



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.03.2010 Bulletin 2010/09

(51) Int Cl.:
F25B 40/06 ^(2006.01) **F25B 13/00** ^(2006.01)

(21) Application number: **09163649.8**

(22) Date of filing: **24.06.2009**

(84) Designated Contracting States:
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 SE SI SK TR

(30) Priority: **25.08.2008 KR 20080082880**

(71) Applicant: **LG Electronics Inc.**
Seoul 150-721 (KR)

(72) Inventors:
• **Jang, Seong Min**
153-802, Seoul (KR)
• **Ryu, Yun Ho**
153-802, Seoul (KR)
• **Lee, Jae Won**
153-802, Seoul (KR)

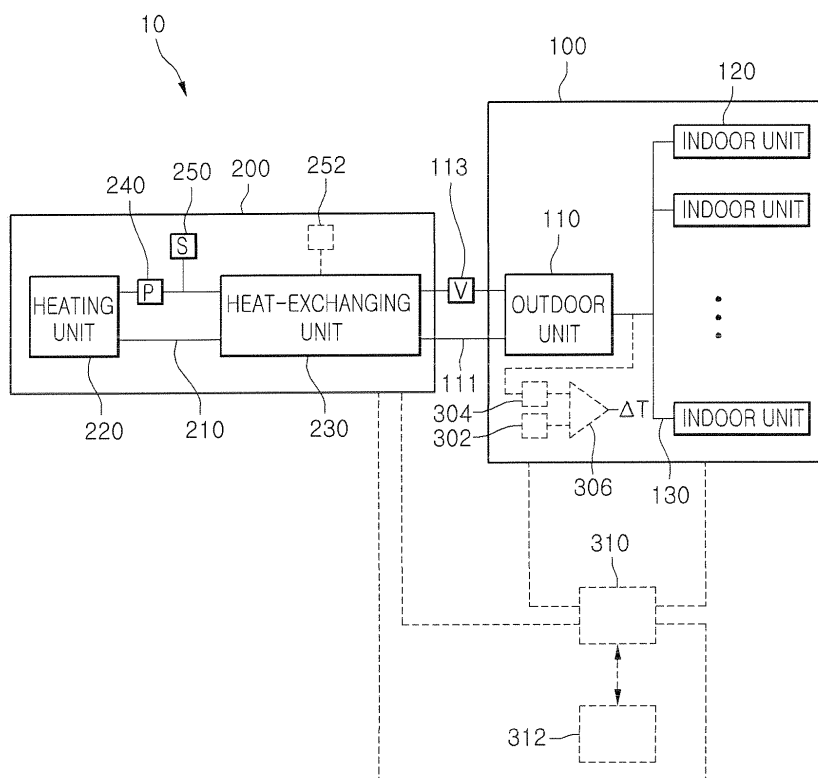
(74) Representative: **Vossius & Partner**
Siebertstraße 4
81675 München (DE)

(54) **Heat pump system and method of controlling the same**

(57) Provided are a heat pump system and a method of controlling the same. In a heating operation, a refrigerant circulating in an air-conditioning device (100) is heat-exchanged with a working fluid heated by a heating

device (200) so as to be heated, and the heating device is controlled according to a temperature of the working fluid. Thus, various types of heating members are conveniently used as the heating device for heating the refrigerant.

FIG. 1



Description

[0001] The present disclosure relates to a heat pump system, and more particularly, to a heat pump system including a heating device for heating a refrigerant in a heating operation and a method of controlling the heat pump system.

[0002] In general, an air conditioning system includes a compressor, a four-way valve, an indoor heat exchanger, and an outdoor heat exchanger that are used to perform heat exchange cycles for cooling or heating an indoor area. In a heating operation, the outdoor heat exchanger is operated as an evaporator, and the indoor heat exchanger is operated as a condenser. In detail, indoor heating is performed as follows: while a refrigerant is evaporated in the outdoor heat exchanger, heat is exchanged between the refrigerant and outdoor air; the refrigerant is then compressed to a high-temperature and highpressure state by the compressor; and then, while the compressed refrigerant is condensed at the indoor heat exchanger, heat is exchanged between the refrigerant and indoor air.

[0003] Embodiments provide a heat pump system configured to achieve more efficient heating and a method of controlling the same.

[0004] In one embodiment, a heat pump system includes: an air-conditioning device configured to cool or heat a space through heat exchange between a circulating refrigerant and both outdoor air and indoor air; and a heating device including a heating unit heating the working fluid, and a heat-exchanging unit heat-exchanging the working fluid heated in the heating unit with the refrigerant, wherein the heating unit is stopped when the temperature of the working fluid is a preset reference temperature or more.

[0005] In another embodiment, a method of controlling a heat pump system includes: driving an air-conditioning device in a heating operation; heat-exchanging a working fluid, heated by a heating device, with a refrigerant circulating in the air-conditioning device; and stopping the heating device when a temperature of the working fluid is a preset reference temperature or more.

[0006] 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.

[0007] Fig. 1 is a block diagram illustrating a heat pump system according to an embodiment of the invention.

[0008] Fig. 2 is a flowchart illustrating a method of controlling a heat pump system according to an embodiment of the invention.

[0009] Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[0010] Fig. 1 is a block diagram illustrating a heat pump system according to an embodiment of the invention.

[0011] Referring to Fig. 1, the heat pump system 10 according to the illustrated and exemplary embodiment

includes an air-conditioning device 100, a heating device 200, a controller 310, and a memory 312. The heating device 200, in a heating operation, heats a refrigerant circulating in the air-conditioning device 100.

[0012] Particularly, the air-conditioning device 100 includes an outdoor unit 110 and at least one indoor unit 120. The outdoor unit 110 is equipped with various components including an outdoor heat exchanger (not shown) and a compressor (not shown). The indoor unit 120 is equipped with various components including an indoor heat exchanger (not shown). The outdoor heat exchanger functions as a condenser in a cooling operation, and as an evaporator in the heating operation. The indoor heat exchanger functions as an evaporator in the cooling operation, and as a condenser in the heating operation. Although the single outdoor unit 110 and the at least one indoor unit 120 are provided in this embodiment, the number of the outdoor units 110 and indoor units 120 are not limited thereto. For example, the outdoor unit 110 may be provided in plurality and the number of indoor units 120 may correspond to the number of the outdoor units 110.

[0013] The outdoor unit 110 may be connected to the indoor unit 120 through a refrigerant pipe 130. The refrigerant circulating in the outdoor unit 110 and the indoor unit 120 flows through the refrigerant pipe 130. Although not shown, the outdoor unit 110 may also be coupled to the indoor unit 120 through a power line and a communication line for the transmission of power and communication therebetween.

[0014] The air conditioning device 100 may include an outdoor air temperature sensor 302, a refrigerant temperature sensor 304 and a comparator circuit 306 configured to provide an indication of a temperature difference, ΔT , between the temperature measured by the outdoor air temperature sensor 302 and the refrigerant temperature sensor 304. The indication may be, for example, a voltage or current proportional to the difference or a predetermined signal if the temperature difference is less than or equal to a predetermined value.

[0015] The outdoor unit 110 may be provided with a bypass pipe 111. The bypass pipe 111 may be configured to selectively circulate the refrigerant circulating in the air-conditioning device 100 through a heat-exchanging unit 230 that will be described later. To this end, both ends of the bypass pipe 111 communicate with the refrigerant pipe 130.

[0016] The bypass pipe 111 is equipped with a valve 113. The valve 113 is configured to selectively direct the refrigerant circulating through the refrigerant pipe 130 to the bypass pipe 111 depending on whether the heating device 200 is operated, that is, whether the refrigerant is heated by the heating device 200.

[0017] The heating device 200 may include a fluid pipe 210, a heating unit 220, the heat-exchanging unit 230, a pump 240, and a sensor 250. A working fluid flows in the fluid pipe 210. Substantially, the heating unit 220 heats the working fluid flowing through the fluid pipe 210 to

generate heat. The heat may be transferred to the refrigerant flowing in bypass pipe 111 within the heat-exchanging unit 230. For example, the heating unit 220 may be a boiler or hot water tank. The heat-exchanging unit 230 transfers heat generated from the heating unit 220 to the refrigerant. More particularly, the heat-exchanging unit 230 heat-exchanges the working fluid heated by the heating unit 220 with the refrigerant circulating in the air-conditioning device 100, so that the refrigerant is heated. To this end, the working fluid flowing through the fluid pipe 210 and the refrigerant flowing through the bypass pipe 111 are heat-exchanged with each other, passing through the heat-exchanging unit 230. It will be appreciated that the working fluid circulating in the fluid pipe 210 and the refrigerant circulating in the bypass pipe 111 are separated from one another in the heat exchanging unit 230. It will further be appreciated that a heat transferring medium may be provided in the heat-exchanging unit 230, for the heat exchange between the refrigerant flowing through the bypass pipe 111 and the working fluid flowing through the fluid pipe 210.

[0018] The pump 240 may force the working fluid to circulate through the fluid pipe 210. The sensor 250 may sense temperature of the working fluid flowing through the fluid pipe 210. For example, the sensor 250 may be installed on one side of the fluid pipe 210 to sense the temperature of the working fluid that is heated in the heating unit 220 and flows to the heat-exchanging unit 230. In an alternate embodiment, a sensor 252 (shown in dashed line) may sense a temperature of the heat transferring medium provided in the heat-exchanging unit 230. Sensor 252 may be used with or instead of sensor 250.

[0019] The heat pump system 10 may also include a controller 310 and a memory 312 operationally coupled to the controller 310. The memory 312 may store instructions, which when executed by the controller 310, may cause the heat pump system 10 to perform according to the following exemplary method. The controller 310 may receive input from, and provide output to, one or both of the air conditioning device 100 and the heating device 200.

Alternatively, the instructions for performing the method of the invention may be stored in a preexisting memory (not shown) in either the air conditioning device 100 or the heating device 200 and be executed by a preexisting controller (not shown) in either the air conditioning device 100 or the heating device 200. In still another embodiment, a method according to an embodiment of the invention may be efficiently carried out by hard-wired digital or analog logic, without a need for a controller and memory.

[0020] Hereinafter, a method of controlling the heat pump system 10 according to an embodiment will now be described in detail with reference to the accompanying drawing.

[0021] Fig. 2 is a flowchart illustrating the method of controlling the heat pump system 10 according to an embodiment of the invention.

[0022] Referring to Fig. 2, at S11, the air-conditioning device 100 is driven in a heating operation. At this point, the outdoor heat exchanger and the indoor heat exchanger of the air-conditioning device 100 function as an evaporator and a condenser, respectively.

[0023] At S13, it is determined whether the refrigerant circulating in the air-conditioning device 100 is required to be heated. Whether the refrigerant is required to be heated is determined, for example, according to whether a difference between a temperature of outdoor air and a temperature of the refrigerant is a less than or equal to a predetermined value. This difference in temperature is an indication of whether sufficient evaporation of the refrigerant occurs in the outdoor heat exchanger.

[0024] If, at S13, it is determined that heating of the refrigerant is required, then at S15, the heating device 200 is operated. Particularly, the heating unit 220 is turned on to heat the working fluid. The heated working fluid flows through the fluid pipe 210 and passes through the heat-exchanging unit 230. The refrigerant circulating in the air-conditioning device 100, and particularly, the refrigerant evaporated at the outdoor heat exchanger and then delivered to the compressor, is permitted to flow through the bypass pipe 111 by opening the valve 113.

The refrigerant flows through the bypass pipe 111 and passes through the heat-exchanging unit 230. Thus, while the refrigerant is heat-exchanged with the working fluid, via, for example, heat transferring medium within the heat-exchanging unit 230, the refrigerant is heated.

[0025] In the state where the heating device 200 is in operation, the sensor 250 senses a temperature of the working fluid. At S17, it is determined whether the temperature of the working fluid is greater than or equal to a predetermined reference temperature.

[0026] At S17, if it is determined that the temperature of the working fluid is greater than or equal to the predetermined reference temperature, the heating device 200 is stopped. This action substantially prevents a phenomenon of overheating the refrigerant.

[0027] In addition, when the heating device 200 is stopped, the valve 113 is closed to stop the bypass of the refrigerant through the bypass pipe 111.

[0028] According to one embodiment, the heating device 200 heats the refrigerant evaporated at the outdoor heat exchanger. Thus, the temperature of the refrigerant delivered to the compressor during heating operation is increased, thereby achieving efficient heating.

[0029] In addition, the heating device 200 may be turned on or off according to a temperature of the working fluid flowing in the heating device. This makes it possible to prevent the phenomenon that the heating device 200 overheats the refrigerant, thereby protecting the heat pump system 10. In an alternate embodiment, the heating device may be turned on or off according to a temperature of the heat transferring medium within the heat-exchanging unit 230. In still another alternate embodiment, the heating device may be turned on or off according to a temperature of one or both of the heat transferring

medium within the heat-exchanging unit 230 and a temperature of the working fluid flowing in the heating device.

[0030] In addition, the operation of the heating device 220 may be controlled according to a temperature of the working fluid heated by the heating unit. Thus, various types of heat producing units may be used as the heating unit. For example, even when a boiler or a hot water heater is used as the heating unit, the boiler is easily controlled.

[0031] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments could be devised by those skilled in the art that will fall within the 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. A heat pump system comprises an air-conditioning device configured to cool or heat a space through heat exchange between a circulating refrigerant and both outdoor air and indoor air; and a heating device configured to heat a working fluid heat-exchanged with the refrigerant circulating in the air-conditioning device,

characterized in that operation of the heating device is controlled according to one of a temperature of the working fluid and a temperature of the refrigerant.

2. The heat pump system according to claim 1, further comprising a bypass pipe to couple the air-conditioning device to the heating device, wherein the refrigerant is selectively directed to the bypass pipe such that the refrigerant is heat-exchanged with the working fluid.

3. The heat pump system according to claim 1 or 2, wherein the air-conditioning device comprises:

at least one outdoor unit equipped with an outdoor heat exchanger and a compressor; and
at least one indoor unit equipped with an indoor heat exchanger.

4. The heat pump system according to any one of claims 1 to 3, wherein the heating device comprises:

a heating unit heating the working fluid; and
a heat-exchanging unit heat-exchanging the

working fluid heated in the heating unit with the refrigerant.

5. The heat pump system of claim 4, wherein operation of the heating device is controlled according to one of a temperature of the working fluid, a temperature of the refrigerant, and a temperature of a heat transferring medium in the heat-exchanging unit.

6. The heat pump system according to any one of claims 1 to 4, wherein the heating device is stopped when the temperature of the working fluid is a preset reference temperature or more.

7. The heat pump system according to any one of claims 1 to 4, wherein the heating device is stopped when the temperature of the refrigerant is a preset reference temperature or more.

8. The heat pump system of claim 1, wherein the heating unit is started when a difference between a temperature of outdoor air and a temperature of the refrigerant circulating in the air-conditioning device is less than or equal to a predetermined value.

9. A method of controlling a heat pump system to prevent overheating of a refrigerant circulating in a heat exchanging unit and in an air-conditioning device, the method comprising:

driving the air-conditioning device in a heating operation;
heat-exchanging a working fluid circulating in the heat exchanging unit and heated by a heating unit, with the refrigerant circulating in the heat exchanging unit and in the air-conditioning device; and
stopping the heating unit when a temperature of the working fluid is a preset reference temperature or more.

10. The method according to claim 9, wherein the heat-exchanging of the working fluid comprises operating the heating unit only when the refrigerant is required to be heated.

11. The method according to claim 10, wherein the heat-exchanging of the working fluid comprises determining whether the refrigerant is required to be heated, at least in consideration of a difference between a temperature of the refrigerant circulating in the air-conditioning device and a temperature of outdoor air.

FIG. 1

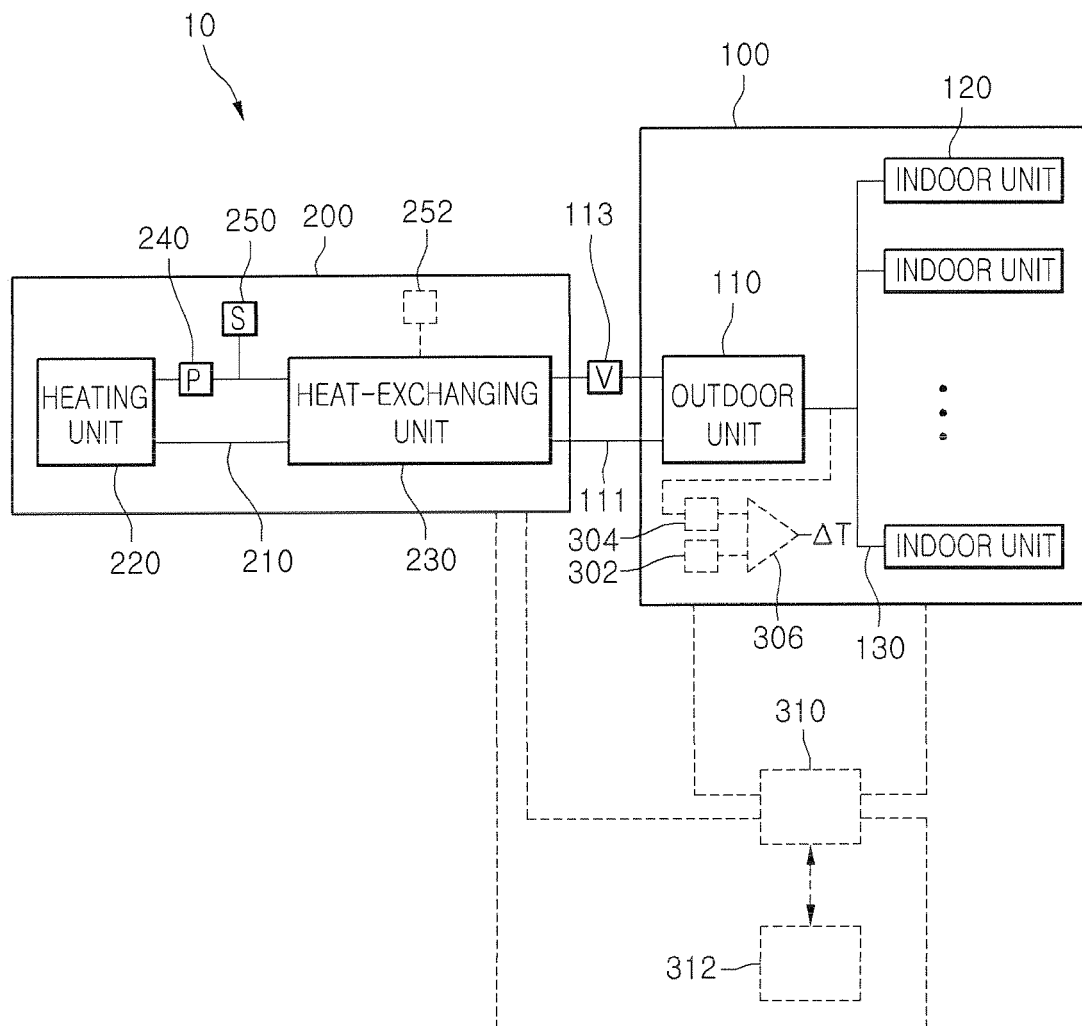


Fig. 2

