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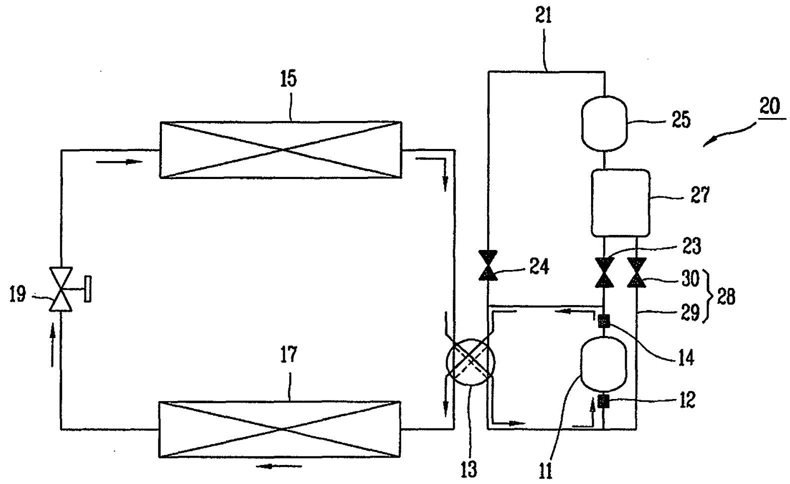
(54) **Air conditioner**

(57) Disclosed is an air conditioner. The air conditioner a main compressor for compressing a refrigerant; a four-way valve disposed at a discharge side of the main compressor and switching a fluid path; an outdoor heat exchanger having one side connected with the four-way valve; an indoor heat exchanger having one side connected with the outdoor heat exchanger and the other side connected with the four-way valve; an expansion valve disposed between the outdoor heat exchanger and the indoor heat exchanger; and an auxiliary compression unit for reducing the load on the main compressor.

Accordingly, since the load on the main compressor decreases, efficiency and reliability of the main compressor are enhanced and noises are reduced. In addition, an instrumental part such as a bearing inside the main compressor is not subject to abrasion and high heat damage to a motor unit is prevented.

FIG. 3



EP 1 701 114 A1

Description

[0001] The present invention relates to an air conditioner. Embodiments relate to an air conditioner reducing a load on a compressor when ambient air temperature is low during heating operation.

[0002] In general, air conditioners are used for adjusting temperature, humidity, air current and cleanliness of air in order to create a pleasant indoor environment.

[0003] According to the unit construction, there are an integral type air conditioner in which an indoor unit and an outdoor unit are received inside one single case and a separated type air conditioner in which a compressor and a condenser as an indoor unit are separated from an evaporator as an outdoor unit. Some air conditioners can selectively perform their cooling or heating functions by being provided with fluid path switch valves to switch a fluid path of a refrigerant.

[0004] Referring to Figure 1, a conventional air conditioner for cooling and heating includes: a compressor 101 for compressing a refrigerant; a four-way valve 103 disposed at a discharge side of the compressor 101 so as to switch a fluid path of a refrigerant; an outdoor heat exchanger 105 and an indoor heat exchanger 107 which are connected with the four-way valve 103 and in which the refrigerant undergoes heat exchange; and an expansion valve 109 disposed between the outdoor heat exchanger 105 and the indoor heat exchanger 107.

[0005] With the construction of Figure 1, during cooling operation, the four-way valve 103 switches the fluid path such that the refrigerant compressed in the compressor 101 flows to the outdoor heat exchanger 105. The refrigerant compressed in the compressor 101 undergoes heat exchange and then is condensed in the outdoor heat exchanger 105. Then condensed refrigerant is decompressed and expanded in the expansion valve 109. Thereafter, the refrigerant performs cooling operation, undergoing heat exchange and absorbing latent heat of evaporation in the indoor heat exchanger 107.

[0006] During heating operation, the four-way valve 103 switches the fluid path such that the refrigerant compressed in the compressor 101 flows to the indoor heat exchanger 107. The refrigerant having undergone heat exchange in the indoor heat exchanger 107 and performed heating operation is condensed, and then is decompressed and expanded while passing the expansion valve 109. The decompressed and expanded refrigerant absorbs latent heat and is evaporated in the outdoor heat exchanger 105. Here, as illustrated in Figure 2, the pressure-enthalpy diagram is formed in an order of a loop 1->2->3->4 in which a difference between a high-pressure side and a low-pressure side forms a first value (ΔP). Meanwhile, when ambient air temperature is very low, the enthalpy diagram is formed in an order of a loop 1'->2'->3->4 in which the difference between the high pressure and the low pressure forms a second value ($\Delta P'$) which is greater than the first value (ΔP).

[0007] As the pressure difference increases from the first value (ΔP) to the second value ($\Delta P'$), the load on the compressor 101 increases. Thus, efficiency and reliability of the compressor 101 are deteriorated and noises are increased. In addition, because of the increase in the compressor 101 load, an instrumental part such as a bearing inside the compressor 101 is subject to abrasion and a motor unit is subject to high heat damage.

[0008] An object of embodiments is to provide an air conditioner reducing load on a compressor when ambient air temperature is low during heating operation.

[0009] In one aspect, there is provided an air conditioner comprising: a main compressor for compressing a refrigerant; a four-way valve disposed at a discharge side of the main compressor and switching a fluid path; an outdoor heat exchanger having one side connected with the four-way valve; an indoor heat exchanger having one side connected with the outdoor heat exchanger and the other side connected with the four-way valve; an expansion valve disposed between the outdoor heat exchanger and the indoor heat exchanger; and an auxiliary compression unit for reducing the load on the main compressor.

[0010] In another aspect, there is provided an air conditioner comprising: a main compressor for compressing a refrigerant; a four-way valve disposed at a discharge side of the main compressor and switching a fluid path; a first heat exchanger for connection to the four-way valve; a second heat exchanger having one side for connection with the first heat exchanger and another side for connection with the four-way valve; an expansion valve for being disposed between the first and second exchangers; and an auxiliary compression unit for reducing the load on the main compressor.

[0011] Features of embodiments are defined in the appended dependent claims.

[0012] The present invention will become more easily understood after reading the following detailed description of the present invention when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic view illustrating a construction of a conventional air conditioner for both cooling and heating;
Figure 2 is a pressure-enthalpy diagram according to ambient air temperature of the air conditioner of Figure 1;
Figure 3 is a schematic view of a first air conditioner;
Figure 4 is a view illustrating the operation of an auxiliary compression unit of Figure 3;
Figure 5 is a control block diagram of the air conditioner of Figure 3;
Figure 6 is a schematic view of a second air conditioner;

Figure 7 is a view illustrating the operation of an auxiliary compression unit of Figure 6; and
Figure 8 is a control block diagram of the air conditioner of Figure 6.

[0013] Referring to Figures 3 and 4, a first air conditioner includes: a main compressor 11 to compress the refrigerant, a four-way valve 13, an outdoor heat exchanger 15, an indoor heat exchanger 17, an expansion valve 19 and an auxiliary compression unit 20.

[0014] The four-way valve 13 is disposed at a discharge side of the main compressor 11 and switches a fluid path of a refrigerant according to its operating mode.

[0015] The outdoor heat exchanger 15 has one side connected with the four-way valve 13 and the refrigerant undergoes heat exchange.

[0016] The indoor heat exchanger 17 has one side connected with the outdoor heat exchanger 15 and the other side connected with the four-way valve 13 and the refrigerant undergoes heat exchange.

[0017] The expansion valve 19 is disposed between the outdoor heat exchanger 15 and the indoor heat exchanger 17, and the refrigerant is decompressed and expanded while passing through the expansion valve 19.

[0018] The auxiliary compression unit 20 is installed between the main compressor 11 and the four-way valve 13, and decreases a load on the main compressor 11 when a difference between a high-pressure side and a low-pressure side is great because ambient air temperature is low during heating operation.

[0019] The auxiliary compression unit 20 includes: an auxiliary fluid path 21, a sub-compressor 25, an inlet-side opening/closing valve 23, an outlet-side opening/closing valve 24, a pressure equalizing tank 27 and an oil return fluid path 28.

[0020] One side of the auxiliary fluid path 21 is connected to the discharge side of the main compressor 11 and the other side thereof is connected to the upstream side of the four-way valve 13.

[0021] The sub-compressor 25 is disposed on the auxiliary fluid path 21, and compresses once again the refi-igerant having been compressed in the main compressor 11.

[0022] The inlet-side opening/closing valve 23 is disposed at an inlet side of the auxiliary fluid path 21, and opens or closes the auxiliary fluid path 21.

[0023] The outlet-side opening/closing valve 24 is disposed at an outlet side of the auxiliary fluid path 21, and opens or closes the auxiliary fluid path 21.

[0024] The pressure equalizing tank 27 is disposed on the downstream side of the inlet-side opening/closing valve 23, and temporarily receives the refrigerant compressed by the main compressor 11. The pressure equalizing tank 27 reduces discharge pulsation of the refrigerant being discharged from the main compressor 11, and a problem resulted from a difference of mass flow per unit time between the main compressor 11 and the sub-compressor 25.

[0025] The oil return fluid path 28 responds to excessive oil discharge in the main compressor 11. To do so, the oil return fluid path 28 includes an oil return pipe 29 and a return pipe opening/closing valve 30.

[0026] One side of the oil return fluid path 28 is installed at the lower part of the pressure equalizing tank 27 and the other side thereof is connected to an intake side of the main compressor 11 such that oil of the pressure equalizing tank 27 is returned to the main compressor 11. Also, to have a convenience in installing oil return fluid path 28, it is desirable that the oil return fluid path 28 includes a capillary tube.

[0027] The oil return pipe 29 have one side connected with the lower part of pressure equalizing tank 27 and the other side connected to the intake side of the main compressor 11.

[0028] The return pipe opening/closing valve 30 is installed on the oil return pipe 29, and opens or closes the oil return pipe 29.

[0029] Meanwhile, the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 can be manually opened or closed by measuring a pressure difference between the intake side and the discharge side of the main compressor 11. However, it is difficult for the user to measure and determine the pressure difference and open or close the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 all the time. Accordingly, in order to do this automatically, a intake-side pressure sensor 12, a discharge-side pressure sensor 14 and a control unit 31 are further included, preferably.

[0030] With reference to Figures 4 and 5, the intake-side pressure sensor 12 is installed at the intake side of the main compressor 11 and transmits a signal to the control unit 31 by detecting the pressure of the intake side of the main compressor 11.

[0031] The discharge-side pressure sensor 14 is installed at the discharge side of the main compressor 11 and transmits a signal to the control unit 31 by detecting the pressure of the discharge side of the main compressor 11.

[0032] The control unit 31 is implemented in the form of MICOM having a control program therein or the like, and controls the opening or closing of the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 by receiving signals of the intake-side pressure sensor 12 and the discharge-side pressure sensor 14. Here, the control unit 31 includes a pressure difference calculating unit 33 for calculating the pressure difference between the intake side and the discharge side of the main compressor 11, preferably.

[0033] Hereinafter, the operation of the first air conditioner illustrated in Figures 3 to 5 will be described. For reference, refrigerant flow is indicated by the full line with the arrow and oil flow is indicated by the dotted line with the arrow.

[0034] With reference to Figures 4 and 5, during heating operation, the control unit 31 controls the four-way valve 13 such that the refrigerant compressed in the main compressor 11 flows to the indoor heat exchanger 17.

[0035] The refrigerant having flowed to the indoor heat exchanger 17 performs heating operation and then is decompressed and expanded while passing the expansion valve 19.

[0036] The refrigerant having passed the expansion valve 19 absorbs latent heat and is evaporated in the outdoor heat exchanger 15, and is drawn into the main compressor 11 via the four-way valve 13.

[0037] The pressure difference calculating unit 33 calculates the pressure difference between the intake side and the discharge side through the signals transmitted from the intake-side pressure sensor 12 and the discharge-side pressure sensor 14.

[0038] Here, when the pressure difference is small because ambient air temperature is high, the refrigerant can be compressed by the main compressor 11 without overload. Accordingly, the control unit 31 blocks the auxiliary fluid path 21 by closing the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 such that compression of the refrigerant can be performed only in the main compressor 11.

[0039] Meanwhile, when the pressure difference is great because ambient air temperature is low, the overload may be on the main compressor 11 when the compression of the refrigerant is performed only by the main compressor 11. Accordingly, the control unit 31 opens the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 and operates the sub-compressor 25 such that the refrigerant can flow to the auxiliary fluid path 21. In this case, part of the refrigerant discharged from the main compressor 11 flows along the auxiliary fluid path 21 and is temporarily received in the pressure equalizing tank 27.

[0040] The refrigerant received temporarily in the pressure equalizing tank 27 is drawn into the sub-compressor 25 and is condensed, then flows along the auxiliary fluid path 21 and joins together with the refrigerant discharged from the main compressor 11, and then flows to the indoor heat exchanger 17 via the four-way valve 13.

[0041] The refrigerant having performed the heating operation in the indoor heat exchanger 17 is drawn into the main compressor 11 via the expansion valve 19, the outdoor heat exchanger 15 and the four-way valve 13, and repeats compression and discharge processes.

[0042] Meanwhile, if oil is accumulated to a certain degree, the control unit 31 opens the return pipe opening/closing valve 30 so as to open the oil return pipe 29.

[0043] If the oil return pipe 29 is opened, oil inside the pressure equalizing tank 27 flows along the oil return pipe 29, is drawn into the intake side of the main compressor 11, and is returned to the inside of the main compressor 11.

[0044] Reference is now made to Figures 6 to 8, showing a second air conditioner, The same reference numerals are given to the same parts as those in the aforementioned and illustrated construction for the purpose of simplicity in description for the drawings, and detailed descriptions therefore will be omitted.

[0045] In the first air conditioner, the auxiliary compression unit 20 is operated when a pressure difference is great after the pressure difference between the intake side and the discharge side of the main compressor 11 is detected. By contrast, in the second embodiment, an auxiliary compression unit 20 is operated when ambient air temperature is low after ambient air temperature is detected instead of the pressure difference. As occasion demands, after both the pressure difference and the ambient air temperature are detected, on the basis of such results, the auxiliary compression unit 20 can be operated.

[0046] To do so, the second air conditioner includes an ambient air temperature sensor 40 instead of the intake-side pressure sensor 12 and the discharge-side pressure sensor 14 of the first embodiment. In addition, the air conditioner of the second embodiment has a control unit 31 excluding the pressure difference calculating unit 33 of the first embodiment. The remaining construction except for this is the same and a detailed description therefore will be omitted.

[0047] With reference to Figures 6 and 8, the ambient air temperature sensor 50 is installed at one side of the outdoor heat exchanger 15, and transmits a signal to the control unit 31 by detecting outside temperature.

[0048] Hereinafter, the operation of the second air conditioner will be described. For reference, refrigerant flow is indicated by the full line with the arrow and oil flow is indicated by the dotted line with the arrow.

[0049] During heating operation, the control unit 31 controls a four-way valve 13 such that the refrigerant compressed in a main compressor 11 flows to an indoor heat exchanger 17.

[0050] The refrigerant having flowed to the indoor heat exchanger 17 performs the heating operation, and is decompressed and expanded while passing through an expansion valve 19.

[0051] The refrigerant having passed the expansion valve 19 absorbs latent heat and is evaporated in the outdoor heat exchanger 15, and is drawn into the main compressor 11 via the four-way valve 13.

[0052] The ambient air temperature sensor 50 detects the outside temperature and transmits a signal to the control unit 31.

[0053] When ambient air temperature is high, compression of the refrigerant can be performed by the main compressor 11 without overload. Accordingly, the control unit 31 blocks an auxiliary fluid path 21 by closing an inlet-side opening/

closing valve 23 and an outlet-side opening/closing valve 24.

[0054] Meanwhile, when the ambient air temperature is low, the overload may be on the main compressor 11. Accordingly, the control unit 31 opens the inlet-side opening/closing valve 23 and the outlet-side opening/closing valve 24 such that the refrigerant can flow to the auxiliary fluid path 21, and operates a sub-compressor 25. In this case, part of the refrigerant discharged from the main compressor 11 flows along the auxiliary fluid path 21 and is temporality received in a pressure equalizing tank 27.

[0055] The refrigerant temporarily received in the pressure equalizing pipe 27 is drawn into the sub-compressor 25 and is compressed, then flows along the auxiliary fluid path 21 and joins together with the refrigerant discharged form the main compressor 11, and then flows to the indoor heat exchanger 17 via the four-way valve 13.

[0056] The refrigerant having performed the heating operation in the indoor heat exchanger 17 passes the expansion valve 19, the outdoor heat exchanger 15, and the four-way valve 13, then is drawn into the main compressor 11, and repeats compression and discharge processes.

[0057] If oil inside the pressure equalizing tank 27 is accumulated to a certain degree, the control unit 31 opens a return pipe opening/closing valve 30 so as to open an oil return pipe 29.

[0058] If the oil return pipe 29 is opened, the oil inside the pressure equalizing tank 27 flows along the oil return pipe 29, is drawn into an intake side of the main compressor 11, and is returned to the inside of the main compressor 11.

[0059] The first and second air conditioners include the auxiliary compression unit 20 reducing the load on the main compressor 11 when ambient air temperature is low during heating operation. Accordingly, since the load on the main compressor 11 decreases, efficiency and reliability of the main compressor 11 are enhanced and noise is reduced. In addition, an instrumental part such as a bearing inside the main compressor 11 is less subject to abrasion and high heat damage to a motor unit is prevented.

[0060] The skilled person will readily see modifications to the embodiments described, and will understand that the invention extends to the full scope of the appended claims.

Claims

1. An air conditioner comprising:

   a main compressor for compressing a refrigerant;
   a four-way valve disposed at a discharge side of the main compressor and switching a fluid path;
   an outdoor heat exchanger having one side connected with the four-way valve;
   an indoor heat exchanger having one side connected with the outdoor heat exchanger and the other side connected with the four-way valve;
   an expansion valve disposed between the outdoor heat exchanger and the indoor heat exchanger; and
   an auxiliary compression unit for reducing a load on the main compressor.

2. An air conditioner as claimed in claim 1, wherein the auxiliary compression unit comprises:

   an auxiliary fluid path having one side connected with the discharge side of the main compressor and the other side connected to the upstream side of the four-way valve;
   a sub-compressor disposed on the auxiliary fluid path and compressing the refrigerant;
   an inlet-side opening/closing valve disposed at an inlet side of the auxiliary fluid path and opening or closing the auxiliary fluid path; and
   an outlet-side opening/closing valve disposed at an outlet side of the auxiliary fluid path and opening or closing the auxiliary fluid path.

3. An air conditioner as claimed in claim 2, wherein the auxiliary compression unit further comprises:

   a pressure equalizing tank disposed on the downstream side of the inlet-side opening/closing valve for temporarily receiving the refrigerant compressed by the main compressor.

4. An air conditioner as claimed in claim 3, wherein the auxiliary compression unit further comprises:

   an oil return fluid path for connecting the pressure equalizing tank with an intake side of the main compressor such that oil of the pressure equalizing tank is returned to the main compressor.

5. An air conditioner as claimed in claim 4, wherein the oil return fluid path comprises:

an oil return pipe having one side connected with the pressure equalizing tank and the other side connected to the intake side of the main compressor; and
a return pipe opening/closing valve for opening or closing the oil return pipe.

6. An air conditioner as claimed in claim 4, wherein the oil return fluid path includes a capillary tube.

7. An air conditioner as claimed in any one of claims 2 to 6, further comprising:

an intake-side pressure sensor for detecting the pressure of the intake side of the main compressor;
a discharge-side pressure sensor for detecting the pressure of the discharge side of the main compressor; and
a control unit for controlling the opening or closing of the inlet-side opening/closing valve and the outlet-side opening/closing valve by receiving signals of the intake-side pressure sensor and the discharge-side pressure sensor.

8. An air conditioner as claimed in claim 7, wherein the control unit includes a pressure difference calculating unit for calculating a pressure difference between the intake side and the discharge side of the main compressor.

9. An air conditioner as claimed in any one claims 2 to 6, further comprising:

an ambient air temperature sensor for detecting ambient air temperature; and
a control unit for controlling the opening or closing of the inlet-side opening/closing valve and the outlet-side opening/closing valve by receiving a signal of the ambient air temperature sensor.

FIG. 1

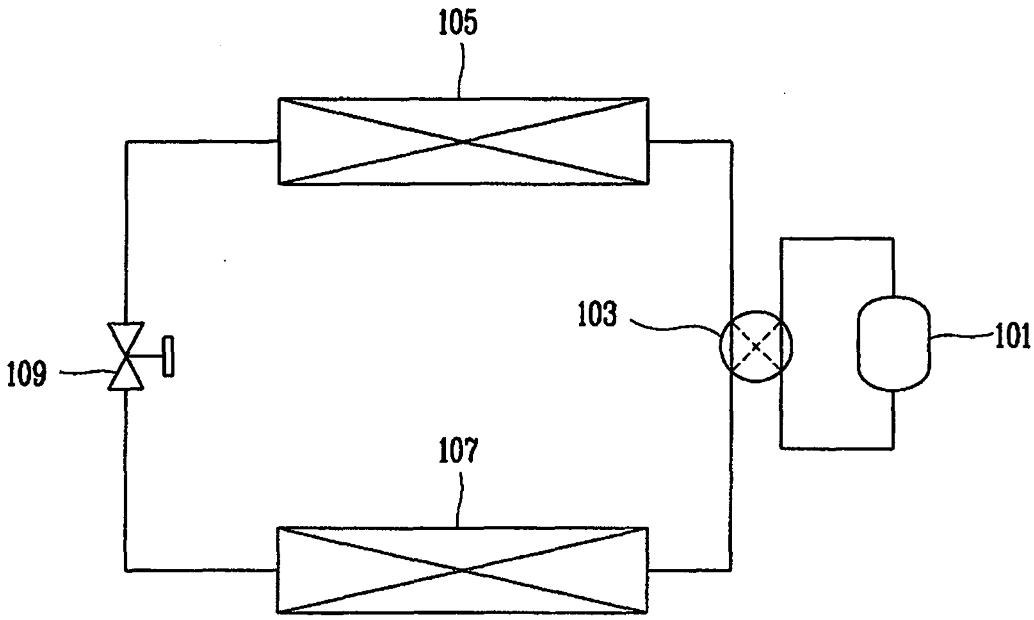


FIG. 2

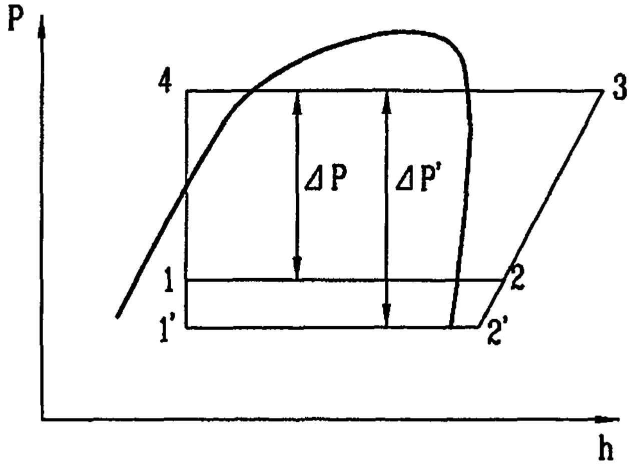


FIG. 3

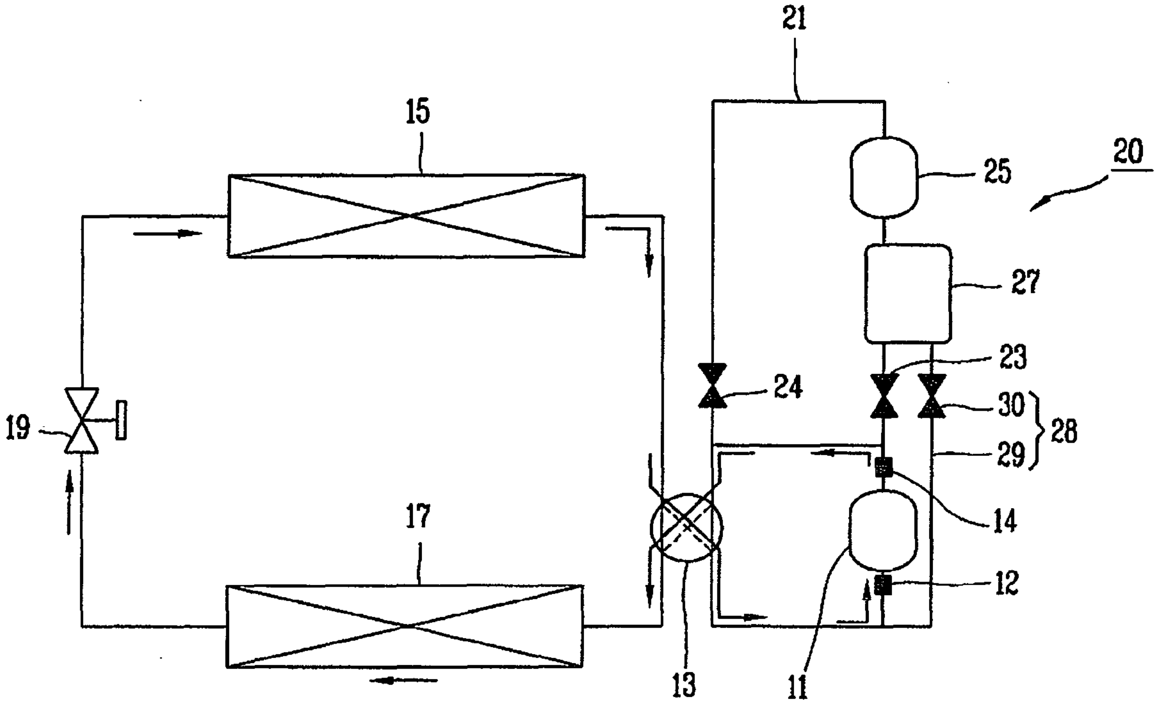

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FIG. 4

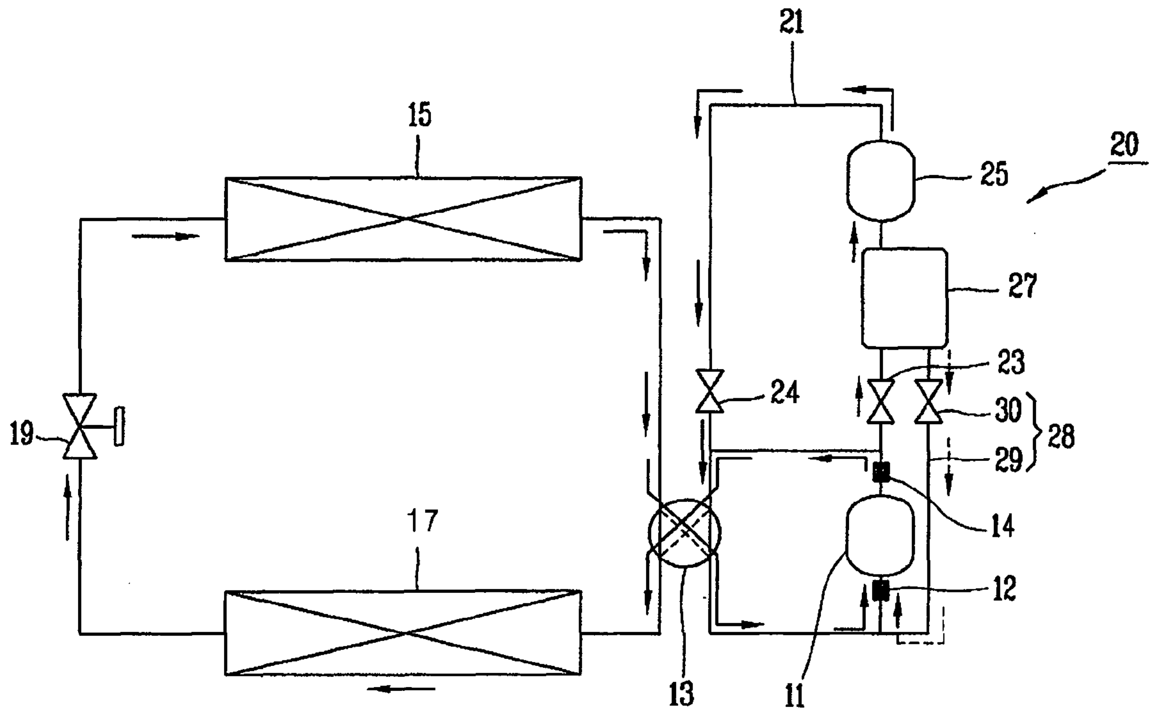
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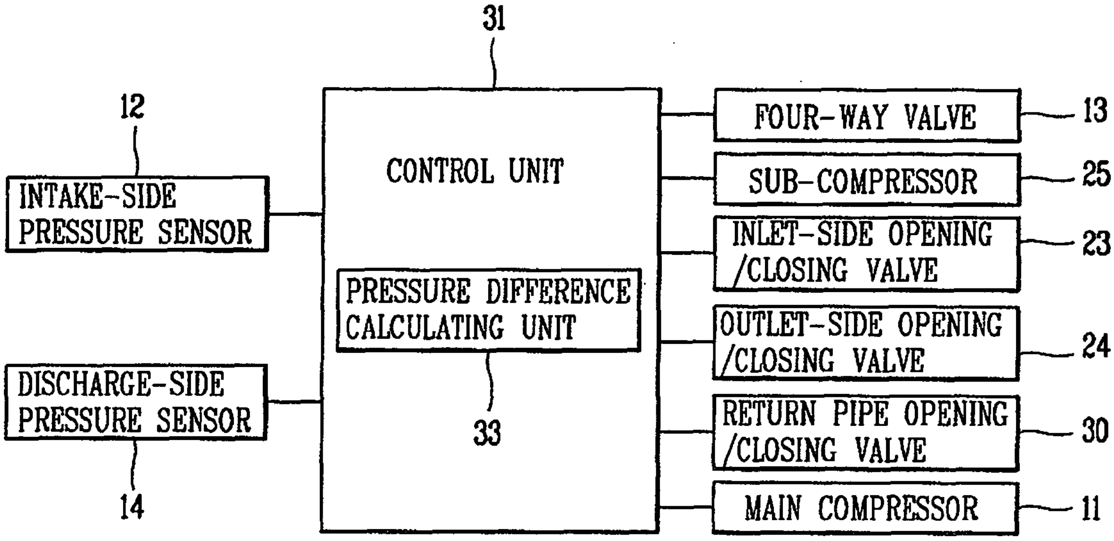
FIG. 5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CONTROL UNIT
INTAKE-SIDE PRESSURE SENSOR
PRESSURE DIFFERENCE CALCULATING UNIT
DISCHARGE-SIDE PRESSURE SENSOR
33
14
FOUR-WAY VALVE
13
SUB-COMPRESSOR
25
INLET-SIDE OPENING /CLOSING VALVE
23
OUTLET-SIDE OPENING /CLOSING VALVE
24
RETURN PIPE OPENING /CLOSING VALVE
30
MAIN COMPRESSOR
11

FIG. 6

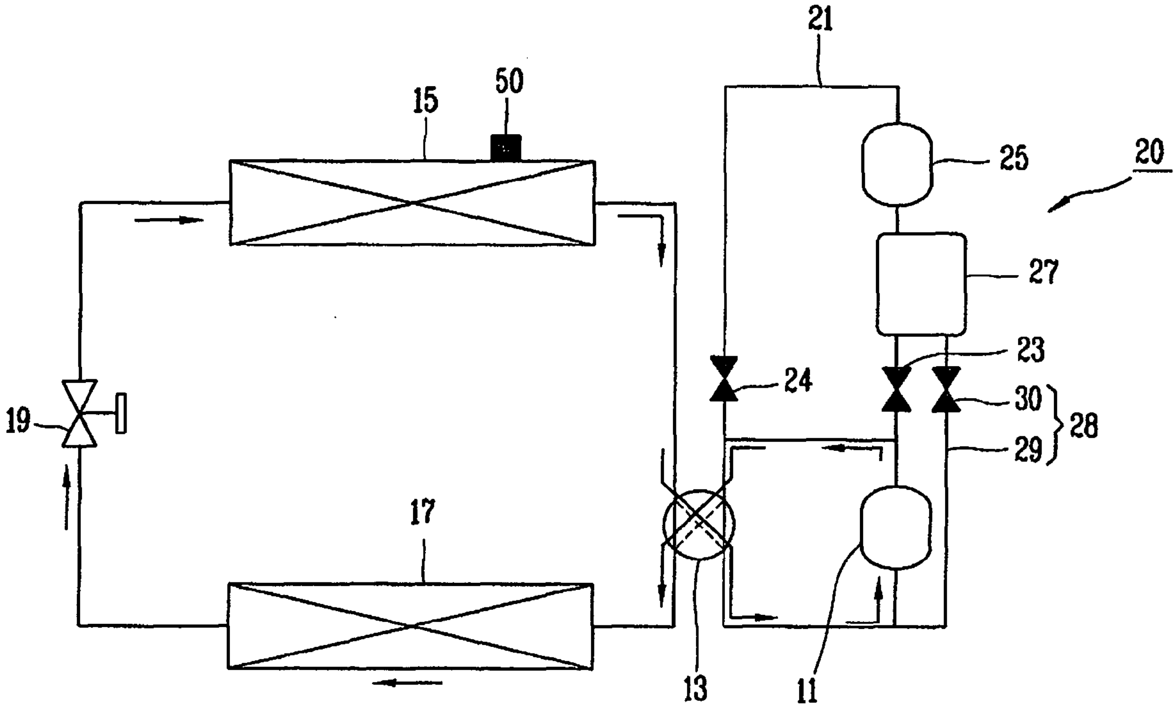
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FIG. 7

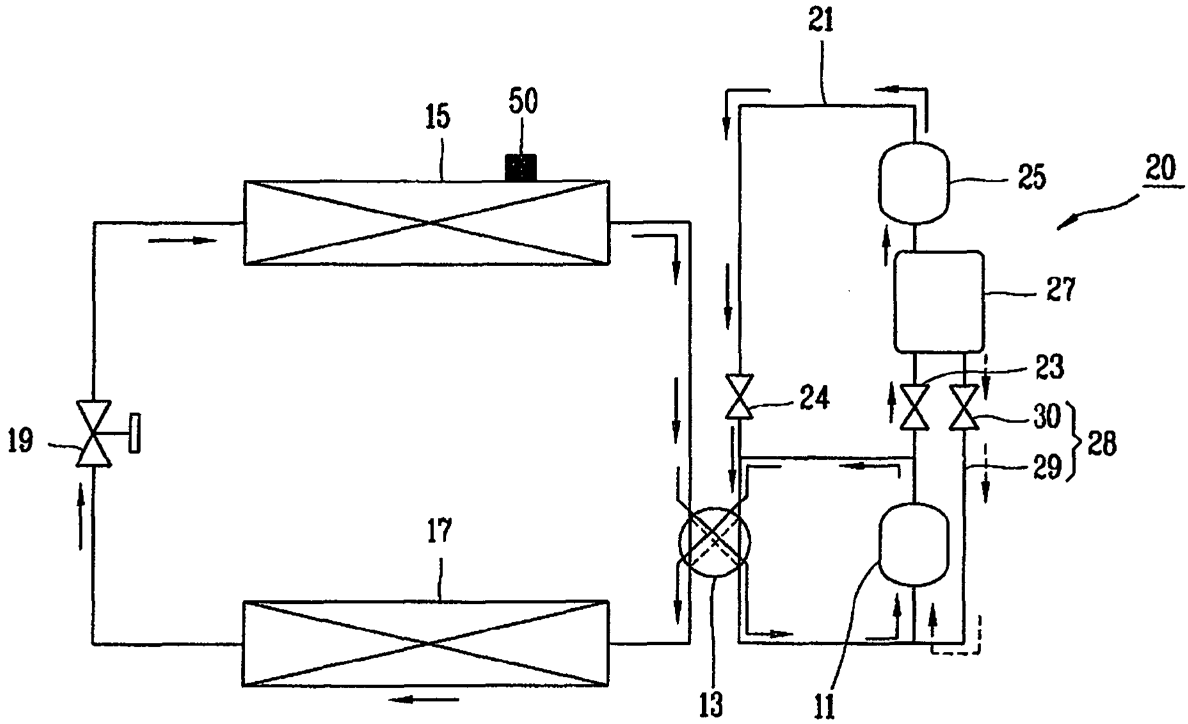
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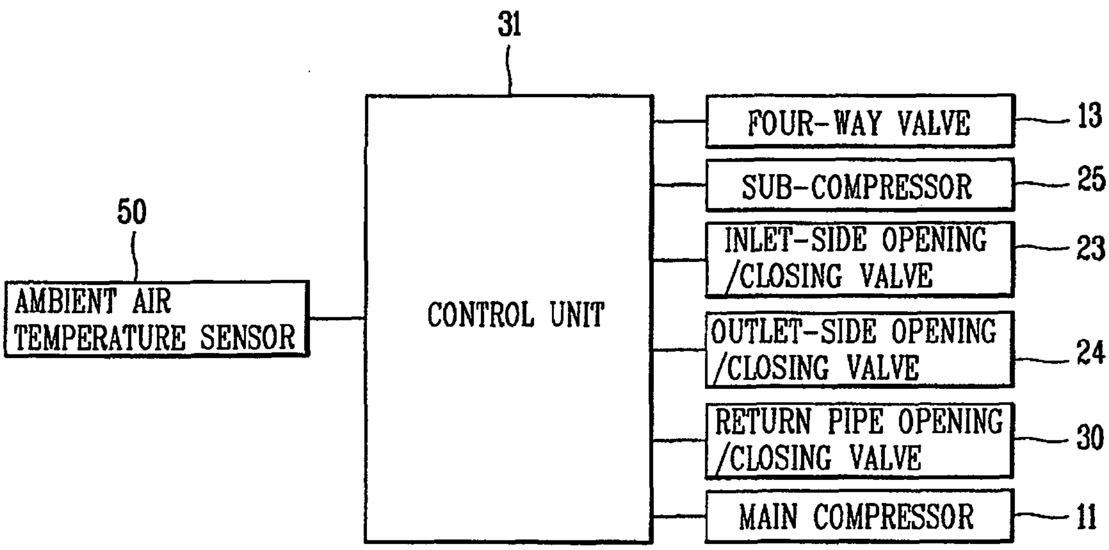
FIG. 8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AMBIENT AIR TEMPERATURE SENSOR
CONTROL UNIT
FOUR-WAY VALVE
13
SUB-COMPRESSOR
25
INLET-SIDE OPENING /CLOSING VALVE
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OUTLET-SIDE OPENING /CLOSING VALVE
24
RETURN PIPE OPENING /CLOSING VALVE
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MAIN COMPRESSOR
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EUROPEAN SEARCH REPORT

Application Number
EP 05 25 6352

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 2003/233838 A1 (LEE WON HEE ET AL) 25 December 2003 (2003-12-25) * abstract; figure 1 * -----	1	INV. F25B13/00
X	US 6 276 148 B1 (SHAW DAVID N) 21 August 2001 (2001-08-21) * abstract; figure 1 * -----	1	
X	US 5 839 886 A (SHAW ET AL) 24 November 1998 (1998-11-24) * abstract; figures 3,4 * -----	1	
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			TECHNICAL FIELDS SEARCHED (IPC)
			F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 July 2006	Valenza, D

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