



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.09.2015 Bulletin 2015/40

(51) Int Cl.:
F25B 1/10 (2006.01) **F25B 40/00** (2006.01)
F25B 40/02 (2006.01) **F25B 41/06** (2006.01)
F25B 49/02 (2006.01)

(21) Application number: **15160070.7**

(22) Date of filing: **20.03.2015**

(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

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(30) Priority: **20.03.2014 KR 20140032959**

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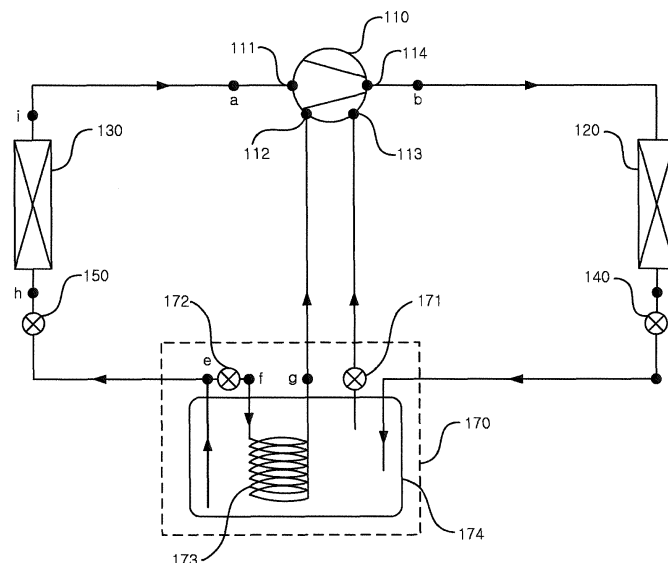
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(54) **AIR CONDITIONER**

(57) The present invention relates to an air conditioner for injecting a refrigerant into a compressor in a simple configuration by two steps. The air conditioner includes a compressor for compressing a refrigerant; a condenser for condensing the refrigerant compressed at the compressor; an evaporator for evaporating the refrigerant condensed at the condenser; and an injection module for separating the refrigerant flown from the condenser

to the evaporator into a vapor-phase refrigerant and liquid-phase refrigerant, expanding the separated vapor-phase refrigerant and injecting the expanded refrigerant into the compressor, expanding and evaporating some of the separated liquid-phase refrigerant and injecting the expanded and evaporated refrigerant into the compressor according to the embodiment of the present invention.

FIG. 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioner, and more particularly to the air conditioner for injecting a refrigerant into a compressor in a simple configuration by two steps.

Related Art

[0002] In general, an air conditioner including a compressor, an outdoor heat exchanger, an expansion valve and an indoor heat exchanger heats or cools the indoor using a refrigeration cycle. That is, it includes a cooler for cooling the indoor and a heater for heating the indoor. In addition, it may be the air conditioner for both heating and cooling for cooling or heating the indoor.

[0003] Such an air conditioner injects some refrigerant condensed during a cooling or heating operation into a compressor, thereby to enhance the efficiency thereof. Injections having two steps for simultaneously injecting the refrigerant into a high pressure side and low pressure side of the compressor are requested to enhance the efficiency, but there are problems in that the structures of injections having two steps are complex and manufacturing cost thereof is increased.

Summary of the Invention

[0004] An advantage of some aspects of the invention is that it provides an air conditioner for injecting a refrigerant into a compressor in a simple configuration by two steps.

[0005] The present invention is not limited to the above-mentioned problems and other problems, which are not described above, can be obviously understood to those skilled in the art from the following description.

[0006] According to an aspect of the invention, there is provided an air conditioner including a compressor for compressing a refrigerant; a condenser for condensing the refrigerant compressed at the compressor; an evaporator for evaporating the refrigerant condensed at the condenser; and an injection module for separating the refrigerant flown from the condenser to the evaporator into a vapor-phase refrigerant and liquid-phase refrigerant, expanding the separated vapor-phase refrigerant and injecting the expanded refrigerant into the compressor, expanding and evaporating some of the separated liquid-phase refrigerant and injecting the expanded and evaporated refrigerant into the compressor.

[0007] According to another aspect of the invention, there is provided an air conditioner including a compressor for compressing a refrigerant; a condenser for condensing the refrigerant compressed at the compressor; an evaporator for evaporating the refrigerant condensed

at the condenser; an injection liquid-vapor separator, disposed at the condenser and the evaporator, for separating the refrigerant to be flown into the vapor-phase refrigerant and liquid-phase refrigerant; a first injection expansion valve, connected to the injection liquid-vapor separator and the compressor, for expanding the vapor-phase refrigerant separated from the injection liquid-vapor separator; a second injection expansion valve, connected to the injection liquid-vapor separator, for expanding some of the separated vapor-phase refrigerant; and an injection heat exchanger, connected to the second injection expansion valve and compressor and disposed at the injection liquid-vapor separator, for evaporating the refrigerant expanded at the second injection expansion valve.

[0008] The specifics of other embodiments are included in the detailed description and drawings.

Brief Description of the Drawings

[0009]

FIG. 1 is a configuration view for an air conditioner according to one embodiment of the present invention.

FIG. 2 is a block view for the air conditioner according to one embodiment of the present invention.

FIG. 3 represents a Pressure-Enthalpy Diagram (hereinafter, refers to a P-h Diagram) on operating the air conditioner according to one embodiment of the present invention.

Detailed Description of the Embodiments

[0010] Benefits and features of the present invention and how to achieve them will become clear with reference to exemplary embodiments to be described below in detail along with the accompanying drawings. However, the present invention is not limited to embodiments disclosed below and can be implemented various type different from each other. Only the embodiment of the present invention is provided to enable a disclosure of the present invention to be completed and to notice one skilled in the art to which the present invention pertains to, of a category of the present invention perfectly and the present invention is only defined by the category of claims. The same reference numerals refer to identical components in the entire specification.

[0011] Hereinafter, the present invention will be described by the embodiments of the present invention with reference to the drawings for describing the air-conditioner and a method for controlling the same.

[0012] FIG. 1 is a configuration view for the air conditioner according to one embodiment of the present invention.

[0013] The air conditioner includes a compressor 110 for compressing a refrigerant, a condenser 120 for condensing the refrigerant compressed at the compressor

110, an evaporator 130 for evaporating the refrigerant condensed at the condenser 120, and an injection module 170 for separating the refrigerant flown from the condenser 120 to the evaporator 130 into a vapor-phase refrigerant and liquid-phase refrigerant, expanding the separated vapor-phase refrigerant and injecting the expanded refrigerant into the compressor 110, expanding and evaporating some of the separated liquid-phase refrigerant and injecting the expanded and evaporated refrigerant into the compressor 110 according to one embodiment of the present invention.

[0014] The compressor 110 compresses the refrigerant, having low temperature and pressure, to be introduced into the refrigerant having high temperature and pressure. The compressor 110 may have various structures, and may be a reciprocating compressor using a cylinder and piston or a scroll compressor using a pivot scroll and fixing scroll. The compressor 110 is the scroll compressor in the present embodiment.

[0015] The compressor 110 includes a first inlet port 111 for introducing the refrigerant evaporated at the evaporator 130, a second inlet port 112 and a third inlet port 113 for introducing the refrigerant expanded and evaporated at an injection module 170, and a discharging port 114 for discharging the compressed refrigerant.

[0016] It is desirable that the second inlet port 112 is formed at a low pressure side of a compressive chamber for compressing the refrigerant in the compressor 110 and the third inlet port 113 is formed at a high pressure side of the compressive chamber in the compressor 110.

[0017] The high pressure side of the compressor 110 is a part having temperature and pressure relatively lower than the low pressure side of the compressor 110. The low pressure side of the compressor 110 is a part closer to the first inlet port 111 in the compressive chamber, and the high pressure side of the compressor 110 is a part closer to the discharging port 114 in the compressive chamber. The refrigerant introduced into the first inlet port of the compressor 110 is introduced into the inside of the compressive chamber and is discharged into the discharging port 114 through the high pressure side via the low pressure side.

[0018] The compressor 110 compresses the refrigerant introduced into the first inlet port 111 at the compressive chamber, meets it with the refrigerant introduced into the second inlet port 112 formed at the low pressure side of the compressive chamber, and compresses the met refrigerant. The compressor 110 compresses the met refrigerant, meets it with the refrigerant introduced into the third inlet port 113 formed at the high pressure side of the compressive chamber, and compresses the met refrigerant. The compressor 110 compresses the met refrigerant and discharges them into the discharging port 114.

[0019] The condenser 120 connected to the compressor 110 condenses the refrigerant compressed at the compressor 110. It is desirable that the condenser 120 disposed at the outdoor is the outdoor heat exchanger for

heat-exchanging outdoor air with the refrigerant when the air conditioner is a cooler cooling the indoor and the condenser 120 disposed at the indoor is the indoor heat exchanger for heat-exchanging indoor air with the refrigerant when the air conditioner is a heater heating the indoor.

[0020] The condenser 120 is connected to the first main expansion valve 140, and therefore the refrigerant condensed at the condenser 120 is flown into the first main expansion valve 140.

[0021] The first main expansion valve 140, connected to the condenser 120, expands the refrigerant condensed at the condenser 120. The first main expansion valve 140 is disposed between the condenser 120 and the injection module 170. The first main expansion valve 140 is connected to the injection module 170, and therefore the refrigerant expanded at the first main expansion valve 140 is guided into the injection module 170.

[0022] The first main expansion valve 140 may be omitted according to the embodiment, and in this case, the refrigerant condensed at the condenser 120 is flown into the injection module 170.

[0023] The injection module 170 disposed between the condenser 120 and evaporator 130 is connected to a high pressure side and a low pressure side of the compressor 110. The injection module 170 is connected to the second inlet port 112 of the compressor 110, the third inlet port 113 of the compressor 110, the first main expansion valve 140 and the second main expansion valve 150. The injection module 170, connected to the first main expansion valve 140, injects the refrigerant expanded at the first main expansion valve 140 into the high pressure side and low pressure side of the compressor 110.

[0024] The injection module 170, connected to the first main expansion valve 140, injects the refrigerant expanded at the first main expansion valve 140 into the high pressure side and low pressure side of the compressor 110.

[0025] The injection module 170 separates the refrigerant flown from the first main expansion valve 140 to the second main expansion valve 150 into a vapor-phase refrigerant and liquid-phase refrigerant, expands the separated vapor-phase refrigerant, and injects the expanded refrigerant into the high pressure side of the compressor 110. The injection module 170 expands and evaporates some of the separated liquid-phase refrigerant to inject into the low pressure side of the compressor 110.

[0026] The injection module 170 is connected to the second main expansion valve 150 and the other of the separated liquid-phase refrigerant is flown into the second main expansion valve 150.

[0027] The injection module 170 includes an injection liquid-vapor separator 174, disposed at the condenser 120 and the evaporator 130, for separating the refrigerant to be flown into the vapor-phase refrigerant and liquid-phase refrigerant, a first injection expansion valve 171, connected to the injection liquid-vapor separator 174 and the compressor, for expanding the vapor-phase refrigerant

ant separated from the injection liquid-vapor separator 174, a second injection expansion valve 172, connected to the injection liquid-vapor separator 174, for expanding some of the separated liquid-phase refrigerant, and an injection heat exchanger 173, connected to the second injection expansion valve 172 and compressor 110 and disposed at the injection liquid-vapor separator, for evaporating the refrigerant expanded at the second injection expansion valve according to one embodiment of the present invention.

[0028] The injection liquid-vapor separator 174 is disposed between the condenser 120 and the evaporator 130. The injection liquid-vapor separator 174 is connected to the first main expansion valve 140, the second main expansion valve 150, the first injection expansion valve 171, and the second injection expansion valve 172, and the injection heat exchanger 173 is disposed at the inside thereof.

[0029] The injection liquid-vapor separator 174 is an accumulator for separating the vapor-phase refrigerant and liquid-phase refrigerant using the pressure difference of the refrigerant. The injection liquid-vapor separator 174 in the embodiment may be configured by various apparatuses capable of separating the vapor-phase refrigerant and liquid-phase refrigerant.

[0030] The injection liquid-vapor separator 174 separates the refrigerant expanded at the first main expansion valve 140 into the vapor-phase refrigerant and liquid-phase refrigerant. The vapor-phase refrigerant separated from the injection liquid-vapor separator 174 is flown into the first injection expansion valve 171. Some of the liquid-phase refrigerant separated from the injection liquid-vapor separator 174 is flown into the second injection expansion valve 172. The other of the liquid-phase refrigerant separated from the injection liquid-vapor separator 174 is flown into the second main expansion valve 150.

[0031] The first injection expansion valve 171 is connected to the injection liquid-vapor separator 174 and the third inlet port 113 of the compressor 110. The first injection expansion valve 171 expands the vapor-phase refrigerant separated from the injection liquid-vapor separator 174. The refrigerant expanded at the first injection expansion valve 171 is injected into the high pressure side of the compressor 110 through the third inlet port 113.

[0032] The second injection expansion valve 172 is connected to the injection liquid-vapor separator 174 and the injection heat exchanger 173. The second injection expansion valve 172 expands some of the liquid-phase refrigerant separated from the injection liquid-vapor separator 174. The refrigerant expanded at the second injection heat exchanger 172 is flown into the injection heat exchanger 173.

[0033] The injection heat exchanger 173 is connected to the second injection expansion valve 172 and the second inlet port 112 of the compressor 110 and disposed at the injection liquid-vapor separator 174. The injection

heat exchanger 173 heat-exchanges the refrigerant expanded at the second injection expansion valve 172 with the refrigerant in the injection liquid-vapor separator 174. The injection heat exchanger 173 preferably heat-exchanges the refrigerant expanded at the second injection expansion valve 172 with the liquid-phase refrigerant in the injection liquid-vapor separator 174.

[0034] The injection heat exchanger 173 heat-exchanges the refrigerant expanded at the second injection expansion valve 172 with the liquid-phase refrigerant in the injection liquid-vapor separator 174 and evaporates the heat-exchanged refrigerant. The refrigerant evaporated at the injection heat exchanger 173 is injected into the low pressure side of the compressor 110 through the second inlet port 112.

[0035] The injection heat exchanger 173 heat-exchanges the liquid-phase refrigerant in the injection liquid-vapor separator 174 with the refrigerant expanded at the second injection expansion valve 172 and supercools the heat-exchanged refrigerant. The refrigerant supercooled at the injection heat exchanger 173 is flown into the second main expansion valve 150 and the second injection expansion valve 172.

[0036] The second main expansion valve 150, connected to the injection module 170, expands the refrigerant flown from the second main expansion valve 150. The second main expansion valve 150 is disposed between the injection module 170 and the evaporator 130. The second main expansion valve 150 is connected to the evaporator 130, and the refrigerant expanded at the first main expansion valve 140 is guided into the evaporator 130.

[0037] The evaporator 130 disposed between the second main expansion valve 150 and the compressor 110 evaporates the refrigerant expanded at the second main expansion valve 150. It is desirable that the evaporator 130 disposed at the indoor is the indoor heat exchanger for heat-exchanging indoor air with the refrigerant when the air conditioner is a cooler cooling the indoor and the evaporator 130 disposed at the outdoor is the outdoor heat exchanger for heat-exchanging outdoor air with the refrigerant when the air conditioner is a heater heating the indoor.

[0038] The evaporator 130 is connected to the first inlet port 111 of the compressor 110, and therefore the refrigerant evaporated at the evaporator 130 is introduced into the compressor 110 through the first inlet port 111.

[0039] FIG. 2 is a block view for the air conditioner according to one embodiment of the present invention.

[0040] Referring to FIG. 2, the air conditioner includes a controller 10 for controlling the air conditioner, a discharge temperature sensor 11 for measuring the discharging temperature of the refrigerant discharged from a discharging port 114 of the compressor 110, a condensation temperature sensor 12 for measuring the condensing temperature of the refrigerant condensed at the condenser 120, a suction temperature sensor 13 for measuring the suctioning temperature of the refrigerant

suctioned into the first inlet port 111 of the compressor 110, an evaporation temperature sensor 14 for measuring the evaporating temperature of the refrigerant evaporated at the evaporator 130, an injection expansion temperature sensor 15 for measuring the temperature of the refrigerant expanded at the second injection expansion valve 172, and an injection evaporation temperature sensor 16 for measuring the temperature of the refrigerant evaporated at the injection heat exchanger 173 according to one embodiment of the present invention.

[0041] The controller 10, which controls operation of the air conditioner, controls the compressor 110, the first main expansion valve 140, the second main expansion valve 150, the first injection expansion valve 171, and the second injection expansion valve 172. The controller 10 controls the openings of the first main expansion valve 140, the second main expansion valve 150, the first injection expansion valve 171, and the first injection expansion valve 172 according to the operation conditions.

[0042] The discharge temperature sensor 11 measures the discharging temperature of the refrigerant that is compressed at the compressor 110 and is discharged into the discharging port 114. The discharge temperature sensor 11 is disposed at various points, may measure temperature of the refrigerant discharged from the compressor 110, and is disposed at a point b in the present embodiment.

[0043] The condensation pressure sensor 12 measures the condensing pressure of the refrigerant condensed at the condenser 120. The condensation temperature sensor 12 is disposed at various points, may measure the condensing pressure of the refrigerant, and is disposed at a point c in the present embodiment. According to the embodiment, the condensation temperature sensor 12 may be disposed at the condenser 120. The condensing pressure of the refrigerant may be converted from the condensing temperature of the refrigerant measured by the pressure sensor in the embodiment.

[0044] The suction temperature sensor 13 measures the suctioning temperature of the refrigerant that is evaporated at the evaporator 140 and introduced into the first inlet port 111 of the compressor 110. The suction temperature sensor 13 is disposed at various points, may measure the temperature of the refrigerant suctioned from the compressor 110, and is disposed at a point a in the present embodiment.

[0045] The evaporation temperature sensor 14 measures the evaporating temperature of the refrigerant evaporated at the evaporator 140. The evaporation temperature sensor 14 is disposed at various points, may measure the evaporating temperature of the refrigerant, and is disposed at a point i in the present embodiment. According to the embodiment, the evaporation temperature sensor 14 may be disposed at the evaporator 140. The evaporating temperature of the refrigerant may be converted from the evaporating pressure of the refrigerant measured by the pressure sensor in the embodiment.

[0046] The injection expansion temperature sensor 15

measures the temperature of the refrigerant expanded at the second injection expansion valve 181, that is, the injection expansion temperature. The injection expansion temperature sensor 15 is disposed at various points, may measure the injection expansion temperature of the refrigerant to be injected, and is disposed at a point f in the present embodiment.

[0047] The injection evaporation temperature sensor 16 measures the injection evaporation temperature of the refrigerant that is evaporated at the injection heat exchanger 182 and injected into the second inlet port 112 of the compressor 110. The injection evaporation temperature sensor 16 is disposed at various points, may measure the injection evaporation temperature, and is disposed at a point g in the present embodiment.

[0048] The controller 10 controls the opening of the first main expansion valve 140 according to the discharging superheat, that is, the difference between the discharging temperature measured by the discharge temperature sensor 11 and the condensing temperature measured by the condensation temperature sensor 12. The controller 10 controls the opening of the first main expansion valve 140 so that the discharging superheat is not deviated from the preset range.

[0049] The controller 10 controls the opening of the second main expansion valve 150 according to the suctioning superheat, that is, the difference between the suctioning temperature measured by the suction temperature sensor 13 and the evaporating temperature measured by the evaporation temperature sensor 14. The controller 10 controls the opening of the second main expansion valve 150 so that the suctioning superheat is not deviated from the preset range.

[0050] The controller 10 controls the opening of the first injection expansion valve 171 according to the operation velocity of the compressor 110. The operation velocity of the compressor 110, which is rotation velocity of a motor (not shown) for generating rotation force to compress the refrigerant in the compressor 110, may be represented in frequencies. The operation velocity of the compressor 110 is proportional to compression capacity of the compressor 110. The controller 10 controls the opening of the first injection expansion valve 171 according to the operation velocity of the compressor 110 or closes the first injection expansion valve 171.

[0051] The controller 10 controls the opening of the second injection expansion valve 172 according to the injection superheat, that is, the difference between the injection evaporation temperature measured by the injection evaporation temperature sensor 16 and the injection expansion temperature measured by the injection expansion temperature sensor 15. The controller 10 controls the opening of the second injection expansion valve 172 so that the injection superheat is within the preset value.

[0052] FIG. 3 represents a Pressure-Enthalpy Diagram (hereinafter, refers to a P-h Diagram) on operating the air conditioner according to one embodiment of the

present invention.

[0053] Referring to FIG. 1 and FIG.3, actions of the air conditioner in one embodiment of the present invention will be described below.

[0054] The refrigerant compressed at the compressor 110 is discharged through the discharging port 114. The refrigerant discharged into the discharging port 114 is flown into the condenser 120 via a point b.

[0055] The refrigerant flown into the condenser 120 is heat-exchanged with air and condensed. The refrigerant flown into the condenser 120 is heat-exchanged with the outdoor air when the air conditioner is the cooler, and the refrigerant flown into the condenser 120 is heat-exchanged with the indoor air when the air conditioner is the heater.

[0056] The refrigerant condensed at the condenser 120 is expanded at the first main expansion valve 140 via a point c. The first main expansion valve 140 controls the opening thereof according to the discharging superheat. The refrigerant expanded at the first main expansion valve 140 is flown into the injection module 170 via a point d.

[0057] The refrigerant flown into the injection module 170 is introduced into the injection liquid-vapor separator 174. The refrigerant introduced into the injection liquid-vapor separator 174 is separated into the vapor-phase refrigerant and liquid-phase refrigerant.

[0058] The vapor-phase refrigerant separated at the injection liquid-vapor separator 174 is flown into the first injection expansion valve 171. The refrigerant expanded at the first injection expansion valve 171 is injected into the high pressure side of the compressor 110 through the third inlet port 113 of the compressor 110.

[0059] The liquid-phase refrigerant separated at the injection liquid-vapor separator 174 is supercooled by the injection heat exchanger 173. Some liquid-phase refrigerant supercooled in the injection liquid-vapor separator 174 is flown into the second injection expansion valve 172 via a point e and the other of it is flown into the second main expansion valve 150 via the point e.

[0060] The refrigerant flown into the second injection expansion valve 172 is expanded to flow into the injection heat exchanger 173 via a point f. The second injection expansion valve 172 controls the opening thereof according to the injection superheat.

[0061] The refrigerant that is supercooled at the second injection expansion valve 172 and is flown into the injection heat exchanger 173 is heated and evaporated. The refrigerant evaporated at the injection heat exchanger 173 is injected into the low pressure side of the compressor 110 through the second inlet port 112 via a point g.

[0062] The refrigerant flown from the injection liquid-vapor separator 174 of the injection module 170 to the second main expansion valve 150 is expanded. The second main expansion valve 150 controls the opening thereof according to the suctioning superheat. The refrigerant expanded at the second main expansion valve

150 is flown into the evaporator 130 via a point h.

[0063] The refrigerant flown into the evaporator 130 is heat-exchanged with air and evaporated. The refrigerant flown into the evaporator 130 is heat-exchanged with the indoor air when the air conditioner is the cooler, and the refrigerant flown into the evaporator 130 is heat-exchanged with the outdoor air when the air conditioner is the heater.

[0064] The refrigerant evaporated from the evaporator 130 is flown into the first inlet port 111 of the compressor 110 via the point i and a. The refrigerant flown into the first inlet port 111 is compressed at the compressor 110 and is met with the refrigerant injected into the second inlet port 112 and third inlet port 113. The refrigerant compressed at the compressor 110 is discharged into the discharging port 114.

[0065] Referring to FIG. 3, one cycle, configured with the discharging port 114 of the compressor 110, the condenser 120, the injection liquid-vapor separator 174, the first injection expansion valve 171 and the third inlet port 113 of the compressor 110, forms one injection step. In addition, one cycle, configured with the discharging port 114 of the compressor 110, the condenser 120, the injection liquid-vapor separator 174, the injection expansion valve 172, the injection heat exchanger 173, and the second inlet port 112 of the compressor 110, forms one injection step.

[0066] In addition, although the preferred embodiments of the present invention are shown and described above, the present invention is not limited to above-described specific embodiment and is variously modified by one skilled in the art without the gist of the present invention claimed in the claim, such that the modified embodiment is not to be understood separately from technical ideas or views of the present invention.

[0067] There are the following effects in the air conditioner of the present invention.

[0068] Firstly, the refrigerant may be injected into the high pressure side and low pressure side of the compressor in a simple configuration.

[0069] Secondly, configurations and their controls of the liquid-vapor separator, heat exchanger and the expansion valve implements the injections having two steps, thereby to enhance the efficiency of the air conditioner.

[0070] Thirdly, the supercooling of the refrigerant and the injections having two steps may be implemented with one module.

Claims

1. An air conditioner, comprising:

- a compressor (110) for compressing a refrigerant;
- a condenser (120) for condensing the refrigerant compressed at the compressor (110);

- an evaporator (130) for evaporating the refrigerant condensed at the condenser (120); and an injection module (170) disposed between the condenser (120) and the evaporator (130) for separating the refrigerant flown from the condenser (120) to the evaporator (130) into a vapor-phase refrigerant and liquid-phase refrigerant, expanding the separated vapor-phase refrigerant and injecting the expanded refrigerant into the compressor (110), expanding and evaporating some of the separated liquid-phase refrigerant and injecting the expanded and evaporated refrigerant into the compressor (110), and supplying the remainder of the separated liquid-phase refrigerant to the evaporator (130).
2. The air conditioner according to claim 1, further comprising a first main expansion valve (140), disposed between the condenser (120) and the injection module (170), for expanding the refrigerant, and a second main expansion valve (150), disposed between the injection module (170) and the evaporator (130), for expanding the refrigerant.
 3. The air conditioner according to claim 2, wherein the first main expansion valve (140) is controlled according to the discharging superheat, that is, the difference between the temperature of the refrigerant discharged at the compressor (110) and the temperature of the refrigerant condensed at the condenser (120).
 4. The air conditioner according to claim 2 or 3, wherein the second main expansion valve (150) is controlled according to the suctioning superheat, that is, the difference between the temperature of the refrigerant suctioned into the compressor (110) and the temperature of the refrigerant evaporated at the evaporator (130).
 5. The air conditioner according to any one of claims 1 to 4, wherein the injection module (170) comprises, an injection liquid-vapor separator (174), disposed between the condenser (120) and the evaporator (130), for separating the refrigerant to be flown into the vapor-phase refrigerant and liquid-phase refrigerant, a first injection expansion valve (171), connected to the injection liquid-vapor separator (174) and the compressor (110), for expanding the vapor-phase refrigerant separated from the injection liquid-vapor separator, a second injection expansion valve (172), connected to the injection liquid-vapor separator (174), for expanding some of the separated liquid-phase refrigerant, and an injection heat exchanger (173), connected to the second injection expansion valve (172) and the com-
- pressor (110) and disposed at the injection liquid-vapor separator (174), for evaporating the refrigerant expanded at the second injection expansion valve (172).
6. The air conditioner according to claim 5, further comprising an injection expansion temperature sensor (15) for measuring the temperature of the refrigerant expanded at the second injection expansion valve (172), and an injection evaporation temperature sensor (16) for measuring the temperature of the refrigerant evaporated at the injection heat exchanger (173).
 7. The air conditioner according to claim 5 or 6, wherein the second injection expansion valve (172) is controlled according to the injection superheat, that is, the difference between the temperature measured by the injection evaporation temperature sensor (16) and the temperature measured by the injection expansion temperature sensor (15).

FIG. 1

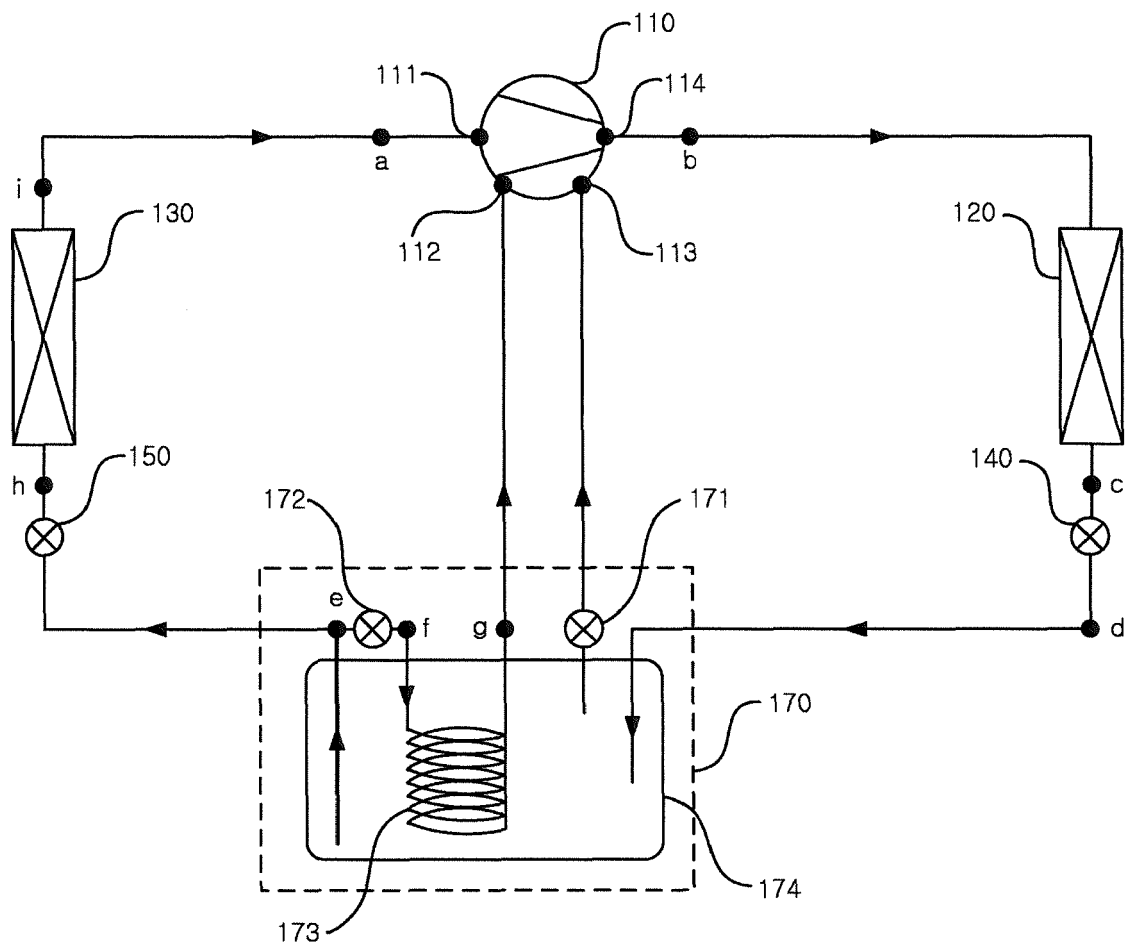


FIG. 2

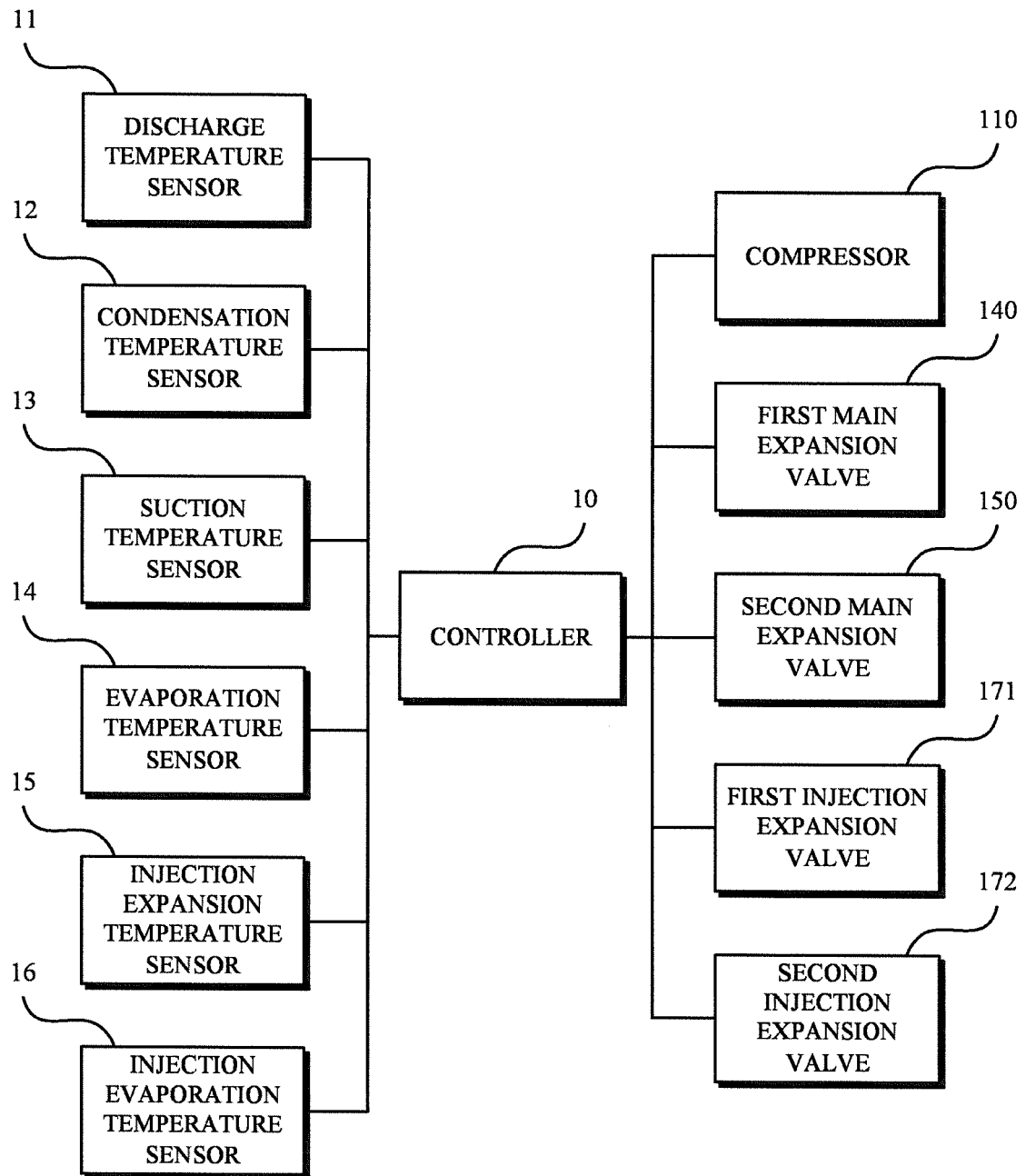
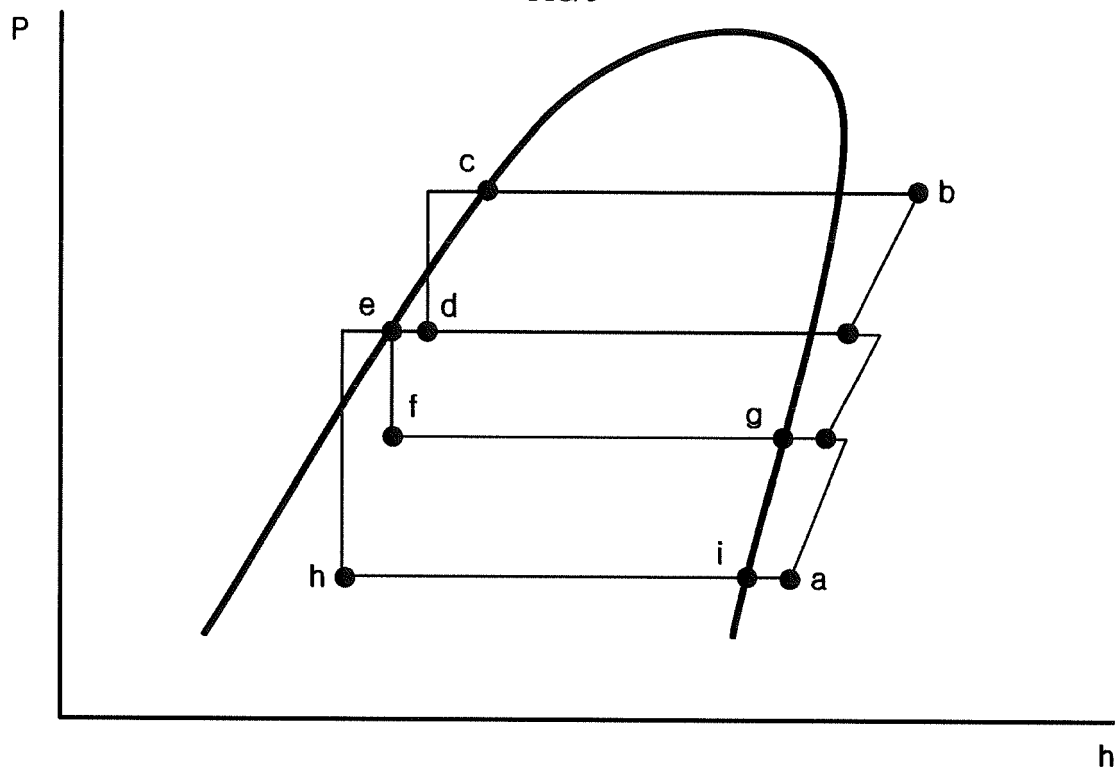


FIG. 3





EUROPEAN SEARCH REPORT

Application Number
EP 15 16 0070

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2013/055754 A1 (KIM BEOMCHAN [KR] ET AL) 7 March 2013 (2013-03-07) * the whole document *	1-7	INV. F25B1/10 F25B40/00 F25B40/02 F25B41/06 F25B49/02
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		19 August 2015	Lucic, Anita
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 16 0070

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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19-08-2015

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