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(54) **HEAT-PUMP DRINKING WATER SYSTEM, CONTROL METHOD THEREOF, AND HEAT-PUMP DRINKING WATER DEVICE**

(57) A heat-pump drinking water system, a control method thereof and a heat-pump drinking water device are provided. The heat-pump drinking water system includes: a compressor, a main condenser, a throttling device and an evaporator connected end-to-end sequentially and configured to form a refrigerant circuit; an auxiliary condenser having a first end connected between an exhaust port of the compressor and the main condenser and a second end connected between the main

condenser and the throttling device; a control valve assembly configured to control an exhausted gas of the compressor to flow through one of the main condenser and the auxiliary condenser selectively; and a hot water storage tank connected with the main condenser for circulating heat exchange with the main condenser, and a cold water storage tank connected with the evaporator for circulating heat exchange with the evaporator.

EP 3 249 318 A1

Description

FIELD

[0001] The present disclosure relates to a technical field of drinking water device, and particularly, to a heat-pump drinking water system, a control method thereof, and a heat-pump drinking water device.

BACKGROUND

[0002] In the related art, cold water and hot water are generally produced by two sets of drinking water devices, one set produces the hot water, and the other set produces the cold water. Generally, the drinking water device used for producing the cold water adopts an evaporative refrigeration cycle, and the drinking water device used for producing the hot water adopts an electrical heating. However, the electrical heating has a large energy consumption, and the two sets of drinking water devices provide a complicated structure.

SUMMARY

[0003] The present disclosure seeks to solve one of the technical problems existing in the related art at least to some extent. Accordingly, a heat-pump drinking water system is provided by embodiments of the present disclosure. The heat-pump drinking water system may produce hot water and cold water at the same time, and has a simple structure and a low energy consumption.

[0004] A control method of the above heat-pump drinking water system is further provided by embodiments of the present disclosure.

[0005] A heat-pump drinking water device having the above heat-pump drinking water system is further provided by embodiments of the present disclosure.

[0006] The heat-pump drinking water system according to a first aspect of embodiments of the present disclosure includes: a compressor, a main condenser, a throttling device and an evaporator connected end-to-end sequentially and configured to form a refrigerant circuit; an auxiliary condenser having a first end connected between an exhaust port of the compressor and the main condenser and a second end connected between the main condenser and the throttling device; a control valve assembly configured to control an exhausted gas of the compressor to flow through one of the main condenser and the auxiliary condenser selectively; a hot water storage tank and a cold water storage tank configured to store water, in which the hot water storage tank is connected with the main condenser for circulating heat exchange with the main condenser, and the cold water storage tank is connected with the evaporator for circulating heat exchange with the evaporator.

[0007] With the heat-pump drinking water system according to embodiments of the present disclosure, the hot water storage tank is connected to and exchanges

heat circularly with the main condenser, the cold water storage tank is connected to and exchanges heat circularly with the evaporator. Thus, the hot water and the cold water may be produced at the same time, the energy consumption is saved, and a high efficient utilization of energy is realized. Moreover, by providing the auxiliary condenser, the cold water with a relative low temperature may be produced by the system and a stable operation of the system is ensured, so a high requirement for drinking water may be satisfied.

[0008] According to some embodiments of the present disclosure, the control valve assembly includes a first on-off valve and a second on-off valve, the first on-off valve is connected with the main condenser in series and disposed adjacent to a refrigerant inlet of the main condenser, and the second on-off valve is connected with the auxiliary condenser in series and disposed adjacent to a refrigerant inlet of the auxiliary condenser.

[0009] According to some embodiments of the present disclosure, the control valve assembly includes a three-way valve having a first valve port, a second valve port and a third valve port, the first valve port is connected with the exhaust port of the compressor, the second valve port is connected with a refrigerant inlet of the main condenser, the third valve port is connected with the first end of the auxiliary condenser, and the three-way valve is configured in such a manner that the first valve port is communicated with one of the second valve port and the third valve port and is cut off from the other one of the second valve port and the third valve port selectively.

[0010] According to some embodiments of the present disclosure, the three-way valve is an electric three-way valve.

[0011] According to some embodiments of the present disclosure, the heat-pump drinking water system further includes a heat-dissipation fan configured for heat dissipation of the auxiliary condenser.

[0012] According to some embodiments of the present disclosure, the heat-pump drinking water system further includes a first one-way valve and a second one-way valve, the first one-way valve is connected with the main condenser in series and configured to allow a refrigerant to circulate only in a direction from a refrigerant outlet of the main condenser to the throttling device, the second one-way valve is connected with the auxiliary condenser in series and configured to allow the refrigerant to circulate only in a direction from the second end of the auxiliary condenser to the throttling device.

[0013] According to some embodiments of the present disclosure, the heat-pump drinking water system further includes an electrical heater disposed in the hot water storage tank.

[0014] The control method of the above heat-pump drinking water system according to a second aspect of embodiments of the present disclosure includes: detecting a water temperature T_m in the hot water storage tank and a water temperature T_n in the cold water storage tank; when $T_m < T_1$ and $T_n > T_2$, controlling by the control

valve assembly the exhausted gas of the compressor to flow towards the main condenser, and forming the refrigerant circuit by the compressor, the main condenser, the throttling device and the evaporator, in which T1 is a first preset temperature and T2 is a second preset temperature; when $T_m \geq T_1$ and $T_n > T_2$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the auxiliary condenser, and forming the refrigerant circuit by the compressor, the auxiliary condenser, the throttling device and the evaporator; and when $T_n \leq T_2$, stopping the compressor operating.

[0015] The control method of the above heat-pump drinking water system according to embodiments of the present disclosure is easy to be controlled and achieved. With the control method, the hot water and the cold water may be produced at the same time, the temperature of the cold water may reach a lower temperature, and the energy consumption saving may be realized better.

[0016] The control method of the above heat-pump drinking water system according to a third aspect of embodiments of the present disclosure includes: detecting a water temperature T_h in the hot water storage tank and a water temperature T_c in the cold water storage tank; when $T_h < T_3$ and $T_c > T_4$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the main condenser, and forming the refrigerant circuit by the compressor, the main condenser, the throttling device and the evaporator, in which T3 is a third preset temperature and T4 is a fourth preset temperature; when $T_5 > T_h \geq T_3$ and $T_c > T_4$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the auxiliary condenser, forming the refrigerant circuit by the compressor, the auxiliary condenser, the throttling device and the evaporator, and starting the electrical heater, in which T5 is a fifth preset temperature and $T_5 > T_3$; when $T_h < T_5$ and $T_c \leq T_4$, stopping the compressor operating, and starting the electrical heater; and when $T_h \geq T_5$ and $T_c \leq T_4$, stopping both the compressor and the electrical heater operating.

[0017] The control method of the above heat-pump drinking water system according to embodiments of the present disclosure is easy to be controlled and achieved. With the control method, it is convenient for the heat-pump drinking water system to start different operation modes according to the water temperatures in the hot water storage tank and in the cold water storage tank, the hot water and the cold water may be produced at the same time, and also the temperatures of the hot water and the cold water may reach a requirement for drinking water. Moreover, the energy consumption saving is realized better.

[0018] The heat-pump drinking water device according to a fourth aspect of embodiments of the present disclosure includes: a cabinet; and a heat-pump drinking water system according to the first aspect of embodiments of the present disclosure, in which the heat-pump drinking water system is disposed in the cabinet.

[0019] With the heat-pump drinking water device ac-

cording to embodiments of the present disclosure, by providing the above heat-pump drinking water system, the hot water and the cold water may be produced at the same time, the energy consumption is saved, and also, a higher requirement for drinking water is satisfied.

[0020] According to some embodiments of the present disclosure, the cabinet has a first chamber, a second chamber and a third chamber arranged in an up and down direction, the hot water storage tank and the cold water storage tank are disposed in the first chamber, the main condenser and the evaporator are disposed in the second chamber, the compressor and the auxiliary condenser are disposed in the third chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a schematic view of a heat-pump drinking water system according to an embodiment of the present disclosure;

Fig. 2 is an operation schematic view of a heat-pump drinking water system according to an embodiment of the present disclosure, in which a first on-off valve is on and a second on-off valve is off;

Fig. 3 is an operation schematic view of a heat-pump drinking water system according to an embodiment of the present disclosure, in which a second on-off valve is on and a first on-off valve is off;

Fig. 4 is a schematic view of a heat-pump drinking water system according to another embodiment of the present disclosure;

Fig. 5 is a schematic view of a heat-pump drinking water system according to another embodiment of the present disclosure;

Fig. 6 is a flow chart of a control method of a heat-pump drinking water system according to an embodiment of the present disclosure, in which a hot water storage tank is not provided with an electrical heater;

Fig. 7 is a flow chart of a control method of a heat-pump drinking water system according to an embodiment of the present disclosure, in which a hot water storage tank is provided with an electrical heater; and

Fig. 8 is a schematic view of a heat-pump drinking water device according to an embodiment of the present disclosure.

Reference numerals:

[0022]

heat-pump drinking water system 100, compressor 10, main condenser 11, throttling device 12, evaporator 13, auxiliary condenser 14, heat-dissipation fan 15, hot water storage tank 16, electrical heater 161, cold water storage tank 17, first water pump 18, second water pump 19, first on-off valve 21, second on-off valve 22, three-

way valve 30, first valve port 31, second valve port 32, third valve port 33, first one-way valve 41, second one-way valve 42,
heat-pump drinking water device 200, cabinet 201, first chamber 202, second chamber 203, third chamber 204.

DETAILED DESCRIPTION

[0023] Embodiments of the present disclosure will be described in detail in the following. Examples of the embodiments are shown in the drawings. The embodiments described with reference to the drawings are illustrative, which is only used to explain the present disclosure and shouldn't be construed to limit the present disclosure.

[0024] In the specification, it should be understood that terms such as "up", "down", "front", "rear", "left", "right", "vertical", "horizontal", "inner", "outer" should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of description and do not require that the present disclosure be constructed or operated in a particular orientation, so shall not be construed to limit the present disclosure.

[0025] In addition, terms such as "first" and "second" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance or to imply the number of indicated technical features. Thus, the feature defined with "first" and "second" may comprise one or more of this feature. In the description of the present disclosure, "a plurality of" means two or more than two, unless specified otherwise.

[0026] In the present disclosure, unless specified or limited otherwise, the terms "mounted", "connected", "coupled", "fixed" should be understood broadly, and may be, for example, fixed connections, detachable connections, or integral connections; may also be direct connections or indirect connections via intervening structures; may also be inner communications or interaction relationships of two elements, unless specified or limited otherwise, which can be understood by those skilled in the art according to specific situations.

[0027] A heat-pump drinking water system 100 according to embodiments of the present disclosure is described in the following with reference to Fig. 1 to Fig. 8.

[0028] As shown in Fig. 1 to Fig. 8, the heat-pump drinking water system 100 according to a first aspect of embodiments of the present disclosure includes a compressor 10, a main condenser 11, a throttling device 12, an evaporator 13, an auxiliary condenser 14, a control valve assembly, a hot water storage tank 16 and a cold water storage tank 17 configured to store water.

[0029] Specifically, the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 are connected end-to-end sequentially and are configured to form a refrigerant circuit. The hot water storage tank 16 is connected with the main condenser 11 for circulating heat exchange with the main condenser 11, such

that the water in the hot water storage tank 16 may exchange heat with the main condenser 11, thus increasing a water temperature in the hot water storage tank 16. The cold water storage tank 17 is connected with the evaporator 13 for circulating heat exchange with the evaporator 13, such that the water in the cold water storage tank 17 may exchange heat with the evaporator 13, thus decreasing a water temperature in the cold water storage tank 17. Therefore, the hot water and the cold water may be produced at the same time, the energy may be made full use of, and the energy consumption may be saved.

[0030] Optionally, the evaporator 13, the main condenser 11 and the auxiliary condenser 14 may be configured to be a plate heat exchanger or a double-pipe heat exchanger; the throttling device 12 may be configured to be an electronic expansion valve, a thermostatic expansion valve or a capillary tube; the auxiliary condenser 14 may be configured to be a micro-channel heat exchanger or a finned tube heat exchanger; and the compressor 10 may be configured to be a vertical compressor or a horizontal compressor.

[0031] The auxiliary condenser 14 has a first end connected between an exhaust port of the compressor 10 and the main condenser 11 and a second end connected between the main condenser 11 and the throttling device 12. The control valve assembly controls an exhausted gas of the compressor 10 to flow through one of the main condenser 11 and the auxiliary condenser 14 selectively. That is, during an operation process of the compressor 10, the control valve assembly controls the compressor 10 to be communicated with one of the main condenser 11 and the auxiliary condenser 14.

[0032] For example, with reference to Fig. 2 (arrows in the figure represent flowing directions of the refrigerant and the water respectively), when the compressor 10 is communicated with the main condenser 11, the compressor 10 is cut off from the auxiliary condenser 14, and thus the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Therefore, the refrigerant is compressed by the compressor 10 into a refrigerant with a high temperature and a high pressure, and the refrigerant with the high temperature and the high pressure is exhausted into the main condenser 11 through the exhaust port of the compressor 10. The refrigerant with the high temperature and the high pressure is condensed and releases heat in the main condenser 11. The refrigerant is throttled and depressurized by the throttling device 12 after flowing out of the main condenser 11, and then flows into the evaporator 13. The refrigerant is evaporated and absorbs heat in the evaporator 13 to form a refrigerant with a low temperature and a low pressure. The refrigerant with the low temperature and the low pressure flows out of the evaporator 13, and then flows back into the compressor 10 through a gas returning port of the compressor 10, so as to be compressed again, thus forming a refrigerant cycle.

[0033] In this case, the water flowing out of the hot

water storage tank 16 may exchange heat with the main condenser 11, absorb the heat radiated from the main condenser 11, and then flow back into the hot water storage tank 16 after the heat exchange with the main condenser 11, repeated in this way, thus increasing the water temperature in the hot water storage tank 16. Also, the water flowing out of the cold water storage tank 17 may exchange heat with the evaporator 13, the refrigerant in the evaporator 13 absorbs the heat radiated from the water flowing out of the cold water storage tank 17 when being evaporated, and then the water flows back into the cold water storage tank 17 after the heat exchange with the evaporator 13, repeated in this way, thus reducing the water temperature in the cold water storage tank 17.

[0034] For example, with reference to Fig. 3 (arrows in the figure represent flowing directions of the refrigerant and the water respectively), when the compressor 10 is communicated with the auxiliary condenser 14, the compressor 10 is cut off from the main condenser 11, and the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Thus, the refrigerant is compressed by the compressor 10 into a refrigerant with a high temperature and a high pressure, and the refrigerant with the high temperature and the high pressure is exhausted into the auxiliary condenser 14 through the exhaust port of the compressor 10. The refrigerant with the high temperature and the high pressure is condensed and releases heat in the auxiliary condenser 14. The refrigerant is throttled and depressurized by the throttling device 12 after flowing out of the auxiliary condenser 14, and then flows into the evaporator 13. The refrigerant is evaporated and absorbs heat in the evaporator 13 to form a refrigerant with a low temperature and a low pressure, and the refrigerant with the low temperature and the low pressure flows back into the compressor 10 through the gas returning port of the compressor 10 after flowing out of the evaporator 13, so as to be compressed again, thus forming a refrigerant cycle. Also, the water flowing out of the cold water storage tank 17 may exchange heat with the evaporator 13, and the refrigerant in the evaporator 13 absorbs the heat radiated from the water flowing out of the cold water storage tank 17 when being evaporated, so the water temperature in the cold water storage tank 17 may be reduced.

[0035] It should be noted that, in an initial operation of the heat-pump drinking water system 100, the water in the hot water storage tank 16 needs to be heated and the water in the cold water storage tank 17 needs to be cooled, so the compressor 10 is communicated with the main condenser 11 and cut off from the auxiliary condenser 14 at this moment. Thus, with the water in the hot water storage tank 16 exchanging heat with the main condenser 11, the water temperature in the hot water storage tank 16 may be increased, and also, with the water in the cold water storage tank 17 exchanging heat with the evaporator 13, the water temperature in the cold water storage tank 17 may be decreased.

[0036] After the heat-pump drinking water system 100

operates for a period of time, the water temperature in the hot water storage tank 16 increases gradually, and the water temperature in the cold water storage tank 17 decreases gradually. Because of characteristics of the heat-pump drinking water system, a condensation temperature cannot be too high, so the water temperature in the hot water storage tank 16 will not increase infinitely, and the water temperature in the cold water storage tank 17 will not continue decreasing. At this time, the compressor 10 may be cut off from the main condenser 11 and communicated with the auxiliary condenser 14, and thus the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Thus, the water in the cold water storage tank 17 may be continued being cooled, so as to allow the water in the cold water storage tank 17 to reach a lower temperature.

[0037] Thus, by means of the heat-pump drinking water system 100 described above, the hot water and the cold water may be produced at the same time, and the energy consumption is saved. Also, the water temperature of the cold water may be lowered further by providing the auxiliary condenser 14, and thus a higher requirement for drinking water is satisfied.

[0038] It may be understood that, when the hot water and the cold water produced by the heat-pump drinking water system 100 reach set temperatures of the drinking water, the user may take water from the hot water storage tank 16 and the cold water storage tank 17. When water quantities in the hot water storage tank 16 and the cold water storage tank 17 are not enough, the hot water storage tank 16 and the cold water storage tank 17 may be supplemented with water.

[0039] With the heat-pump drinking water system 100 according to embodiments of the present disclosure, the hot water storage tank 16 is connected to and exchanges heat circularly with the main condenser 11, and the cold water storage tank 17 is connected to and exchanges heat circularly with the evaporator 13, such that the hot water and the cold water may be produced at the same time. Thus, a high efficient utilization of energy is realized, and the energy consumption is saved. By providing the auxiliary condenser 14, the cold water with a lower temperature may be produced by the system and a stable operation of the system is ensured, so a higher requirement for drinking water is satisfied.

[0040] A plurality of embodiments of the heat-pump drinking water system 100 according to the present disclosure will be described in detail with reference to Fig. 1 to Fig. 8.

Embodiment one

[0041] With reference to Figs. 1-3, in the present embodiment, the control valve assembly includes a first on-off valve 21 and a second on-off valve 22. The first on-off valve 21 is connected with the main condenser 11 in series and disposed adjacent to a refrigerant inlet of the

main condenser 11, and the second on-off valve 22 is connected with the auxiliary condenser 14 in series and disposed adjacent to a refrigerant inlet of the auxiliary condenser 14.

[0042] Thus, when the first on-off valve 21 is on and the second on-off valve 22 is off, the compressor 10 is communicated with the main condenser 11 and cut off from the auxiliary condenser 14, and thus the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 form the refrigerant circuit; when the second on-off valve 22 is on and the first on-off valve 21 is off, the compressor 10 is communicated with the auxiliary condenser 14 and cut off from the main condenser 11, and thus the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Please refer to what is mentioned above for a specific operation process, which will not be repeated in detail here.

[0043] The heat-pump drinking water system 100 may further include a heat-dissipation fan 15 configured for heat dissipation of the auxiliary condenser 14, so the heat radiated from the auxiliary condenser 14 may be dissipated timely, thus improving an operation efficiency of the system.

[0044] The heat-pump drinking water system 100 may further include a first one-way valve 41 and a second one-way valve 42. The first one-way valve 41 is connected with the main condenser 11 in series and configured to allow the refrigerant to circulate only in a direction from a refrigerant outlet of the main condenser 11 to the throttling device 12, thus preventing the refrigerant from backflow. The second one-way valve 42 is connected with the auxiliary condenser 14 in series and configured to allow the refrigerant to circulate only in a direction from the second end of the auxiliary condenser 14 to the throttling device 12, thus preventing the refrigerant from backflow.

[0045] The heat-pump drinking water system 100 may further include a first water pump 18 and a second water pump 19. The first water pump 18 is connected between the hot water storage tank 16 and the main condenser 11. The first water pump 18 is used for drawing the water out of the hot water storage tank 16 to exchange heat with the main condenser 11 and pumping the water into the hot water storage tank 16 after the heat exchange, so that the water in the hot water storage tank 16 may exchange heat with the main condenser 11 repeatedly, and a flow cycle of the water is accelerated, thus improving the heat exchange efficiency. The second water pump 19 is connected between the cold water storage tank 17 and the evaporator 13. The second water pump 19 is used for drawing the water out of the cold water storage tank 17 to exchange heat with the evaporator 13 and pumping the water into the cold water storage tank 17 after the heat exchange, so that the water in the cold water storage tank 17 may exchange heat with the evaporator 13 repeatedly, and the flow cycle of the water is accelerated, thus improving the heat exchange efficiency.

[0046] In addition, the hot water storage tank 16 is further provided with an electrical heater 161 used for heating therein. When the water temperature in the hot water storage tank 16 is not high enough, the electrical heater 161 may be used to heat the water so as to further increase the water temperature, so that the water temperature in the hot water storage tank 16 may reach a higher temperature.

[0047] In the operation process of the heat-pump drinking water system 100, according to changes of the water temperature in the hot water storage tank 16 and the water temperature in the cold water storage tank 17, two following cases are included.

[0048] First case: after the heat-pump drinking water system 100 operates for a period of time, the water temperature in the hot water storage tank 16 reaches a set heating temperature of the heat-pump drinking water system. At this time, the water temperature in the hot water storage tank 16 has a small difference from the temperature of the main condenser 11, and the heat exchange cannot be performed. However, the water temperature in the cold water storage tank 17 has not reached a set drinking temperature of cold water, so the water in the cold water storage tank 17 needs to be cooled further. In this case, the control valve assembly may control the exhausted gas of the compressor 10 to flow through the auxiliary condenser 14, that is, the compressor 10 is communicated with the auxiliary condenser 14 and cut off from the main condenser 11, and thus the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Thus, the water in the cold water storage tank 17 may continue exchanging heat with the evaporator 13, so that the water temperature in the cold water storage tank 17 may be reduced further, and thus the water temperature in the cold water storage tank 17 may reach a lower temperature. When the water temperature in the cold water storage tank 17 is reduced to the set drinking temperature of the cold water, the compressor 10 stops operating. Nevertheless, the water in the hot water storage tank 16 may be heated by the electrical heater 161, so that the water temperature in the hot water storage tank 16 may be increased to a higher temperature, for example a set drinking temperature of hot water.

[0049] Second case: after the heat-pump drinking water system 100 operates for a period of time, the water temperature in the cold water storage tank 17 reaches the set drinking temperature of the cold water, while the water temperature in the hot water storage tank 16 has not reached a set heating temperature of the heat-pump drinking water system. As the water in the cold water storage tank 17 needs not to be cooled further, the compressor 10 stops operating. At this time, the water in the hot water storage tank 16 may be heated by the electrical heater 161, so as to increase the water temperature in the hot water storage tank 16 to the set drinking temperature of the hot water.

Embodiment two

[0050] The heat-pump drinking water system 100 in the present embodiment differs from the heat-pump drinking water system 100 in above embodiment one only in configurations of the control valve assembly, and other structures of these two heat-pump drinking water systems 100 are substantially same, which will not be repeated in detail here.

[0051] With reference to Fig. 4 and Fig. 5, in the present embodiment, the control valve assembly includes a three-way valve 30. The three-way valve 30 has a first valve port 31, a second valve port 32 and a third valve port 33. The first valve port 31 is connected with the exhaust port of the compressor 10, the second valve port 32 is connected with a refrigerant inlet of the main condenser 11, and the third valve port 33 is connected with the first end of the auxiliary condenser 14. The three-way valve 30 is configured in such a manner that the first valve port 31 is communicated with one of the second valve port 32 and the third valve port 33 and is cut off from the other one of the second valve port 32 and the third valve port 33 selectively.

[0052] Thus, when the first valve port 31 is communicated with the second valve port 32 and the first valve port 31 is cut off from the third valve port 33, the compressor 10 is communicated with the main condenser 11 and cut off from the auxiliary condenser 14, and thus the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 form the refrigerant circuit. When the first valve port 31 is communicated with the third valve port 33 and the first valve port 31 is cut off from the second valve port 32, the compressor 10 is communicated with the auxiliary condenser 14 and cut off from the main condenser 11, and thus the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. Please refer to what is mentioned above for a specific operation process, which will not be repeated in detail here. Optionally, the three-way valve 30 may be an electric three-way valve.

[0053] A control method of the heat-pump drinking water system 100 according to embodiments of the present disclosure will be described with reference to Fig. 6 and Fig. 7.

[0054] With reference to Fig. 6, a control method of the above heat-pump drinking water system 100 according to a second aspect of embodiments of the present disclosure is provided, in which the hot water storage tank 16 is not provided with the electrical heater 161 therein. The control method includes: detecting a water temperature T_m in the hot water storage tank 16 and a water temperature T_n in the cold water storage tank 17, and comparing the water temperature T_m and the water temperature T_n with preset temperatures. The comparison results may include several cases as followed.

[0055] When $T_m < T_1$ and $T_n > T_2$, the control valve assembly controls the exhausted gas of the compressor 10

to flow towards the main condenser 11, and the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 form the refrigerant circuit. In this case, the water in the hot water storage tank 16 may exchange heat with the main condenser 11, and thus the water temperature in the hot water storage tank 16 may be increased. The water in the cold water storage tank 17 may exchange heat with the evaporator 13, and thus the water temperature in the cold water storage tank 17 may be reduced. T_1 is a first preset temperature, for example T_1 is a set drinking temperature of hot water, and T_2 is a second preset temperature, for example T_2 is a set drinking temperature of cold water.

[0056] When $T_m \geq T_1$ and $T_n > T_2$, the control valve assembly controls the exhausted gas of the compressor 10 to flow towards the auxiliary condenser 14, and the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit. In this case, the water in the cold water storage tank 17 may exchange heat with the evaporator 13, thus reducing the water temperature in the cold water storage tank 17 further.

[0057] When $T_n \leq T_2$, the water temperature in the cold water storage tank 17 reaches the set drinking temperature of the cold water, and the compressor stops operating.

[0058] When the water temperature in the hot water storage tank 16 decreases or the water temperature in the cold water storage tank 17 increases, the above cycle is repeated.

[0059] The control method of the heat-pump drinking water system 100 according to embodiments of the present disclosure is easy to be controlled and achieved. With the control method, the hot water and the cold water may be produced at the same time, the temperature of the cold water may reach a lower temperature, and also, the energy consumption saving may be realized better.

[0060] With reference to Fig. 7, the control method of the above heat-pump drinking water system 100 according to a third aspect of embodiments of the present disclosure is provided, in which the hot water storage tank 16 is provided with the electrical heater 161 therein. The control method includes: detecting a water temperature T_h in the hot water storage tank 16 and a water temperature T_c in the cold water storage tank 17, and comparing the water temperature T_h and the water temperature T_c with preset temperatures. The comparison results may include several cases as followed.

[0061] When $T_h < T_3$ and $T_c > T_4$, the control valve assembly controls the exhausted gas of the compressor 10 to flow towards the main condenser 11, and the compressor 10, the main condenser 11, the throttling device 12 and the evaporator 13 form the refrigerant circuit. In this case, the water in the hot water storage tank 16 may exchange heat with the main condenser 11, thus increasing the water temperature in the hot water storage tank 16. Also, the water in the cold water storage tank 17 may exchange heat with the evaporator 13, thus reducing the

water temperature in the cold water storage tank 17. T3 is a third preset temperature, for example T3 is a set heating temperature of the heat-pump drinking water system. T4 is a fourth preset temperature, for example T4 is a set drinking temperature of cold water.

[0062] When $T_5 > T_h \geq T_3$ and $T_c > T_4$, the control valve assembly controls the exhausted gas of the compressor 10 to flow towards the auxiliary condenser 14, the compressor 10, the auxiliary condenser 14, the throttling device 12 and the evaporator 13 form the refrigerant circuit, and the electrical heater 161 is started. In this case, the water in the cold water storage tank 17 may exchange heat with the evaporator 13, thus reducing the water temperature in the cold water storage tank 17 further; the water in the hot water storage tank 16 is heated further by the electrical heater 161. T5 is a fifth preset temperature and $T_5 > T_3$, for example T5 is a set drinking temperature of hot water.

[0063] When $T_h < T_5$ and $T_c \leq T_4$, the water temperature in the cold water storage tank 17 reaches the set drinking temperature of the cold water and the water in the cold water storage tank 17 does not to be cooled, so the compressor stops operating. However, the water temperature in the hot water storage tank 16 has not reached the set drinking temperature of the hot water, so the electrical heater 161 is started to heat the water in the hot water storage tank 16.

[0064] When $T_h \geq T_5$ and $T_c \leq T_4$, the water temperature in the hot water storage tank 16 reaches the set drinking temperature of the hot water, the water temperature in the cold water storage tank 17 reaches the set drinking temperature of the cold water, and thus both the compressor 10 and the electrical heater 161 stop operating.

[0065] When the water temperature in the hot water storage tank 16 decreases or the water temperature in the cold water storage tank 17 increases, the above cycle is repeated.

[0066] The preset temperatures T3, T4 and T5 may be determined according to actual situations. For example, for a conventional refrigerant, T3 is about 55°C, and for some refrigerants such as carbon dioxide, T3 may reach 90°C. T4 may be set between 1°C and 5°C, and T5 may be set between 80°C and 100°C.

[0067] The control method of the heat-pump drinking water system 100 according to embodiments of the present disclosure is easy to be controlled and achieved. With the control method, it is convenient for the heat-pump drinking water system 100 to start different operation modes according to the water temperatures in the hot water storage tank 16 and in the cold water storage tank 17, such that the hot water and the cold water may be produced at the same time, and also, the temperatures of the hot water and of the cold water may satisfy drinking requirements, thus realizing the energy consumption saving better.

[0068] A heat-pump drinking water device 200 according to embodiments of the present disclosure will be described with reference to Fig. 8.

[0069] With reference to Fig. 8, the heat-pump drinking water device 200 according to a fourth aspect of embodiments of the present disclosure includes: a cabinet 201 and the heat-pump drinking water system 100 according to the first aspect of embodiments of the present disclosure, and the heat-pump drinking water system 100 is disposed in the cabinet 201.

[0070] By providing the above heat-pump drinking water system 100, the heat-pump drinking water device 200 may produce hot water and cold water at the same time, and also satisfy higher requirements for drinking water. In addition, the energy consumption is saved.

[0071] In some embodiments of the present disclosure, with reference to Fig. 8, the cabinet 201 has a first chamber 202, a second chamber 203 and a third chamber 204 arranged in an up and down direction. The hot water storage tank 16 and the cold water storage tank 17 are disposed in the first chamber 202, the main condenser 11 and the evaporator 13 are disposed in the second chamber 203, and the compressor 10 and the auxiliary condenser 14 are disposed in the third chamber 204. For example, the hot water storage tank 16 and the cold water storage tank 17 are spaced apart from each other along a left and right direction, the main condenser 11 and the evaporator 13 are spaced apart from each other along the left and right direction, and the compressor 10 and the auxiliary condenser 14 are spaced apart from each other along the left and right direction. By separating a space in the cabinet 201 into an upper layer, a medium layer and a lower layer and allocating respective parts into the first chamber 202, the second chamber 203 and the third chamber 204 reasonably, a structure of the heat-pump drinking water device 200 is more compact and reasonable.

[0072] Reference throughout this specification to "an embodiment", "some embodiments", "an example", "a specific example" or "some examples" means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. In the present specification, the illustrative statement of the terms above is not necessarily referring to the same embodiment or example. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples. In addition, the different embodiments or examples as well as the features in the different embodiments or examples described in the specification can be combined or united by those skilled in the related art in the absence of contradictory circumstances.

[0073] Although embodiments of the present disclosure have been shown and described, it would be appreciated that the embodiments above are illustrative and shall not be construed to limit the present disclosure, changes, alternatives, variation and modifications can be made in the embodiments without departing from the scope of the present disclosure by those skilled in the art.

Claims

1. A heat-pump drinking water system (100), comprising:

a compressor (10), a main condenser (11), a throttling device (12) and an evaporator (13) connected end-to-end sequentially and configured to form a refrigerant circuit;
 an auxiliary condenser (14) having a first end connected between an exhaust port of the compressor (10) and the main condenser (11) and a second end connected between the main condenser (11) and the throttling device (12);
 a control valve assembly configured to control an exhausted gas of the compressor (10) to flow through one of the main condenser (11) and the auxiliary condenser (14) selectively; and
 a hot water storage tank (16) and a cold water storage tank (17) configured to store water, wherein the hot water storage tank (16) is connected with the main condenser (11) for circulating heat exchange with the main condenser (11), and the cold water storage tank (17) is connected with the evaporator (13) for circulating heat exchange with the evaporator (13).

2. The heat-pump drinking water system (100) according to claim 1, wherein the control valve assembly comprises a first on-off valve (21) and a second on-off valve (22), the first on-off valve (21) is connected with the main condenser (11) in series and disposed adjacent to a refrigerant inlet of the main condenser (11), and the second on-off valve (22) is connected with the auxiliary condenser (14) in series and disposed adjacent to a refrigerant inlet of the auxiliary condenser (14).

3. The heat-pump drinking water system (100) according to claim 1, wherein the control valve assembly comprises a three-way valve (30) having a first valve port (31), a second valve port (32) and a third valve port (33), the first valve port (31) is connected with the exhaust port of the compressor (10), the second valve port (32) is connected with a refrigerant inlet of the main condenser (11), the third valve port (33) is connected with the first end of the auxiliary condenser (14), and the three-way valve (30) is configured in such a manner that the first valve port (31) is communicated with one of the second valve port (32) and the third valve port (33) and is cut off from the other one of the second valve port (32) and the third valve port (33) selectively.

4. The heat-pump drinking water system (100) according to claim 3, wherein the three-way valve (30) is an electric three-way valve.

5. The heat-pump drinking water system (100) according to claim 1, further comprising a heat-dissipation fan (15) configured for heat dissipation of the auxiliary condenser (14).

6. The heat-pump drinking water system (100) according to claim 1, further comprising a first one-way valve (41) and a second one-way valve (42), wherein the first one-way valve (41) is connected with the main condenser (11) in series and configured to allow a refrigerant to circulate only in a direction from a refrigerant outlet of the main condenser (11) to the throttling device (12), and the second one-way valve (42) is connected with the auxiliary condenser (14) in series and configured to allow the refrigerant to circulate only in a direction from the second end of the auxiliary condenser (14) to the throttling device (12).

7. The heat-pump drinking water system (100) according to any one of claims 1 to 6, further comprising an electrical heater (161) disposed in the hot water storage tank (16).

8. A control method of a heat-pump drinking water system according to any one of claims 1 to 6, comprising:

detecting a water temperature T_m in the hot water storage tank and a water temperature T_n in the cold water storage tank;
 when $T_m < T_1$ and $T_n > T_2$, controlling by the control valve assembly an exhausted gas of the compressor to flow towards the main condenser, and forming the refrigerant circuit by the compressor, the main condenser, the throttling device and the evaporator, wherein T_1 is a first preset temperature and T_2 is a second preset temperature;
 when $T_m \geq T_1$ and $T_n > T_2$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the auxiliary condenser, and forming the refrigerant circuit by the compressor, the auxiliary condenser, the throttling device and the evaporator; and
 when $T_n \leq T_2$, stopping the compressor operating.

9. A control method of a heat-pump drinking water system according to claim 7, comprising:

detecting a water temperature T_h in the hot water storage tank and a water temperature T_c in the cold water storage tank;
 when $T_h < T_3$ and $T_c > T_4$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the main condenser, and forming the refrigerant circuit by the compressor, the main condenser, the throttling de-

vice and the evaporator, wherein T3 is a third preset temperature and T4 is a fourth preset temperature;

when $T5 > T_h \geq T3$ and $T_c > T4$, controlling by the control valve assembly the exhausted gas of the compressor to flow towards the auxiliary condenser, forming the refrigerant circuit by the compressor, the auxiliary condenser, the throttling device and the evaporator, and starting the electrical heater, wherein T5 is a fifth preset temperature and $T5 > T3$; 5 10

when $T_h < T5$ and $T_c \leq T4$, stopping the compressor operating, and starting the electrical heater; and

when $T_h \geq T5$ and $T_c \leq T4$, stopping both the compressor and the electrical heater operating. 15

10. A heat-pump drinking water device (200), comprising: 20

a cabinet (201); and

a heat-pump drinking water system (100) according any one of claims 1-7, wherein the heat-pump drinking water system (100) is disposed in the cabinet (201). 25

11. The heat-pump drinking water device (200) according to claim 10, wherein the cabinet (201) defines a first chamber (202), a second chamber (203) and a third chamber (204) arranged in an up and down direction, the hot water storage tank (16) and the cold water storage tank (17) are disposed in the first chamber (202), the main condenser (11) and the evaporator (13) are disposed in the second chamber (203), and the compressor (10) and the auxiliary condenser (14) are disposed in the third chamber (204). 30 35

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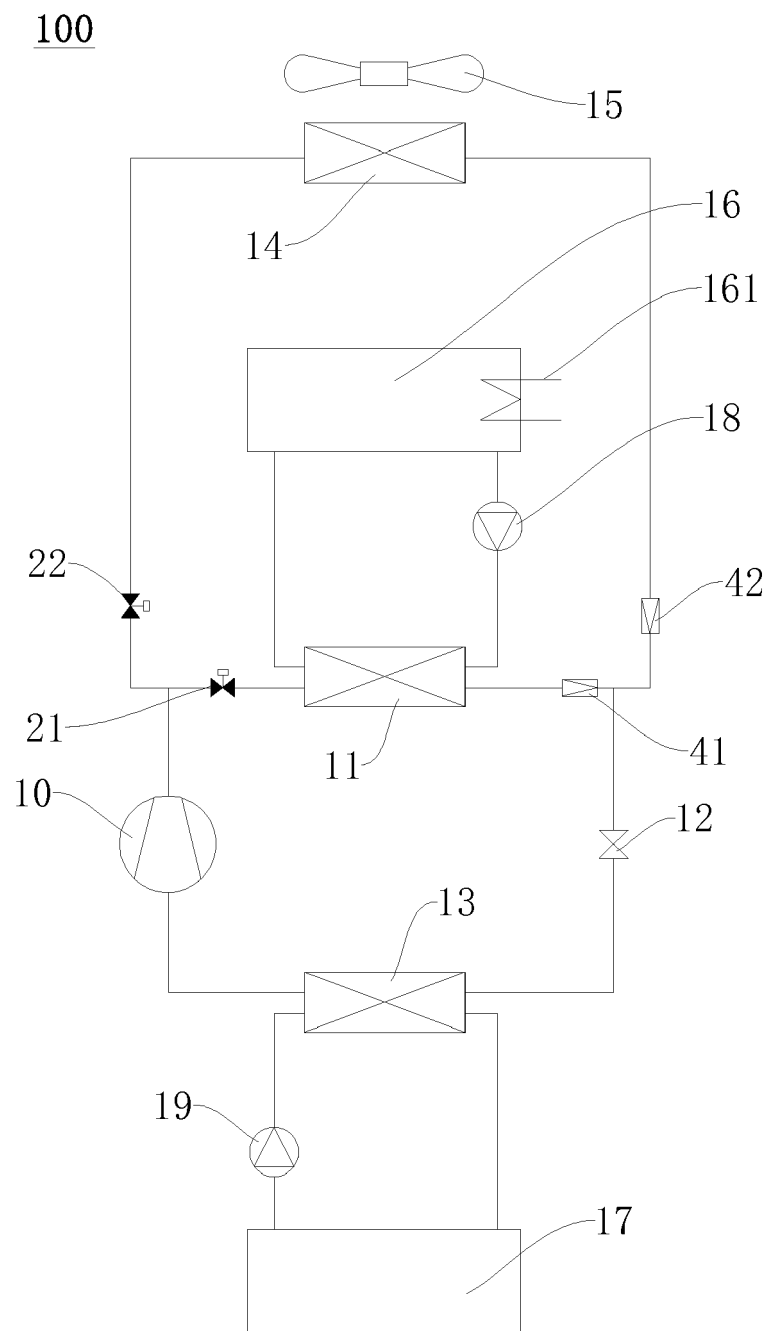


Fig. 1

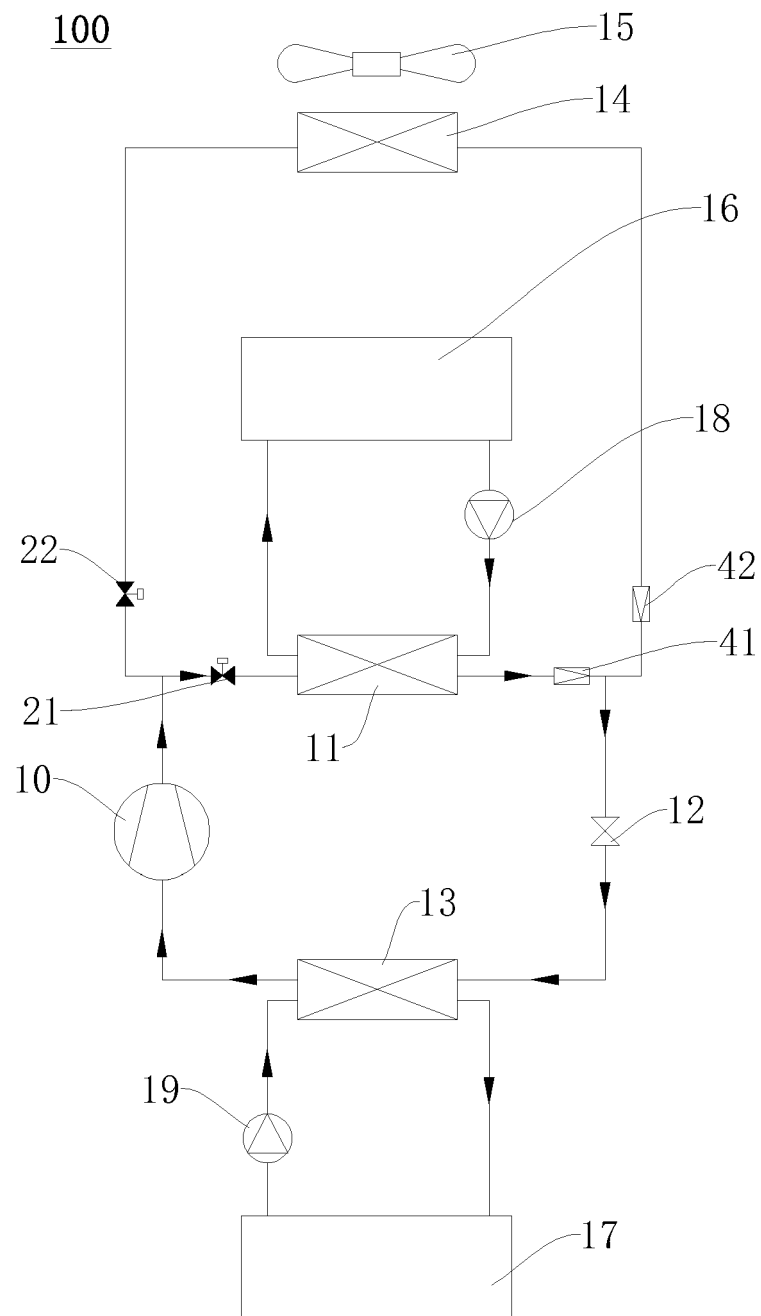


Fig. 2

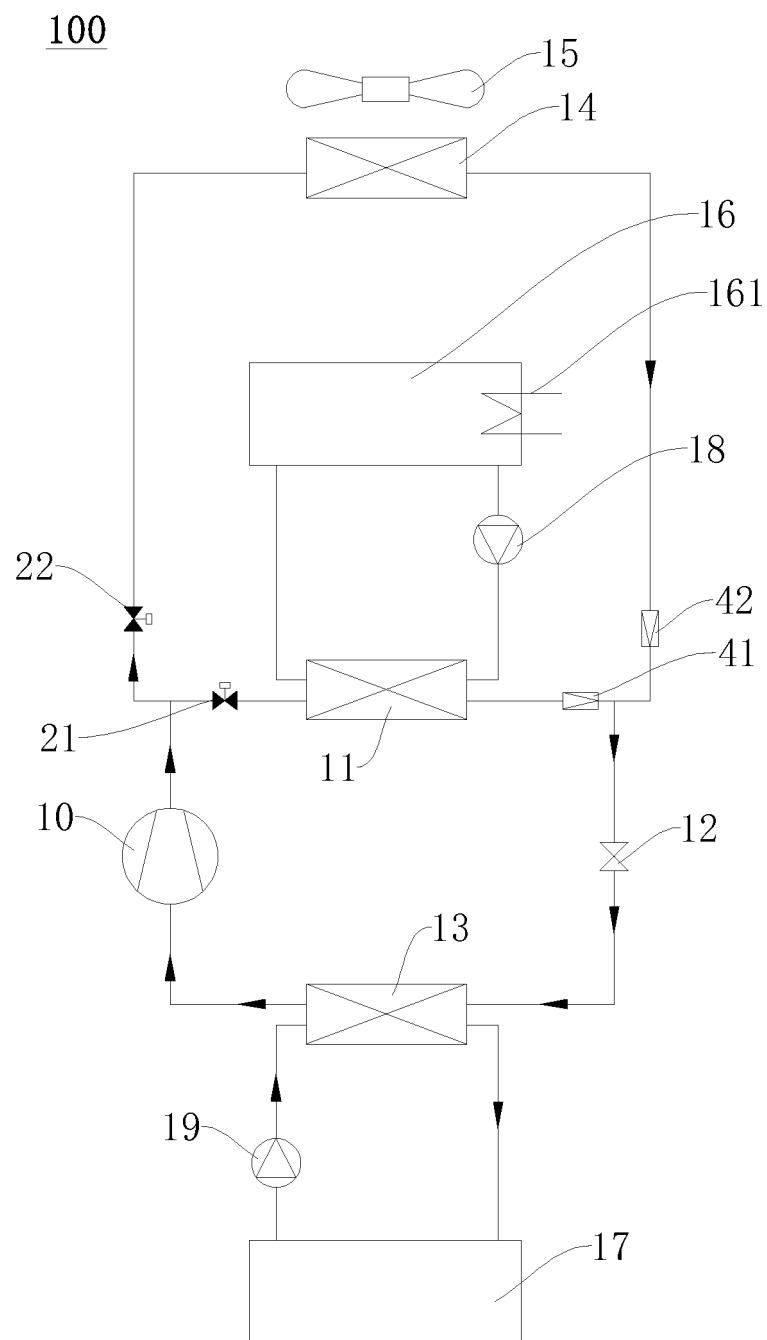


Fig. 3

100

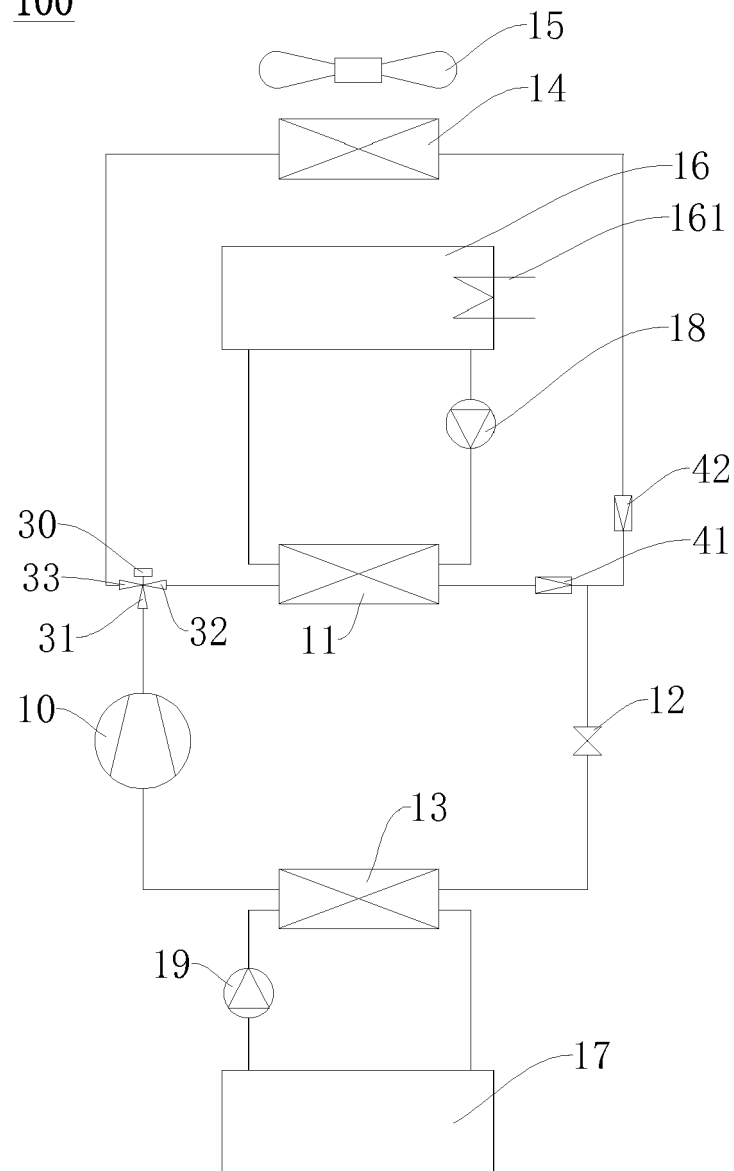


Fig. 4

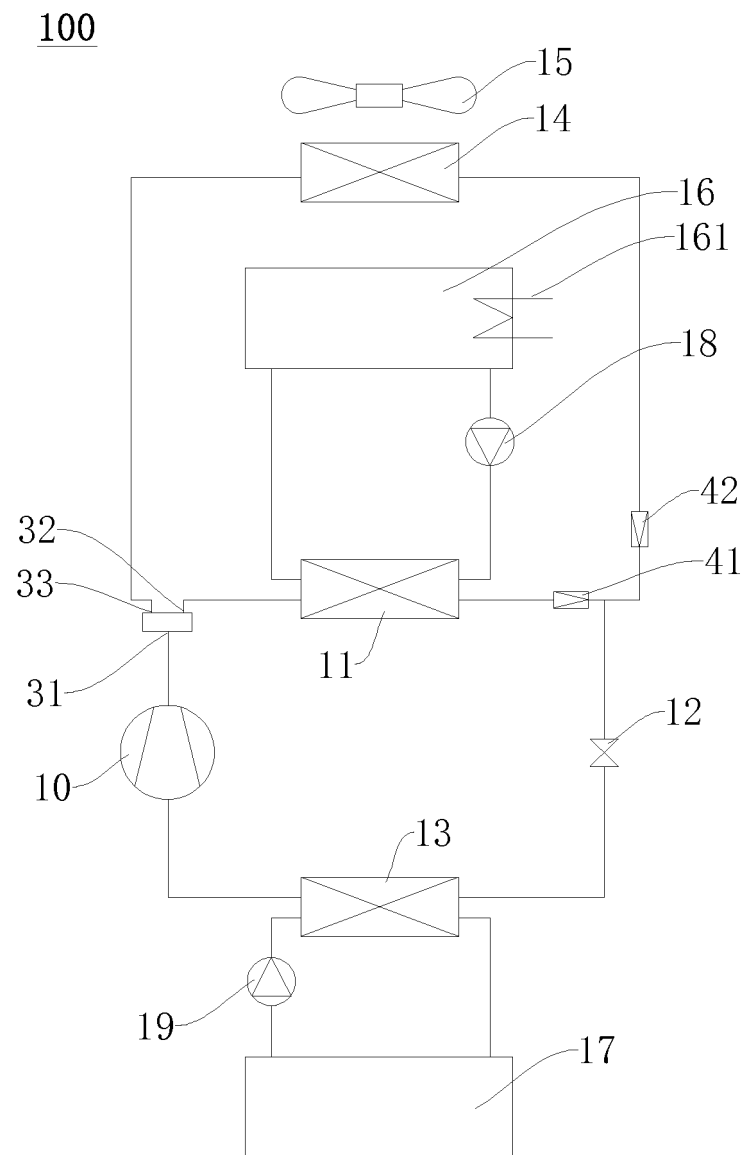


Fig. 5

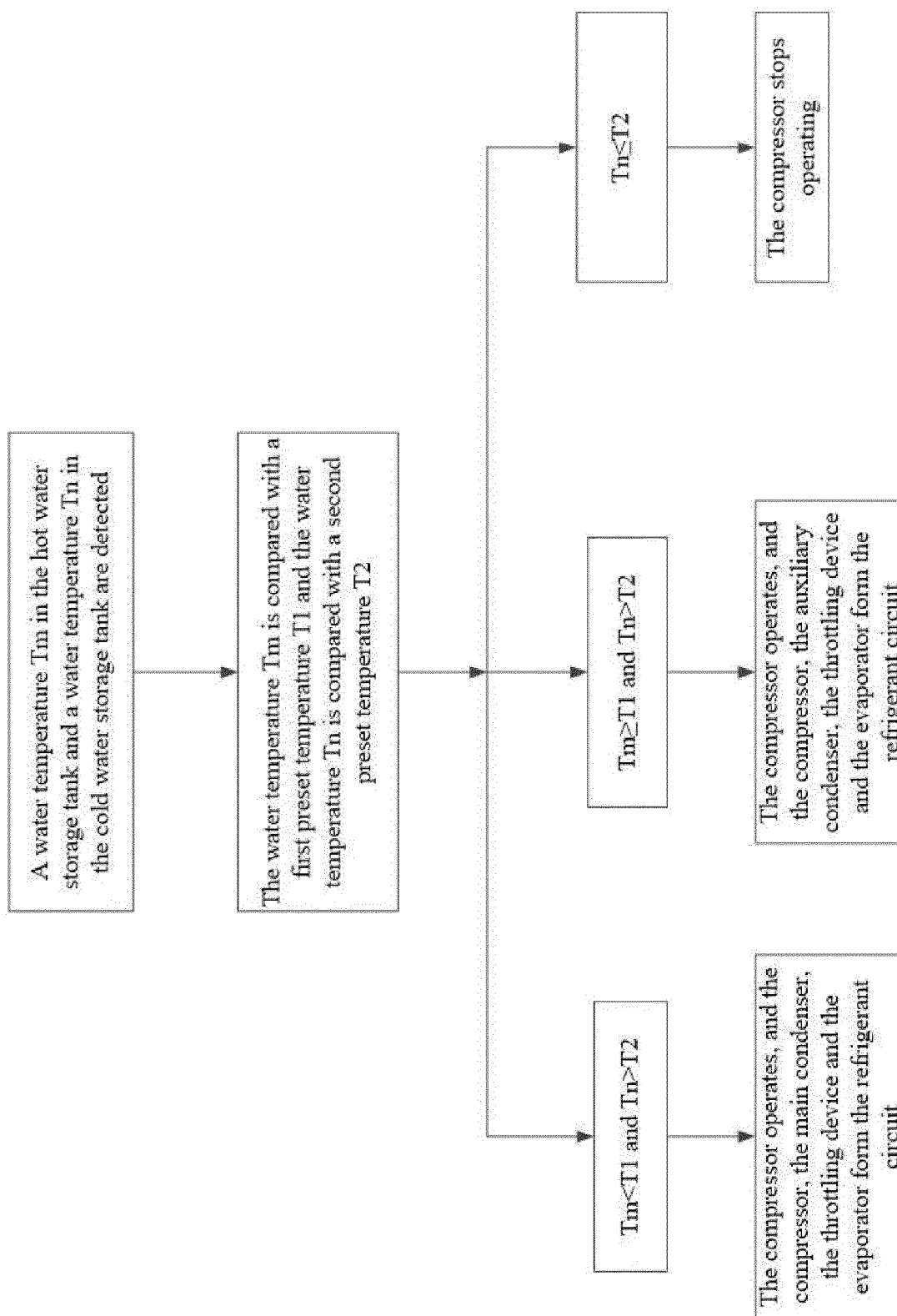


Fig. 6

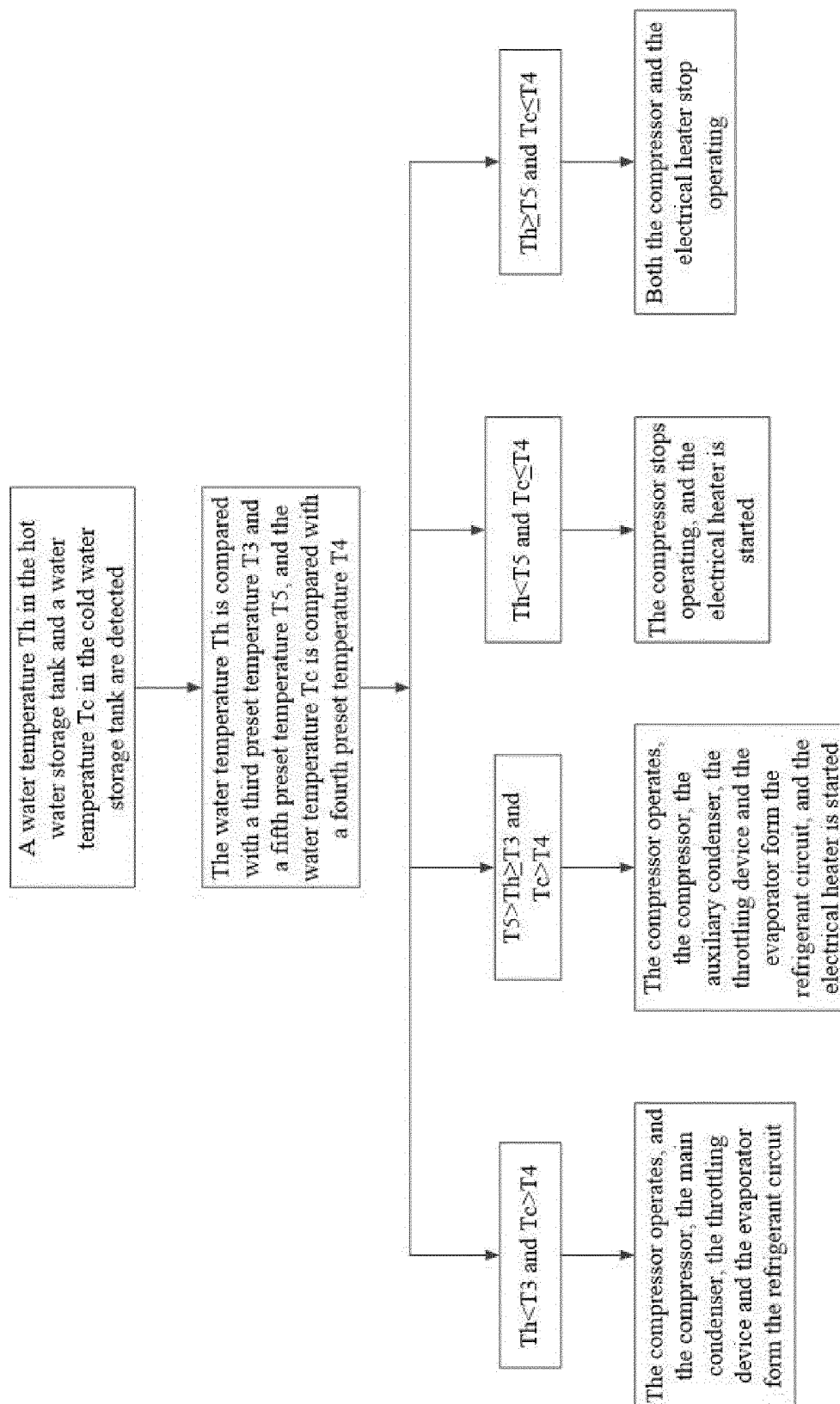


Fig. 7

200

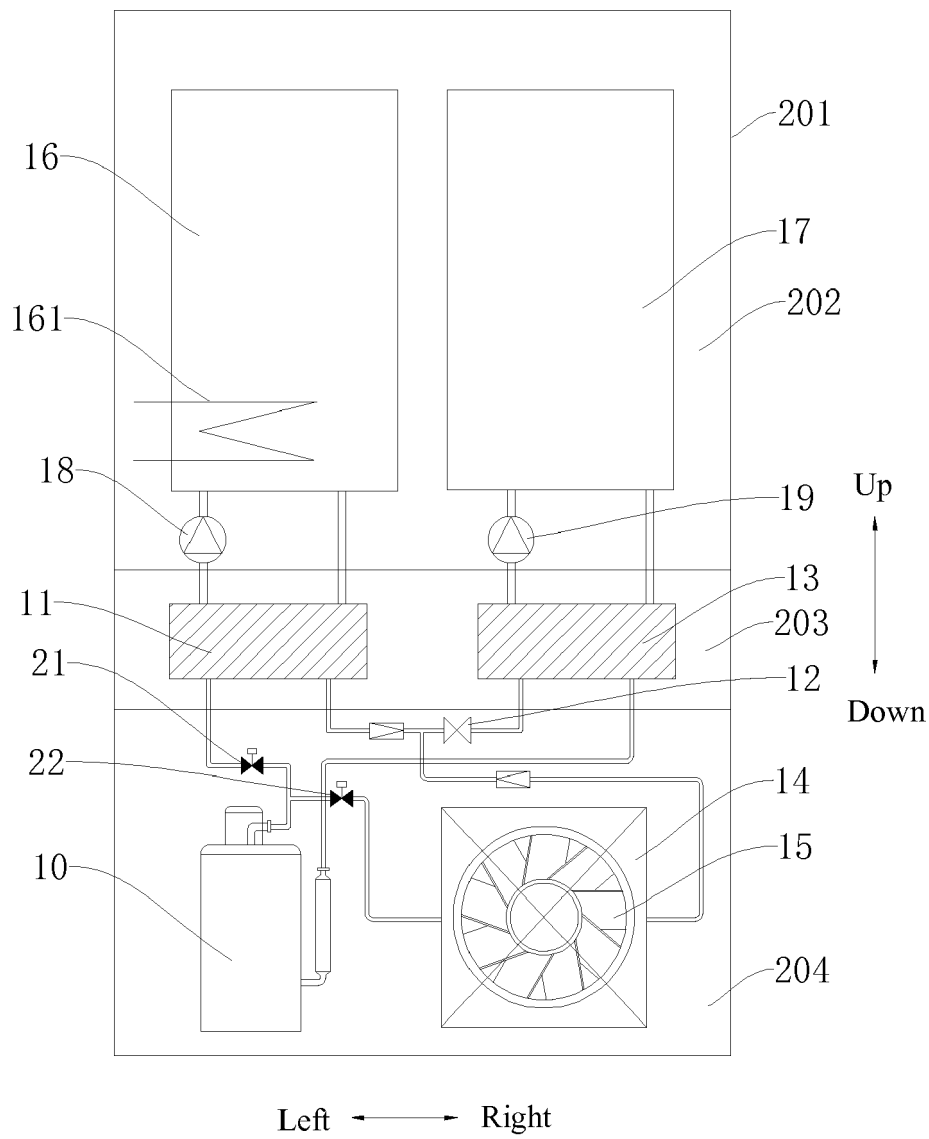


Fig. 8



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 17 1690

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			F25B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 September 2017	Examiner 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			

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