260.

[0096] The depressurized refrigerant may be branched from the branch part 201 c to the first and second distribution pipes 211 and 221, and then may be introduced into the first and second distributors 210 and 220, respectively. At this time, the first and second valve devices 215 and 225 may be opened by a predetermined opening degree. For example, the first and second valve devices 215 and 225 may be completely opened.

[0097] The refrigerant flowing to the first distributor 210 is introduced into the refrigerant pipes 202 through the plurality of capillary tubes 207, heat-exchanged and then introduced into the upper header 205a. The refrigerant flowing to the second distributor 220 is introduced into the refrigerant pipes 202 through the plurality of capillary tubes 207, heat-exchanged and then introduced into the lower header 205b. At this time, the refrigerant may evaporate while being heat-exchanged.

[0098] The refrigerant introduced into the lower header 205b flows to the upper header 205a, and is combined with the refrigerant introduced into the upper header 205a. At this time, the refrigerant in the lower header 205b may flow to the upper header 205a via the check valve 240 (referring to the dotted line arrow).

[0099] The combined refrigerant may be discharged to the first inlet/outlet pipe 201a connected to the upper header 205a, and may be introduced into the gas-liquid separator 280 via the flow switching part 130, and the separated gaseous refrigerant may be suctioned into the first and second compressors 110 and 112. This cycle may be repeated.

[0100] Like this, when the air conditioner 10 performs the heating operation, the refrigerant may be introduced into the outdoor heat exchanger 200 through the first and second distributors 210 and 220, and heat exchange may be performed using all of a path at a side of the first distributor 210 and a path at a side of the second distributor 220.

[0101] Therefore, the flow path of the refrigerant in the outdoor heat exchanger 200 is reduced, but the number of paths branched to the outdoor heat exchanger 200 is increased. Accordingly, the pressure loss of the refrigerant may be reduced, and thus the evaporating pressure drop may be prevented, and the evaporation efficiency may be improved.

[0102] When the air conditioner 10 performs the cooling operation, the oil is separated from the high temperature and high pressure refrigerant compressed in the first and second compressors 110 and 112, while the refrigerant passes through the first and second oil separators 120 and 122, and the separated oil is returned to the first and second compressors 110 and 112 through the collection path 116. And the refrigerant from which the oil is separated flows toward the first inlet/outlet pipe 201a via the flow switching part 130, and is introduced into the header 205 of the outdoor heat exchanger 200.

[0103] The refrigerant introduced into the header 205 is located at the upper header 205a, and restricted from being introduced into the lower header 205b by the check valve 240.

[0104] The refrigerant in the upper header 205a is introduced into the refrigerant pipes 202 fixed to the first plate 203a through the plurality of refrigerant introduction pipes 232. The refrigerant in the refrigerant pipes 202 is heat-exchanged, and then flows to the plurality of capillary tubes 207 through the branch pipes 209. At this time, the refrigerant may be primarily condensed while being heat-exchanged.

[0105] The refrigerant in the plurality of capillary tubes 207 is combined in the first distributor 210, and introduced into the lower header 205b through the first distribution pipe 211 and the connection pipe 230. At this time, the first valve device 215 is closed, and thus the refrigerant is restricted from flowing to the branch part 201 c. And the third valve device 235 is turned on, or opened by a predetermined opening degree, and allows the refrigerant to flow to the connection pipe 230.

[0106] The refrigerant introduced into the lower header 205b is introduced into the plurality of refrigerant pipes 202 fixed to the first plate 203a through the plurality of refrigerant introduction pipes 232. And the refrigerant may be secondarily condensed while flowing through the plurality of refrigerant pipes 202.

[0107] The secondarily condensed refrigerant is introduced into the second distributor 220 through the branch pipes 209 and the plurality of capillary tubes 207. The refrigerant in the second distributor 220 flows through the second inlet/outlet pipe 201 b via the second distribution pipe 221 and the branch part 201c, and is discharged from the outdoor heat exchanger 200.

[0108] The refrigerant discharged from the outdoor heat exchanger 200 may flow toward the indoor unit via the heat sinking panel 265 and the supercooling heat exchanger 270. The refrigerant may be expanded and evaporated in the indoor unit, and then may be suctioned into the first and second compressors 110 and 120 via the flow switching part 130 and the gas-liquid separator 280. This cycle may be repeated.

[0109] Like this, when the air conditioner 10 performs the cooling operation, the refrigerant introduced into the outdoor heat exchanger 200 is primarily condensed in the refrigerant pipes 202 connected to a side of the upper header 205a, and secondarily condensed in the refrigerant pipes 202 connected to a side of the lower header 205b. Therefore, the flow path of the refrigerant in the outdoor heat exchanger 200 is increased, but the number of paths branched to the outdoor heat exchanger 200 is reduced. Accordingly, the flow speed of the refrigerant is increased, and the condensing pressure is reduced, and thus the condensation efficiency may be improved.

[0110] Meanwhile, the lower header 205b may be filled with the liquid refrigerant. Specifically, the refrigerant is primarily condensed while flowing through the refrigerant pipes 202 connected to the upper header 205a, and thus may have two phases. Therefore, the refrigerant introduced into the lower header 205b through the connection pipe 230 may be in a state in which a gas phase and a liquid phase are included.

[0111] Since the liquid refrigerant has a greater specific gravity than the gaseous refrigerant, the liquid refrigerant may fill a lower side of the lower header 205b. It may be understood that the liquid refrigerant is a refrigerant which is completely condensed and which does not need the heat exchange any more. Therefore, when the liquid refrigerant is introduced into the refrigerant pipes 202 and then heat-exchanged again, heat exchange performance of the heat exchanger may be degraded, and the pressure loss due to the liquid refrigerant may occur.

[0112] Therefore, the embodiment is characterized by providing the bypass pipe 250 which diverts the liquid refrigerant to the outlet side of the outdoor heat exchanger 200. The bypass pipe 250 extends from the lower header 205b to the second inlet/outlet pipe 201 b, and discharges the refrigerant accumulated in the lower header 205b to the second inlet/outlet pipe 201 b during the cooling operation.

[0113] Hereinafter, a structure of the lower header 205b will be described in detail with reference to FIG. 4.

[0114] FIG. 4 is an enlarged view of the lower header 205b of the outdoor heat exchanger according to the embodiment of the present invention.

[0115] Referring to FIG. 4, the outdoor heat exchanger 200 according to the embodiment of the present invention includes the bypass pipe 250 which diverts the liquid refrigerant in the header 205 to the outlet side of the outdoor heat exchanger 200.

[0116] The bypass pipe 250 extends from a lower portion of the lower header 205b of the header 205 toward the second inlet/outlet pipe 201 b.

[0117] The outdoor heat exchanger 200 according to the embodiment of the present invention includes the plurality of refrigerant introduction pipes 232 which extend from the lower header 205b to the plurality of refrigerant pipes 202. The plurality of refrigerant introduction pipes 232 include a lowermost introduction pipe 232a, and a plurality of upper introduction pipes 232b which are disposed above the lowermost introduction pipe 232a. A height H2 of the lowermost introduction pipe 232a may be formed higher than a height H1 of the connection pipe 230 which extends from one point of the first distribution pipe 211 to the lower header 205b. Here, it may be understood that each of the heights H2 and H1 is a distance from a reference line ℓ0, and, for example, the reference line ℓ0 may be a base which forms a bottom of the outdoor unit, or a ground surface.

[0118] Like this, since the height H1 of the connection pipe 230 is formed lower than the height H2 of the lowermost introduction pipe 232a, the liquid refrigerant in the lower header 205b may be prevented from being introduced into the lowermost introduction pipe 232a.

[0119] FIG. 5 is a view illustrating a case in which the lowermost introduction pipe is formed lower than the height of the connection pipe.

[0120] Hereinafter, an effect of the outdoor heat exchanger in which the height of the connection pipe 230 is designed lower than the height of the lowermost introduction pipe 232a will be described with reference to FIGS. 4 and 5.

[0121] As described above, the refrigerant introduced into the lower header 205b through the connection pipe 230 simultaneously contains the gas phase and the liquid phase refrigerant. However, since the liquid refrigerant has a greater specific gravity than the gaseous refrigerant, the liquid refrigerant fills the lower side of the lower header 205b, and the gaseous refrigerant fills above the liquid refrigerant. Therefore, a part of the plurality of refrigerant pipes which are in communication with the lower header 205b are blocked by the liquid refrigerant.

[0122] As illustrated in FIG. 5, since the refrigerant introduction pipes 232 disposed at an area A in which a liquid refrigerant L is located are blocked by the liquid refrigerant L, the gaseous refrigerant to be secondarily condensed may flow through only the refrigerant introduction pipes 232 disposed at an area B. Therefore, the gaseous refrigerant may not smoothly flow to the plurality of refrigerant introduction pipes 232, and thus the condensation efficiency and the heat exchange performance of the outdoor heat exchanger are degraded.

[0123] However, in the embodiment shown in FIG. 4, since the height H2 of the lowermost introduction pipe 232a is formed higher than the height H1 of the connection pipe 230, the plurality of refrigerant introduction pipes 232 are prevented from being blocked by the liquid refrigerant L, and thus the condensation efficiency and the heat exchange performance of the outdoor heat exchanger 200 may be improved.

[0124] Also, since the bypass pipe 250 is provided, the liquid refrigerant in the lower header 205b may be diverted to the outlet side of the outdoor heat exchanger 200, and thus the heat exchange performance of the outdoor heat exchanger 200 may be improved.

[0125] In other words, since the liquid refrigerant filling the lower side of the lower header 205b is a refrigerant which does not need to heat exchange, the liquid refrigerant may be diverted to the outlet side of the outdoor heat exchanger 200 through the bypass pipe 250, and the gaseous refrigerant which needs to heat exchange may be effectively heat-exchanged by the openings of all the plurality of refrigerant introduction pipes 232.

[0126] And since the bypass pipe 250 extends downward from a lower surface of the lower header 205b, the gaseous refrigerant in the lower header 205b may be prevented from being discharged through the bypass pipe 250 by a pressure difference between the gaseous refrigerant and the liquid refrigerant.

[0127] Meanwhile, the air conditioner 10 further includes a bypass pipe valve 252 which is installed at the bypass pipe 250 to control an amount of the refrigerant flowing through the bypass pipe 250.

[0128] The bypass pipe valve 252 may include an electronic expansion valve of which an opening degree may be controlled.

[0129] When the bypass pipe valve 252 is opened, the liquid refrigerant filling the lower side of the lower header 205b is diverted to the outlet side of the outdoor heat exchanger 200, and when the bypass pipe valve 252 is closed, the liquid refrigerant filling the lower side of the lower header 205b is prevented from flowing to the outlet side of the outdoor heat exchanger 200.

[0130] As described above, the refrigerant introduced into the lower header 205b through the connection pipe 230 is in the state in which the gas phase and the liquid phase are included. Therefore, since the liquid refrigerant has the greater specific gravity than the gaseous refrigerant, the liquid refrigerant may fill the lower side of the lower header 205b. Since the liquid refrigerant is a refrigerant which is completely condensed and which does not need to heat exchange any more, the liquid refrigerant may be diverted to the outlet side of the outdoor heat exchanger 200 through the bypass pipe 250, and thus the heat exchange performance of the outdoor heat exchanger 200 may be enhanced.

[0131] Also, since a flow of the liquid refrigerant to the outlet side of the outdoor heat exchanger 200 may be controlled by controlling the opening degree of the bypass pipe valve 252, the liquid refrigerant may be prevented from accumulating at one side due to force of gravity, and the pressure loss of the refrigerant may be minimized, and thus efficiency of the cooling operation may be maximized.

[0132] Meanwhile, a detector 30 (see, for example, FIG. 7) which detects the amount of the refrigerant may be provided at a refrigerant flowing space of the header 205. Specifically, the detector 30 is disposed at a path in the lower header 205b in which the primarily condensed refrigerant flows.

[0133] The detector 30 which detects an amount of the liquid refrigerant may be provided at the lower header 205b. Hereinafter, a method of detecting the amount of the liquid refrigerant using the detector 30 will be described.

[0134] FIG. 6 is an enlarged view of the lower head having a temperature sensor according to another embodiment of the present invention.

[0135] FIG. 4 illustrates the lower header 205b in which a liquid level sensor 290 is provided, and FIG. 6 illustrates the lower header 205b in which a temperature sensor 300 is provided. The liquid level sensor 290 and the temperature sensor 300 are an example for detecting the amount of the liquid refrigerant introduced into the lower header 205b. However, the present invention is not limited thereto, and various structures for detecting the amount of the liquid refrigerant may be provided. Also, both of the liquid level sensor 290 and the temperature sensor 300 may be disposed at the lower header 205b.

[0136] Referring to FIG. 4, the detector 30 may include the liquid level sensor 290 which is provided at an inside of the lower header 205b to detect a level of the liquid refrigerant introduced into the lower header 205b.

[0137] Specifically, the liquid level sensor 290 may be provided at a refrigerant path of the lower header 205b to be in contact with the liquid refrigerant, and thus to detect a liquid level in the lower header 205b. That is, when the liquid level sensor 290 is in contact with the liquid refrigerant, it indicates that the liquid refrigerant is introduced into the lower header 205b to a height at which the liquid level sensor is installed, and thus the amount of the liquid refrigerant may be detected by calculating the height at which the liquid level sensor is installed in the lower header 205b.

[0138] For example, the liquid level sensor 290 may be disposed between the bypass pipe 250 and the connection pipe 230. Since the plurality of refrigerant introduction pipes 232 to which the refrigerant in the lower header 205b flows so as to be secondarily condensed are blocked by an increase in the amount of the liquid refrigerant, the gaseous refrigerant which is required to be condensed may not be introduced into the refrigerant pipes 202. Therefore, the liquid level sensor 290 is installed between the connection pipe 230 and the bypass pipe 250, and when the liquid refrigerant is at an amount that is detected by the liquid level sensor 290, the bypass pipe valve 252 may be opened, and thus the liquid refrigerant may be discharged to an outside of the outdoor heat exchanger 200. Due to the discharge of the liquid refrigerant, the gaseous refrigerant is introduced into the refrigerant pipes 202, and a secondary condensing process is performed.

[0139] Meanwhile, a plurality of liquid level sensors 290 may be disposed. When the plurality of liquid level sensors 290 are provided, the liquid level sensors 290 may include a first liquid level sensor 292 which is disposed at the lowermost side of the lower header 205b, and a plurality of liquid level sensors 293 which are disposed above the first liquid level sensor 292. That is, the liquid level sensors 290 may be provided at the inside of the lower header 205b to be spaced upward from each other at regular intervals from the lower surface of the lower header 205b. In this case, there is an advantage that the amount of the liquid refrigerant introduced into the lower header 205b may be detected more specifically.

[0140] Referring to FIG. 6, the detector 30 may include the temperature sensor 300 which is provided at the inside of the lower header 205b to detect a temperature of the liquid refrigerant introduced into the lower header 205b.

[0141] The temperature sensor 300 may include a first temperature sensor 302 which is installed adjacent to the lower surface of the lower header 205b, and a second temperature sensor 304 which is installed adjacent to an upper surface of the lower header 205b.

[0142] Specifically, the first temperature sensor 302 is provided at the lower portion of the lower header 205b to be relatively close to the bypass pipe 250, and the second temperature sensor 304 is provided at the upper portion of the lower header 205b to be relatively close to the check valve 240. Therefore, the first temperature sensor 302 may be referred to as a lower sensor 302, and the second temperature sensor 304 may be referred to as an upper sensor 304.

[0143] The positions of the first and second temperature sensors 302 and 304 are just an example, and may be variously installed to have different installation heights in the lower header 205b.

[0144] A method of detecting the amount of the liquid refrigerant introduced into the lower header 205b using the temperature sensor 300 will be described.

[0145] When the bypass pipe valve 252 is closed, and thus the lower header 205b is filled from a lower end thereof with the liquid refrigerant, the first temperature sensor 302 adjacent to the lower end thereof detects the temperature of the liquid refrigerant. However, since the gaseous refrigerant is located at the upper portion of the lower header 205b which is not filled with the liquid refrigerant, and the gaseous refrigerant has a relatively higher temperature than the liquid refrigerant, the first temperature sensor 302 detects a relatively lower temperature than the second temperature sensor 304.

[0146] When the liquid refrigerant is continuously introduced into the lower header 205b, the liquid refrigerant fills the lower header 205b to an installation height of the second temperature sensor 304. Therefore, the second temperature sensor 304 also detects the temperature of the liquid refrigerant which is approximately similar to a value of the temperature detected by the first temperature sensor 302. Accordingly, it may be detected that the liquid refrigerant fills the lower header 205b to the installation height of the second temperature sensor 304.

[0147] Meanwhile, a plurality of temperature sensors 300 which are more than two may be provided. When more than two temperature sensors 300 are provided, the temperature sensors 300 may be provided at the inside of the lower header 205b to be spaced upward from each other at regular intervals from the lower surface of the lower header 205b. In this case, there is an advantage that the amount of the liquid refrigerant introduced into the lower header 205b may be detected more specifically.

[0148] Also, there is another advantage in that it is possible to grasp a supercooled degree of the liquid refrigerant and the gaseous refrigerant through the temperature sensor 300 and thus, determine a cooled state.

[0149] FIG. 7 is a block diagram of the air conditioner according to the embodiment of the present invention.

[0150] Referring to FIG. 7, the air conditioner 10 may include a controller 20, a detector 30, a memory 40 and a valve driver 50. Elements illustrated in FIG. 7 are not essential to realize the air conditioner, and thus the air conditioner 10 described in the specification may have more elements or less elements than the above-described ones.

[0151] More specifically, the detector 30 among the elements is an element which detects the amount of the refrigerant introduced into the lower header 205b, as described above, and may include the liquid level sensor 290 and/or the temperature sensor 300.

[0152] Various set values are inputted to the memory 40. For example, the set values may include an opening degree of the bypass pipe valve 252, an installation height of the liquid level sensor 290, a set range for a difference value of the temperature sensor 300 and so on.

[0153] The valve driver 50 receives a command from the controller based on information about the liquid refrigerant detected by the detector 30, and controls the opening degree of the bypass pipe valve 252. Specifically, the valve driver 50 includes a first valve driver 51 which controls the opening degree of the first valve device 215, a second valve driver 52 which controls the opening degree of the second valve device 225, a third valve driver 53 which controls the opening degree of the third valve device 235, and a fourth valve driver 54 which controls the opening degree of the bypass pipe valve 252.

[0154] Typically, the controller 20 controls an overall operation of the air conditioner 10. The controller 20 serves to process a signal and information input or output through the above-described elements, or to drive the elements. The controller 20 may be a microprocessor, a digital signal processor (DSP), integrated circuit, or the like.

[0155] Hereinafter, a method of controlling the outdoor heat exchanger 200 will be described using an example in which the air conditioner 10 performs the cooling operation.

[0156] FIG. 8 is a flowchart of the method of controlling the outdoor heat exchanger according to a first embodiment of the present invention.

[0157] Referring to FIG. 8, the air conditioner 10 performs the cooling operation (S100). The refrigerant introduced into the upper header 205a is introduced into the lower header 205b via the refrigerant pipe 202, the branch pipe 209, the first distributor 210 and the connection pipe 230.

[0158] Therefore, in the lower header 205b, there is the refrigerant having the two phases of the gaseous refrigerant and the liquid refrigerant which are mixed. However, since the liquid refrigerant has the greater specific gravity than the gaseous refrigerant, the liquid refrigerant fills the lower side of the lower header 205b. At this time, the liquid level sensor 290 detects the liquid refrigerant filling the lower header 205b (S110).

[0159] And whether the level of the liquid refrigerant is increased to an installation height of the liquid level sensor 290 in the lower header 205b is detected (S120). When the level of the liquid refrigerant is lower than the liquid level sensor 290, the bypass pipe valve 252 is closed (S140), and thus the lower header 205b is continuously filled with the liquid refrigerant.

[0160] However, when the level of the liquid refrigerant is increased to the installation height of the liquid level sensor 290, the controller 20 sends a signal to the valve driver 50, and thus the fourth valve driver 54 opens the bypass pipe valve 252 (S130). Therefore, the liquid refrigerant introduced into the lower header 205b is diverted to the outlet side of the outdoor heat exchanger 200 through the bypass pipe 250, and thus the heat exchange performance in the outdoor heat exchanger 200 may be improved. Meanwhile, the gaseous refrigerant contained in the introduced refrigerant is introduced into the plurality of refrigerant introduction pipes 232, and then secondarily condensed.

[0161] FIG. 9 is a flowchart of a method of controlling the outdoor heat exchanger according to a second embodiment of the present invention.

[0162] Referring to FIG. 9, the air conditioner 10 performs the cooling operation (S200). The refrigerant introduced into the upper header 205a is introduced into the lower header 205b via the refrigerant pipe 202, the branch pipe 209, the first distributor 210 and the connection pipe 230.

[0163] The temperature sensor 300 detects the temperature of the introduced refrigerant (S210).

[0164] The plurality of temperature sensors 300 are provided to have heights different from each other. Since the gaseous refrigerant contained in the refrigerant having the two phases has a different temperature from the liquid refrigerant, and the lower side of the lower header 205b is filled with the liquid refrigerant, a temperature detected at the lower surface of the lower header 205b is lower at the beginning.

[0165] That is, the first temperature sensor 302 among the plurality of temperature sensors is disposed at the lower side of the lower header 205b first detects the temperature of the liquid refrigerant. The second temperature sensor 304 is disposed at the upper side of the lower header 205b. When the lower header 205b is filled with the liquid refrigerant to the installation height of the second temperature sensor 304, the second temperature sensor 304 detects the temperature of the liquid refrigerant.

[0166] In other words, in the beginning, the temperature detected by the first temperature sensor 302 which detects the temperature of the liquid refrigerant is lower than that detected by the second temperature sensor 304 which detects the temperature of the gaseous refrigerant. When the liquid refrigerant fills continuously, and thus the second temperature sensor 304 detects the temperature of the liquid refrigerant, the first and second temperature sensors 302 and 304 have the similar temperature values.

[0167] The controller 20 compares the first temperature sensor 302 with the second temperature sensor 304 (S220). When a difference between the temperature values detected by the first and second temperature sensors 302 and 304 deviates from a set range in the memory 40, it indicates that the liquid refrigeranthas not filled to the installation height of the second temperature sensor 304, and thus the controller 20 controls the valve driver 50 so that the fourth valve driver 54 has the bypass pipe valve 252 closed(S240). When the bypass pipe valve 252 is closed, the lower header 205b is continuously filled with the liquid refrigerant.

[0168] However, when the difference between the temperature values detected by the first and second temperature sensors 302 and 304 is within the set range, it indicates that the liquid refrigerant has filled to the installation height of the second temperature sensor 304, and thus the controller 20 sends a command to the valve driver 50 to open the bypass pipe valve 252 (S230). Therefore, the liquid refrigerant introduced into the lower header 205b is diverted to the outlet side of the outdoor heat exchanger 200 through the bypass pipe 250, and thus the heat exchange performance of the outdoor heat exchanger 200 may be improved.

[0169] The air conditioner and the method of controlling the same have the following effects.

[0170] During the cooling operation and the heating operation of the air conditioner, the number of the paths through which the refrigerant passes through the outdoor heat exchanger and the length of each of the paths are formed differently, and thus the heat exchange efficiency in the outdoor heat exchanger can be improved.

[0171] Specifically, when the air conditioner performs the heating operation, the number of the paths through which the refrigerant is introduced into the outdoor heat exchanger can be reduced, and the length of each of the paths can be increased. Therefore, the flow speed of the refrigerant is increased, and the condensing pressure is reduced, and thus the condensation efficiency can be improved.

[0172] Also, since there is provided the bypass pipe through which the liquid refrigerant in the lower side of the header of the outdoor heat exchanger is diverted to the outlet side of the outdoor heat exchanger, the liquid refrigerant can be prevented from accumulating at the lower side of the header during the cooling operation.

[0173] Eventually, since the liquid refrigerant which is already condensed, and thus does not need to heat exchange can be discharged from the outdoor heat exchanger, the heat exchange performance (the condensation performance) of the outdoor heat exchanger can be improved, and the pressure loss due to the liquid refrigerant can be prevented.

[0174] Also, there is an advantage that it is possible to detect the state of the amount of the liquid refrigerant and the gaseous refrigerant through the detecting sensor provided at the lower header.

[0175] Also, there is another advantage that the cooling efficiency and the heat exchange efficiency of the heat exchanger can be enhanced by controlling the opening degree of the valve provided at the bypass pipe according to detected information.

[0176] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. An air conditioner comprising:

a compressor;
a flow switching part disposed at an outlet side of the compressor to switch a flow direction of a refrigerant according to whether a cooling operation or heating operation is performed;
an outdoor heat exchanger connected to the flow switching part and having a plurality of the refrigerant pipes to guide the refrigerant which heat-exchanges with outdoor air;
a main expansion valve connected to one side of the outdoor heat exchanger;
a first inlet/outlet pipe connecting the flow switching part to the outdoor heat exchanger; and
a second inlet/outlet pipe connecting the outdoor heat exchanger to the main expansion valve,
wherein the outdoor heat exchanger comprises:

a header to form a flowing space of the refrigerant and including an upper header and a lower header;
a check valve disposed between the upper header and the lower header to guide the refrigerant to flow one way;
a bypass pipe connecting the lower header to the second inlet/outlet pipe and to guide a discharge of a liquid refrigerant located in the lower header; and
a bypass pipe valve that is installed on the bypass pipe and controls an amount of the liquid refrigerant flowing through the bypass

pipe.

2. The air conditioner according to claim 1, further comprising a detector disposed in the refrigerant flowing space of the header to detect the amount of the liquid refrigerant in the lower header.

3. The air conditioner according to claim 2, wherein the detector comprises a liquid level sensor disposed in the refrigerant flowing space of the header to detect a level of the liquid refrigerant introduced into the lower header.

4. The air conditioner according to claim 3, wherein the liquid level sensor comprises a first liquid level sensor disposed at a lower side of the lower header such that a plurality of liquid level sensors are disposed above the first liquid level sensor.

5. The air conditioner according to claim 2, wherein the detector comprises a temperature sensor disposed in the refrigerant flowing space of the header to detect a temperature of the liquid refrigerant introduced into the lower header.

6. The air conditioner according to claim 5, wherein the temperature sensor comprises a first temperature sensor disposed at a lower side of the lower header such that a second temperature sensor is disposed above the first temperature sensor.

7. The air conditioner according to claim 2, wherein, when the amount of the liquid refrigerant measured by the detector is more than a set range, the bypass pipe valve is opened, and the liquid refrigerant stored in the outdoor heat exchanger is discharged from the outdoor heat exchanger, and
when the amount of the liquid refrigerant measured by the detector is less than the set range, the bypass pipe valve is closed.

8. The air conditioner according to claim 1, wherein the outdoor heat exchanger further comprises a first refrigerant pipe connected to the upper header; a connection pipe to guide the refrigerant flowing through the first refrigerant pipe to the lower header; and a refrigerant introduction pipe connecting the lower header to a second refrigerant pipe, and
the refrigerant introduction pipe located higher than the connection pipe.

9. The air conditioner according to claim 8, wherein the refrigerant introduction pipe comprises a lower introduction pipe disposed at a lower side of the lower header such that a plurality of upper introduction pipes is disposed above the lower introduction pipe, and
a height of the lower introduction pipe is higher than a height of the connection pipe with respect to a bottom of the outdoor heat exchanger.

10. The air conditioner according to claim 1, wherein the bypass pipe extends from a surface of the lower header.

11. The air conditioner according to claim 1, further comprising:

first and second distribution pipes branching from the second inlet/outlet pipe; and
first and second distributors connected to the respective first and second distribution pipes to branch and introduce the refrigerant into the plurality of refrigerant pipes,
wherein the first distributor is connected to the first distribution pipe and in communication with the upper header; and
the second distributor is connected to the second distribution pipe and in communication with the lower header.

12. The air conditioner according to claim 11, further comprising:

a first valve device disposed at the first distribution pipe;
a second valve device disposed at the second distribution pipe; and
a third valve device disposed at the connection pipe.

13. A method of controlling an air conditioner, comprising:

driving a cooling operation in an indoor unit to allow refrigerant discharged from a compressor to be introduced into the outdoor heat exchanger;
detecting an amount of a liquid refrigerant introduced into the outdoor heat exchanger by a detector; and
controlling a degree of opening of a valve disposed at a bypass pipe to discharge the liquid refrigerant from the outdoor heat exchanger, by a controller based on the detected amount of the liquid refrigerant.

14. The method according to claim 13, wherein the controller controls by opening the bypass pipe valve when the amount of the liquid refrigerant detected by the detector is more than a set range, and closes the bypass pipe valve when the amount of the liquid refrigerant is less than the set range.

15. The method according to claim 13, wherein the detector comprises one of a temperature sensor dis-

posed at a refrigerant path of the outdoor heat exchanger to detect a temperature of the refrigerant and a liquid level sensor disposed at a refrigerant path of the outdoor heat exchanger to detect a level of the liquid refrigerant, and
the controller determines the amount of the liquid refrigerant introduced into the outdoor heat exchanger based on one of a temperature value of the refrigerant detected by the temperature sensor and level value of the liquid refrigerant detected by the liquid level sensor.

FIG. 1

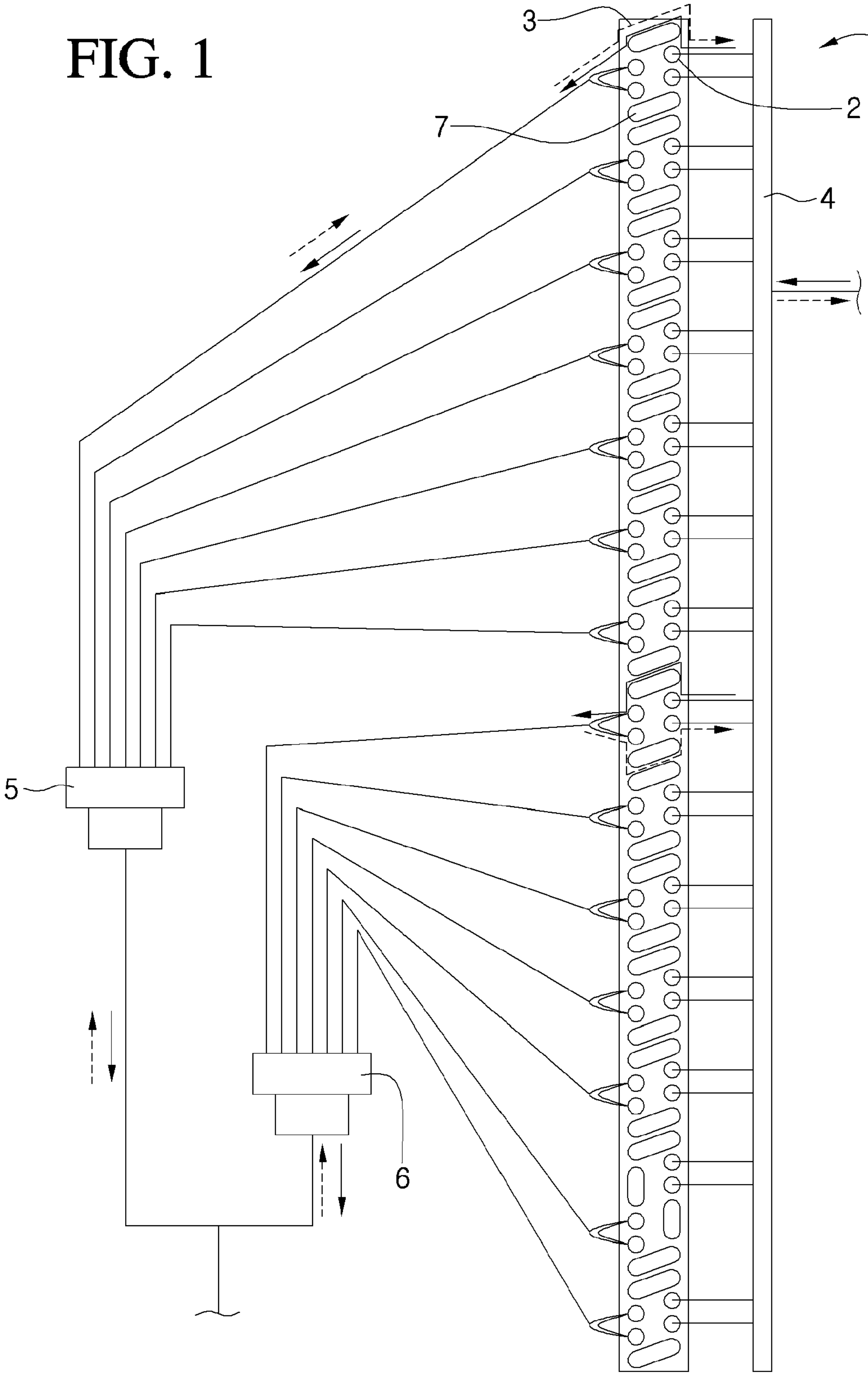
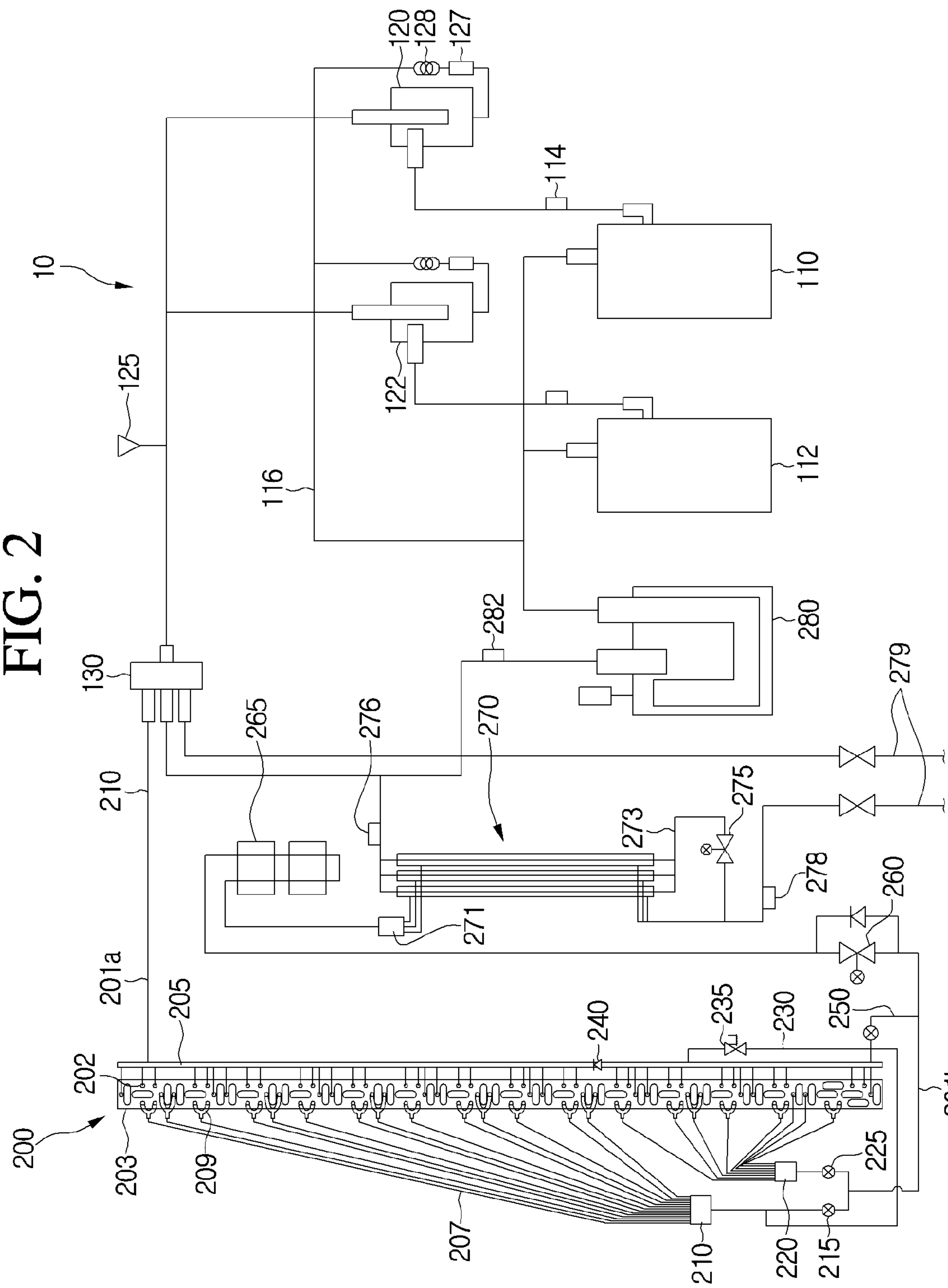


FIG. 2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128
127
114
110
112
125
122
116
130
282
280
265
276
270
210
273
275
279
278
271
260
201a
205
240
235
230
250
202
200
203
209
207
225
201b
210
220
215

FIG. 3

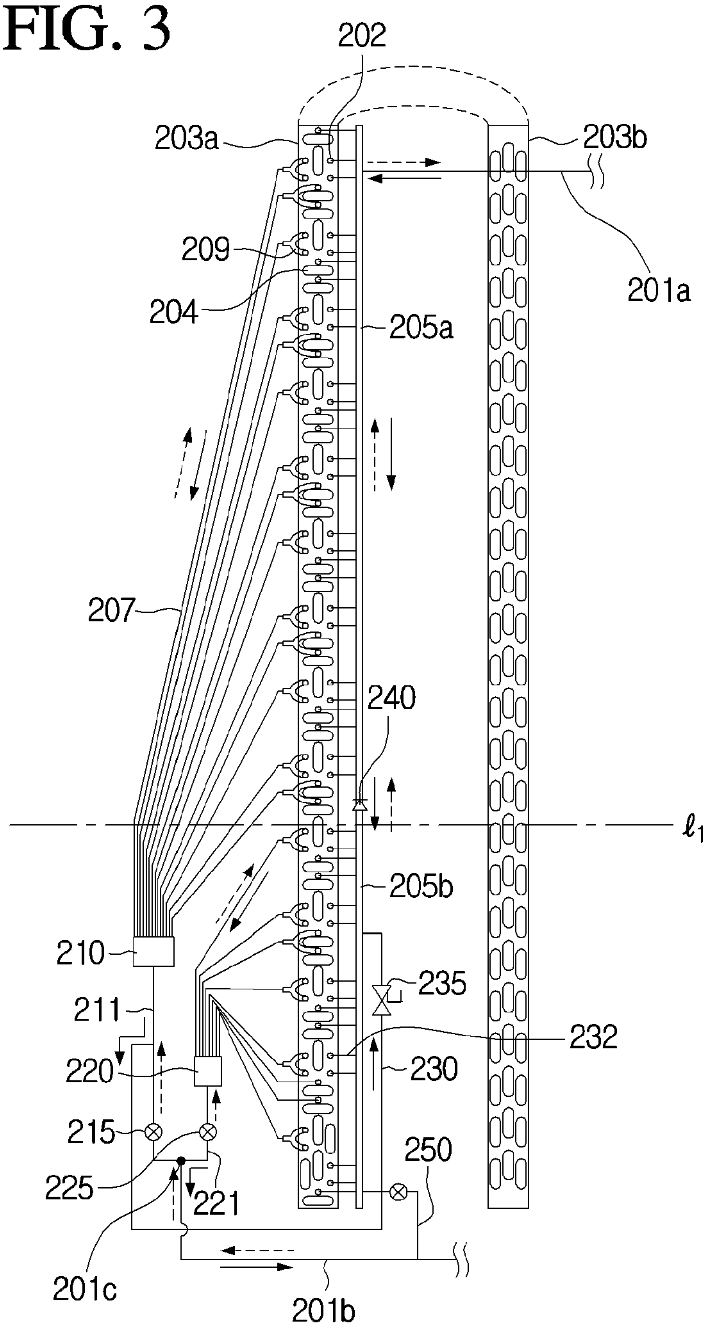

202
203a
203b
209
204
201a
205a
207
240
ℓ_1
205b
210
235
211
232
220
230
215
250
225
221
201c
201b

FIG. 4

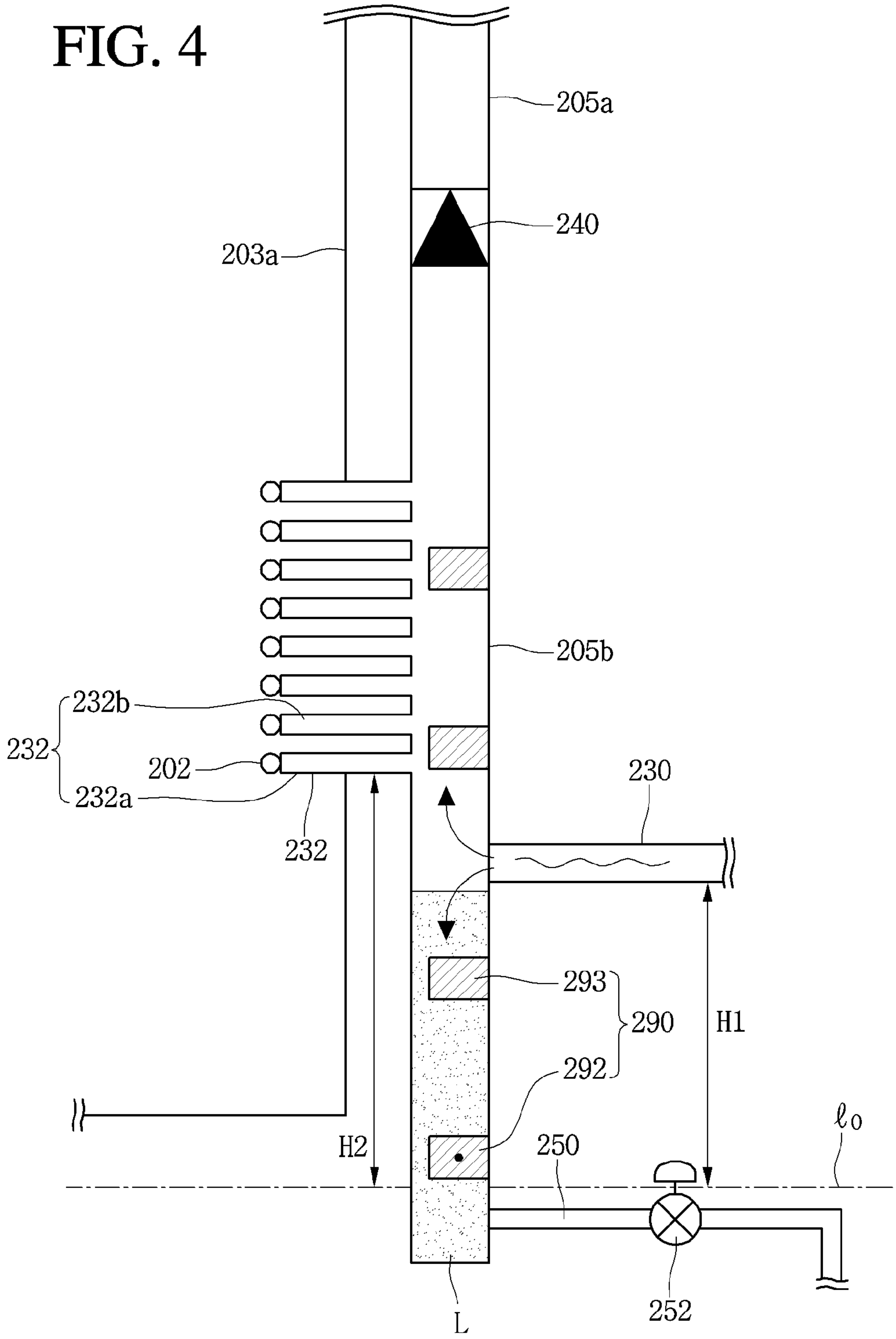

205a
240
203a
205b
232b
232
202
232a
232
230
293
290
292
H1
H2
250
ℓ0
252
L

FIG. 5

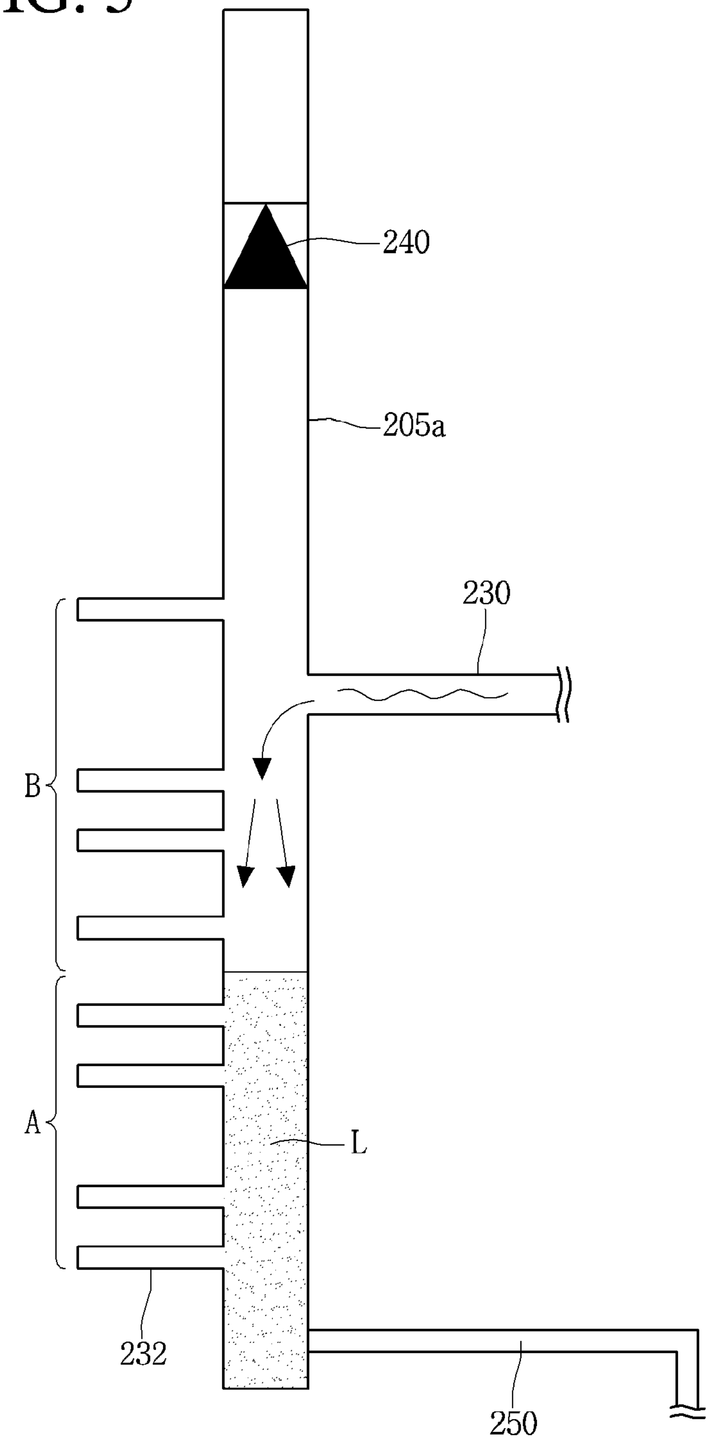


FIG. 6

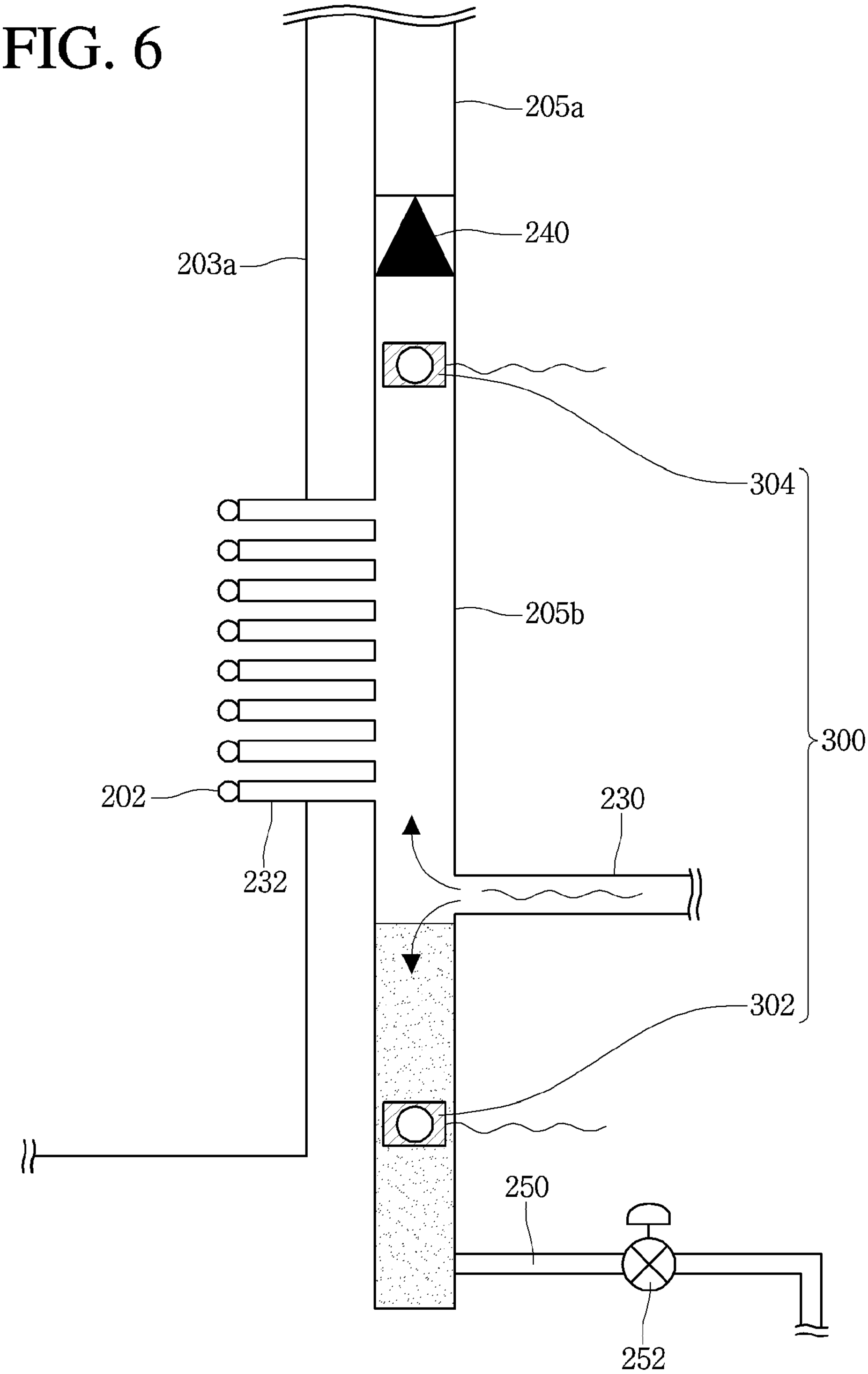


FIG. 7

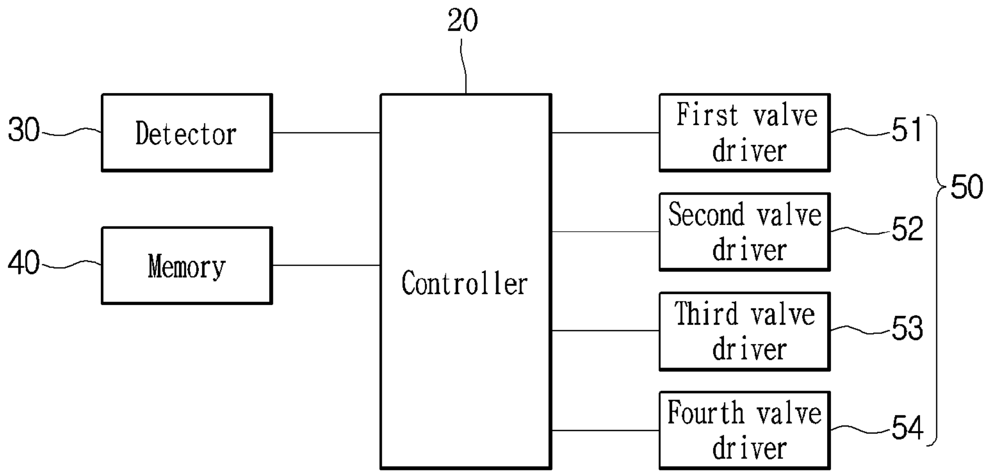

20
30
Detector
40
Memory
Controller
First valve driver
51
Second valve driver
52
Third valve driver
53
Fourth valve driver
54
50

FIG. 8

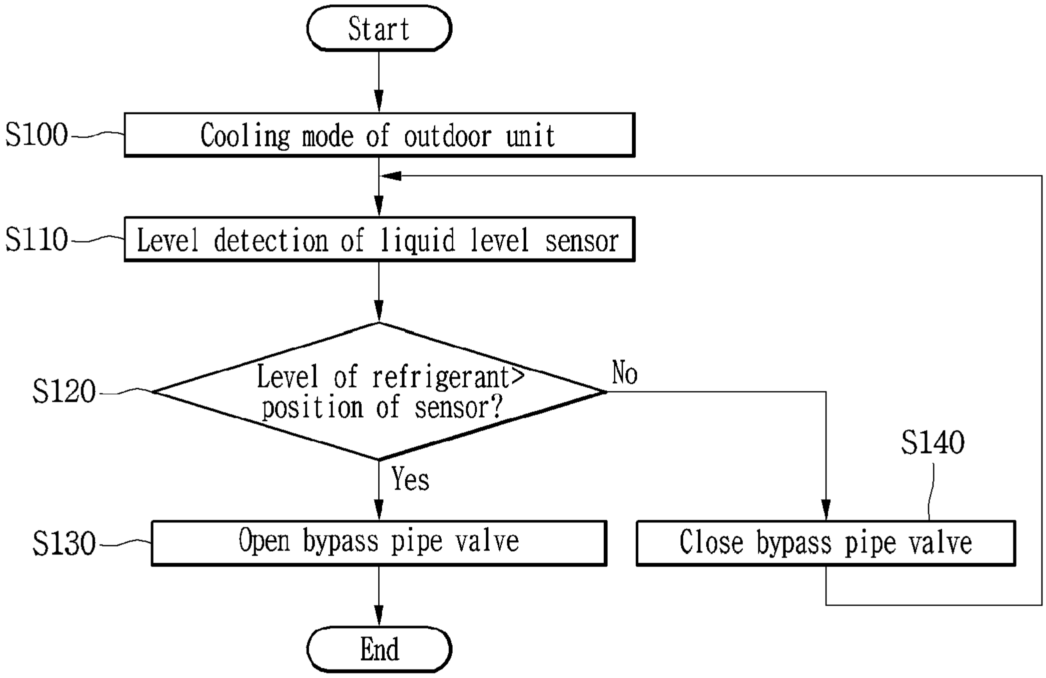
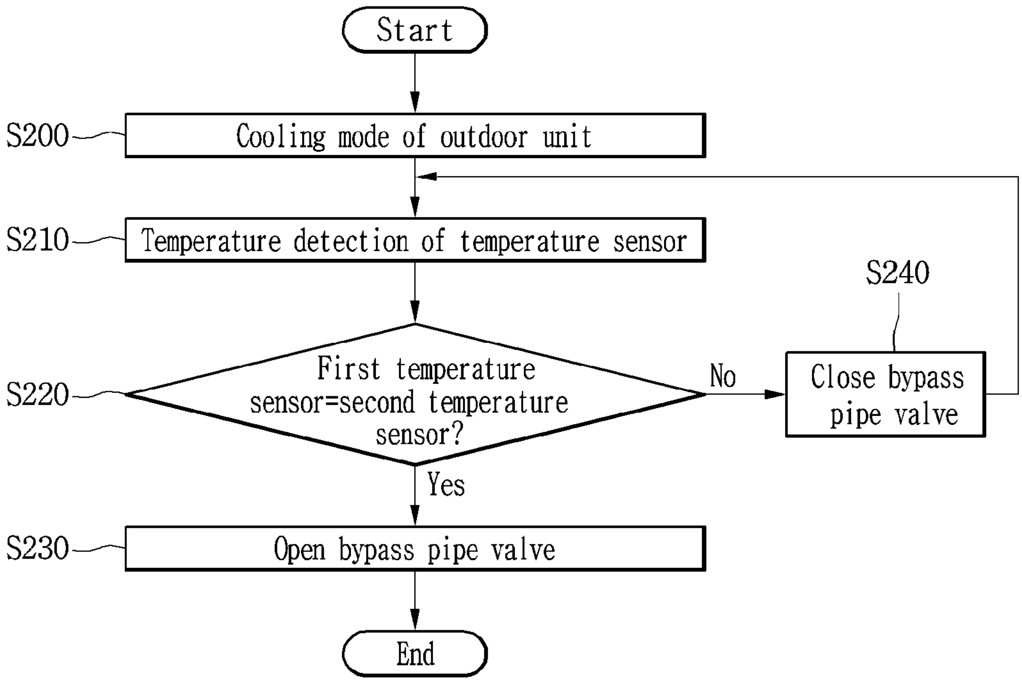

Start
S100
Cooling mode of outdoor unit
S110
Level detection of liquid level sensor
S120
Level of refrigerant>
position of sensor?
No
Yes
S130
Open bypass pipe valve
S140
Close bypass pipe valve
End

FIG. 9


Start
S200
Cooling mode of outdoor unit
S210
Temperature detection of temperature sensor
S240
S220
First temperature sensor=second temperature sensor?
No
Close bypass pipe valve
Yes
S230
Open bypass pipe valve
End

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 1922

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F25B

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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