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(54) HEAT PUMP SYSTEM AND CONTROL METHOD THEREOF

(57) The present application provides a heat pump system 100 and a control method thereof. The heat pump system comprises a compressor 110; a heat storage heat exchanger 140, the pipeline connection of which is configured to be disconnectable from the heat pump system 100; an indoor heat exchanger 120 and an outdoor heat exchanger 130; a plurality of throttling elements 171, 172, 173; and a first four-way valve 151 and a second four-way valve 153, the ports of which are respectively connected to the inlet 110a and the outlet 110b of the compressor 110; wherein the remaining ports of the first four-way valve are respectively connected to the outdoor heat exchanger 130 and the heat storage heat exchanger 140; and the remaining ports of the second four-way valve are respectively connected to the indoor heat exchanger 120 and connected to the port connected to the inlet 110a through a capillary or on-off valve; wherein in a combined defrosting mode, the refrigerant dissipates heat from the indoor heat exchanger 120 and the outdoor heat exchanger 130 respectively, and absorbs heat from the heat storage heat exchanger 140. The heat pump system and control method according to the present application can maintain the heating operation of the indoor unit while defrosting the outdoor unit, and improve indoor heating comfort during defrosting.

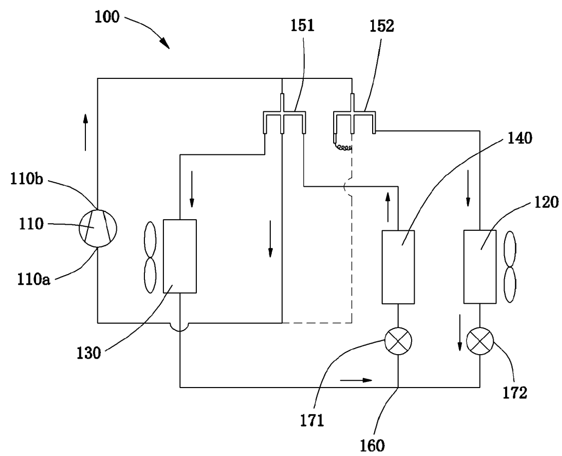


Fig.1

Description

[0001] The present application relates to the field of conditioning equipment, in particular, the present application relates to a heat pump system and a control method thereof.

[0002] Heat pump systems are widely used in commercial buildings, home spaces and other places, and can also provide relatively comfortable cooling/heating effects. However, engineers in this field are still committed to optimizing and improving all aspects, one of which is to maintain heating operation during defrosting of heat pump system.

[0003] A defrosting mode is a common function of the heat pump system. It usually exists when the heat pump system is used for heating in winter. At this time, the heat exchanger in the outdoor unit that is already in a low temperature environment is still used to absorb heat to evaporate the refrigerant in the pipeline. Finned pipes on the external surface of outdoor heat exchanger are susceptible to frosting in the resulting low temperature and high humidity environment. Therefore, the defrosting mode has become a necessary operation. In a typical defrosting mode a reversing operation is carried out by switching a flow path switch valve, so that high-temperature gaseous refrigerant discharged from the compressor directly flows into the outdoor heat exchanger, and defrosting is hence achieved by heat dissipation from the high-temperature refrigerant.

[0004] However, during the operation of this defrosting mode, the refrigerant in the heat pump system needs to flow in a reverse direction, so that only the refrigerant with low temperature and low pressure flows through the indoor heat exchanger. Thus, the heating operation of the indoor heat exchanger needs to be interrupted, which will in turn affect the user's comfort.

[0005] According to one aspect of the present application, a heat pump system is provided, which comprises: a compressor with an inlet and an outlet; a heat storage heat exchanger, the pipeline connection of which is configured to be disconnectable from the heat pump system; an indoor heat exchanger and an outdoor heat exchanger; a plurality of throttling elements respectively arranged between any two of the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger; and a first four-way valve and a second four-way valve, the ports of which are respectively connected to the inlet and the outlet of the compressor; wherein the remaining (unconnected) ports of the first four-way valve are respectively connected to the outdoor heat exchanger and the heat storage heat exchanger; and the remaining (unconnected) ports of the second four-way valve are respectively connected to the indoor heat exchanger and connected to the port connected to the inlet through a capillary or on-off valve; wherein in a combined defrosting mode, the refrigerant dissipates heat from the indoor heat exchanger and the outdoor heat exchanger respectively, and absorbs heat from the heat storage heat exchanger.

[0006] Thus, two ports of the first four-way valve are connected to the inlet and outlet of the compressor and two ports of the second four-way valve are connected to the inlet and outlet of the compressor. The other two ports of the first four-way valve are connected to the outdoor heat exchanger and the heat storage heat exchanger. The other two ports of the second four-way valve include one port that is connected to the indoor heat exchanger and another port that is connected through a capillary or on-off valve to the port of the second four-way valve that is connected to the inlet of the compressor. In the combined defrosting mode, which may be alternatively called a combined defrosting and heating mode, the four-way valves may be configured so that refrigerant is directed to dissipate heat from the indoor heat exchanger and from the outdoor heat exchanger respectively, and directed to absorb heat from the heat storage heat exchanger. Thus, the flow paths for the refrigerant may direct refrigerant to the heat storage heat exchanger for heat absorption and to direct refrigerant to the indoor heat exchanger and the outdoor heat exchanger for heat rejection.

[0007] Optionally, the plurality of throttling elements include a first throttling element and a second throttling element; and there is a three-way intersection point on connecting pipelines between the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger. In this configuration the first throttling element may be arranged on a first connecting pipeline between the three-way intersection point and the heat storage exchanger; and the second throttling element may be arranged either on a second connecting pipeline between the three-way intersection point and the indoor heat exchanger or on a third connecting pipeline between the three-way intersection point and the outdoor heat exchanger.

[0008] Optionally, the plurality of throttling elements include a first throttling element, a second throttling element and a third throttling element; and there is a three-way intersection point on connecting pipelines between the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger. In this configuration the first throttling element may be arranged on a first connecting pipeline between the three-way intersection point and the heat storage exchanger; the second throttling element may be arranged on a second connecting pipeline between the three-way intersection point and the indoor heat exchanger, and the third throttling element may be arranged on a third connecting pipeline between the three-way intersection point and the outdoor heat exchanger.

[0009] Optionally, in the combined defrosting mode, refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively; and at the same time, refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively. Thus, the refrigerant from the compressor outlet may be split and flow with one part going via the first four-way valve to the outdoor heat exchanger and another part going via the second four-way valve to the indoor heat exchanger.

[0010] Optionally, the heat storage heat exchanger is configured as a PCM heat exchanger.

[0011] According to another aspect of the application, a control method for the heat pump system described above is also provided, which includes: a combined defrosting mode in which switching the pipeline connection of the first four-way valve and the second four-way valve, so that the outlet of the compressor is connected with the outdoor heat exchanger and the indoor heat exchanger respectively, and the heat storage heat exchanger is connected with the inlet of the compressor; wherein a part of refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively; at the same time, another part of refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the heat storage exchanger and the inlet of the compressor successively.

[0012] Optionally, the control method also includes: a cooling mode wherein the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is connected with the outdoor heat exchanger, and the indoor heat exchanger is connected with the inlet of the compressor; at the same time, the pipeline connection of the heat storage heat exchanger is disconnected in the heat pump system; wherein the refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the indoor heat exchanger and the inlet of the compressor successively.

[0013] Optionally, the control method also includes: a heating mode in which the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is connected with the indoor heat exchanger, and the outdoor heat exchanger is connected with the inlet of the compressor; at the same time, the pipeline connection of the heat storage heat exchanger is disconnected in the heat pump system; wherein the refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively.

[0014] Optionally, the control method also includes: a heating and heat storage mode in which the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is respectively connected with the indoor heat exchanger and the heat storage heat exchanger, and the outdoor heat exchanger is connected with the inlet of the compressor; wherein a part of refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively; at the same time, another part of refrigerant from the outlet of the compressor flows through the heat storage exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively.

[0015] According to the heat pump system of the present application, by additionally setting a heat storage heat exchanger in the heat pump system and correspondingly controlling the on-off of the flow path, the heat pump system can store heat in some modes, and achieve short-term operation of simultaneous defrosting and maintaining the heating mode under the combined defrosting mode, thus avoiding frequent interruption of the heating mode and improving the user experience. Moreover, this flow path layout achieves the feasibility of combined defrosting mode with fewer valves, fully considering the balance of system cost and performance.

[0016] The first four-way valve may be a first type four-way valve and/or the second four-way valve may be a second type four-way valve.

[0017] Certain embodiments will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of the system flow direction in the combined defrosting mode of a heat pump system;

Figure 2 is a schematic diagram of the system flow direction in the refrigeration mode of the heat pump system;

Figure 3 is a schematic diagram of the system flow direction of the heat pump system in the heating and heat storage modes; and

Figure 4 is a schematic diagram of the system flow direction in the combined defrosting mode of another heat pump system.

[0018] Hereinafter, the present application will be described in detail with reference to the exemplary embodiments in the accompanying drawings. However, it should be noted that this application can be implemented in many different forms, and should not be interpreted as limiting to the embodiments described herein. These embodiments are provided here to make the disclosure content of the application more complete and comprehensive, and to fully convey the concept of the application to those skilled in the art.

[0019] Figures 1 to 3 show different operating modes of the first embodiment of the heat pump system, and Figure 4 shows different operating modes of another embodiment of the heat pump system. Specifically, in each drawing, the flow direction of refrigerant under the current working mode is shown by arrows, and the on/off state of the flow path is indicated by solid lines and dotted lines connected between components. The flow path configuration of embodiments of the corresponding heat pump system will be described below in conjunction with each group of drawings respectively, and then each operation mode in each embodiment will be described in conjunction with each drawing.

[0020] Referring further to Figures 1 to 3, the heat pump system 100 includes a compressor 110 having an inlet 110a and an outlet 110b, an indoor heat exchanger 120, an outdoor heat exchanger 130, a heat storage heat exchanger 140, and throttling elements. The heat storage exchanger 140 is configured so that its pipeline connection is configured to be disconnectable from the heat pump system, such as through a fully open and closed throttling element or a valve dedicated to controlling on-off. In addition, a plurality of throttling elements 171 and 172 are respectively arranged between the indoor heat exchanger 120, the outdoor heat exchanger 130 and the heat storage heat exchanger 140 to ensure that the refrigerant will be throttled at least once when flowing between any two of them.

[0021] In addition, in order to realize the switching function of the heat pump system 100 between various operating modes, corresponding flow path switching valve assemblies are also provided. The flow path switching valve assembly in this embodiment is a first four-way valve 151 and a second four-way valve 152. The four ports of the first four-way valve 151 are respectively connected to the inlet 110a and the outlet 110b of the compressor 110, the outdoor heat exchanger 130 and the heat storage exchanger 140; the three ports of the second four-way valve 152 are respectively connected to the inlet 110a and the outlet 110b of the compressor 110 and the indoor heat exchanger 120. In addition, the fourth (unconnected) port of the second four-way valve 152 (the leftmost port of the second four-way valve 152 in Figure 1) is connected to the port connected to the inlet through a capillary or an on-off valve.

[0022] The heat storage heat exchanger is a known type of heat exchanger, which is usually a PCM (phase change material) heat exchanger with a phase change material as the main body of heat storage. Although the refrigerant in the heat pump system also absorbs or emits heat through phase change, it usually does not have long-term heat storage capacity. Once the compressor as the power source in the heat pump system stops working, the heat stored in the refrigerant will be quickly dissipated. In contrast, PCM heat storage exchanger not only has the ability to absorb or dissipate heat through phase change, but also has the ability to store this part of heat for a period of time, so as to achieve its heat storage purpose, and release this part of heat at the appropriate time for different field applications, such as, the present concept of maintaining indoor heating while defrosting i. e. the application of heat stored by such heat storage exchanger in other modes to maintain indoor heating in the short period of defrosting.

[0023] At this time, in the combined defrosting mode of the heat pump system, the refrigerant can absorb heat from the heat storage heat exchanger 140, release part of the heat at the indoor heat exchanger to provide heating, and release the other part of the heat at the outdoor heat exchanger to perform defrosting.

[0024] According to the heat pump system of the application, by additionally setting a heat storage heat exchanger in the heat pump system and correspondingly controlling the on-off of the flow path, the heat pump system can store heat in some modes, and achieve short-term operation of simultaneous defrosting and maintaining the heating mode under the combined defrosting mode, thus avoiding frequent interruption of the heating mode and improving the user experience. Moreover, this flow path layout achieves the feasibility of combined defrosting mode with fewer valves, fully considering the balance of system cost and performance.

[0025] Various possible modifications of the heat pump system will be introduced below in conjunction with the attached drawings. In addition, in order to further improve the energy efficiency or reliability of the system, some additional parts can be added, as also detailed described below.

[0026] As an example, as shown in Figures 1 to 3, the provision of the throttling element is intended to enable the refrigerant that needs to flow through two heat exchangers or between two parts of the heat exchanger to be expanded and throttled, so as to realize condensation heat dissipation and evaporation heat absorption functions before and after expansion and throttling. For this course, one or more throttling elements can be set in the flow path to achieve this purpose.

[0027] Referring to Figures 1 to 3, as an example, the flow path is provided with two throttling elements, namely, the first throttling element 171 and the second throttling element 172. When the three-way intersection point 160 on the connecting pipeline between the indoor heat exchanger 120, the outdoor heat exchanger 130 and the heat storage heat exchanger 140 is taken as the dividing point, the first throttling element 171 is arranged on the first connecting pipeline between the heat storage heat exchanger 140 and the three-way intersection point 160; and the second throttling element 172 is arranged on the second connecting pipeline between the indoor heat exchanger 120 and the three-way intersection 160. At this time, there is at least one throttling element between any two heat exchangers. For example, the second throttling element 172 is arranged between the indoor heat exchanger 120 and the outdoor heat exchanger 130; the first throttling element 171 is arranged between the heat storage heat exchanger 140 and the outdoor heat exchanger 130; and the second throttling element 172 and the first throttling element 171 are successively arranged between the indoor heat exchanger 120 and the heat storage heat exchanger 140.

[0028] As shown in Figure 4, as another example, the flow path is also provided with two throttling elements, namely, the first throttling element 171 and a third throttling element 173. When the three-way intersection point 160 on the connecting pipeline between the indoor heat exchanger 120, the outdoor heat exchanger 130 and the heat storage heat exchanger 140 is taken as the dividing point, the first throttling element 171 is arranged on the first connecting pipeline between the heat storage heat exchanger 140 and the three-way intersection point 160; the third throttling element 173 is arranged on the third connecting pipe between the outdoor heat exchanger 130 and the three-way junction 160. At this time, there is at least one throttling element between any two heat exchangers. For example, the third throttling element 173 is arranged between the indoor heat exchanger 120 and the outdoor heat exchanger 130; the first throttling element 171 and the third throttling element 173 are successively arranged between the heat storage heat exchanger 140 and the outdoor heat exchanger 130; and the first throttling element 171 is arranged between the indoor heat exchanger 120 and the heat storage heat exchanger 140.

[0029] Under the arrangement of the above two examples, when multiple throttling elements are selected to perform throttling or conduction functions, the throttling elements on the downstream flow path after convergence should be used for throttling and the throttling elements on the upstream branch(es) should be kept fully open, otherwise, system reliability problems may be caused.

[0030] In addition, although not shown in the figure, the above three throttling elements can also be arranged in the system at the same time. At this time, there are two throttling elements between any two heat exchangers. In this arrangement, when the corresponding flow path is connected, the two throttling elements in the flow path can play a throttling role, thus achieving the twice throttling effect on any flow path, with a larger throttling regulation range; or else just make one of them play the role of throttling, while the other fully open as a valve used for conduction of the flow path. When multiple throttling elements are selected to perform throttling or conduction functions, throttling elements on the downstream flow path after convergence shall be used for throttling and the throttling elements on the upstream branch(es) shall be kept fully open, otherwise system reliability may be caused.

[0031] A control method applied to the heat pump system 100 will be described below in conjunction with Figures 1 to 4.

[0032] Referring to Figure 1, the combined defrosting mode of one embodiment of the heat pump system 100 is shown. At this time, the pipeline connection of the first four-way valve 151 and the second four-way valve 152 can be switched so that the outlet 110b of the compressor 110 is connected with the outdoor heat exchanger 130 and the indoor heat exchanger 120 respectively, and the PCM heat exchanger is connected with the inlet of the compressor 110.

[0033] At this time, the refrigerant passes through the compressor 110 successively to achieve gas phase compression. Then, a part of the refrigerant from the outlet 110b of the compressor 110 flows through the outdoor heat exchanger 130 via the first four-way valve 151, and the refrigerant flow pipeline is correspondingly defrosted; at the same time, another part of refrigerant from the outlet 110b of the compressor 110 flows through the indoor heat exchanger 120 via the second four-way valve 152, and heats the room accordingly. Thereafter, this part of refrigerant flows through the fully opened second throttling element 172 and converges with another part of refrigerant. The converged refrigerant enters the heat storage heat exchanger 140 for evaporation and heat absorption after throttling and expansion through the first throttling element 171, and returns to the inlet 110a of the compressor 110 via the first four-way valve 151, thus completing the cycle.

[0034] Similarly, refer to Figure 4, which shows the combined defrosting mode of another embodiment of the heat pump system 100. At this time, the pipeline connection of the first four-way valve 151 and the second four-way valve 152 can be switched so that the outlet 110b of the compressor 110 is connected with the outdoor heat exchanger 130 and the indoor heat exchanger 120 respectively, and the PCM heat exchanger is connected with the inlet of the compressor 110.

[0035] At this time, the refrigerant passes through the compressor 110 successively to achieve gas phase compression. Then, a part of the refrigerant from the outlet 110b of the compressor 110 flows through the indoor heat exchanger 120 via the second four-way valve 152, and heats the room accordingly; at the same time, another part of refrigerant from the outlet 110b of the compressor 110 flows through the outdoor heat exchanger 130 via the first four-way valve 151, and the refrigerant flow pipeline is correspondingly defrosted. Thereafter, this part of refrigerant flows through the fully opened third throttling element 173 and converges with another part of refrigerant. The converged refrigerant enters the heat storage heat exchanger 140 for evaporation and heat absorption after throttling and expansion through the first throttling element 171, and returns to the inlet 110a of the compressor 110 via the first four-way valve 151, thus completing the cycle.

[0036] Under the above system layout, the combined defrosting mode can achieve the purpose of defrosting without taking heat from the room, and has better advantages in improving indoor comfort than the conventional defrosting mode of taking heat from the room. In addition, it can also maintain the heating operation of the indoor heat exchanger while defrosting, and its system flow path layout is relatively simple, without additional arrangement of several valves to control the on-off and direction change of the flow path. The control logic is simple, and it has good applicability in low-cost occasions.

[0037] Of course, the heat pump system can also achieve the conventional cooling mode, heating mode and simultaneous heating and heat storage mode. An exemplary description will be given below in conjunction with Figures 2 and 3.

[0038] Referring to Figure 2, which shows the refrigeration mode of one embodiment of the heat pump system 100. At this time, the pipeline connection of the first four-way valve 151 and the second four-way valve 152 can be switched so that the outlet 110b of the compressor 110 is connected with the outdoor heat exchanger 130, and the indoor heat exchanger 120 is connected with the inlet 110a of the compressor 110. At the same time, the first throttling element 171 is used to disconnect the pipeline connection of the heat storage heat exchanger 140 in the heat pump system.

[0039] At this time, after the gas phase compression is achieved through the compressor 110, the refrigerant from the outlet 110b of the compressor 110 flows through the outdoor heat exchanger 130 for condensation and heat dissipation via the first four-way valve 151. Thereafter, the refrigerant is expanded and throttled through the second throttling element 172, and then flows through the indoor heat exchanger 120 to evaporate and absorb heat, and correspondingly provides refrigeration for the room, and returns to the inlet 110a of the compressor 110 via the second four-way valve 152, thus completing the refrigerant circulation.

[0040] Referring to Figure 3, which shows the heating and heat storage mode of one embodiment of the heat pump system 100. At this time, the pipeline connection of the first four-way valve 151 and the second four-way valve 152 can be switched so that the outlet 110b of the compressor 110 is respectively connected with the indoor heat exchanger 120 and the heat storage heat exchanger 140, and the outdoor heat exchanger 130 is connected with the inlet 110a of the compressor 110.

[0041] At this time, after the gas phase compression is achieved through the compressor 110, a part of refrigerant from the outlet 110b of the compressor 110 flows through the heat storage exchanger 140 for condensation and heat dissipation via the first four-way valve 151, which correspondingly enables the heat storage exchanger to absorb and store this part of heat. Thereafter, this part of refrigerant is throttled and expanded through the first throttling element 171, then flows through the outdoor heat exchanger 130 for evaporation and heat absorption, and returns to the inlet 110a of the compressor 110 via the first four-way valve 151, thus completing the circulation of this part of refrigerant. At the same time, another part of refrigerant from the outlet 110b of the compressor 110 flows through the indoor heat exchanger 120 for condensation and heating via the second four-way valve 152, and through the second throttling element 172 for throttling and expansion, then flows through the outdoor heat exchanger 130 for evaporation and heat absorption, and returns to the inlet 110a of the compressor 110 via the first four-way valve 151, thus completing the circulation of this part of refrigerant.

[0042] Furthermore, although it is not shown in the figure, only the heating function part of the heating and heat storage mode shown in Figure 3 can be executed, without the heat storage function, so that indoor heating can be fully guaranteed. This mode is defined as heating mode. At this time, the pipeline connection of the first four-way valve 151 and the second four-way valve 152 can be switched, so that the outlet 110b of the compressor 110 is connected with the indoor heat exchanger 120, and the outdoor heat exchanger 130 is connected with the inlet 110a of the compressor 110 respectively; at the same time, pipeline connection of the heat storage heat exchanger in the heat pump system is disconnected.

[0043] At this time, after the refrigerant achieves gas phase compression through the compressor 110, it flows from the outlet 110b of the compressor 110 to the indoor heat exchanger 120 for condensation and heating via the second four-way valve 152, and then through the second throttling element 172 for throttling and expansion, and then flows through the outdoor heat exchanger 130 for evaporation and heat absorption, and returns to the inlet 110a of the compressor 110 via the first four-way valve 151, thus completing the refrigerant cycle.

[0044] Furthermore, although it is not shown in the figure, only the heat storage function part of the heating and heat storage mode shown in Figure 3 can be executed, without the heating function, so that the heat storage at leisure can be fully guaranteed. This mode is defined as heat storage mode and will not be detailed described here.

[0045] It should be understood that although embodiments of the control method of the heat pump system are described in a certain order, these steps are not necessarily performed in the order described. Unless explicitly stated in this document, the execution of these steps is not strictly limited in order, and they can be executed in other order. Moreover, at least a part of the steps of the method can include a plurality of sub steps or stages. These sub steps or stages are not necessarily completed at the same time, but can be executed at different times. Their execution order is not necessarily sequential, but can be executed in turn or alternately with other steps or at least a part of the sub steps or stages of other steps.

[0046] The above examples mainly illustrate the heat pump system and its control method of the invention. Although only some embodiments of the invention have been described, those skilled in the art should understand that the invention can be implemented in many other forms without departing from its subject matter and scope. Therefore, the examples and embodiments shown are considered schematic rather than restrictive. Without departing from the scope of the invention as defined in the appended claims, the invention may cover various modifications and replacements.

Claims

1. A heat pump system comprising:

a compressor with an inlet and an outlet;

a heat storage heat exchanger, the pipeline connection of which is configured to be disconnectable from the heat pump system;
an indoor heat exchanger and an outdoor heat exchanger;
a plurality of throttling elements respectively arranged between any two of the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger; and
a first four-way valve and a second four-way valve, two ports of which are each respectively connected to the inlet and the outlet of the compressor; wherein the remaining ports of the first four-way valve are respectively connected to the outdoor heat exchanger and the heat storage heat exchanger; and the remaining ports of the second four-way valve are respectively connected to the indoor heat exchanger and connected to the port connected to the inlet through a capillary or on-off valve;
wherein in a combined defrosting mode, the refrigerant dissipates heat from the indoor heat exchanger and the outdoor heat exchanger respectively, and absorbs heat from the heat storage heat exchanger.

2. The heat exchange system according to claim 1, wherein the plurality of throttling elements include a first throttling element and a second throttling element; and a three-way intersection point is provided on connecting pipelines between the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger; wherein, the first throttling element is arranged on a first connecting pipeline between the three-way intersection point and the heat storage exchanger; and the second throttling element is arranged on a second connecting pipeline between the three-way intersection point and the indoor heat exchanger, or on a third connecting pipeline between the three-way intersection point and the outdoor heat exchanger.

3. The heat exchange system according to claim 1, wherein the plurality of throttling elements include a first throttling element, a second throttling element and a third throttling element; and a three-way intersection point is provided on connecting pipelines between the indoor heat exchanger, the outdoor heat exchanger and the heat storage heat exchanger; wherein, the first throttling element is arranged on a first connecting pipeline between the three-way intersection point and the heat storage exchanger; the second throttling element is arranged on a second connecting pipeline between the three-way intersection point and the indoor heat exchanger, and the third throttling element is arranged on a third connecting pipeline between the three-way intersection point and the outdoor heat exchanger.

4. The heat exchange system according to any one of claims 1-3, wherein in the combined defrosting mode, refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively; and at the same time, refrigerant from the outlet of the compressor, flows through the indoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively.

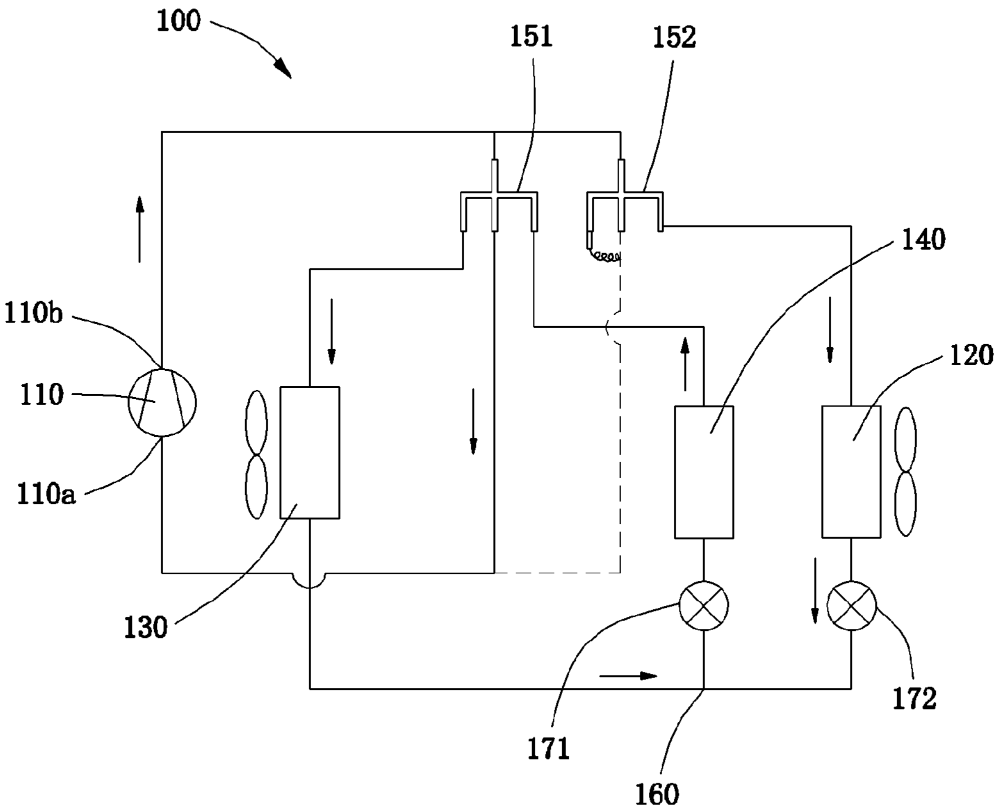
5. The heat exchange system according to any one of claims 1-4, wherein the heat storage heat exchanger is configured as a PCM heat exchanger.

6. A control method for the heat pump system according to any one of claims 1-5, comprising: a combined defrosting mode in which switching the pipeline connection of the first four-way valve and the second four-way valve, so that the outlet of the compressor is connected with the outdoor heat exchanger and the indoor heat exchanger respectively, and the heat storage heat exchanger is connected with the inlet of the compressor; wherein a part of refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the heat storage heat exchanger and the inlet of the compressor successively; and wherein at the same time, another part of refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the heat storage exchanger and the inlet of the compressor successively.

7. The control method according to claim 6, further comprising: a cooling mode in which the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is connected with the outdoor heat exchanger, and the indoor heat exchanger is connected with the inlet of the compressor; at the same time, the pipeline connection of the heat storage heat exchanger is disconnected in the heat pump system; wherein the refrigerant from the outlet of the compressor flows through the outdoor heat exchanger, the throttling element, the indoor heat exchanger and the inlet of the compressor successively.

8. The control method according to claim 6 or 7, further comprising: a heating mode in the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is connected with the indoor heat exchanger, and the outdoor heat exchanger is connected with the inlet of the compressor; at the same time, the pipeline connection of the heat storage heat exchanger is disconnected in the heat pump system; wherein the refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively.

9. The control method according to any of claims 6 to 8, further comprising: a heating and heat storage mode in which the first four-way valve and the second four-way valve are operated so that the outlet of the compressor is respectively connected with the indoor heat exchanger and the heat storage heat exchanger, and the outdoor heat exchanger is connected with the inlet of the compressor; wherein a part of refrigerant from the outlet of the compressor flows through the indoor heat exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively; at the same time, another part of refrigerant from the outlet of the compressor flows through the heat storage exchanger, the throttling element, the outdoor heat exchanger and the inlet of the compressor successively.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140
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110
110a
130
172
171
160

Fig.1

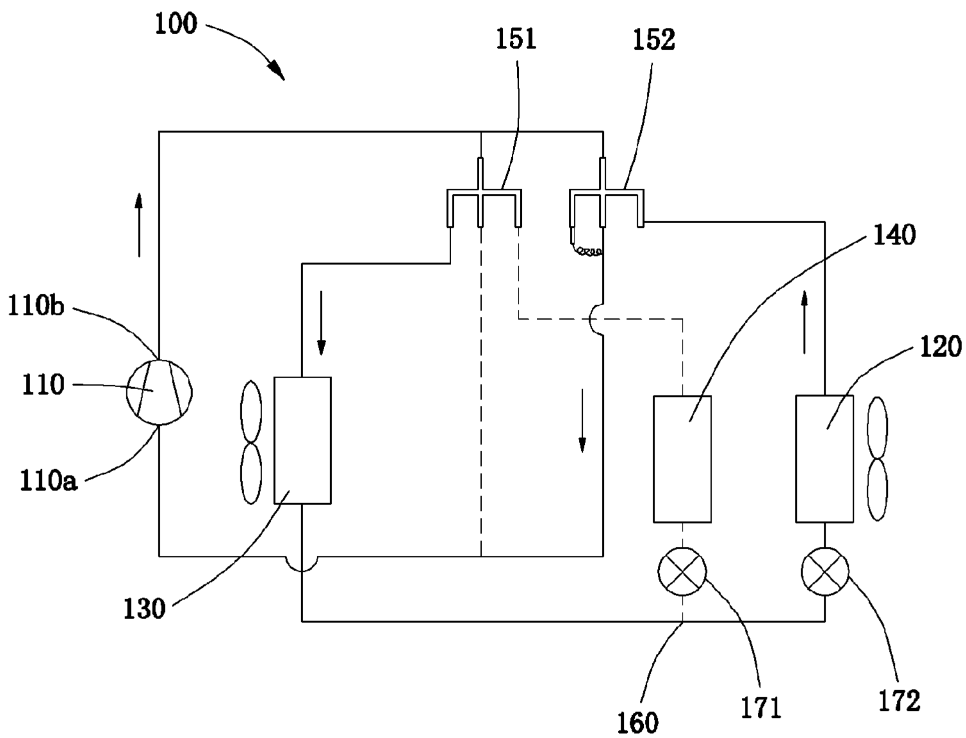
100
151
152
140
110b
120
110
110a
130
160
171
172

Fig.2

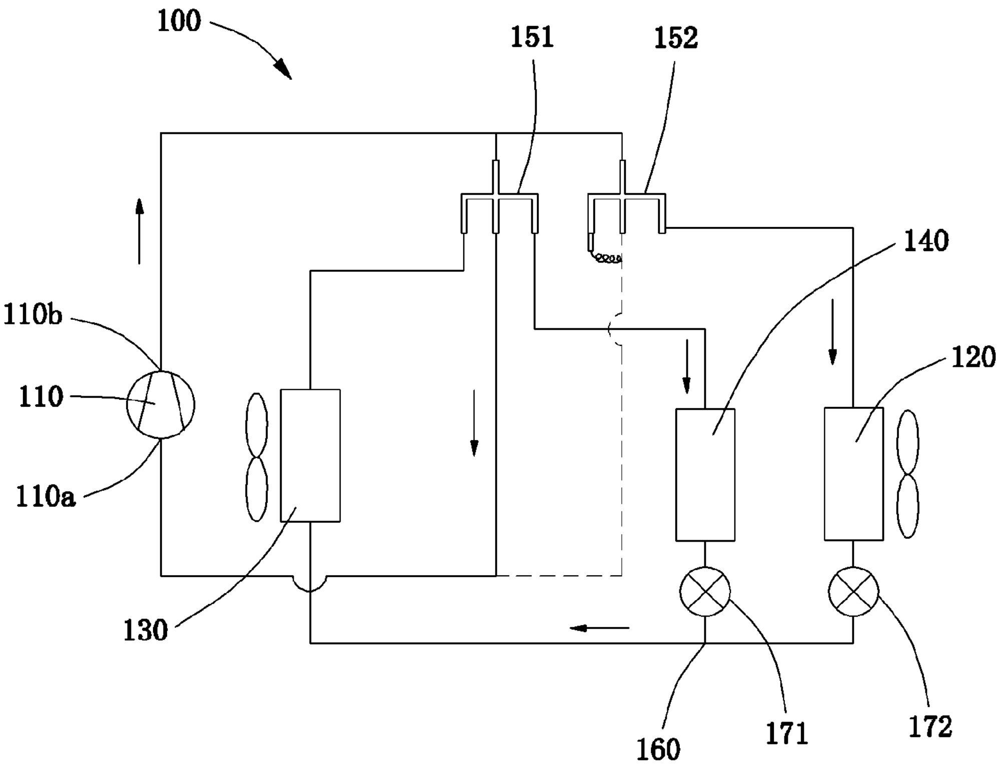
100
151
152
140
110b
110
120
110a
130
160
171
172

Fig.3

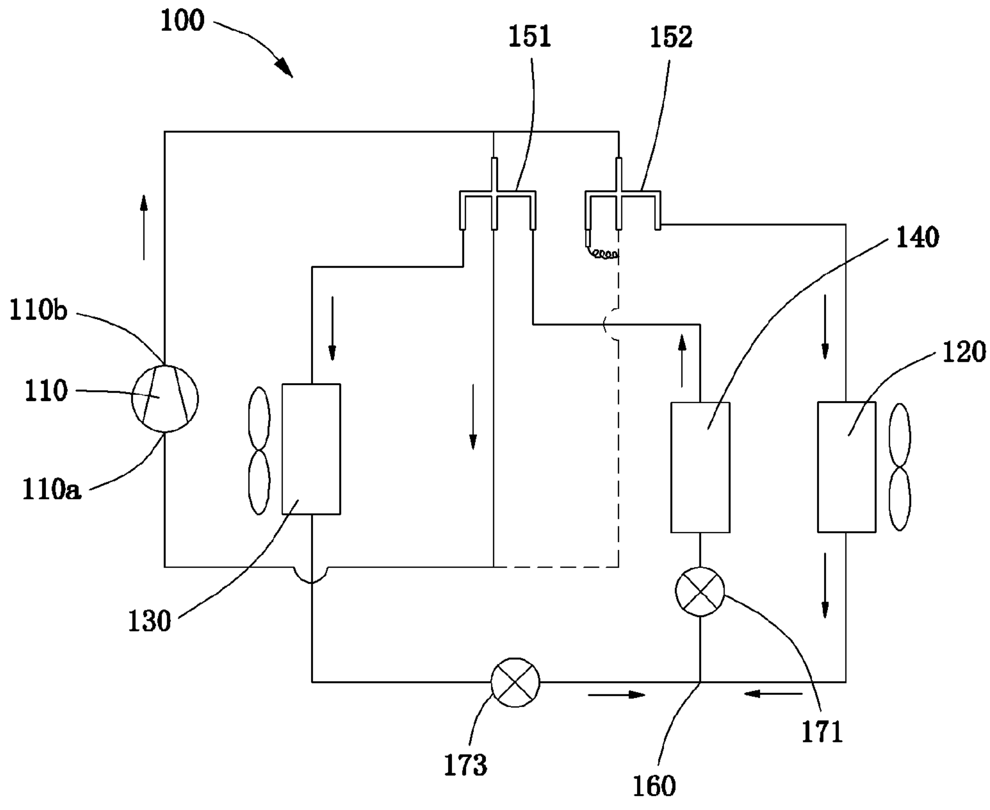
100
151
152
140
110b
110
120
110a
130
173
160
171

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 0603

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F25B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	8 May 2023	Weisser, Meinrad

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