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(54) **AIR-CONDITIONING SYSTEM**

(57) Provided is an air-conditioning system. The air-conditioning system comprises a compressor, a four-way valve, a gas-liquid separator, a water tank, a throttling device, a liquid storage device, a target heat exchanger, a first circuit, a valve assembly, and a controller. The controller is coupled to the valve assembly and the four-way valve, so as to control the connection or disconnection of the first circuit. The controller is configured to obtain a target operation mode of the air-conditioning system, wherein the target operation mode comprises a water heating mode. The state of the valve assembly and the connection state between different ports of the four-way valve are controlled according to the target operation mode, so as to adjust the water temperature in the water tank.

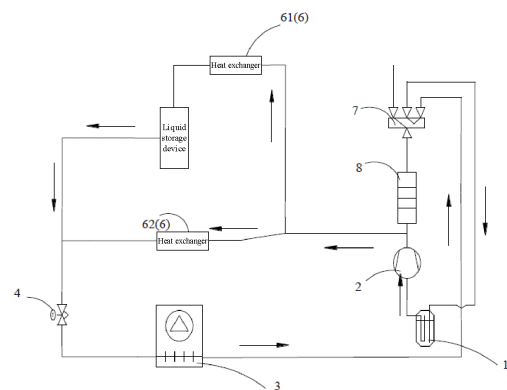


FIG. 7

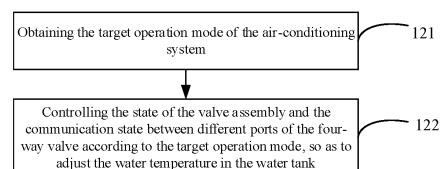


FIG. 8A

EP 4 772 803 A1

Description

[0001] This application claims priority to Chinese Patent Application No. 202311119252.1 filed on August 31, 2023, Chinese Patent Application No. 202311119322.3 filed on August 31, 2023, Chinese Patent Application No. 202311119288.X filed on August 31, 2023, Chinese Patent Application No. 202311119275.2 filed on August 31, 2023, and Chinese Patent Application No. 202311119311.5 filed on August 31, 2023, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of air conditioning technologies, and in particular, to an air-conditioning system.

BACKGROUND

[0003] Air-conditioning systems are widely used for adjusting indoor temperatures, and include indoor units and outdoor units. The indoor unit is arranged indoors and configured to perform heat exchange on indoor air. The outdoor unit includes a compressor, and the compressor compresses a low-temperature or low-pressure refrigerant into a high-temperature and high-pressure refrigerant and outputs the refrigerant to a heat exchanger, so that the refrigerant exchanges heat with air.

SUMMARY

[0004] In an aspect, an air-conditioning system is provided. The air-conditioning system includes a compressor, a four-way valve, a gas-liquid separator, a water tank, a throttling device, a liquid storage device, a target heat exchanger, a first circuit, a valve assembly, and a controller. The four-way valve includes a first port, a second port, a third port and a fourth port. The gas-liquid separator is connected to a first end of the compressor and the second port. The water tank is connected to a second end of the compressor and the fourth port. The liquid storage device is connected to the throttling device. The target heat exchanger is connected to the first port and the third port, and the target heat exchanger is configured to exchange heat with air to absorb heat of the air. A refrigerant flows through the first circuit, the first circuit includes a heat exchange flow path, and the heat exchange flow path is formed by connecting the compressor and the water tank, and configured to exchange heat between the refrigerant in the heat exchange flow path and water in the water tank. The valve assembly is arranged in the first circuit and configured to connect or disconnect the first circuit. The controller is coupled to the valve assembly and the four-way valve, so as to control the connection or disconnection of the first circuit. The controller is configured to obtain a target operation mode of the air-conditioning system; the target operation mode

including a water heating mode. A state of the valve assembly and a communication state between different ports of the four-way valve are controlled according to the target operation mode, so as to adjust a water temperature in the water tank.

[0005] In another aspect, an air-conditioning system is provided. The air-conditioning system includes a compressor, a four-way valve, a gas-liquid separator, a water tank, a throttling device, a liquid storage device, a first heat exchanger, a second heat exchanger, a second circuit, a valve assembly, and a controller. The four-way valve includes a first port, a second port, a third port and a fourth port. The gas-liquid separator is connected to a first end of the compressor and the second port. The water tank is connected to a second end of the compressor and the fourth port. The liquid storage device is connected to the throttling device. The first heat exchanger is configured to exchange heat with first indoor air, a first end of the first heat exchanger is connected to a second end of the liquid storage device, and a second end of the first heat exchanger is connected to the first port. The second heat exchanger is configured to exchange heat with second indoor air, a first end of the second heat exchanger is connected to a first end of the throttling device and a first end of the liquid storage device, and a second end of the second heat exchanger is connected to the second end of the first heat exchanger and the third port. A refrigerant of the second circuit flows through the second circuit, so that the refrigerant exchanges heat with the first indoor air and the second indoor air respectively. The valve assembly is arranged in the second circuit and configured to connect or disconnect the second circuit; the controller is connected to the valve assembly and the four-way valve and configured to: obtain a target operation mode of the air-conditioning system, the target operation mode including a fourth coordination mode, and the fourth coordination mode including a heating mode and a cooling mode; determine that the target operation mode is the fourth coordination mode; and control the valve assembly to be opened and closed and control the third port and the fourth port of the four-way valve to be communicated according to the fourth coordination mode, so as to adjust one of the first heat exchanger and the second heat exchanger to be a condenser and the other to be an evaporator.

[0006] In some embodiments, the valve assembly includes a first valve, a second valve, a third valve, a fourth valve, a fifth valve, a sixth valve, and a seventh valve. A first valve port of the first valve is connected to the third port, and a second valve port of the first valve is connected to the second end of the second heat exchanger. A first valve port of the second valve is connected to a second end of the throttling device, and a second valve port of the second valve is connected to the second valve port of the first valve. A first valve port of the third valve is connected to the first end of the second heat exchanger, and a second valve port of the third valve is connected to the first end of the throttling device and the first end of the

liquid storage device. A first valve port of the fourth valve is connected to the first end of the first heat exchanger, and a second valve port of the fourth valve is connected to the second end of the liquid storage device. A first valve port of the fifth valve is connected to the first port, and a second valve port of the fifth valve is connected to the second end of the second heat exchanger. A first valve port of the sixth valve is connected to the second end of the first heat exchanger. A first valve port of the seventh valve is connected to a second valve port of the sixth valve, and a second valve port of the seventh valve is connected to the second end of the second heat exchanger.

[0007] In some embodiments, the valve assembly further includes a ninth valve and an eleventh valve. A first valve port of the ninth valve is connected to an outlet of the compressor and the water tank, and a second valve port of the ninth valve is connected to the second valve port of the sixth valve and the first valve port of the seventh valve. A first valve port of the eleventh valve is connected to the first end of the second heat exchanger, and a second valve port of the eleventh valve is connected to the second end of the throttling device and the first valve port of the second valve.

[0008] In some embodiments, the controller is further configured to: control the first heat exchanger to be started, and control the second heat exchanger to be started. The valve assembly is controlled to be in a twelfth state. In the twelfth state, the fourth valve, the fifth valve, the seventh valve, the ninth valve, and the eleventh valve are respectively opened, and the first valve, the second valve, the third valve, and the sixth valve are respectively closed.

[0009] In some embodiments, the valve assembly further includes a tenth valve and a twelfth valve. A first valve port of the tenth valve is connected to the second end of the second heat exchanger, and a second valve port of the tenth valve is connected to the second valve port of the first valve. A first valve port of the twelfth valve is connected to the outlet of the compressor and the water tank, and a second valve port of the twelfth valve is connected to the second valve port of the tenth valve. The controller is further configured to: control the first heat exchanger to be started, and control the second heat exchanger to be started. The valve assembly is controlled to be in a thirteenth state. In the thirteenth state, the fourth valve, the fifth valve, the seventh valve, the tenth valve, the eleventh valve, and the twelfth valve are respectively opened, and the first valve, the second valve, the third valve, the sixth valve, and the ninth valve are respectively closed.

[0010] In some embodiments, the valve assembly further includes a tenth valve. A first valve port of the tenth valve is connected to the second end of the second heat exchanger, and a second valve port of the tenth valve is connected to the second valve port of the first valve; the controller is further configured to: control the first heat exchanger to be started, and control the second

heat exchanger to be started. The valve assembly is controlled to be in a fourteenth state. In the fourteenth state, the first valve, the fourth valve, the sixth valve, the ninth valve, the tenth valve, and the eleventh valve are respectively opened; the second valve, the third valve, the fifth valve and the seventh valve are respectively closed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1A is a structural view of an air-conditioning system according to some embodiments;

FIG. 1B is a schematic diagram of a refrigerant cycle corresponding to a cooling mode in some embodiments;

FIG. 2 is a block diagram of the air-conditioning system according to some embodiments;

FIG. 3 is another schematic diagram of the refrigerant cycle corresponding to the cooling mode in some embodiments;

FIG. 4 is still another schematic diagram of the refrigerant cycle corresponding to the cooling mode in some embodiments;

FIG. 5 is still another schematic diagram of the refrigerant cycle corresponding to the cooling mode in some embodiments;

FIG. 6 is a schematic diagram of a refrigerant cycle corresponding to a heating mode in some embodiments;

FIG. 7 is another schematic diagram of the refrigerant cycle corresponding to the heating mode in some embodiments;

FIG. 8A is a flow chart of steps performed by a controller in some embodiments;

FIG. 8B is a schematic diagram of a refrigerant cycle corresponding to a water heating mode in some embodiments;

FIG. 9 is another schematic diagram of the refrigerant cycle corresponding to the water heating mode in some embodiments;

FIG. 10A is another flow chart of the steps performed by the controller in some embodiments;

FIG. 10B is a schematic diagram of a refrigerant cycle corresponding to a first coordination mode in some embodiments;

FIG. 11 is another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;

FIG. 12 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;

FIG. 13 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;

FIG. 14 is still another schematic diagram of the refrigerant cycle corresponding to the first coordina-

tion mode in some embodiments;
 FIG. 15 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;
 FIG. 16 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;
 FIG. 17 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;
 FIG. 18 is still another schematic diagram of the refrigerant cycle corresponding to the first coordination mode in some embodiments;
 FIG. 19A is still another flow chart of the steps performed by the controller in some embodiments;
 FIG. 19B is a schematic diagram of a refrigerant cycle corresponding to a second coordination mode in some embodiments;
 FIG. 20 is another schematic diagram of the refrigerant cycle corresponding to the second coordination mode in some embodiments;
 FIG. 21 is still another schematic diagram of the refrigerant cycle corresponding to the second coordination mode in some embodiments;
 FIG. 22A is still another flow chart of the steps performed by the controller in some embodiments;
 FIG. 22B is a schematic diagram of a refrigerant cycle corresponding to a third coordination mode in some embodiments;
 FIG. 23 is another schematic diagram of the refrigerant cycle corresponding to the third coordination mode in some embodiments;
 FIG. 24A is still another flow chart of the steps performed by the controller in some embodiments;
 FIG. 24B is a schematic diagram of a refrigerant cycle corresponding to a fourth coordination mode in some embodiments;
 FIG. 25 is another schematic diagram of the refrigerant cycle corresponding to the fourth coordination mode in some embodiments;
 FIG. 26 is another schematic diagram of the refrigerant cycle corresponding to the fourth coordination mode in some embodiments; and
 FIG. 27 is another schematic diagram of the refrigerant cycle corresponding to the fourth coordination mode in some embodiments.

DETAILED DESCRIPTION

[0012] Some embodiments of the present disclosure are clearly and completely described below with reference to the accompanying drawings. However, the described embodiments are not all but only a part of the embodiments of the present disclosure. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present disclosure shall fall within the protection scope of the present disclosure.

[0013] Unless required otherwise in the context, throughout the specification and the claims, the term "comprise" and its other forms such as "comprises" and "comprising" are interpreted as open and inclusive meaning "including, but not limited to". In the description of the specification, the terms "one embodiment", "some embodiments", "exemplary embodiments", "example", "specific example", "some examples", or the like, are intended to indicate that a particular feature, structure, material, or characteristic in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. The schematic representations of the above terms do not necessarily refer to the same embodiment or example. In addition, the particular feature, structure, material, or characteristic may be included in any suitable manner in any one or more embodiments or examples.

[0014] Hereinafter, the 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 include one or more of this feature explicitly or implicitly. In the description of the embodiments of the present disclosure, "a plurality" means two or more unless otherwise specified.

[0015] In describing some embodiments, the expressions "coupled" and "connected" along with their derivatives may be used. The term "connected" is to be interpreted broadly, and for example, "connected" may be a fixed connection, a detachable connection, or an integral connection; may be a direct connection or indirect connection via an intermediate medium. The term "coupled" indicates that two or more components are in direct physical or electrical contact. The terms "coupled" or "communicatively coupled" may also mean that two or more components are not in direct contact with each other, but yet still cooperate or interact with each other. The embodiments disclosed herein are not necessarily limited to the contents herein.

[0016] "At least one of A, B, and C" and "at least one of A, B, or C" have the same meaning and both include the following combinations of A, B, and C: A alone, B alone, C alone, a combination of A and B, a combination of A and C, a combination of B and C, and a combination of A, B, and C.

[0017] The use of "adapted to" or "configured for" herein means open and inclusive languages and does not exclude devices adapted to or configured for performing additional tasks or steps.

[0018] As used herein, "about", "roughly", or "approximately" includes the stated value as well as an average value within an acceptable deviation range for the particular value as determined by one of ordinary skill in the art in view of the measurement in question and the error associated with measuring the particular quantity (i.e., the limitations of the measurement system).

[0019] Typically, an air-conditioning system generates

excess heat during operation. For example, during heating or cooling of an indoor unit, a refrigerant in a condenser exchanges heat with air, and the air cannot absorb all heat released from the refrigerant. The unabsorbed heat is directly discharged to an environment, thereby increasing thermal pollution of the environment and causing energy waste.

[0020] In order to solve the above problem, some embodiments of the present disclosure provide an air-conditioning system 1000. The air-conditioning system 1000 can meet the requirements of cooling, heating and water heating, and can make full use of the excess heat generated by the indoor unit during cooling or heating to produce hot water, thereby reducing the thermal pollution of the environment, reducing the energy waste and saving an electricity charge.

[0021] In some embodiments, as shown in FIG. 1A, the air-conditioning system 1000 includes an indoor unit 100. The indoor unit 100 is arranged indoors and exchanges heat with indoor air.

[0022] In some embodiments, as shown in FIG. 1A, the air-conditioning system 1000 further includes an outdoor unit 200. The indoor unit 100 and the outdoor unit 200 are connected by a pipeline to transport a refrigerant.

[0023] It should be noted that since the indoor unit 100 is located indoors and the outdoor unit 200 is located outdoors in FIG. 1A, the outdoor unit 200 is indicated by a dotted line in FIG. 1A.

[0024] In some embodiments, as shown in FIG. 1B, the air-conditioning system 1000 includes a compressor 2. The compressor 2 is configured to compress the refrigerant, so that the low-temperature and low-pressure refrigerant is compressed to form a high-temperature and high-pressure refrigerant.

[0025] As shown in FIG. 1B, the air-conditioning system 1000 further includes a four-way valve 7. The four-way valve 7 is configured to switch a flow direction of the refrigerant between different components. The four-way valve 7 includes four ports: a first port E, a second port S, a third port C and a fourth port D.

[0026] It should be noted that, according to a working principle of the four-way valve, when the fourth port D is communicated with one of the first port E and the third port C, the other two ports are also communicated. For example, when the fourth port D is communicated with the first port E, the second port S is communicated with the third port C; for another example, when the fourth port D is communicated with the third port C, the second port S is communicated with the first port E.

[0027] As shown in FIG. 1B, the air-conditioning system 1000 further includes a gas-liquid separator 1. The gas-liquid separator 1 is configured to separate a gaseous refrigerant from a liquid refrigerant to allow the gaseous refrigerant to enter the compressor 2. A first end of the gas-liquid separator 1 is connected to a first end of the compressor 2. A second end of the gas-liquid separator 1 is connected to the third port C.

[0028] As shown in FIG. 1B, the air-conditioning sys-

tem 1000 further includes a target heat exchanger 30. The target heat exchanger 30 is connected to the four-way valve 7, and configured to exchange heat with outdoor air or indoor air to absorb heat of the outdoor air or the indoor air.

[0029] As shown in FIG. 1B, the target heat exchanger 30 includes a third heat exchanger 3 (finned heat exchanger). The third heat exchanger 3 is configured to exchange heat between air and the refrigerant transported in the third heat exchanger 3. A first end of the third heat exchanger 3 is connected to the second port S. It should be noted that the third heat exchanger 3 may be arranged in the outdoor unit 200.

[0030] As shown in FIG. 1B, the air-conditioning system 1000 further includes a throttling device 4. The throttling device 4 includes, for example, an expansion valve. A second end of the throttling device 4 is connected to a second end of the third heat exchanger 3. An opening degree of the throttling device 4 is adjustable to control a flow rate and pressure of the refrigerant flowing through the throttling device 4. For example, the liquid refrigerant condensed in a condenser expands into a low-pressure liquid refrigerant through the throttling device 4.

[0031] As shown in FIG. 1B, the air-conditioning system 1000 further includes a liquid storage device 5. The liquid storage device 5 is configured to store the liquid refrigerant. A first end of the liquid storage device 5 is connected to a first end of the throttling device 4. In this way, the pressure of the refrigerant flowing through the third heat exchanger 3 and the liquid storage device 5 can be adjusted by the opening degree of the throttling device 4, so as to adjust the flow rate of the refrigerant flowing between the third heat exchanger 3 and the liquid storage device 5.

[0032] As shown in FIG. 1B, the target heat exchanger 30 further includes a heat exchanger group 6. It should be noted that the heat exchanger group 6 may be arranged in the indoor unit 100.

[0033] As shown in FIG. 1B, the heat exchanger group 6 includes a first heat exchanger 61. A first end of the first heat exchanger 61 is connected to a second end of the liquid storage device 5. A second end of the first heat exchanger 61 is connected to the first port E.

[0034] As shown in FIG. 1B, the heat exchanger group 6 further includes a second heat exchanger 62. The second heat exchanger 62 is arranged in parallel with the first heat exchanger 61. The heat exchanger group 6 corresponds to a plurality of refrigerant flow path branches, and the first heat exchanger 61 and the second heat exchanger 62 are arranged on different refrigerant flow path branches.

[0035] A first end of the second heat exchanger 62 is connected to the second end of the throttling device 4 and to the first end of the liquid storage device 5. In this way, the pressure of the refrigerant flowing through the third heat exchanger 3 and the second heat exchanger 62 can be adjusted by the opening degree of the throttling device 4, so as to adjust the flow rate of the refrigerant flowing

between the third heat exchanger 3 and the second heat exchanger 62. A second end of the second heat exchanger 62 is connected to the first port E.

[0036] It will be appreciated that the first end of the second heat exchanger 62 is a first end of the heat exchanger group 6. The first end of the first heat exchanger 61 is a second end of the heat exchanger group 6. The second end of the first heat exchanger 61 is a third end of the heat exchanger group 6. The second end of the second heat exchanger 62 is a fourth end of the heat exchanger group 6.

[0037] As shown in FIG. 1B, the air-conditioning system 1000 further includes a water tank 8. The water tank 8 is configured to contain water. A first end of the water tank 8 is connected to the fourth port D of the compressor. A second end of the water tank 8 is connected to a second end of the compressor 2.

[0038] In some embodiments, the water tank 8 includes a heat exchange tube, and the heat exchange tube may be in a coil shape. The water tank 8 further includes an inner container. The inner container can be made of metal, and the heat exchange tube can be wound around an outer side of the inner container.

[0039] In some embodiments, the water tank 8 further includes a heat conducting member. The heat conducting member is arranged between the heat exchange tube and the inner container to enhance heat transfer. For example, the heat conducting member is silicone grease.

[0040] As shown in FIG. 1B, the air-conditioning system 1000 further includes a first circuit 11 (refrigerant circuit). The first circuit 11 is formed by connecting at least the compressor 2, the water tank 8, the target heat exchanger 30, the four-way valve 7, and the gas-liquid separator 1 to each other. For example, at least some of the compressor 2, the four-way valve 7, the third heat exchanger 3, the throttling device 4, the liquid storage device 5, the heat exchanger group 6, the four-way valve 7, the gas-liquid separator 1, the water tank 8, and the compressor 2 are connected to each other to form the first circuit 11.

[0041] It should be noted that the first circuit 11 is different for different target operation modes of the air-conditioning system 1000.

[0042] As shown in FIG. 1B, the first circuit 11 includes a heat exchange flow path 12. A first end of the heat exchange flow path 12 is connected to the second end of the compressor 2, and a second end of the heat exchange flow path 12 is connected to the fourth port D. The high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with domestic water in the water tank 8 through the heat exchange flow path 12 to heat the domestic water, thereby supplying the hot water.

[0043] As shown in FIG. 1B and FIG. 2, the air-conditioning system 1000 further includes a valve assembly 9 (a control valve group). The valve assembly 9 is arranged in the first circuit 11 and configured to connect or disconnect the first circuit 11.

[0044] In some embodiments, as shown in FIG. 1B, the valve assembly 9 includes a first valve 901. A first valve port a of the first valve 901 is connected to the third port C, and a second valve port b of the first valve 901 is connected to the first end of the third heat exchanger 3.

[0045] As shown in FIG. 1B, the valve assembly 9 further includes a second valve 902. A first valve port a of the second valve 902 is connected to the first end of the throttling device 4, and a second valve port b of the fifth valve 905 is connected to the second end of the third heat exchanger 3.

[0046] As shown in FIG. 1B, the valve assembly 9 further includes a third valve 903. A first valve port a of the third valve 903 is connected to the first end of the second heat exchanger 62, and a second valve port b of the third valve 903 is connected to the second end of the throttling device 4 and the first end of the liquid storage device 5.

[0047] As shown in FIG. 1B, the valve assembly 9 further includes a fourth valve 904. A first valve port a of the fourth valve 904 is connected to the first end of the first heat exchanger 61, and a second valve port b of the fourth valve 904 is connected to the second end of the liquid storage device 5.

[0048] As shown in FIG. 1B, the valve assembly 9 further includes a fifth valve 905. A first valve port a of the fifth valve 905 is connected to the first port E, and a second valve port b of the fifth valve 905 is connected to the second end of the first heat exchanger 61.

[0049] As shown in FIG. 1B, the valve assembly 9 further includes a sixth valve 906. A first valve port a of the sixth valve 906 is connected to the second end of the first heat exchanger 61.

[0050] As shown in FIG. 1B, the valve assembly 9 further includes a seventh valve 907. A first valve port a of the seventh valve 907 is connected to a second valve port b of the sixth valve 906, and a second valve port b of the seventh valve 907 is connected to the second end of the second heat exchanger 62.

[0051] In some embodiments, as shown in FIG. 1B, the valve assembly 9 further includes an eighth valve 908. A first valve port a of the eighth valve 908 is connected to the second end of the heat exchange flow path 12, and a second valve port b of the eighth valve 908 is connected to a third end of the liquid storage device 5.

[0052] In some embodiments, as shown in FIG. 1B, the valve assembly 9 further includes a ninth valve 909. A first valve port a of the ninth valve 909 is connected to the second end of the compressor 2, and a second valve port b of the ninth valve 909 is connected to the second valve port b of the sixth valve 906 and the first valve port a of the seventh valve 907.

[0053] In some embodiments, as shown in FIG. 1B, the valve assembly 9 further includes a twelfth valve 912. A first valve port a of the twelfth valve 912 is connected to the second end of the compressor 2, and a second valve port b of the twelfth valve 912 is connected to the first end of the third heat exchanger 3.

[0054] The first valve 901, the second valve 902, the third valve 903, the fourth valve 904, the fifth valve 905, the sixth valve 906, the seventh valve 907, the eighth valve 908, the ninth valve 909, and the twelfth valve 912 may be multi-way valves respectively. The multi-way valve is, for example, a three-way valve or a four-way valve.

[0055] It should be noted that the flow direction of the refrigerant in the air-conditioning system 1000 can be changed by opening and closing each valve in the valve assembly 9. The valve assembly 9 corresponds to a plurality of states. The multiple valves in the valve assembly 9 have different opened and closed states for the plurality of states.

[0056] It should be noted that when the compressor 2, the water tank 8, the four-way valve 7, and the gas-liquid separator 1 are connected, the connection needs to be performed in a determined direction. That is, the compressor 2, the water tank 8, the four-way valve 7, and the gas-liquid separator 1 have directivity. When the valve assembly 9, the first heat exchanger 61, the second heat exchanger 62, and the third heat exchanger 3 are connected, there is no need to consider directivity of the connection.

[0057] In some embodiments, as shown in FIG. 2, the air-conditioning system 1000 further includes a controller 10. The controller 10 is connected to the valve assembly 9 and the four-way valve 7. The controller 10 includes a processor. The processor may include a central processing unit (CPU), a microprocessor, and an application specific integrated circuit (ASIC), and may be configured to perform corresponding operations described in the controller 10 when the processor executes a program stored in a non-transitory computer-readable medium coupled to the controller 10.

[0058] In some embodiments, the controller 10 is configured to: obtain a target operation mode of the air-conditioning system 1000, and control opening and closing of the valve assembly 9 and communication between different ports of the four-way valve 7 according to the target operation mode, so as to adjust an indoor temperature or a temperature of the water in the water tank 8.

[0059] It should be noted that the target operation mode includes a cooling mode, a heating mode, and a water heating mode. Different target operation modes correspond to different control instructions.

[0060] It should be noted that a user may send the control instruction to the air-conditioning system 1000 by means of a language, a gesture, or the like, through a remote controller, an application in a mobile terminal, or a control panel on a body of the air-conditioning system 1000, and the air-conditioning system 1000 runs the target operation mode corresponding to the instruction after receiving the corresponding instruction.

[0061] Different target operation modes are described below according to various states corresponding to the valve assembly 9 and communication or blockage between the four ports of the four-way valve 7.

[0062] In some embodiments, the target operation mode is the cooling mode, and as shown in FIG. 1B and FIG. 3, the first circuit 11 includes a fourteenth sub-circuit 111. The controller 10 is configured to: according to the cooling mode, control the valve assembly 9 to be in a fifteenth state, and control the third port C to be communicated with the fourth port D to connect the fourteenth sub-circuit 111, so as to cause the indoor temperature to reach a fifth preset temperature. The fifth preset temperature may be set by the user.

[0063] When the valve assembly 9 is in the fifteenth state, the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the first valve port a of the second valve 902 is communicated with the second valve port b of the second valve 902, the first valve port a of the third valve 903 is communicated with the second valve port b of the third valve 903, the first valve port a of the fourth valve 904 is communicated with the second valve port b of the fourth valve 904, the first valve port a of the fifth valve 905 is communicated with the second valve port b of the fifth valve 905, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, and the first valve port a of the seventh valve 907 is communicated with the second valve port b of the seventh valve 907. The first valve port a of the eighth valve 908 is blocked from the second valve port b of the eighth valve 908, the first valve port a of the ninth valve 909 is blocked from the second valve port b of the ninth valve 909, and the first valve port a of the twelfth valve 912 is blocked from the second valve port b of the twelfth valve 912.

[0064] In the case where a first control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the cooling mode. As shown in FIG. 1B and FIG. 3, the refrigerant circulates in the fourteenth sub-circuit 111 in the direction of the arrows shown in FIG. 3, and the fourteenth sub-circuit 111 is shown by the bold solid line in FIG. 1B. Since the fourth port D is communicated with the third port C, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows to the fourth port D through the water tank 8. Since the first valve port a and the second valve port b of the first valve 901 are communicated with each other, the refrigerant may flow into the first valve port a of the first valve 901 through the third port C of the four-way valve 7, and flow into the third heat exchanger 3 through the second valve port b of the first valve 901. The high-temperature and high-pressure refrigerant flows through the third heat exchanger 3 to exchange heat with the outdoor air to be converted into a low-temperature refrigerant, and the outdoor air absorbs the heat released by the high-temperature and high-pressure refrigerant. Since the first valve port a and the second valve port b of the second valve 902 are communicated with each other, the refrigerant after heat release can flow into the throttling device 4 through the second valve 902.

[0065] After the throttling device 4 adjusts the flow rate

of the refrigerant, since the first valve port a and the second valve port b of the third valve 903 are communicated with each other, a first part of the refrigerant flows into the second heat exchanger 62 through the third valve 903, and the low-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor air to absorb heat of the indoor air, thereby lowering the indoor temperature. A second part of the refrigerant flows into the liquid storage device 5 and can be stored by the liquid storage device 5. The refrigerant discharged from the liquid storage device 5 flows into the first heat exchanger 61 through the fourth valve 904, and the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor air to absorb heat of the indoor air, thereby lowering the indoor temperature. Accordingly, the refrigerant exchanges heat with the indoor air through the first heat exchanger 61 and the second heat exchanger 62, so as to cause the indoor temperature to reach the fifth preset temperature.

[0066] Since the first valve port a of the seventh valve 907 is communicated with the second valve port b of the seventh valve 907, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, and the first valve port a of the fifth valve 905 is communicated with the second valve port b of the fifth valve 905, the refrigerant flowing out of the second heat exchanger 62 passes through the seventh valve 907, the sixth valve 906, and the fifth valve 905 in sequence to flow into the first port E. The refrigerant flowing out of the first heat exchanger 61 flows into the first port E through the fifth valve 905. Since the first port E is communicated with the second port S, the refrigerant flows into the gas-liquid separator 1 through the second port S, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, by controlling the valve assembly 9 to be in the fifteenth state, and controlling the third port C to be communicated with the fourth port D of the four-way valve 7 to connect the fourteenth sub-circuit 111, the indoor temperature reaches the fifth preset temperature to meet the cooling requirement.

[0067] In some embodiments, as shown in FIG. 4 and FIG. 5, the target operation mode is the cooling mode, and the first circuit 11 includes a fifteenth sub-circuit 112. The controller 10 is further configured to: according to the cooling mode, control the valve assembly 9 to be in a sixteenth state, and control the third port C to be communicated with the fourth port D of the four-way valve 7 to connect the fifteenth sub-circuit 112, so as to cause the indoor temperature to reach the fifth preset temperature.

[0068] When the valve assembly 9 is in the sixteenth state, the first valve port a of the second valve 902 is communicated with the second valve port b of the second valve 902, the first valve port a of the third valve 903 is communicated with the second valve port b of the third valve 903, the first valve port a of the fourth valve 904 is communicated with the second valve port b of the fourth

valve 904, the first valve port a of the fifth valve 905 is communicated with the second valve port b of the fifth valve 905, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, and the first valve port a of the seventh valve 907 is communicated with the second valve port b of the seventh valve 907. The first valve port a of the twelfth valve 912 is communicated with the second valve port b of the twelfth valve 912. The first valve port a of the first valve 901 is blocked from the second valve port b of the first valve 901, the first valve port a of the eighth valve 908 is blocked from the second valve port b of the eighth valve 908, and the first valve port a of the ninth valve 909 is blocked from the second valve port b of the ninth valve 909.

[0069] In the case where a second control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the cooling mode. As shown in FIG. 4 and FIG. 5, the refrigerant circulates in the fifteenth sub-circuit 112 in the direction of the arrows shown in FIG. 5, and the fifteenth sub-circuit 112 is shown by the bold solid line in FIG. 4. Since the first valve port a of the twelfth valve 912 and the second valve port b of the twelfth valve 912 are communicated with each other, the high-temperature and high-pressure refrigerant discharged from the compressor 2 may flow into the third heat exchanger 3 through the twelfth valve 912. The high-temperature and high-pressure refrigerant flows through the third heat exchanger 3 to exchange heat with the outdoor air to be converted into a low-temperature refrigerant, and the outdoor air absorbs the heat released by the high-temperature and high-pressure refrigerant. Since the first valve port a and the second valve port b of the second valve 902 are communicated with each other, the refrigerant after heat release can flow into the throttling device 4 through the second valve 902.

[0070] After the throttling device 4 adjusts the flow rate of the refrigerant, since the first valve port a and the second valve port b of the third valve 903 are communicated with each other, a first part of the refrigerant flows into the second heat exchanger 62 through the third valve 903, and the low-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor air to absorb heat of the indoor air, thereby lowering the indoor temperature. A second part of the refrigerant flows into the liquid storage device 5 and can be stored by the liquid storage device 5. The refrigerant discharged from the liquid storage device 5 flows into the first heat exchanger 61 through the fourth valve 904, and the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor air to absorb heat of the indoor air, thereby lowering the indoor temperature. Accordingly, the refrigerant exchanges heat with the indoor air through the first heat exchanger 61 and the second heat exchanger 62, so as to cause the indoor temperature to reach the fifth preset temperature.

[0071] Since the first valve port a of the seventh valve 907 is communicated with the second valve port b of the

seventh valve 907, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, and the first valve port a of the fifth valve 905 is communicated with the second valve port b of the fifth valve 905, the refrigerant flowing out of the second heat exchanger 62 passes through the seventh valve 907, the sixth valve 906, and the fifth valve 905 in sequence to flow into the first port E. The refrigerant flowing out of the first heat exchanger 61 flows into the first port E through the fifth valve 905. Since the first port E is communicated with the second port S, the refrigerant may flow into the gas-liquid separator 1 through the second port S, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, by controlling the valve assembly 9 to be in the sixteenth state, and controlling the third port C to be communicated with the fourth port D of the four-way valve 7 to connect the fifteenth sub-circuit 112, the indoor temperature reaches the fifth preset temperature to meet the cooling requirement.

[0072] It should be noted that although the third port C is communicated with the fourth port D, since the first valve port a of the first valve 901 is blocked from the second valve port b of the first valve 901, the refrigerant cannot flow to the third heat exchanger 3 through the first valve 901.

[0073] In some embodiments, the target operation mode is the heating mode, and as shown in FIG. 6 and FIG. 7, the first circuit 11 includes a sixteenth sub-circuit 113. The controller 10 is configured to: according to the heating mode, control the valve assembly 9 to be in a seventeenth state, and control the first port E to be communicated with the fourth port D of the four-way valve 7 to connect the sixteenth sub-circuit 113, so as to cause the indoor temperature to reach a fourth preset temperature. The fourth preset temperature may be set by the user.

[0074] When the valve assembly 9 is in the seventeenth state, the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the first valve port a of the second valve 902 is communicated with the second valve port b of the second valve 902, the first valve port a of the third valve 903 is communicated with the second valve port b of the third valve 903, the first valve port a of the fourth valve 904 is communicated with the second valve port b of the fourth valve 904, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, the first valve port a of the seventh valve 907 is communicated with the second valve port b of the seventh valve 907, and the first valve port a of the ninth valve 909 is communicated with the second valve port b of the ninth valve 909. The first valve port a of the fifth valve 905 is blocked from the second valve port b of the fifth valve 905, the first valve port a of the eighth valve 908 is blocked from the second valve port b of the eighth valve 908, and the first valve port a of the twelfth valve 912 is

blocked from the second valve port b of the twelfth valve 912.

[0075] It should be noted that although the third port E is communicated with the fourth port D, since the first valve port a of the fifth valve 905 is blocked from the second valve port b of the fifth valve 905, the refrigerant cannot flow to the first heat exchanger 61 through the fifth valve 905.

[0076] In the case where a third control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the heating mode. As shown in FIG. 6 and FIG. 7, the refrigerant circulates in the sixteenth sub-circuit 113 in the direction of the arrows shown in FIG. 7, and the sixteenth sub-circuit 113 is shown by the bold solid line in FIG. 6. Since the first valve port a of the ninth valve 909 is communicated with the second valve port b of the ninth valve 909, the first valve port a of the sixth valve 906 is communicated with the second valve port b of the sixth valve 906, and the seventh valve 907 is opened, after the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows through the ninth valve 909, a first part of the refrigerant flows into the second heat exchanger 62 through the seventh valve 907, the high-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor air to release heat to an indoor environment, so as to increase the indoor temperature, and the low-temperature refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the throttling device 4 through the third valve 903. A second part of the refrigerant flows into the first heat exchanger 61 through the sixth valve 906, the high-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor air to release heat to the indoor environment, so as to increase the indoor temperature, the low-temperature refrigerant after heat exchange flowing out of the first heat exchanger 61 flows into the liquid storage device 5 to be stored, the low-temperature refrigerant discharged from the liquid storage device 5 flows into the throttling device 4, and thus, the refrigerant exchanges heat with the indoor air through the first heat exchanger 61 and the second heat exchanger 62, so as to cause the indoor temperature to reach the fourth preset temperature.

[0077] Since the first valve port a of the second valve 902 is communicated with the second valve port b of the second valve 902, the low-temperature refrigerant passing through the throttling device 4 may flow into the third heat exchanger 3 through the second valve 902 after the flow rate of the refrigerant is adjusted, the low-temperature refrigerant in the third heat exchanger 3 exchanges heat with the outdoor air to absorb heat of an outdoor environment, and since the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the refrigerant after heat absorption flows into the third port C through the first valve 901, and since the third port C is communicated with the second port S, the refrigerant may flow into the gas-liquid separator 1 through the second port S, and the gas-liquid

separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, by controlling the valve assembly 9 to be in the seventeenth state, and controlling the first port E to be communicated with the fourth port D of the four-way valve 7 to connect the sixteenth sub-circuit 113, the indoor temperature reaches the fourth preset temperature to meet the heating requirement.

[0078] In some embodiments, the target operation mode is the water heating mode, and as shown in FIG. 9, the first circuit 11 includes a first sub-circuit 119. The first sub-circuit 119 is formed by sequentially connecting the compressor 2, the water tank 8, the liquid storage device 5, the throttling device 4, the third heat exchanger 3, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The refrigerant flows along the first sub-circuit 119.

[0079] In some embodiments, as shown in FIG. 8A, the controller is further configured to perform step 121 and step 122.

[0080] Step 121: obtaining the target operation mode of the air-conditioning system 1000.

[0081] The target operation mode includes the water heating mode.

[0082] Step 122: controlling the state of the valve assembly 9 and the communication state between different ports of the four-way valve 7 according to the target operation mode, so as to adjust the water temperature in the water tank 8.

[0083] In some embodiments, the controller 10 is further configured to: determine that the target operation mode is the water heating mode; control the third heat exchanger 3 to be started; and control the valve assembly 9 to be in a first state, and control the first port E and the fourth port D of the four-way valve 7 to be communicated.

[0084] When the valve assembly is in the first state, the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the first valve port a of the second valve 902 is communicated with the second valve port b of the second valve 902, and the first valve port a of the eighth valve 908 is communicated with the second valve port b of the eighth valve 908. The first valve port a of the third valve 903 is blocked from the second valve port b of the third valve 903, the first valve port a of the fourth valve 904 is blocked from the second valve port b of the fourth valve 904, the first valve port a of the fifth valve 905 is blocked from the second valve port b of the fifth valve 905, the first valve port a of the sixth valve 906 is blocked from the second valve port b of the sixth valve 906, and the first valve port a of the seventh valve 907 is blocked from the second valve port b of the seventh valve 907.

[0085] In the case where a fourth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the water heating mode. As shown in FIG. 8B and FIG. 9, the refrigerant circulates in the first sub-circuit 119 in the direction of the arrows

shown in FIG. 9, and the first sub-circuit 119 is shown by the bold solid line in FIG. 8B. Due to the communication between the first valve port a of the eighth valve 908 and the second valve port b of the eighth valve 908, after flowing through the water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows to the liquid storage device 5 through the eighth valve 908, the refrigerant discharged from the liquid storage device 5 flows through the throttling device 4 to adjust the flow rate of the refrigerant, and then, due to the communication between the first valve port a of the second valve 902 and the second valve port b of the second valve 902, the refrigerant flows into the third heat exchanger 3 through the second valve 902, the low-temperature refrigerant in the third heat exchanger 3 exchanges heat with the outdoor environment, and the low-temperature refrigerant absorbs heat of the outdoor air.

[0086] Since the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the refrigerant after heat absorption flows into the second port S through the first valve 901, and then flows into the gas-liquid separator 1 through the third port C, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, the valve assembly 9 is controlled to be in the first state, and the first port E and the fourth port D of the four-way valve 7 are controlled to be communicated to connect the first sub-circuit 119, so as to meet the water heating requirement.

[0087] The above description is given with the target operation mode including the cooling mode, the heating mode, and the water heating mode as an example, but certainly, in some embodiments, the target operation mode further includes a plurality of coordination modes, and each of the plurality of coordination modes includes a combination of at least two of the cooling mode, the heating mode, and the water heating mode.

[0088] For example, the target operation mode further includes a first coordination mode which is a combination of the heating mode and the water heating mode; the target operation mode further includes a second coordination mode which is a combination of the cooling mode and the water heating mode; the target operation mode further includes a third coordination mode which is a combination of the cooling mode, the heating mode and the water heating mode; the target operation mode includes a fourth coordination mode which is a combination of the cooling mode and the heating mode.

[0089] In the case where the target operation mode includes the first coordination mode, as shown in FIG. 10A, the controller 10 is further configured to execute step 131 and step 132.

[0090] Step 131: determining that the target operation mode is the first coordination mode.

[0091] Step 132: according to the first coordination mode, controlling opening and closing of the valve as-

sembly 9, controlling the first port E and the fourth port D to be communicated to adjust the indoor temperature, and heating the water in the water tank 8 to a first preset temperature.

[0092] In some embodiments, the controller 10 is further configured to: determine a first priority order corresponding to the first coordination mode, the first priority order indicating that the water heating mode takes priority over the heating mode; control the first heat exchanger and the second heat exchanger to be stopped, and control the third heat exchanger to be started; control the valve assembly to be in the first state; obtain the water temperature in the water tank; if the water temperature in the water tank is determined to reach the first preset temperature, control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started; and control the valve assembly to be in a second state.

[0093] In the second state, as shown in FIG. 12, the first valve 901, the second valve 902, the third valve 903, the fourth valve 904, the sixth valve 906, the seventh valve 907, and the ninth valve 909 are opened, and the fifth valve 905 is closed.

[0094] It should be noted that the opening of the valve may mean that the first valve port is communicated with the second valve port of the valve, and the closing of the valve may mean that the first valve port is blocked from the second valve port of the valve.

[0095] In the case where a fifth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 10B and FIG. 11, the refrigerant circulates in the first sub-circuit 119 in the direction of the arrows shown in FIG. 11, and the first sub-circuit 119 is shown by the bold solid line in FIG. 10B. Due to the communication between the first valve port a of the eighth valve 908 and the second valve port b of the eighth valve 908, after flowing through the water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows to the liquid storage device 5 through the eighth valve 908, the refrigerant discharged from the liquid storage device 5 flows through the throttling device 4 to adjust the flow rate of the refrigerant, and then, due to the communication between the first valve port a of the second valve 902 and the second valve port b of the second valve 902, the refrigerant flows into the third heat exchanger 3 through the second valve 902, the low-temperature refrigerant in the third heat exchanger 3 exchanges heat with the outdoor environment, and the low-temperature refrigerant absorbs heat of the outdoor air.

[0096] Since the first valve port a of the first valve 901 is communicated with the second valve port b of the first valve 901, the refrigerant after heat absorption flows into the second port S through the first valve 901, and then flows into the gas-liquid separator 1 through the third port C, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the

gaseous refrigerant to enter the compressor 2.

[0097] As shown in FIG. 10B to FIG. 13, the first circuit 11 further includes a second sub-circuit 120 and a third sub-circuit 121. The second sub-circuit 120 is formed by sequentially connecting the compressor 2, the first heat exchanger 61, the liquid storage device 5, the throttling device 4, the third heat exchanger 3, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The third sub-circuit 121 is formed by sequentially connecting the compressor 2, the second heat exchanger 62, the throttling device 4, the third heat exchanger 3, the four-way valve 7, the gas-liquid separator 1, and the compressor 2.

[0098] In the process that the air-conditioning system 1000 runs the water heating mode, the controller 10 is further configured to obtain the water temperature of the water tank 8 and judge whether the water temperature reaches the first preset temperature. If the water temperature reaches the first preset temperature, the air-conditioning system 1000 is controlled to run the heating mode.

[0099] As shown in FIG. 12 and FIG. 13, in the heating mode of the air-conditioning system 1000, the refrigerant circulates in the second sub-circuit 120 and the third sub-circuit 121 in the direction of the arrows shown in FIG. 13, and the second sub-circuit 120 and the third sub-circuit 121 are shown by the bold solid lines in FIG. 12. After the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows through the ninth valve 909, a first part of the refrigerant may flow along the second sub-circuit 120, and a second part of the refrigerant may flow along the third sub-circuit 121.

[0100] It should be noted that the refrigerant first flows along the first sub-circuit 119, and then flows along the third sub-circuit 121 and the second sub-circuit 120 respectively.

[0101] The first coordination mode is mainly described above with the water heating mode taking priority over the heating mode as an example, but certainly, in some embodiments, the heating mode may take priority over the water heating mode.

[0102] In some embodiments, the controller 10 is further configured to: determine a second priority order corresponding to the first coordination mode, the second priority order indicating that the heating mode takes priority over the water heating mode; control the first heat exchanger 61, the second heat exchanger 62 and the third heat exchanger 3 to be started; control the valve assembly 9 to be in the second state; obtain the indoor temperature; if the indoor temperature is determined to reach a second preset temperature, control the first heat exchanger 61 and the second heat exchanger 62 to be stopped, and control the third heat exchanger 3 to be started; and control the valve assembly 9 to be in the first state to adjust the water temperature in the water tank 8 to the first preset temperature.

[0103] In the case where a sixth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the second coordination mode.

tioning system 1000 runs the first coordination mode. As shown in FIG. 12 and FIG. 13, in the heating mode of the air-conditioning system 1000, the refrigerant circulates in the second sub-circuit 120 and the third sub-circuit 121 in the direction of the arrows shown in FIG. 13, and the second sub-circuit 120 and the third sub-circuit 121 are shown by the bold solid lines in FIG. 12.

[0104] When the indoor temperature reaches the second preset temperature, as shown in FIG. 10B and FIG. 11, the refrigerant circulates in the first sub-circuit 119 in the direction of the arrows shown in FIG. 11, and the first sub-circuit 119 is shown by the bold solid line in FIG. 10B. Due to the communication between the first valve port a of the eighth valve 908 and the second valve port b of the eighth valve 908, after flowing through the water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows to the liquid storage device 5 through the eighth valve 908, the refrigerant discharged from the liquid storage device 5 flows through the throttling device 4 to adjust the flow rate of the refrigerant, and then, due to the communication between the first valve port a of the second valve 902 and the second valve port b of the second valve 902, the refrigerant flows into the third heat exchanger 3 through the second valve 902, the low-temperature refrigerant in the third heat exchanger 3 exchanges heat with the outdoor environment, and the low-temperature refrigerant absorbs heat of the outdoor air.

[0105] After the indoor temperature is determined to reach the second preset temperature, after the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows through the ninth valve 909, a first part of the refrigerant may flow along the second sub-circuit 120, and a second part of the refrigerant may flow along the third sub-circuit 121.

[0106] It should be noted that the refrigerant first flows along the second sub-circuit 120 and the third sub-circuit 121, and then flows along the first sub-circuit 119.

[0107] The above description is given with the water heating mode taking priority over the heating mode and the heating mode taking priority over the water heating mode as examples, but certainly, in some embodiments, the water heating mode and the heating mode may be run synchronously.

[0108] For example, as shown in FIG. 14, when the water heating mode and the heating mode are run synchronously, the refrigerant flows along the first sub-circuit 119, the second sub-circuit 120, and the third sub-circuit 121 respectively.

[0109] In some embodiments, the controller 10 is further configured to: determine a third priority order corresponding to the first coordination mode, the third priority order indicating that the water heating mode and the heating mode are run synchronously.

[0110] In some embodiments, the controller 10 is further configured to: control the first heat exchanger 61, the second heat exchanger 62 and the third heat exchanger 3 to be started; and control the valve assembly

9 to be in a third state. In the third state, the first valve 901, the second valve 902, the third valve 903, the fourth valve 904, the sixth valve 906, the seventh valve 907, the eighth valve 908, and the ninth valve 909 are opened, and the fifth valve 905 is closed.

[0111] In the case where a seventh control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 14, the refrigerant circulates in the first sub-circuit 119, the second sub-circuit 120, and the third sub-circuit 121 in the direction of the arrows shown in FIG. 14, and the first sub-circuit 119, the second sub-circuit 120, and the third sub-circuit 121 are shown by the bold solid lines in FIG. 14.

[0112] It should be noted that reference can be made to the above description of FIG. 10B to FIG. 13 for a flowing principle of the refrigerant herein, which is not repeated herein.

[0113] The above description is mainly given with the refrigerant respectively flowing along the first sub-circuit 119, the second sub-circuit 120, and the third sub-circuit 121 when the water heating mode and the heating mode are run respectively as an example, but certainly, in some embodiments, the refrigerant may flow along other circuits when the water heating mode and the heating mode are run synchronously.

[0114] For example, as shown in FIG. 15, the first circuit 11 includes a third sub-circuit 121 and a fourth sub-circuit 122. The fourth sub-circuit 122 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the first heat exchanger 61, the liquid storage device 5, the throttling device 4, the third heat exchanger 3, the four-way valve 7, the gas-liquid separator 1, and the compressor 2.

[0115] In some embodiments, the controller 10 is further configured to: control the first heat exchanger 61, the second heat exchanger 62 and the third heat exchanger 3 to be started; and control the valve assembly to be in a fourth state. In the fourth state, the first valve 901, the second valve 902, the third valve 903, the fourth valve 904, the fifth valve 905, the seventh valve 907, and the ninth valve 909 of the valve assembly 9 are in an opened state respectively, and the sixth valve 906 and the eighth valve 908 of the valve assembly 9 are in a closed state.

[0116] It should be noted that the refrigerant flows along the third sub-circuit 121 and the fourth sub-circuit 122 respectively.

[0117] In the case where an eighth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 15, the refrigerant circulates in the third sub-circuit 121 and the fourth sub-circuit 122 in the direction of the arrows shown in FIG. 15, and the third sub-circuit 121 and the fourth sub-circuit 122 are shown by the bold solid lines in FIG. 15. A first part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the water

in the water tank 8 along the fourth sub-circuit 122 to produce hot water and form a low-temperature refrigerant, and then, the low-temperature refrigerant passes through the first heat exchanger 61, the throttling device 4, the third heat exchanger 3, the four-way valve 7 and the gas-liquid separator 1 to flow back to the compressor 2. A second part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows along the third sub-circuit 121, so that the water heating mode and the heating mode can be respectively implemented, energy waste during operation of the air-conditioning system 1000 can be effectively reduced, and the thermal pollution of the environment can be reduced.

[0118] The above description is given with the refrigerant respectively flowing along the third sub-circuit and the fourth sub-circuit when the water heating mode and the heating mode are run respectively as an example, but certainly, in some embodiments, the refrigerant may flow only along the fourth sub-circuit 122 when the water heating mode and the heating mode are synchronized.

[0119] It should be noted that in FIG. 14, the first heat exchanger 61 and the second heat exchanger 62 are respectively started to realize the cooling mode and the water heating mode. Certainly, in some embodiments, the water heating mode and the heating mode may be realized by starting one of the first heat exchanger 61 and the second heat exchanger 62 and stopping the other.

[0120] For example, as shown in FIG. 16, the first circuit 11 includes the fourth sub-circuit 122. The fourth sub-circuit 122 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the first heat exchanger 61, the liquid storage device 5, the throttling device 4, the third heat exchanger 3, the four-way valve 7, the separator 1, and the compressor 2. The refrigerant flows along the fourth sub-circuit 122.

[0121] In some embodiments, the controller 10 is further configured to: control the first heat exchanger 61 to be started, control the second heat exchanger 62 to be stopped, and control the third heat exchanger 3 to be started; and control the valve assembly 9 to be in a fifth state. In the fifth state, the first valve 901, the second valve 902, the fourth valve 904, and the fifth valve 905 of the valve assembly 9 are in an opened state, and the third valve 903, the sixth valve 906, the seventh valve 907, the eighth valve 908, and the ninth valve 909 of the valve assembly 9 are in a closed state.

[0122] In the case where a ninth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 16, the bold solid line in FIG. 16 indicates the fourth sub-circuit 122. After the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the water in the water tank 8, although a temperature of the high-temperature refrigerant is reduced to a certain extent, the temperature may still be considered to be high, and the high-temperature refrigerant passes through the fourth port D and the first port E of the four-way valve and exchanges heat with the

indoor air through the first heat exchanger 61, so as to release heat to the indoor environment. Then, the refrigerant passes through the throttling device 4 and the third heat exchanger 3, and exchanges heat with the outdoor air to absorb heat of the outdoor air, and the refrigerant after heat absorption flows back to the compressor 2 through the four-way valve 7 and the gas-liquid separator 1. In this way, the water heating mode and the heating mode may be separately realized.

[0123] In FIG. 16, the description is given with the first heat exchanger 61 started and the refrigerant flowing along one sub-circuit (for example, the fourth sub-circuit 122) as an example, but certainly, in some embodiments, the refrigerant may flow along two sub-circuits when the first heat exchanger 61 is started.

[0124] For example, as shown in FIG. 17, in the case where the first circuit 11 includes the first sub-circuit 119 and the second sub-circuit 120, the controller 10 is further configured to: control the first heat exchanger 61 to be started, control the second heat exchanger 62 to be stopped, and control the third heat exchanger 3 to be started. The valve assembly 9 is controlled to be in a sixth state. In the sixth state, the first valve 901, the second valve 902, the fourth valve 904, the sixth valve 906, the eighth valve 908, and the ninth valve 909 of the valve assembly 9 are in an opened state respectively, and the third valve 903, the fifth valve 905, and the seventh valve 907 of the valve assembly 9 are in a closed state. It should be noted that the refrigerant flows along the first sub-circuit 119 and the second sub-circuit 120 respectively.

[0125] In the case where a tenth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 17, the bold solid lines in FIG. 17 indicate the first sub-circuit 119 and the second sub-circuit 120. A first part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the water tank 8, and exchanges heat with the water tank 8 to release heat to the water tank 8 when flowing to the water tank 8, the water in the water tank 8 is heated by the refrigerant, the refrigerant after heat release flows into the liquid storage device 5 to be stored through the ninth valve 909 through the communication between the first valve port a and the second valve port b of the ninth valve 909, and the refrigerant discharged from the liquid storage device 5 flows to the throttling device 4.

[0126] Since the first valve port a and the second valve port b of the sixth valve 906 are communicated and the first valve port a and the second valve port b of the eighth valve 908 are communicated, a second part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the eighth valve 908, then flows into the sixth valve 906 from the eighth valve 908, and flows into the first heat exchanger 61 through the sixth valve 906, the high-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to release heat to the indoor environment, so as to increase the indoor temperature, the

refrigerant after heat exchange flows into the liquid storage device 5 to be stored, the refrigerant discharged from the liquid storage device 5 flows into the throttling device 4, the refrigerant flowing through the throttling device 4 is subjected to flow rate adjustment and then flows into the third heat exchanger 3 through the second valve 902 through the communication between the first valve port a and the second valve port b of the second valve 902, the third heat exchanger 3 exchanges heat between the low-temperature refrigerant and the outdoor environment, the refrigerant after heat absorption flows into the second port S of the four-way valve 7 through the communication between the first valve port a and the second valve port b of the first valve 901, and then flows into the gas-liquid separator 1 through the third port C of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0127] The above description is given with the controller 10 controlling the first heat exchanger 61 to be started and the second heat exchanger 62 to be stopped as an example, but certainly, in some embodiments, the controller 10 may control the first heat exchanger 61 to be stopped and the second heat exchanger 62 to be started.

[0128] It should be noted that one of the first heat exchanger 61 and the second heat exchanger 62 may be located in the indoor unit 100, and the other may be located in the outdoor unit 200. Alternatively, the first heat exchanger 61 and the second heat exchanger 62 may be respectively located in different indoor spaces. Thus, one indoor space can be selected to be heated as required.

[0129] For example, as shown in FIG. 18, the first circuit 11 includes the first sub-circuit 119 and the third sub-circuit 121. The controller 10 is further configured to: control the first heat exchanger 61 to be stopped, control the second heat exchanger 62 to be started, and control the third heat exchanger 3 to be started. The valve assembly 9 is controlled to be in a seventh state. In the seventh state, the first valve 901, the second valve 902, the third valve 903, the sixth valve 906, the seventh valve 907, the eighth valve 908, and the ninth valve 909 of the valve assembly 9 are in an opened state respectively, and the fourth valve 904 and the fifth valve 905 of the valve assembly 9 are in a closed state.

[0130] It should be noted that the refrigerant flows along the first sub-circuit 119 and the third sub-circuit 121 respectively.

[0131] In the case where an eleventh control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the first coordination mode. As shown in FIG. 18, the bold solid lines in FIG. 18 indicate the first sub-circuit 119 and the third sub-circuit 121. A first part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the water tank 8, and exchanges heat with the water tank 8 to release heat to the water tank 8 when flowing to the water tank 8, the water in the water tank 8 is

heated by the refrigerant, the refrigerant after heat release flows into the liquid storage device 5 to be stored through the ninth valve 909 through the communication between the first valve port a and the second valve port b of the ninth valve 909, and the refrigerant discharged from the liquid storage device 5 flows to the throttling device 4.

[0132] Since the ninth valve 909 and the seventh valve 907 are respectively opened, a second part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the ninth valve 909, then flows into the seventh valve 907 from the ninth valve 909, and flows into the second heat exchanger 62 through the seventh valve 907, the high-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor environment to release heat to the indoor environment, so as to increase the indoor temperature, and since the third valve 903 and the second valve 902 are respectively opened, the refrigerant after heat exchange flows to the throttling device 4 through the third valve 903, the refrigerant flowing through the throttling device 4 is subjected to flow rate adjustment and then flows into the third heat exchanger 3 through the second valve 902, the third heat exchanger 3 exchanges heat between the low-temperature refrigerant and the outdoor environment, the refrigerant after heat absorption flows into the second port S of the four-way valve 7 through the communication between the first valve port a and the second valve port b of the first valve 901, and then flows into the gas-liquid separator 1 through the third port C of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0133] In some embodiments of the present disclosure, by controlling the valve assembly 9 to be in different states, and controlling the first port E and the fourth port D of the four-way valve 7 to be communicated, the first coordination mode is realized, and the air-conditioning system 1000 produces hot water by running the heating mode, thereby effectively reducing energy waste during the operation of the air-conditioning system 1000, reducing the thermal pollution of the environment, and saving a large quantity of electricity charges for the user.

[0134] The above description is given with the target operation mode including the first coordination mode as an example, but certainly, the target operation mode may include the second coordination mode.

[0135] In some embodiments, as shown in FIG. 19A, the controller 10 is further configured to perform step 141 and step 142.

[0136] Step 141: determining that the target operation mode is the second coordination mode.

[0137] Step 142: according to the second coordination mode, controlling opening and closing of the valve assembly 9, controlling the third port C and the fourth port D of the four-way valve 7 to be communicated to adjust the indoor temperature, and adjusting the water temperature

in the water tank 8 to a third preset temperature.

[0138] In some embodiments, the controller 10 is further configured to: control the first heat exchanger 61, the second heat exchanger 62 and the third heat exchanger to be started; and control the valve assembly to be in the seventh state. In the seventh state, the first valve 901, the second valve 902, the third valve 903, the fourth valve 904, the fifth valve 905, the sixth valve 906, the seventh valve 907, and the eighth valve 908 are opened respectively.

[0139] As shown in FIG. 19B, the first circuit 11 includes a fifth sub-circuit 123, a sixth sub-circuit 124, and a seventh sub-circuit 125. The fifth sub-circuit 123 is formed by sequentially connecting the compressor 2, the water tank 8, the liquid storage device 5, the first heat exchanger 61, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The sixth sub-circuit 124 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the third heat exchanger 3, the throttling device 4, the second heat exchanger 62, the four-way valve 7, the separator 1, and the compressor. The seventh sub-circuit 125 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the third heat exchanger 3, the throttling device 4, the liquid storage device 5, the first heat exchanger 61, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The refrigerant flows along the fifth sub-circuit 123, the sixth sub-circuit 124, and the seventh sub-circuit 125 respectively.

[0140] In the case where a twelfth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the second coordination mode. As shown in FIG. 19B, the bold solid lines in FIG. 19B indicate the fifth sub-circuit 123, the sixth sub-circuit 124, and the seventh sub-circuit 125. The high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the water tank 8 and then flows to the fourth port D of the four-way valve 7, and since the first valve port a and the second valve port b of the first valve 901 are communicated, the refrigerant can flow into the first valve port a of the first valve 901 through the third port C of the four-way valve 7 and flow into the third heat exchanger 3 through the second valve port b of the first valve 901, the third heat exchanger 3 exchanges heat between the high-temperature and high-pressure refrigerant and the outdoor air, the outdoor air absorbs heat of the high-temperature and high-pressure refrigerant to release heat to the outdoor environment, and since the first valve port a and the second valve port b of the second valve 902 are communicated, the refrigerant after heat release can flow into the throttling device 4 through the second valve 902 to be subjected to flow rate adjustment, and since the first valve port a and the second valve port b of the third valve 903 are communicated, a part of the refrigerant flows into the second heat exchanger 62 through the third valve 903, and the low-temperature refrigerant in the second heat exchanger 62 exchanges

heat with the indoor environment to absorb indoor heat, thereby lowering the indoor temperature.

[0141] Since the first valve port a and the second valve port b of each of the seventh valve 907, the sixth valve 906, and the fifth valve 905 are communicated with each other, the refrigerant after heat exchange flowing out of the second heat exchanger 62 sequentially passes through the seventh valve 907, the sixth valve 906, and the fifth valve 905, flows into the first port E of the four-way valve 7, and then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. The other part of the refrigerant flows into the liquid storage device 5 to be stored, the refrigerant discharged from the liquid storage device 5 flows into the first heat exchanger 61 from the fourth valve 904, the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to absorb the indoor heat, so as to lower the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger flows into the first port of the four-way valve 7 through the fifth valve 905, then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0142] In this way, the cooling mode and the water heating mode can be realized, and the air-conditioning system 1000 produces hot water by running the cooling mode, thereby effectively reducing energy waste during the operation of the air-conditioning system 1000, reducing the thermal pollution of the environment, and saving a large quantity of electricity charges for the user.

[0143] The above description is given with the controller 10 controlling the first heat exchanger 61 and the second heat exchanger 62 to be started as an example, but certainly, in some embodiments, the controller 10 may control only one of the first heat exchanger 61 and the second heat exchanger 62 to be started to realize the second coordination mode. For example, the controller 10 controls the first heat exchanger 61 to be started and the second heat exchanger 62 to be stopped.

[0144] As shown in FIG. 20, the first circuit 11 includes only the fifth sub-circuit 123 and the seventh sub-circuit 125. The controller 10 is further configured to: control the first heat exchanger 61 to be started, control the second heat exchanger 62 to be stopped, and control the third heat exchanger 3 to be started. The valve assembly is controlled to be in an eighth state. In the eighth state, the first valve 901, the second valve 902, the fourth valve 904, the fifth valve 905, and the eighth valve 908 are opened, and the third valve 903, the sixth valve 906, and the seventh valve 907 are closed.

[0145] In the case where a thirteenth control instruction is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the second coordination

mode. As shown in FIG. 20, the bold solid lines in FIG. 20 indicate the fifth sub-circuit 123 and the seventh sub-circuit 125. When flowing into the domestic water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the domestic water tank 8 to release heat to the domestic water tank 8, the water in the water tank 8 is heated by the refrigerant, a first part of the refrigerant after heat release flows into the liquid storage device 5 to be stored through the eighth valve 908 through the communication of the first valve port a and the second valve port b of the eighth valve 908, a second part of the refrigerant discharged from the water tank 8 flows into the third heat exchanger 3 through the fourth port D and the third port C of the four-way valve 7 and the first valve 901, the third heat exchanger 3 exchanges heat between the high-temperature refrigerant and the outdoor environment, the high-temperature refrigerant releases heat to the outdoor environment, the refrigerant after heat release flows into the throttling device 4 through the second valve 902 to be subjected to flow rate adjustment and then stored by the liquid storage device 5, the low-temperature refrigerant discharged from the liquid storage device 5 flows into the first heat exchanger 61 through the fourth valve 904, the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to absorb the indoor heat, so as to lower the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 flows into the first port E of the four-way valve 7 through the communication of the first valve port a and the second valve port b of the fifth valve 905, and then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0146] The second coordination mode is described above with the controller 10 controlling the first heat exchanger 61 to be started and the second heat exchanger 62 to be stopped as an example, but certainly, in some embodiments, the controller 10 may control the first heat exchanger 61 to be stopped and the second heat exchanger 62 to be started.

[0147] For example, as shown in FIG. 21, the first circuit 11 includes the sixth sub-circuit 124. The refrigerant flows along the sixth sub-circuit 124. The controller 10 is further configured to: control the first heat exchanger 61 to be stopped, control the second heat exchanger 62 to be started and control the third heat exchanger 3 to be started; and control the valve assembly 9 to be in a ninth state. In the ninth state, the first valve 901, the second valve 902, the third valve 903, the fifth valve 905, the sixth valve 906, and the seventh valve 907 are opened respectively, and the fourth valve 904 is closed.

[0148] When the thirteenth control instruction is sent to the air-conditioning system 1000, the refrigerant circulates in the sixth sub-circuit 124 in the direction of the arrows shown in FIG. 21 in the first coordination mode of

the air-conditioning system 1000, and the sixth sub-circuit 124 is shown by the bold solid line in FIG. 21. When flowing into the water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the water tank 8 to release heat to the water tank 8, the water in the water tank 8 is heated by the refrigerant, the refrigerant after heat release flows into the third heat exchanger 3 through the fourth port D of the four-way valve 7, the third port C of the four-way valve 7 and the first valve 901, the third heat exchanger 3 exchanges heat between the high-temperature refrigerant and the outdoor environment, the high-temperature refrigerant releases heat to the outdoor environment, the refrigerant after heat release flows into the throttling device 4 through the second valve 902, is subjected to flow rate adjustment by the throttling device 4, and then flows into the second heat exchanger 62 through the third valve 903, the low-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor environment to absorb the indoor heat, so as to lower the indoor temperature, and due to the communication of the first valve port a and the second valve port b of each of the seventh valve 907, the sixth valve 906 and the fifth valve 905, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the first port E of the four-way valve 7 through the seventh valve 907, the sixth valve 906 and the fifth valve 905 in sequence, and then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0149] In some embodiments of the present disclosure, by controlling the valve assembly 9 to be in different states, and controlling the third port C and the fourth port D of the four-way valve 7 to be communicated, the second coordination mode is realized, and the air-conditioning system 1000 produces hot water by running the cooling mode, thereby effectively reducing energy waste during the operation of the air-conditioning system 1000, reducing the thermal pollution of the environment, and saving a large quantity of electricity charges for the user.

[0150] The above description is given with the target operation mode including the first coordination mode or the second coordination mode as an example, but certainly, the target operation mode may include the third coordination mode.

[0151] In some embodiments, as shown in FIG. 22A, the controller 10 is further configured to perform step 151 and step 152.

[0152] Step 151: determining that the target operation mode is the third coordination mode.

[0153] Step 152: according to the third coordination mode, controlling opening and closing of the valve assembly 9, controlling the third port C and the fourth port D of the four-way valve 7 to be communicated to adjust the indoor temperature, and adjusting the water temperature in the water tank 8.

[0154] In some embodiments, as shown in FIG. 22B, the valve assembly 9 further includes a tenth valve 910. A first valve port a of the tenth valve 910 is connected to the second end of the second heat exchanger 62, and a second valve port b of the tenth valve 910 is connected to the second valve port b of the first valve 901.

[0155] In some embodiments, as shown in FIG. 22B, the valve assembly 9 further includes an eleventh valve 911. A first valve port a of the eleventh valve 911 is connected to the first end of the second heat exchanger 62, and a second valve port b of the eleventh valve 911 is connected to the second end of the throttling device 4.

[0156] In some embodiments, the target heat exchanger 30 includes the first heat exchanger 61 and the second heat exchanger 62. The controller 10 is further configured to: control the first heat exchanger 61 and the second heat exchanger 62 to be started; and control the valve assembly 9 to be in a tenth state. In the tenth state, the first valve 901, the fourth valve 904, the fifth valve 905, the seventh valve 907, the ninth valve 909, the tenth valve 910, and the eleventh valve 911 are respectively opened, and the second valve 902, the third valve 903, and the sixth valve 906 are closed.

[0157] It should be noted that the second heat exchanger 62 is the condenser, and the first heat exchanger 61 is an evaporator.

[0158] In some embodiments, as shown in FIG. 22B, the first circuit 11 further includes an eighth sub-circuit 126. The eighth sub-circuit 126 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the second heat exchanger 62, the throttling device 4, the liquid storage device 5, the first heat exchanger 61, the four-way valve 7, the gas-liquid separator 1, and the compressor 2.

[0159] In some embodiments, as shown in FIG. 22B, the first circuit 11 further includes a ninth sub-circuit 127. The ninth sub-circuit 127 is formed by sequentially connecting the compressor 2, the second heat exchanger 62, the throttling device 4, the liquid storage device 5, the first heat exchanger 61, the four-way valve 7, the gas-liquid separator 1, and the compressor 2.

[0160] It should be noted that the refrigerant flows along the eighth sub-circuit 126 and the ninth sub-circuit 127 respectively.

[0161] When a fourteenth control instruction is sent to the air-conditioning system 1000, the refrigerant circulates in the eighth sub-circuit 126 and the ninth sub-circuit 127 in the direction of the arrows shown in FIG. 22B in the third coordination mode of the air-conditioning system 1000, and the eighth sub-circuit 126 and the ninth sub-circuit 127 are shown by the bold solid lines in FIG. 22B. When flowing into the water tank 8, a first part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the water tank 8 to release heat to the water tank 8, the water in the water tank 8 is heated by the refrigerant, and the refrigerant after heat release flows into the fourth port D of the four-way valve 7, then flows into the first valve 901

through the third port C of the four-way valve 7, flows into the tenth valve 910 through the communication between the first valve port a and the second valve port b of the first valve 901, and flows into the second heat exchanger 62 through the communication between the first valve port a and the second valve port b of the tenth valve 910.

[0162] Since the ninth valve 909 and the seventh valve 907 are respectively opened, a second part of the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the second heat exchanger 62 through the ninth valve 909 and the seventh valve 907, the high-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor air to release heat to the indoor environment, so as to increase the indoor temperature, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the throttling device 4 through the eleventh valve 911 to be subjected to flow rate adjustment and then flow into the liquid storage device 5, the refrigerant discharged from the liquid storage device 5 flows into the first heat exchanger 61 through the fourth valve 904, the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to absorb the indoor heat, so as to lower the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 flows into the first port E of the four-way valve 7 through the fifth valve 905 through the communication between the first valve port a and the second valve port b of the fifth valve 905, and then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0163] In FIG. 22B, the description is given with the second heat exchanger 62 as the condenser and the first heat exchanger 61 as the evaporator, but certainly, in some embodiments, the second heat exchanger 62 may be the evaporator and the first heat exchanger 61 may be the condenser, so as to realize the third coordination mode.

[0164] For example, as shown in FIG. 23, the first circuit 11 includes a tenth sub-circuit 128. The tenth sub-circuit 128 is formed by sequentially connecting the compressor 2, the water tank 8, the four-way valve 7, the first heat exchanger 61, the liquid storage device 5, the throttling device 4, the second heat exchanger 62, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The refrigerant flows along the tenth sub-circuit 128. The controller is further configured to: control the first heat exchanger 61 and the second heat exchanger 62 to be started; and control the valve assembly 9 to be in an eleventh state; in the eleventh state, the first valve 901, the fourth valve 904, the fifth valve 905, the tenth valve 910, and the eleventh valve 911 are respectively opened, and the second valve 902, the third valve 903, the sixth valve 906, the seventh valve 907, and the

ninth valve 909 are closed.

[0165] When a fifteenth control instruction is sent to the air-conditioning system 1000, the refrigerant circulates in the tenth sub-circuit in the direction of the arrows shown in FIG. 23 in the third coordination mode of the air-conditioning system 1000, and the tenth sub-circuit is shown by the bold solid line in FIG. 23. When flowing into the water tank 8, the high-temperature and high-pressure refrigerant discharged from the compressor 2 exchanges heat with the water tank 8 to release heat to the water tank 8, the water in the water tank 8 is heated by the refrigerant, the refrigerant after heat release flows to the fourth port D of the four-way valve 7, flows into the fifth valve 905 through the first port E of the four-way valve 7, and flows into the first heat exchanger 61 through the first valve port a and the second valve port b of the fifth valve 905, the high-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor air to release heat to the indoor environment, so as to increase the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 is stored by the liquid storage device 5, and the refrigerant discharged from the liquid storage device 5 flows into the throttling device 4.

[0166] After the flow rate of the refrigerant is adjusted by the throttling device 4, the refrigerant flows into the second heat exchanger 62 through the eleventh valve 911 through the communication between the first valve port a and the second valve port b of the eleventh valve 911, the low-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor air to absorb indoor heat, so as to lower the indoor temperature, and since the first valve port a and the second valve port b of each of the tenth valve 910 and the first valve 901 are communicated, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the first valve 901 through the tenth valve 910, then flows into the third port C of the four-way valve 7 through the first valve 901, and flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0167] In some embodiments of the present disclosure, by controlling the valve assembly 9 to be in different states, and controlling the third port C and the fourth port D of the four-way valve 7 to be communicated, the third coordination mode is realized, the function of simultaneous water heating, heating and cooling is achieved, and the air-conditioning system 1000 produces hot water by running the cooling mode and the heating mode, thereby effectively reducing energy waste during the operation of the air-conditioning system 1000, reducing the thermal pollution of the environment, and saving a large quantity of electricity charges for the user.

[0168] The above description is given with the target operation mode including the first coordination mode, the second coordination mode or the third coordination mode as an example, but certainly, the target operation mode

may include the fourth coordination mode.

[0169] In some embodiments, as shown in FIG. 24A, the controller 10 is further configured to perform step 161 to step 163.

5 **[0170]** Step 161: obtaining the target operation mode of the air-conditioning system.

[0171] The target operation mode includes the fourth coordination mode; the fourth coordination mode includes the heating mode and the cooling mode.

10 **[0172]** Step 162: determining that the target operation mode is the fourth coordination mode.

[0173] Step 163: according to the fourth coordination mode, controlling opening and closing of the valve assembly 9, and controlling the third port C and the fourth port D of the four-way valve 7 to be communicated, so as to adjust one of the first heat exchanger 61 and the second heat exchanger 62 to be the condenser and the other to be the evaporator.

[0174] In some embodiments, the first heat exchanger 61 is configured to exchange heat with first indoor air.

[0175] In some embodiments, the second heat exchanger 62 is configured to exchange heat with second indoor air.

[0176] It should be noted that the first heat exchanger 61 and the second heat exchanger 62 are arranged in different spaces.

[0177] In some embodiments, as shown in FIG. 24B, the air-conditioning system 100 further includes a second circuit 118. The refrigerant flows through the second circuit 118 to exchange heat with the first indoor air and the second indoor air respectively.

[0178] In some embodiments, the valve assembly 9 is arranged in the second circuit 118, and the valve assembly 9 is further configured to connect or disconnect the second circuit 118.

[0179] In some embodiments, the controller 10 is further configured to: control the first heat exchanger 61 and the second heat exchanger 62 to be started; and control the valve assembly 9 to be in a twelfth state. In the twelfth state, the fourth valve 904, the fifth valve 905, the seventh valve 907, the ninth valve 909, and the eleventh valve 911 are opened, and the first valve 901, the second valve 902, the third valve 903, and the sixth valve 906 are closed.

[0180] As shown in FIG. 24B, the second circuit 118 includes an eleventh sub-circuit 129. The eleventh sub-circuit 129 is formed by sequentially connecting the compressor 2, the second heat exchanger 62, the throttling device 4, the liquid storage device 5, the first heat exchanger 61, the gas-liquid separator 1, and the compressor 2. The compressor 2 and the second heat exchanger 62 are communicated with each other through the ninth valve 909 and the seventh valve 907.

[0181] When a sixteenth control instruction is sent to the air-conditioning system 1000, the refrigerant circulates in the eleventh sub-circuit in the direction of the arrows shown in FIG. 24B in the fourth coordination mode of the air-conditioning system 1000, and the eleventh

sub-circuit is shown by the bold solid line in FIG. 24B. Since the ninth valve 909 and the seventh valve 907 are respectively opened, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the second heat exchanger 62 through the ninth valve 909 and the seventh valve 907, the high-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor environment to release heat to the indoor environment, so as to increase the indoor temperature, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the throttling device 4 through the eleventh valve 911 to be subjected to flow rate adjustment by the throttling device 4 and then flow into the liquid storage device 5, the refrigerant discharged from the liquid storage device 5 flows to the first heat exchanger 61 through the fourth valve 904, the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to absorb the indoor heat, so as to lower the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 flows into the first port E of the four-way valve 7 through the fifth valve 905, and then flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, the air-conditioning system 1000 may run the cooling mode and the heating mode respectively.

[0182] The fourth coordination mode is described in FIG. 24B with the second circuit 118 including the eleventh sub-circuit 129 as an example, but certainly, in some embodiments, the second circuit may include other sub-circuits.

[0183] In some embodiments, the air-conditioning system 1000 further includes the twelfth valve 912, the first valve port a of the twelfth valve 912 is connected to the outlet of the compressor 2 and the water tank, and the second valve port b of the twelfth valve 912 is connected to the second valve port b of the tenth valve 910.

[0184] For example, as shown in FIG. 25, the second circuit 118 includes a twelfth sub-circuit 130. The twelfth sub-circuit 130 is formed by sequentially connecting the compressor 2, the second heat exchanger 62, the throttling device 4, the liquid storage device 5, the first heat exchanger 61, the gas-liquid separator 1, and the compressor 2. The compressor 2 and the second heat exchanger 62 are communicated with each other through the twelfth valve 912 and the tenth valve 910. The refrigerant flows along the twelfth sub-circuit 130. The controller 10 is further configured to: control the first heat exchanger 61 and the second heat exchanger 62 to be started; and control the valve assembly 9 to be in a thirteenth state. In the thirteenth state, the fourth valve 904, the fifth valve 905, the seventh valve 907, the tenth valve 910, the eleventh valve 911, and the twelfth valve 912 are opened, and the first valve 901, the second valve 902, the third valve 903, the sixth valve 906, and the ninth

valve 909 are closed.

[0185] When a seventeenth control instruction is sent to the air-conditioning system 1000, the refrigerant circulates in the twelfth sub-circuit in the direction of the arrows shown in FIG. 25 in the fourth coordination mode of the air-conditioning system 1000, and the twelfth sub-circuit is shown by the bold solid line in FIG. 25. The high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the second heat exchanger 62 through the twelfth valve 912 and the tenth valve 910, the high-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor environment to release heat to the indoor environment, so as to increase the indoor temperature, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the first heat exchanger 61 through the eleventh valve 911, the throttling device 4 and the liquid storage device 5 in sequence, the low-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to absorb indoor heat, so as to lower the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 flows into the first port E of the four-way valve 7 through the fifth valve 905, then flows into the second port S of the four-way valve 7 from the first port E of the four-way valve 7, and flows into the gas-liquid separator 1 through the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2. In this way, the air-conditioning system 1000 may run the cooling mode and the heating mode respectively.

[0186] The fourth coordination mode is described in FIG. 24B and FIG. 25 with the first heat exchanger 61 as the evaporator and the second heat exchanger 62 as the condenser as an example, but certainly, in some embodiments, the fourth coordination mode may be realized when the first heat exchanger 61 serves as the condenser and the second heat exchanger 62 serves as the evaporator.

[0187] For example, as shown in FIG. 26 and FIG. 27, the second circuit 118 includes a thirteenth sub-circuit 131. The thirteenth sub-circuit 131 is formed by sequentially connecting the compressor 2, the first heat exchanger 61, the liquid storage device 5, the throttling device 4, the second heat exchanger 62, the four-way valve 7, the gas-liquid separator 1, and the compressor 2. The refrigerant flows along the thirteenth sub-circuit 131. The controller is further configured to: control the first heat exchanger 61 and the second heat exchanger 62 to be started; and control the valve assembly 9 to be in a fourteenth state. In the fourteenth state, the first valve 901, the fourth valve 904, the sixth valve 906, the ninth valve 909, the tenth valve 910, and the eleventh valve 911 are respectively opened; the second valve 902, the third valve 903, the fifth valve 905, and the seventh valve 907 are closed respectively.

[0188] In the case where an eighteenth control instruc-

tion is sent to the air-conditioning system 1000, the air-conditioning system 1000 runs the fourth coordination mode. As shown in FIG. 26 and FIG. 27, the refrigerant circulates in the thirteenth sub-circuit 131 in the direction of the arrows shown in FIG. 27, and the thirteenth sub-circuit 131 is shown by the bold solid line in FIG. 27. Since the first valve port a and the second valve port b of the ninth valve 909 are communicated and the first valve port a and the second valve port b of the sixth valve 906 are communicated, the high-temperature and high-pressure refrigerant discharged from the compressor 2 flows into the first heat exchanger 61 through the ninth valve 909 and the sixth valve 906, the high-temperature refrigerant in the first heat exchanger 61 exchanges heat with the indoor environment to release heat to the indoor environment, so as to increase the indoor temperature, the refrigerant after heat exchange flowing out of the first heat exchanger 61 is stored by the liquid storage device 5, and since the first valve port a and the second valve port b of the eleventh valve 911 are communicated, after subjected to flow rate adjustment by the throttling device 4, the refrigerant discharged from the liquid storage device 5 flows into the second heat exchanger 62 through the eleventh valve 911, the low-temperature refrigerant in the second heat exchanger 62 exchanges heat with the indoor environment to absorb indoor heat, so as to lower the indoor temperature, and since the first valve port a and the second valve port b of the tenth valve 910 are communicated and the first valve port a and the second valve port b of the first valve 901 are communicated, the refrigerant after heat exchange flowing out of the second heat exchanger 62 flows into the first valve 901 through the tenth valve 910, then flows into the third port C of the four-way valve 7 from the first valve 901, and flows into the gas-liquid separator 1 from the second port S of the four-way valve 7, and the gas-liquid separator 1 separates the gaseous refrigerant from the liquid refrigerant, so as to cause the gaseous refrigerant to enter the compressor 2.

[0189] In some embodiments of the present disclosure, by controlling the valve assembly 9 to be in different states, and controlling the third port C and the fourth port D of the four-way valve 7 to be communicated, the fourth coordination mode is realized, thereby meeting the cooling requirement and the heating requirement

[0190] It should be noted that the step numbers in some embodiments of the present disclosure are only for convenience of describing some embodiments of the present disclosure, and are not to be construed as limiting the order of the steps. The execution sequence of the steps may be determined according to actual requirements, and is not limited to the sequence of the steps in some embodiments of the present disclosure, and the steps may be deleted according to circumstances.

[0191] It should be noted that any technical solution in the present disclosure can solve one or more of the above technical problems to a certain extent and achieve a certain object; a plurality of technical solutions can be

combined into an integral solution to solve one or more of the above technical problems and achieve a certain object of the invention; some of the technical solutions can be selected to be combined into an integral solution, and meanwhile, the related art and the degradation solutions are adopted, but the degradation trend can be compensated by the technical disclosure means, so as to overall solve one or more of the above technical problems to a certain extent and achieve a certain object of the invention; each technical solution is combined into a complete technical solution, and an integral solution which is organic and indivisible is formed, so as to overall solve the technical problems and achieve a certain object of the invention.

[0192] Any technical solution and recombinations of plural technical solutions in the present disclosure can form complete technical solutions, can solve one or more of the above technical problems and achieve the object of the invention, are all contained in the disclosure, and are directly and unambiguously determined from the disclosure.

[0193] It will be understood by those skilled in the art that the scope of the disclosure of the present disclosure is not limited to the particular embodiments described above, and that modifications and substitutions of certain elements of the embodiments may be made without departing from the spirit of the disclosure. The scope of the present disclosure is limited by the appended claims.

Claims

1. An air-conditioning system, comprising:

- a compressor;
- a four-way valve, the four-way valve comprising a first port, a second port, a third port and a fourth port;
- a gas-liquid separator connected to a first end of the compressor and the second port;
- a water tank connected to a second end of the compressor and the fourth port;
- a throttling device;
- a liquid storage device connected to the throttling device;
- a target heat exchanger, the target heat exchanger being connected to the first port and the third port, and the target heat exchanger being configured to exchange heat with air to absorb heat of the air;
- a first circuit, a refrigerant flowing through the first circuit, the first circuit comprising a heat exchange flow path, and the heat exchange flow path being formed by connecting the compressor and the water tank, and configured to exchange heat between the refrigerant in the heat exchange flow path and water in the water tank;

a valve assembly arranged in the first circuit and configured to connect or disconnect the first circuit; and

a controller coupled to the valve assembly and the four-way valve, so as to control the connection or disconnection of the first circuit; the controller being configured to:

obtain a target operation mode of the air-conditioning system; the target operation mode comprising a water heating mode; and

according to the target operation mode, control a state of the valve assembly and a communication state between different ports of the four-way valve, so as to adjust a water temperature in the water tank.

2. The air-conditioning system according to claim 1, wherein the target heat exchanger comprises any two of a first heat exchanger, a second heat exchanger, and a third heat exchanger;

the first heat exchanger is configured to exchange heat with indoor air, a first end of the first heat exchanger is connected to a second end of the liquid storage device, and a second end of the first heat exchanger is connected to the first port;

the second heat exchanger is configured to exchange heat with the indoor air, a first end of the second heat exchanger is connected to a first end of the throttling device and a first end of the liquid storage device, and a second end of the second heat exchanger is connected to the second end of the first heat exchanger and the first port;

the third heat exchanger is configured to exchange heat with outdoor air, a first end of the third heat exchanger is connected to the third port, and a second end of the third heat exchanger is connected to a second end of the throttling device.

3. The air-conditioning system according to claim 2, wherein the valve assembly comprises:

a first valve, a first valve port of the first valve being connected to the third port, and a second valve port of the first valve being connected to the first end of the third heat exchanger;

a second valve, a first valve port of the second valve being connected to the second end of the throttling device, and a second valve port of the second valve being connected to the second end of the third heat exchanger;

a third valve, a first valve port of the third valve being connected to the first end of the second

heat exchanger, and a second valve port of the third valve being connected to the first end of the throttling device and the first end of the liquid storage device;

a fourth valve, a first valve port of the fourth valve being connected to the first end of the first heat exchanger, and a second valve port of the fourth valve being connected to the second end of the liquid storage device;

a fifth valve, a first valve port of the fifth valve being connected to the first port, and a second valve port of the fifth valve being connected to the second end of the first heat exchanger;

a sixth valve, a first valve port of the sixth valve being connected to the second end of the first heat exchanger; and

a seventh valve, a first valve port of the seventh valve being connected to a second valve port of the sixth valve, and a second valve port of the seventh valve being connected to the second end of the second heat exchanger.

4. The air-conditioning system according to claim 3, wherein the target heat exchanger comprises the third heat exchanger; the valve assembly further comprises an eighth valve, a first valve port of the eighth valve being connected to an outlet of the water tank, and a second valve port of the eighth valve being connected to a third end of the liquid storage device;

wherein the controller is further configured to:

determine that the target operation mode is the water heating mode;

control the third heat exchanger to be started; and

control the valve assembly to be in a first state, and control the first port and the fourth port of the four-way valve to be communicated;

wherein in the first state, the first valve, the second valve, and the eighth valve of the valve assembly are respectively in an opened state, and the third valve, the fourth valve, the fifth valve, the sixth valve, and the seventh valve are respectively in a closed state;

the first circuit comprises a circuit formed by sequentially connecting the compressor, the water tank, the liquid storage device, the throttling device, the third heat exchanger, the four-way valve and the separator.

5. The air-conditioning system according to claim 3, wherein the target operation mode further comprises a first coordination mode, the first coordination mode comprising a heating mode and the water heating

mode; the controller is further configured to:

determine that the target operation mode is the first coordination mode; and
according to the first coordination mode, control opening and closing of the valve assembly, control the first port and the fourth port to be communicated to adjust an indoor temperature, and heat water in the water tank to a first preset temperature.

6. The air-conditioning system according to claim 5, wherein the valve assembly further comprises a ninth valve, a first valve port of the ninth valve is connected to an outlet of the compressor and the water tank, and a second valve port of the ninth valve is connected to the second valve port of the sixth valve and the first valve port of the seventh valve of the valve assembly.

7. The air-conditioning system according to claim 6, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

determine a first priority order corresponding to the first coordination mode, the first priority order indicating that the water heating mode takes priority over the heating mode;
control the first heat exchanger and the second heat exchanger to be stopped, and control the third heat exchanger to be started;
control the valve assembly to be in a first state, wherein in the first state, the first valve, the second valve, and the eighth valve of the valve assembly are respectively in an opened state, and the third valve, the fourth valve, the fifth valve, the sixth valve, and the seventh valve are respectively in a closed state;
obtain the water temperature in the water tank; and
if the water temperature in the water tank is determined to reach the first preset temperature, control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started; and control the valve assembly to be in a second state, wherein in the second state, the first valve, the second valve, the third valve, the fourth valve, the sixth valve, the seventh valve, and the ninth valve of the valve assembly are respectively in an opened state, and the fifth valve of the valve assembly is in a closed state.

8. The air-conditioning system according to claim 6, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further

configured to:

determine a second priority order corresponding to the first coordination mode, the second priority order indicating that the heating mode takes priority over the water heating mode;
control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started;
control the valve assembly to be in a second state, wherein in the second state, the first valve, the second valve, the third valve, the fourth valve, the sixth valve, the seventh valve, and the ninth valve of the valve assembly are respectively in an opened state, and the fifth valve of the valve assembly is in a closed state;
obtain the indoor temperature; and
if the indoor temperature is determined to reach a second preset temperature, control the first heat exchanger and the second heat exchanger to be stopped, and control the third heat exchanger to be started; and control the valve assembly to be in a first state to adjust the water temperature in the water tank to the first preset temperature, wherein in the first state, the first valve, the second valve, and the eighth valve of the valve assembly are respectively in an opened state, and the third valve, the fourth valve, the fifth valve, the sixth valve, and the seventh valve are respectively in a closed state.

9. The air-conditioning system according to claim 6, wherein the valve assembly further comprises:

an eighth valve, a first valve port of the eighth valve being connected to an outlet of the water tank, and a second valve port of the eighth valve being connected to a third end of the liquid storage device;
wherein the controller is further configured to: determine a third priority order corresponding to the first coordination mode, the third priority order indicating that the water heating mode and the heating mode are run synchronously.

10. The air-conditioning system according to claim 9, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started; and
control the valve assembly to be in a third state, wherein in the third state, the first valve, the second valve, the third valve, the fourth valve, the sixth valve, the seventh valve, the eighth

valve and the ninth valve of the valve assembly are respectively in an opened state, and the fifth valve of the valve assembly is in a closed state.

11. The air-conditioning system according to claim 9, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started; and
control the valve assembly to be in a fourth state, wherein in the fourth state, the first valve, the second valve, the third valve, the fourth valve, the fifth valve, the seventh valve, and the ninth valve of the valve assembly are respectively in an opened state, and the sixth valve and the eighth valve of the valve assembly are in a closed state.

12. The air-conditioning system according to claim 9, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger to be started, control the second heat exchanger to be stopped and control the third heat exchanger to be started; and
control the valve assembly to be in a fifth state, wherein in the fifth state, the first valve, the second valve, the fourth valve, and the fifth valve of the valve assembly are respectively in an opened state, and the third valve, the sixth valve, the seventh valve, the eighth valve, and the ninth valve of the valve assembly are in a closed state.

13. The air-conditioning system according to claim 9, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger to be started, control the second heat exchanger to be stopped and control the third heat exchanger to be started; and
control the valve assembly to be in a sixth state, wherein in the sixth state, the first valve, the second valve, the fourth valve, the sixth valve, the eighth valve and the ninth valve of the valve assembly are respectively in an opened state, and the third valve, the fifth valve, and the seventh valve of the valve assembly are in a closed state.

14. The air-conditioning system according to claim 9, wherein the controller is further configured to:

control the first heat exchanger to be stopped and control the second heat exchanger and the third heat exchanger of the target heat exchanger to be started; and
control the valve assembly to be in a seventh state, wherein in the seventh state, the first valve, the second valve, the third valve, the sixth valve, the seventh valve, the eighth valve and the ninth valve of the valve assembly are respectively in an opened state, and the fourth valve and the fifth valve of the valve assembly are in a closed state.

15. The air-conditioning system according to claim 3, wherein the target operation mode further comprises a second coordination mode, the second coordination mode comprising a cooling mode and the water heating mode; the controller is further configured to:

determine that the target operation mode is the second coordination mode; and
according to the second coordination mode, control opening and closing of the valve assembly, control the third port and the fourth port of the four-way valve to be communicated to adjust an indoor temperature, and adjust the water temperature in the water tank to a third preset temperature.

16. The air-conditioning system according to claim 15, wherein the valve assembly further comprises an eighth valve, a first valve port of the eighth valve being connected to an outlet of the water tank, and a second valve port of the eighth valve being connected to a third end of the liquid storage device.

17. The air-conditioning system according to claim 16, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger, the second heat exchanger and the third heat exchanger to be started; and
control the valve assembly to be in a seventh state, wherein in the seventh state, the first valve, the second valve, the third valve, the fourth valve, the fifth valve, the sixth valve, the seventh valve, and the eighth valve are respectively opened.

18. The air-conditioning system according to claim 16, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger,

and the third heat exchanger; the controller is further configured to:

control the first heat exchanger to be started,
control the second heat exchanger to be stopped and control the third heat exchanger to be started; and
control the valve assembly to be in an eighth state, wherein in the eighth state, the first valve, the second valve, the fourth valve, the fifth valve, and the eighth valve are respectively opened, and the third valve, the sixth valve, and the seventh valve are respectively closed.

19. The air-conditioning system according to claim 16, wherein the target heat exchanger comprises the first heat exchanger, the second heat exchanger, and the third heat exchanger; the controller is further configured to:

control the first heat exchanger to be stopped, and control the second heat exchanger and the third heat exchanger to be started; and
control the valve assembly to be in a ninth state, wherein in the ninth state, the first valve, the second valve, the third valve, the fifth valve, the sixth valve, and the seventh valve are respectively opened, and the fourth valve is closed.

20. The air-conditioning system according to claim 3, wherein the target operation mode further comprises a third coordination mode, the third coordination mode comprising a cooling mode, a heating mode and the water heating mode; the controller is further configured to:

determine that the target operation mode is the third coordination mode; and
according to the third coordination mode, control opening and closing of the valve assembly, control the third port and the fourth port of the four-way valve to be communicated to adjust an indoor temperature, and adjust the water temperature in the water tank.

21. The air-conditioning system according to claim 20, wherein the valve assembly further comprises:

a ninth valve, a first valve port of the ninth valve being connected to an outlet of the compressor and the water tank, and a second valve port of the ninth valve being connected to the second valve port of the sixth valve and the first valve port of the seventh valve;
a tenth valve, a first valve port of the tenth valve being connected to the second end of the second heat exchanger, and a second valve port of the tenth valve being connected to the second

valve port of the first valve; and
an eleventh valve, a first valve port of the eleventh valve being connected to the first end of the second heat exchanger, and a second valve port of the eleventh valve being connected to the second end of the throttling device.

22. The air-conditioning system according to claim 21, wherein the target heat exchanger comprises the first heat exchanger and the second heat exchanger; the controller is further configured to:

control the first heat exchanger and the second heat exchanger to be started; and
control the valve assembly to be in a tenth state, in the tenth state, the first valve, the fourth valve, the fifth valve, the seventh valve, the ninth valve, the tenth valve, and the eleventh valve being respectively opened, and the second valve, the third valve, and the sixth valve being closed.

23. The air-conditioning system according to claim 21, wherein the target heat exchanger comprises the first heat exchanger and the second heat exchanger;

the controller is further configured to:
control the first heat exchanger and the second heat exchanger to be started; and
the controller is further configured to: control the valve assembly to be in an eleventh state, in the eleventh state, the first valve, the fourth valve, the fifth valve, the tenth valve, and the eleventh valve being respectively opened, and the second valve, the third valve, the sixth valve, the seventh valve, and the ninth valve being closed.

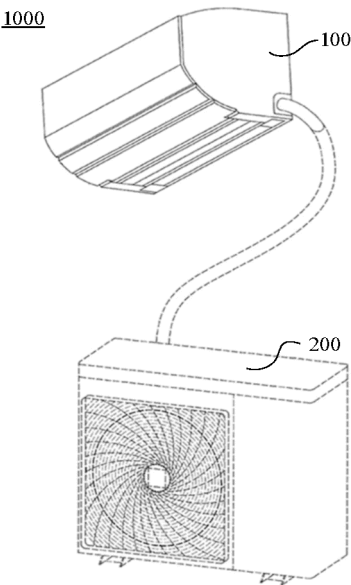


FIG. 1A

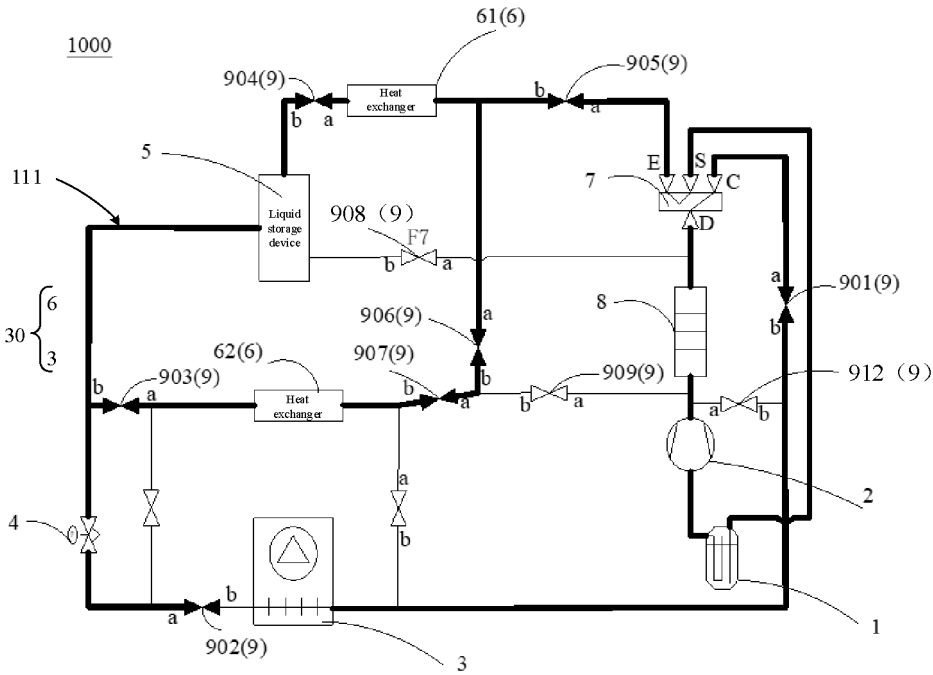


FIG. 1B

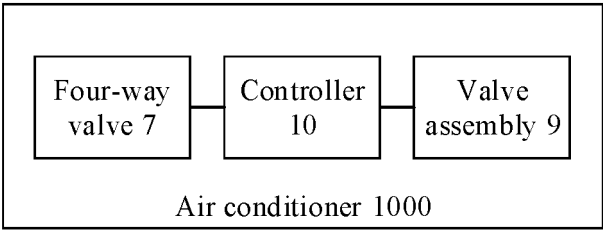


FIG. 2

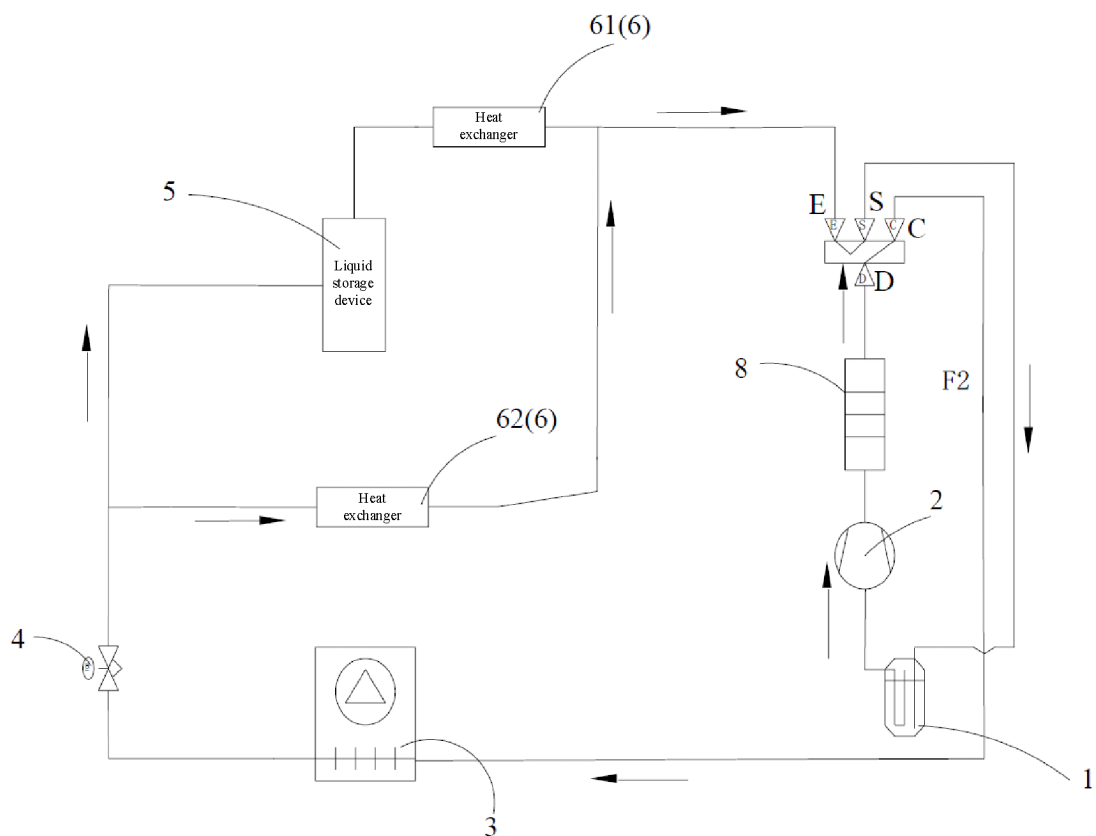


FIG. 3

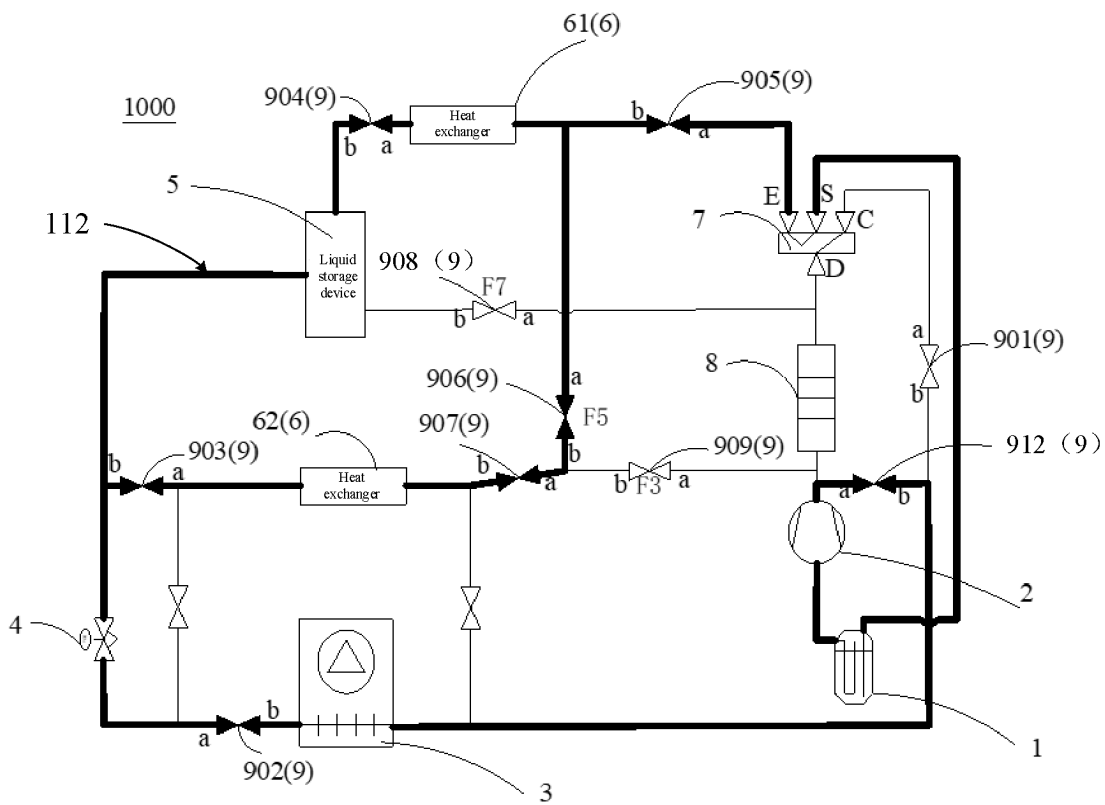


FIG. 4

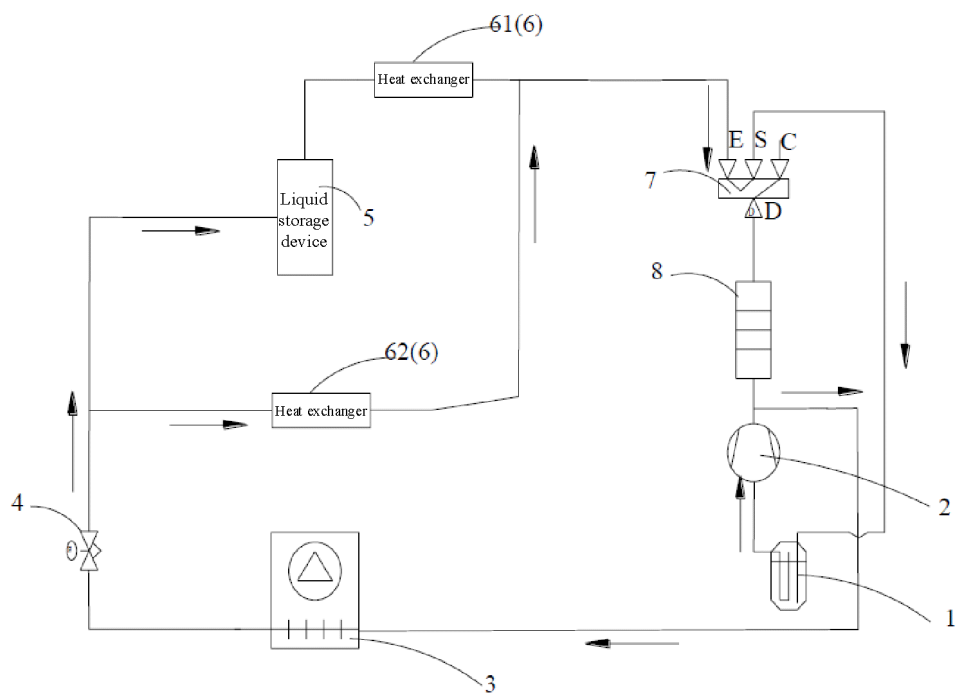


FIG. 5

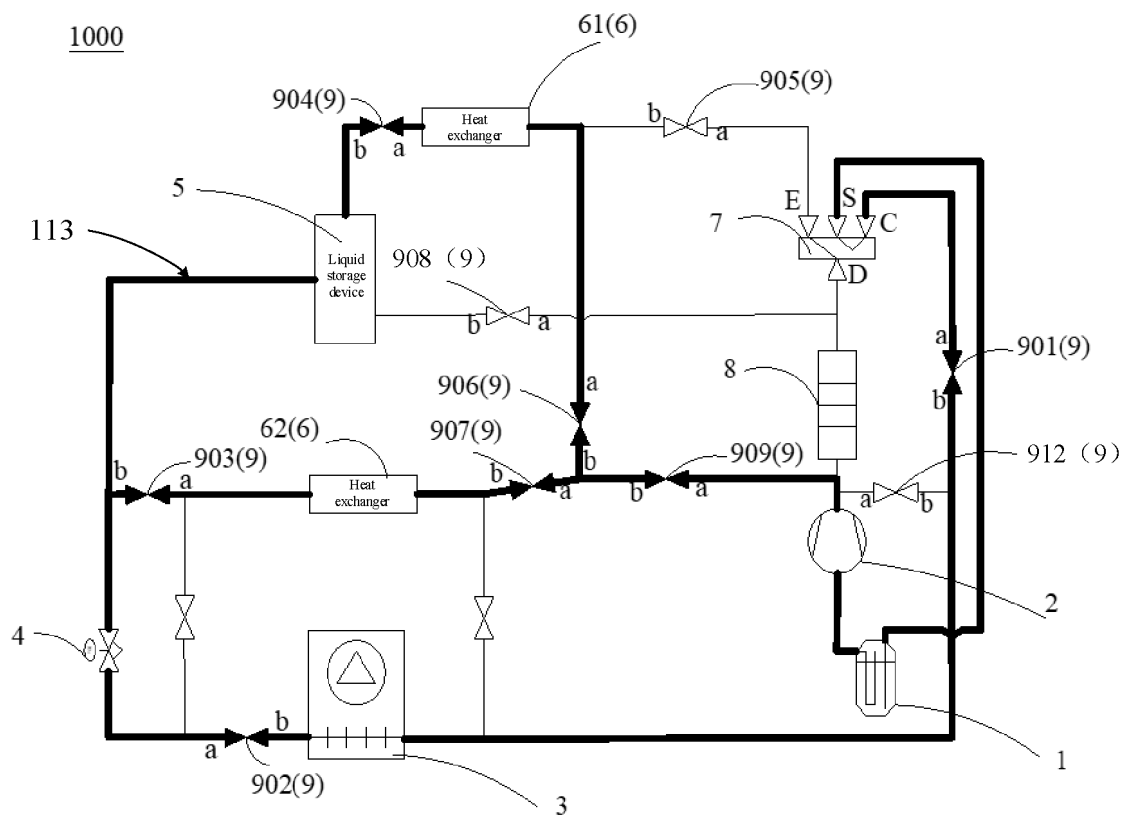


FIG. 6

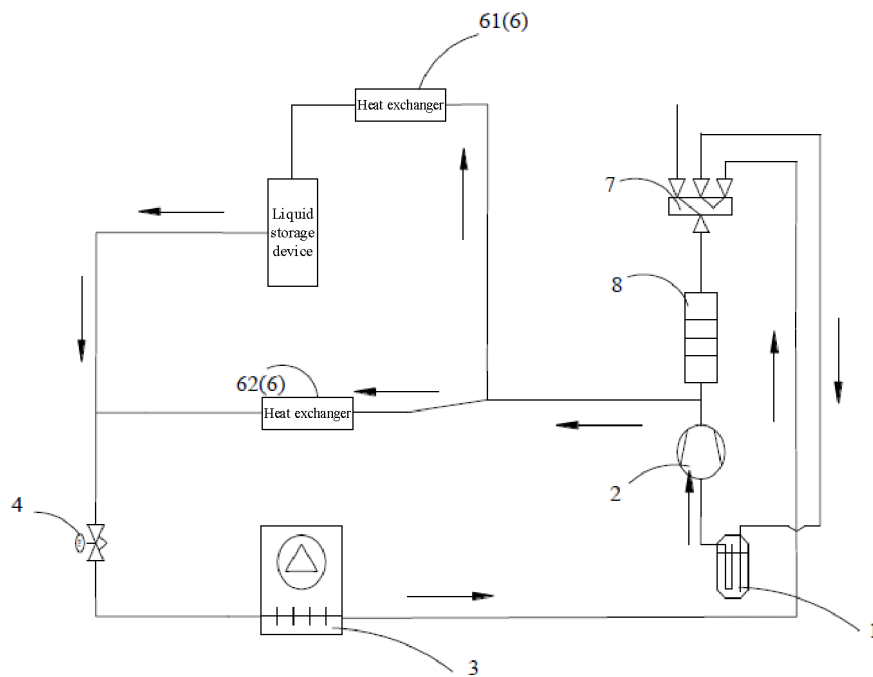


FIG. 7

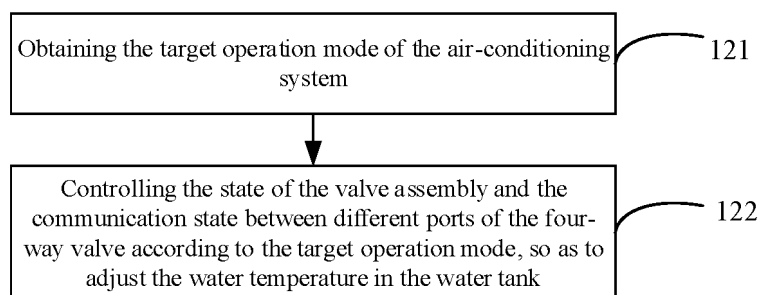


FIG. 8A

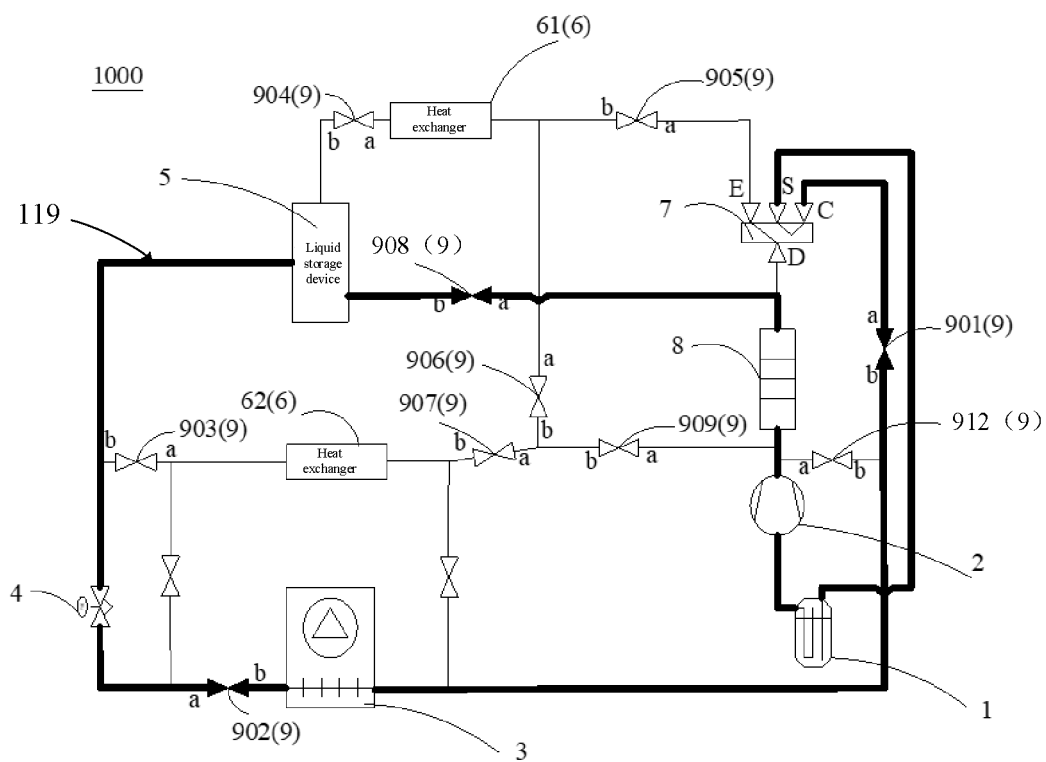


FIG. 8B

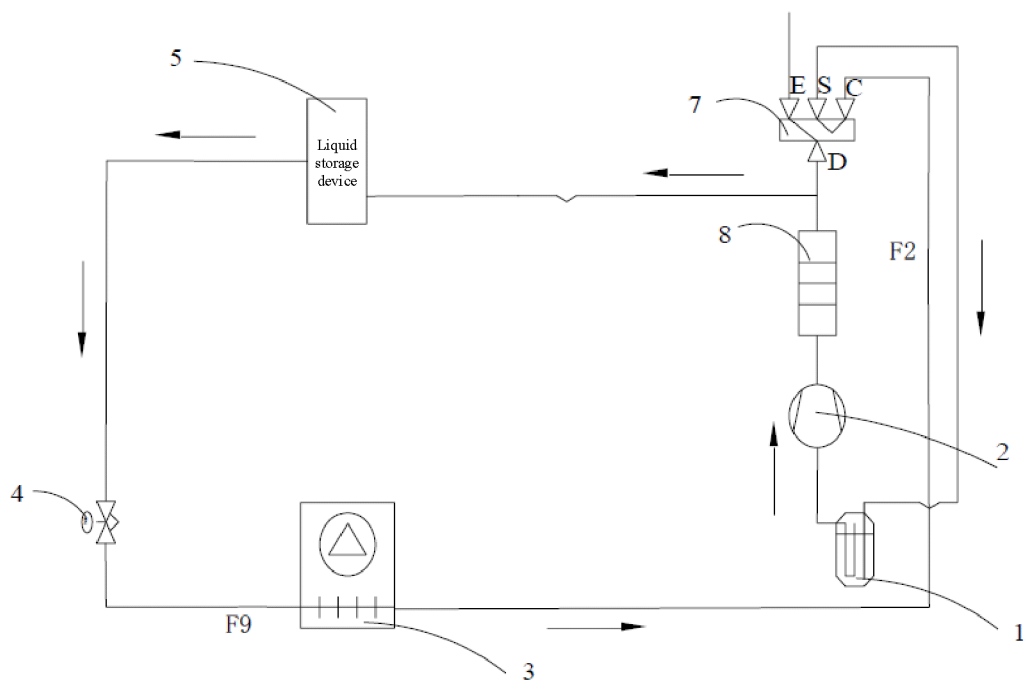


FIG. 9

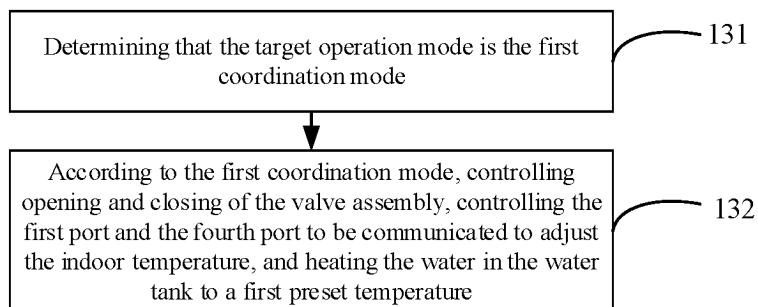


FIG. 10A

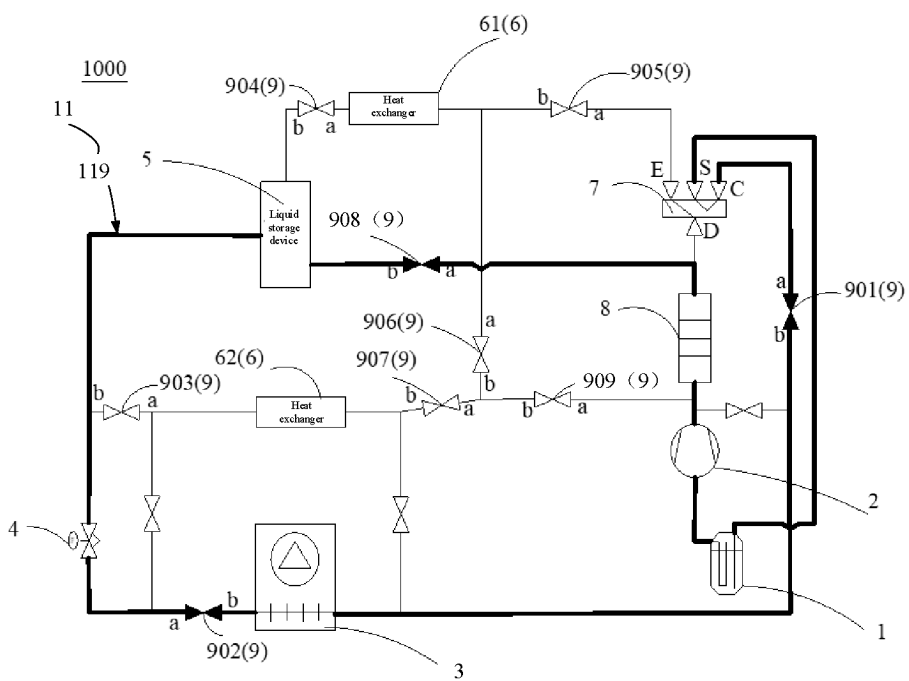


FIG. 10B

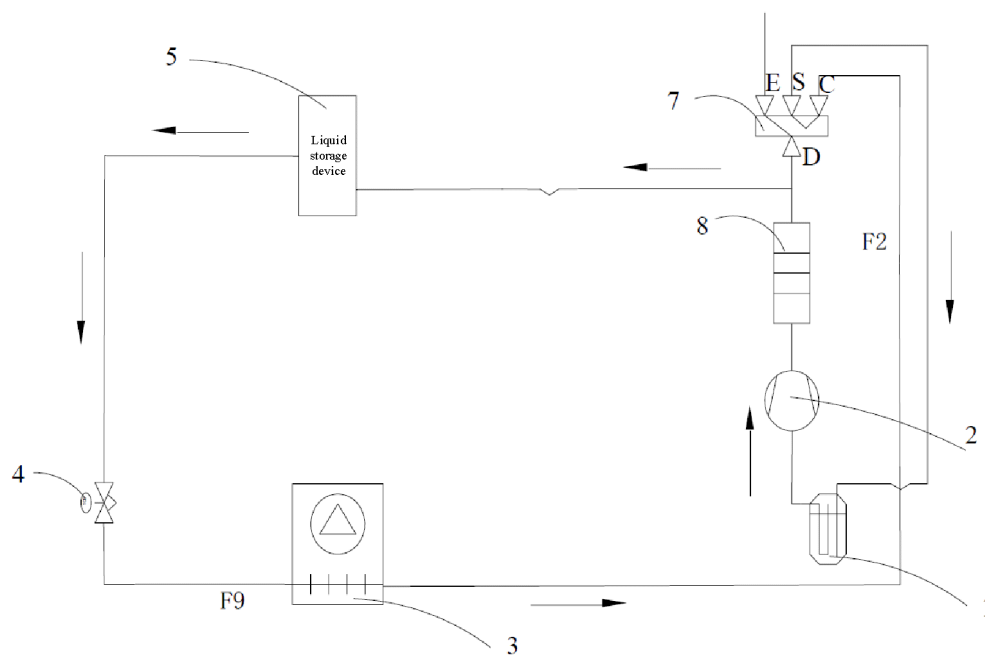


FIG. 11

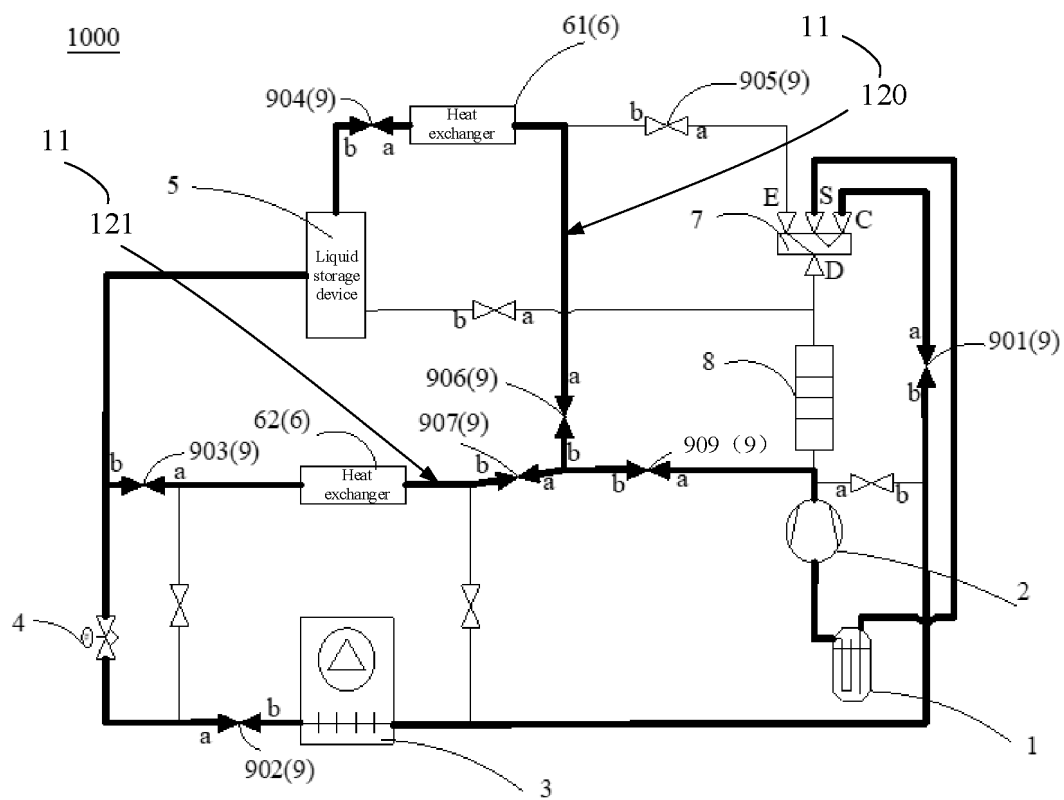


FIG. 12

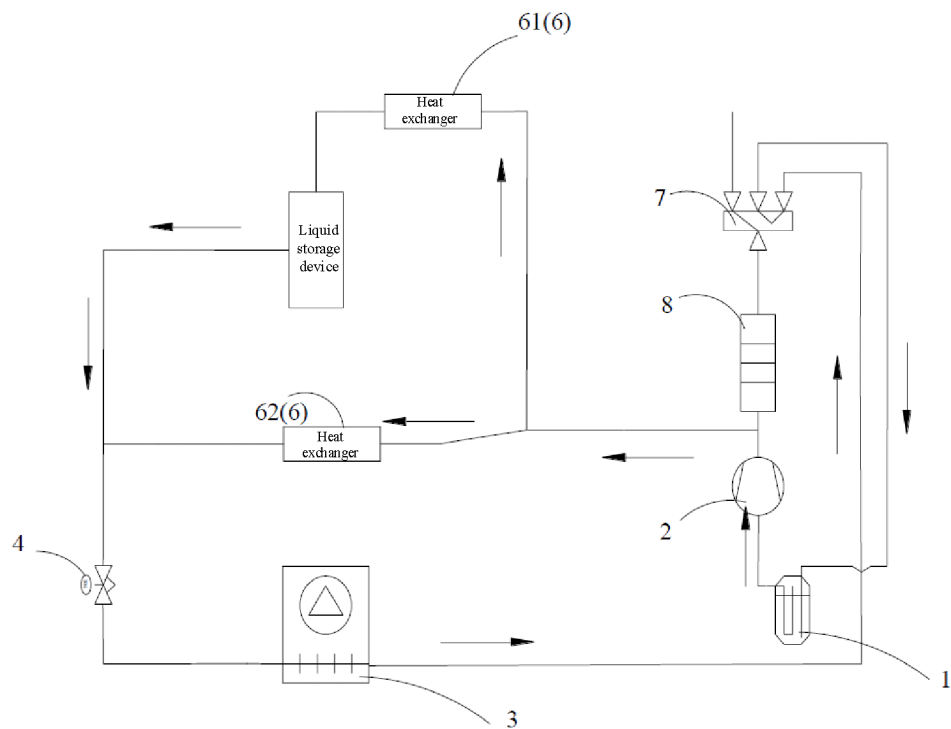


FIG. 13

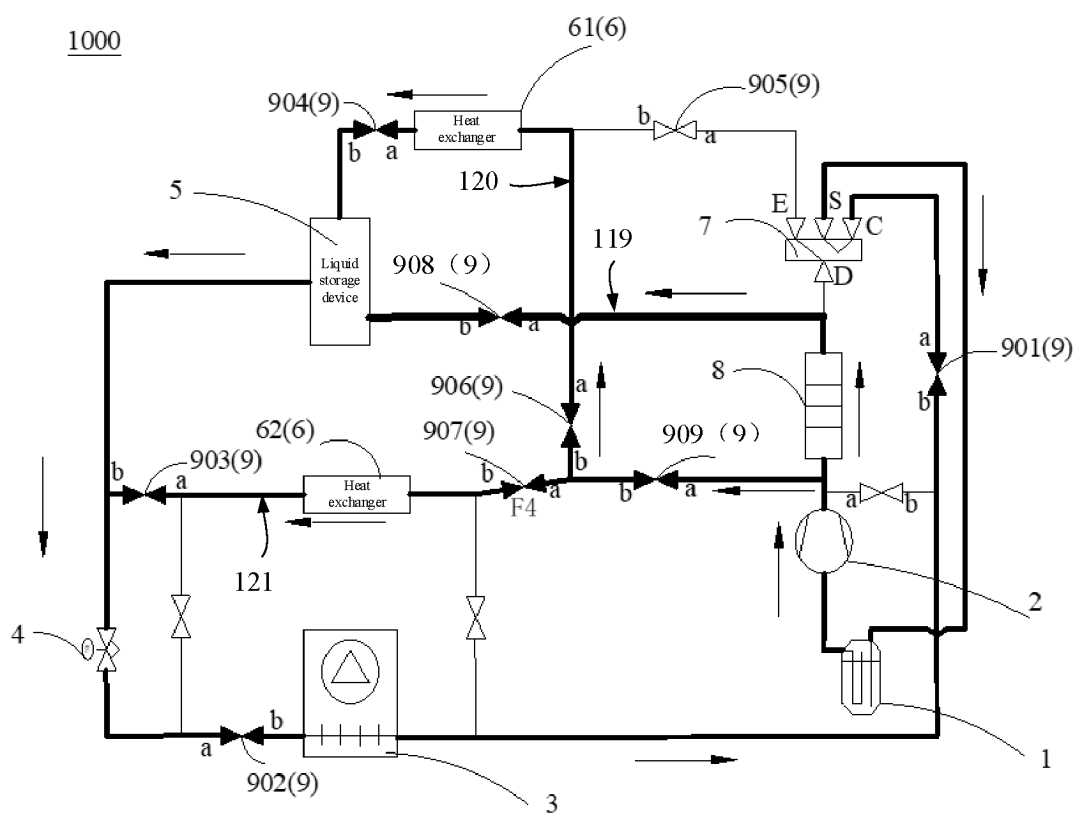


FIG. 14

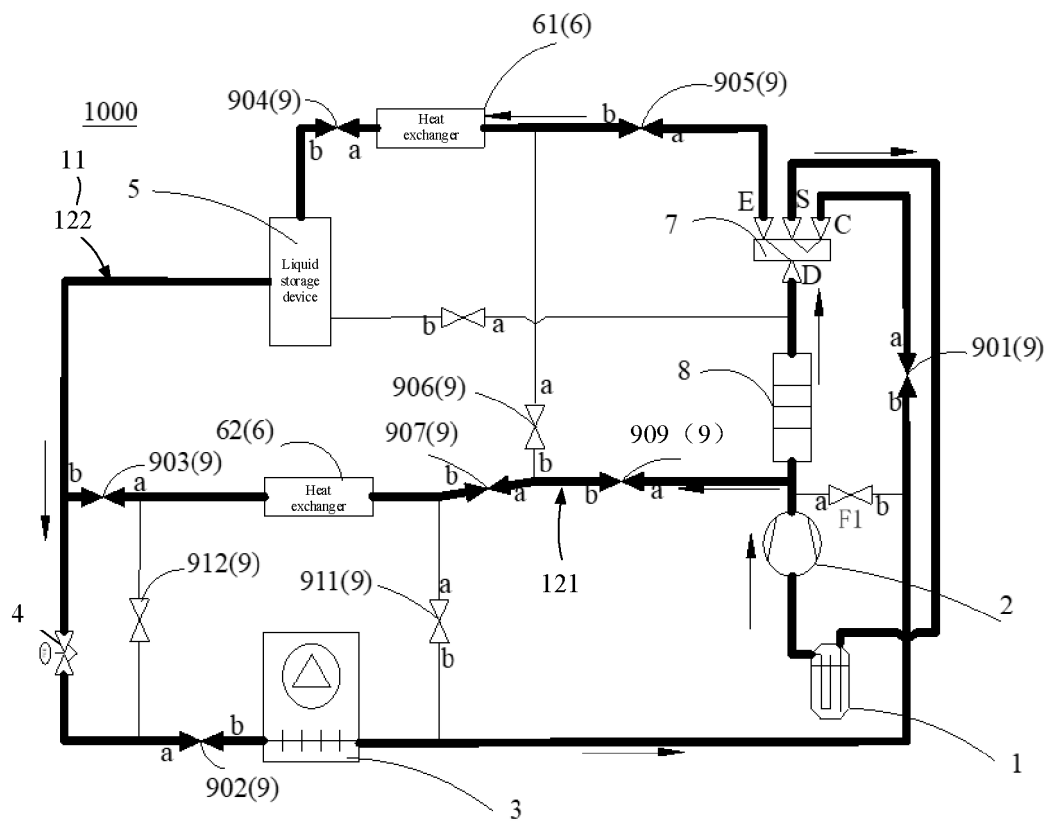


FIG. 15

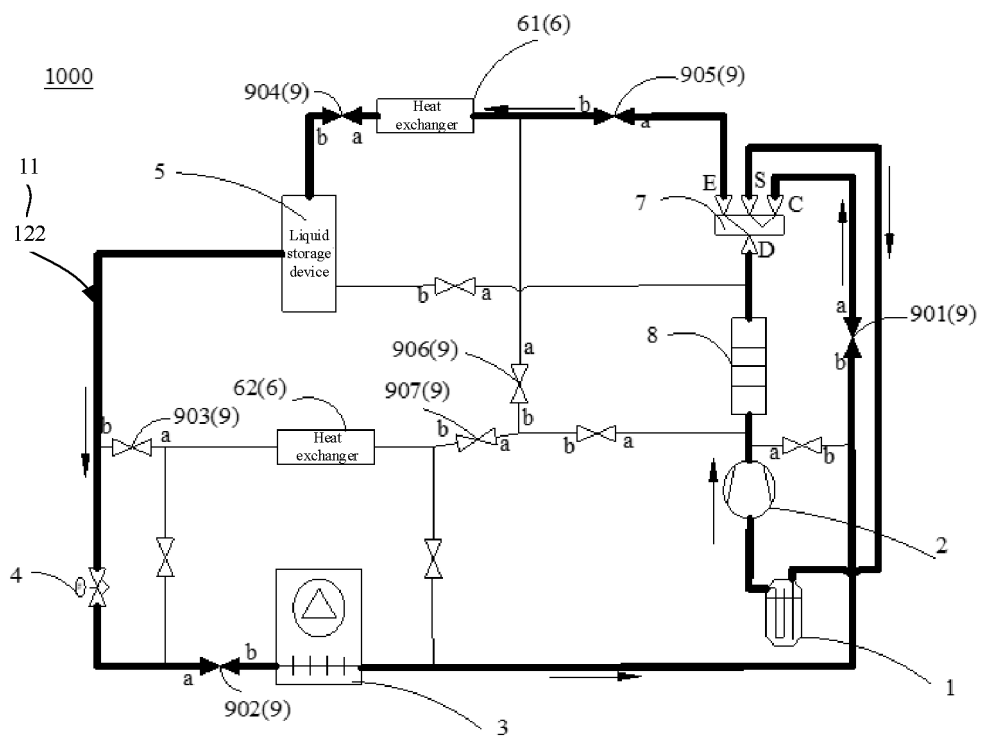
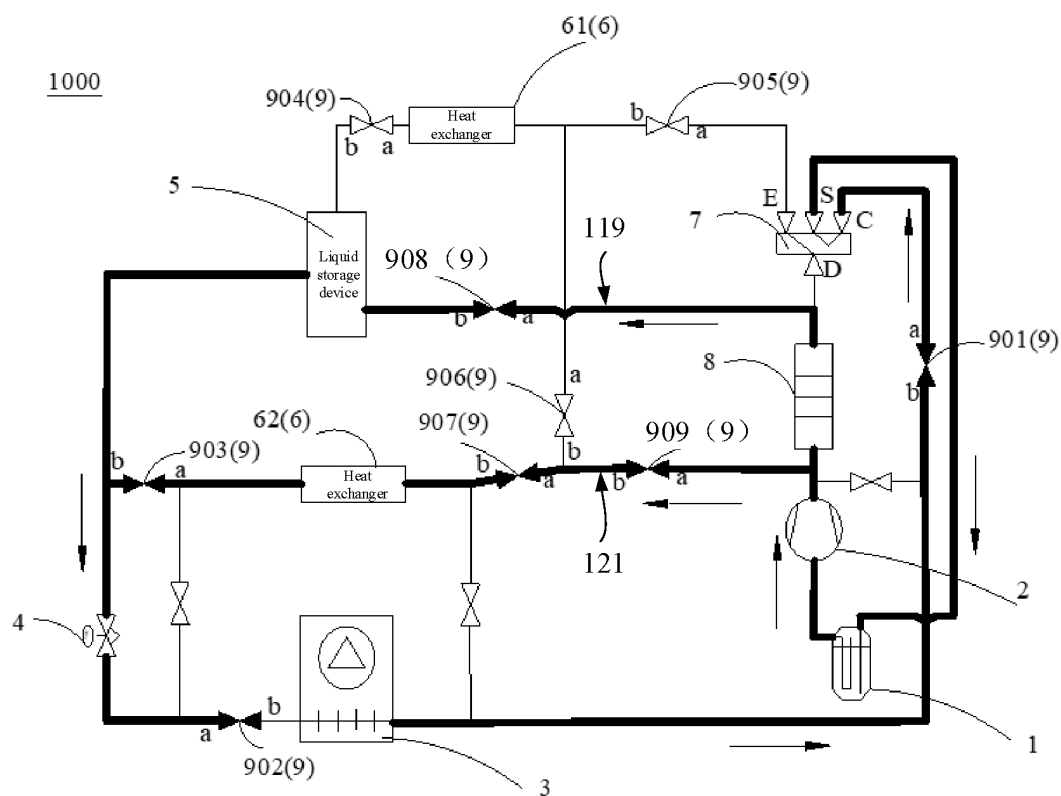
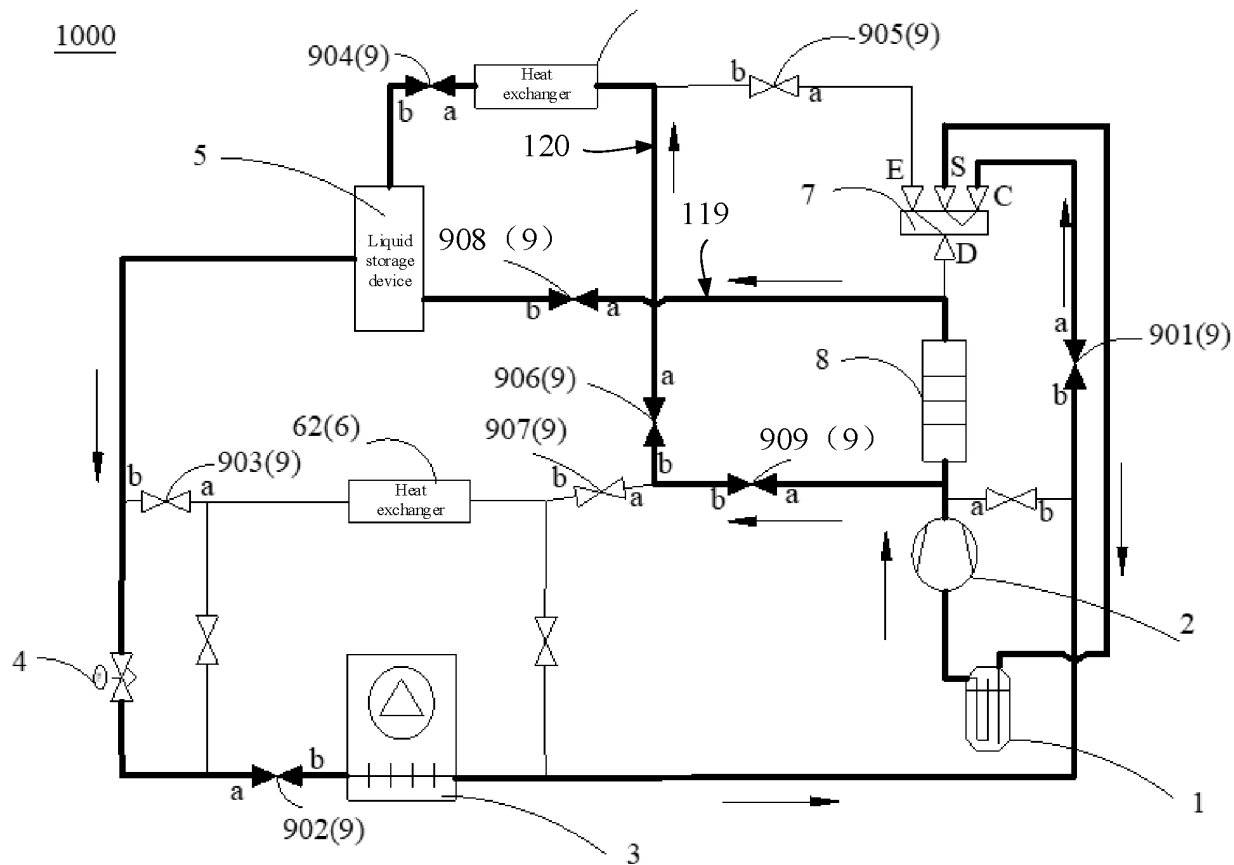


FIG. 16



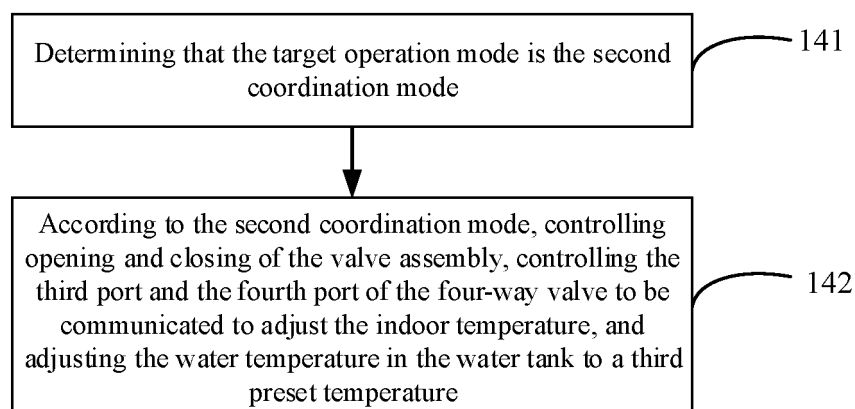


FIG. 19A

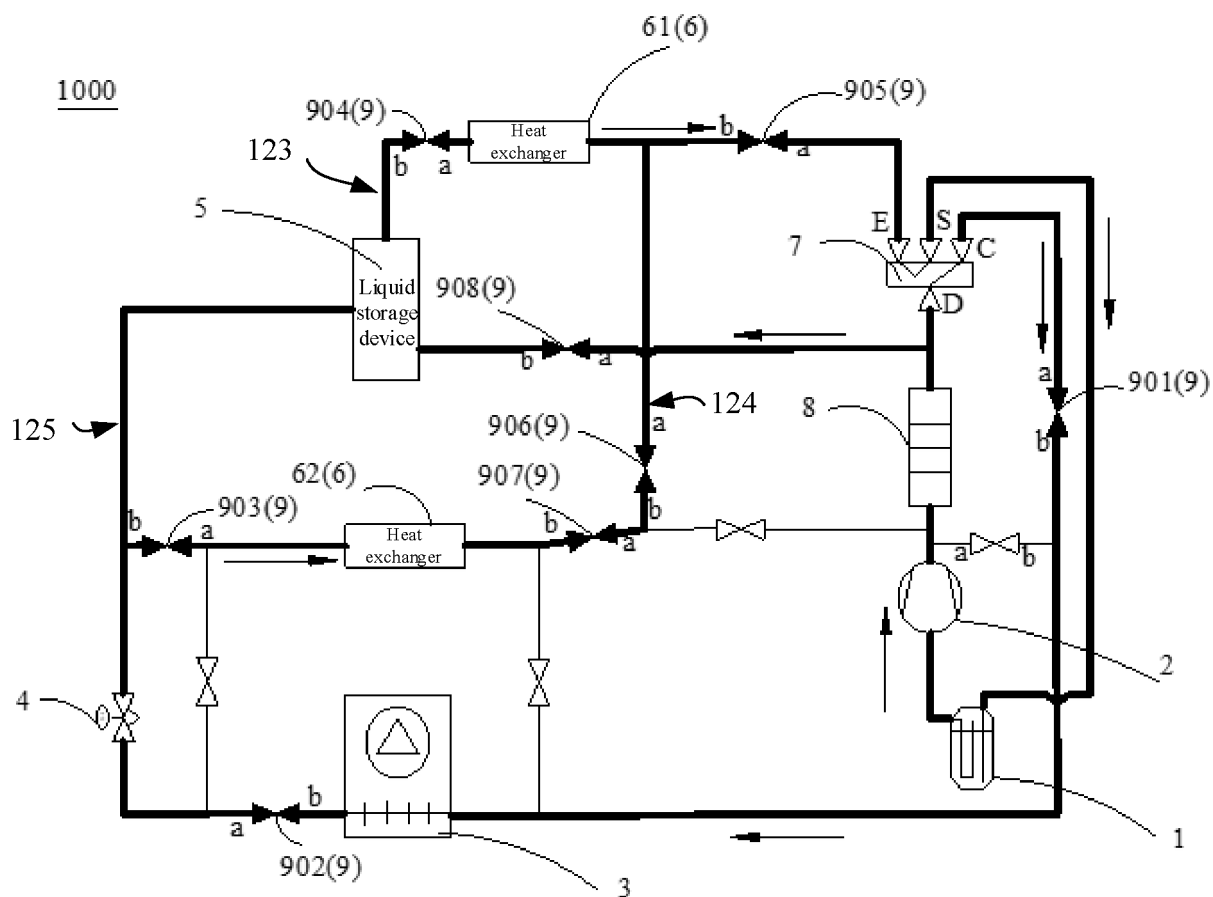


FIG. 19B

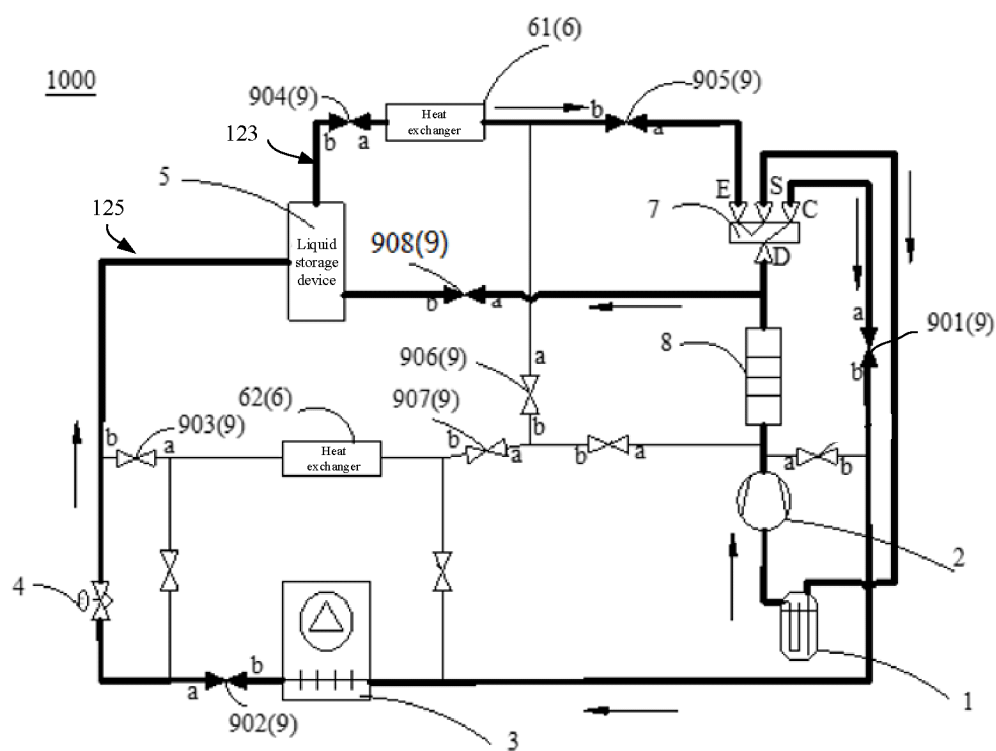


FIG. 20

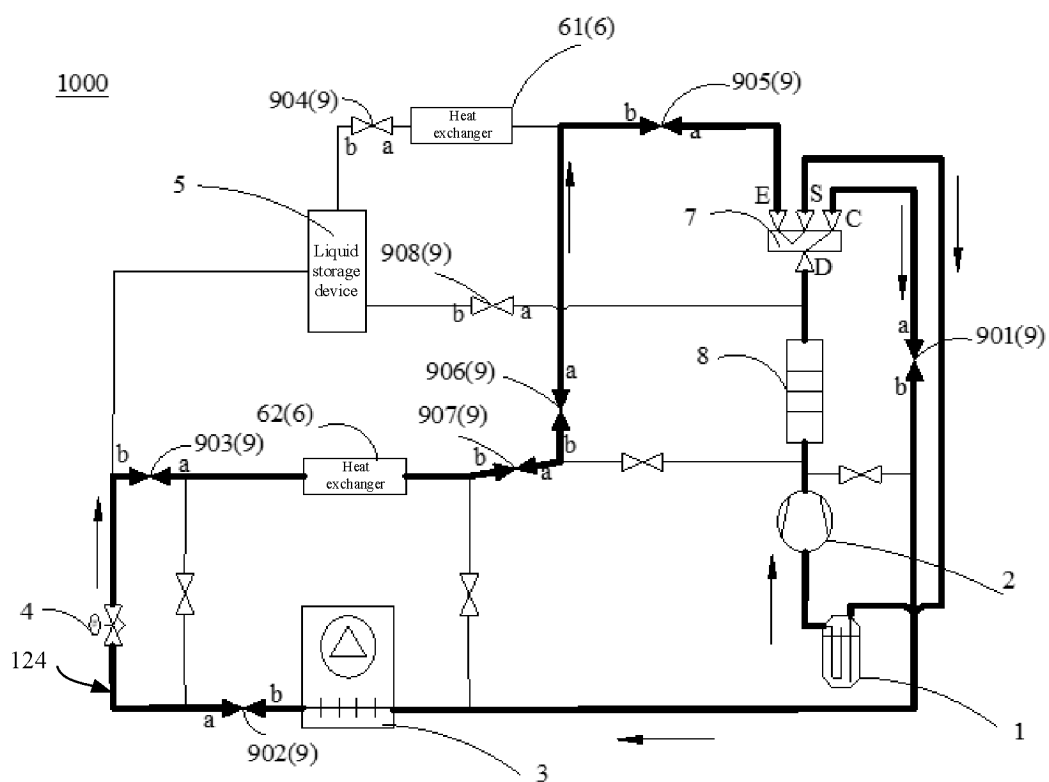


FIG. 21

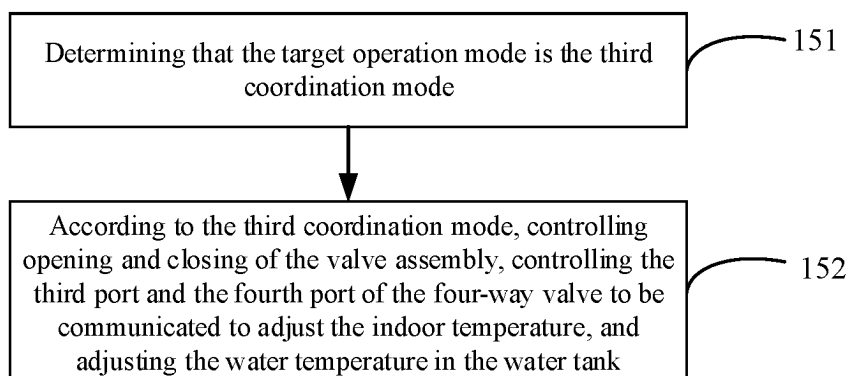


FIG. 22A

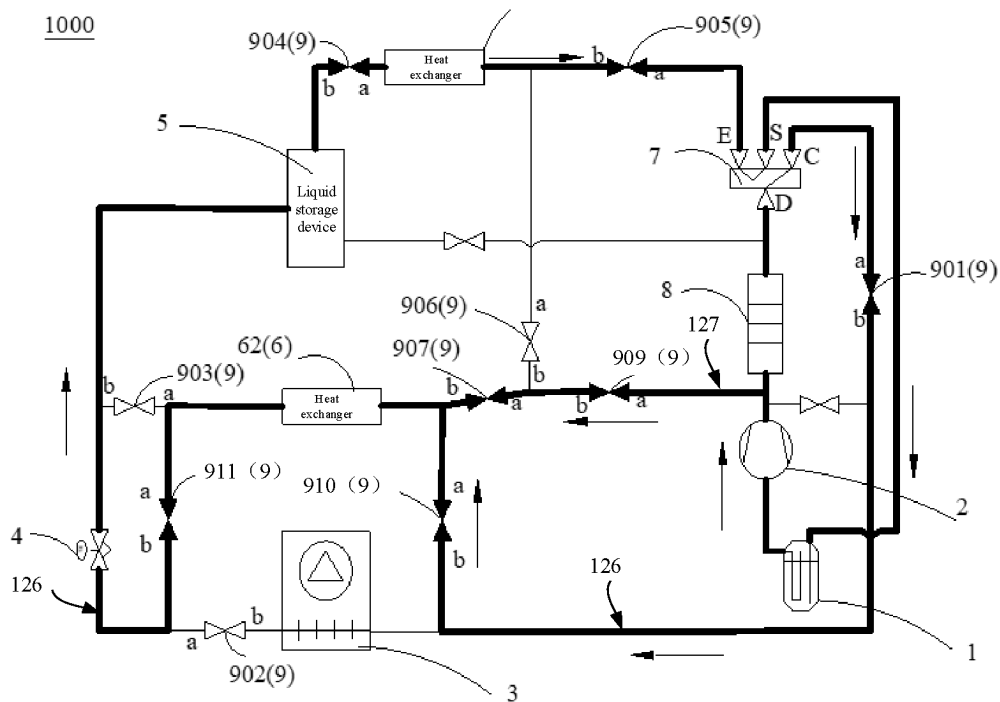


FIG. 22B

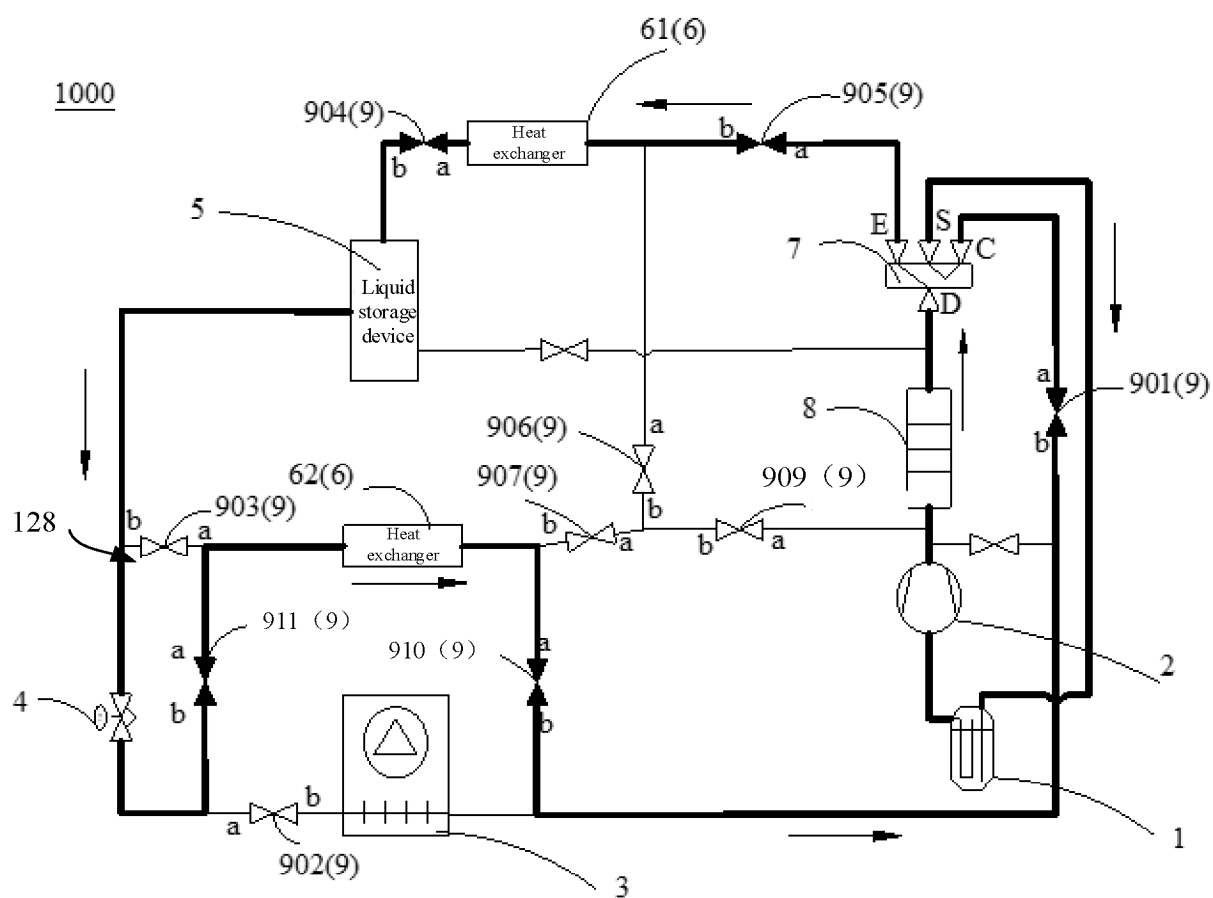


FIG. 23

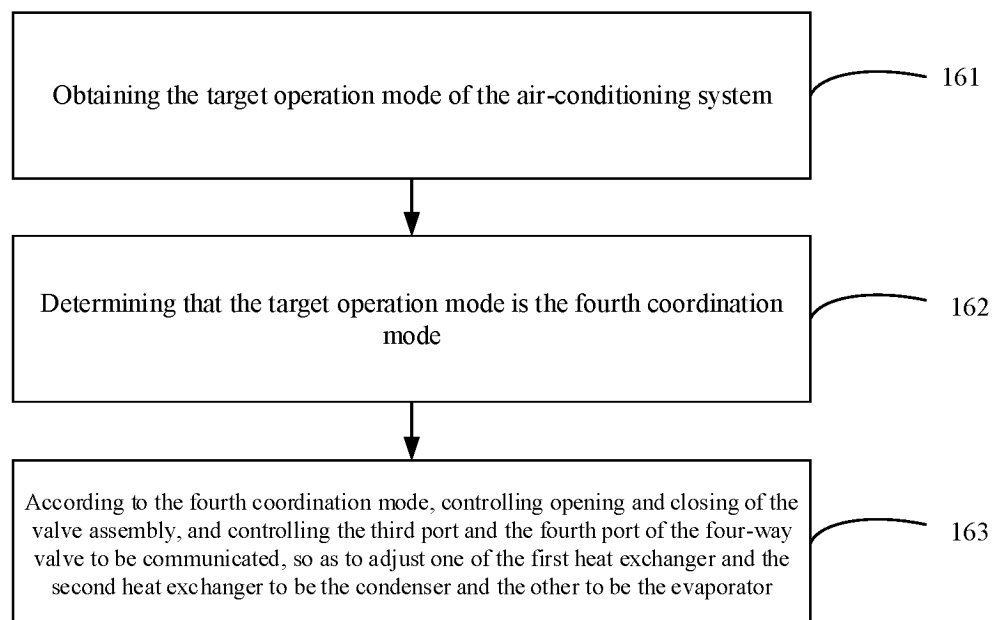


FIG. 24A

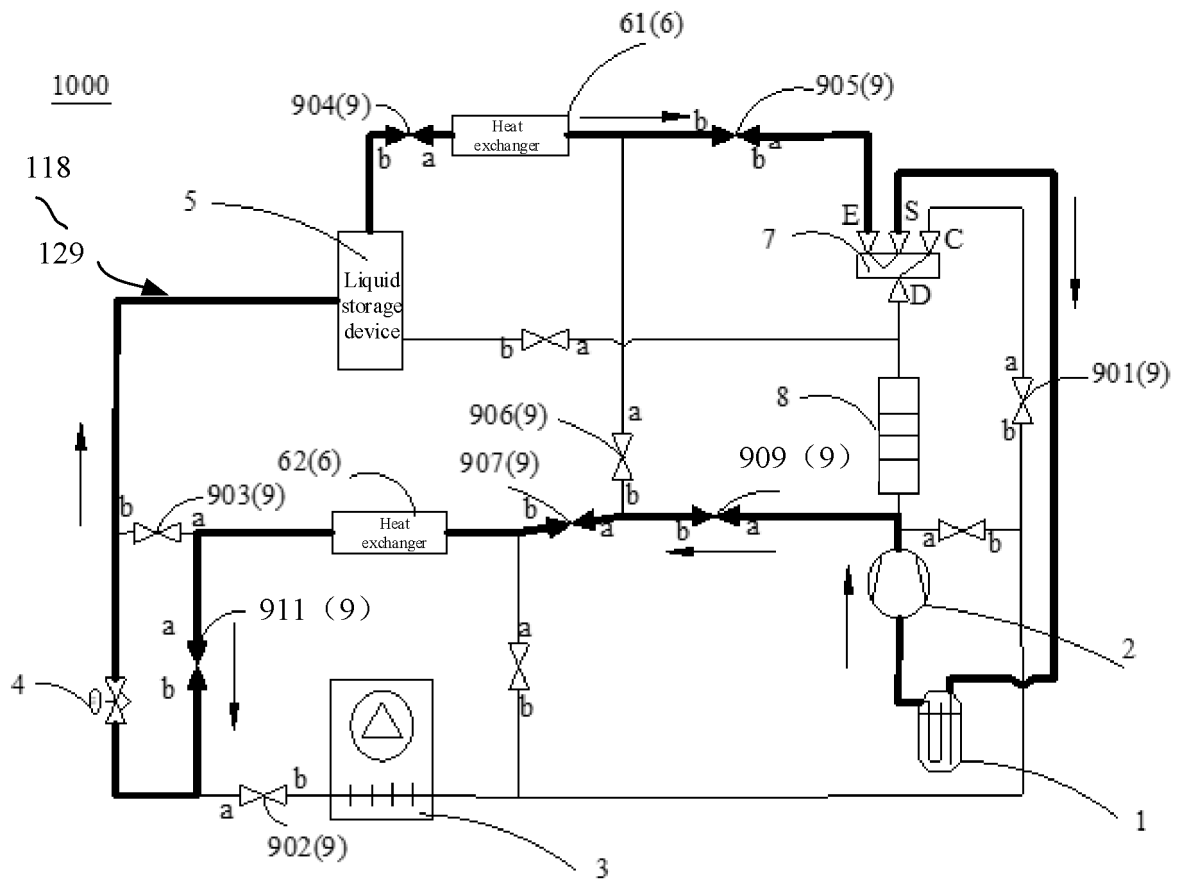


FIG. 24B

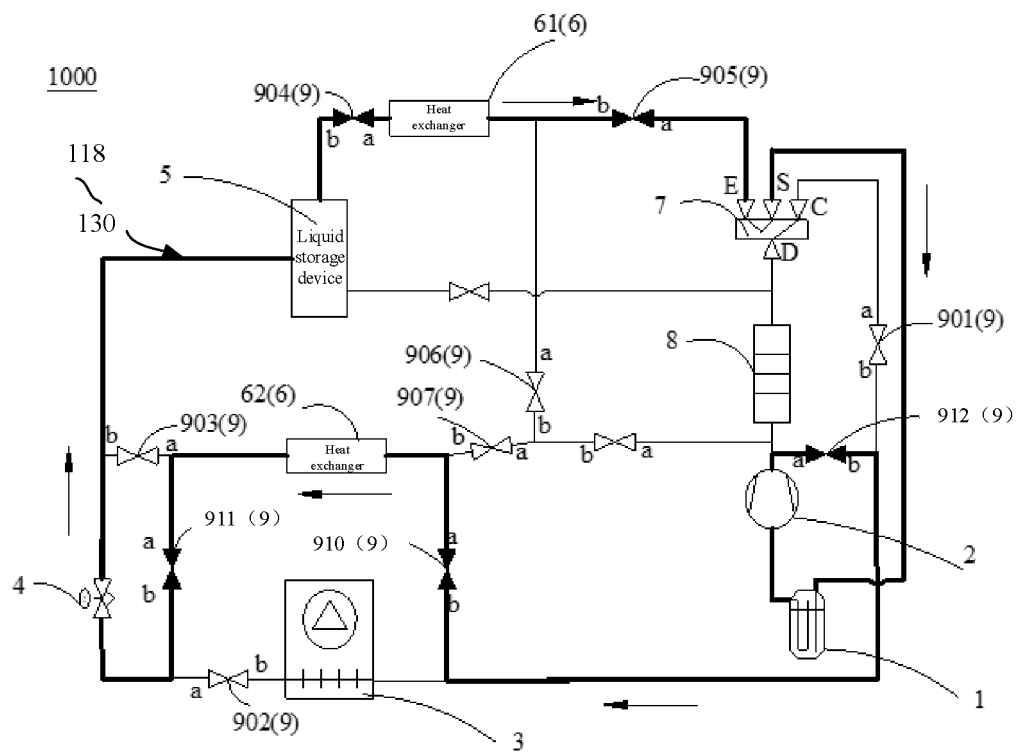


FIG. 25

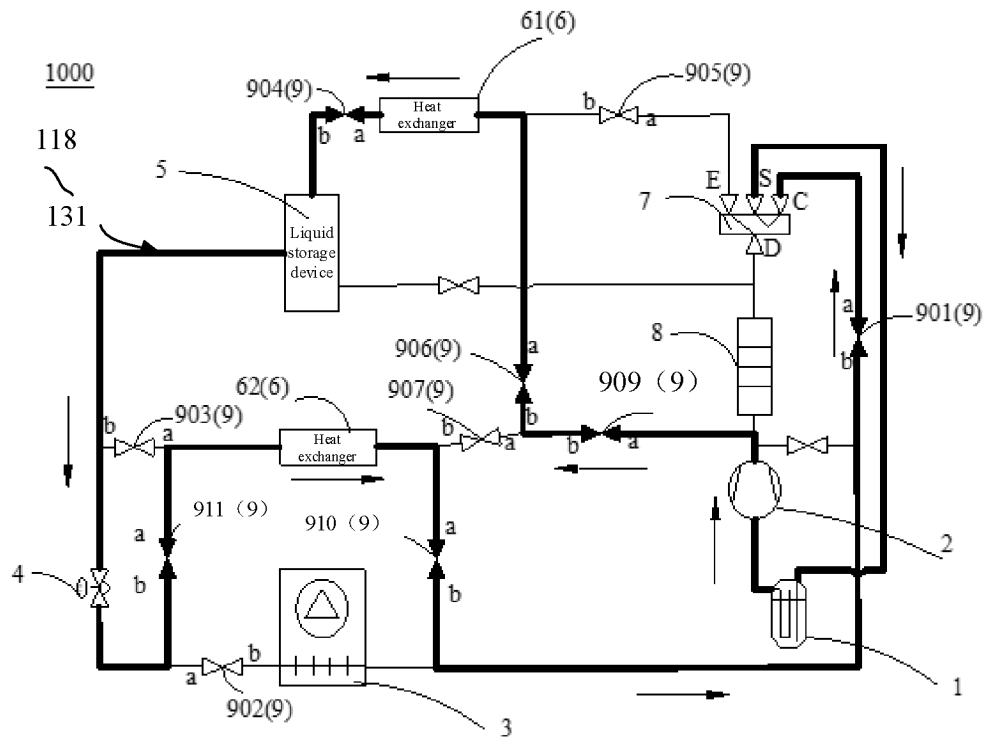


FIG. 26

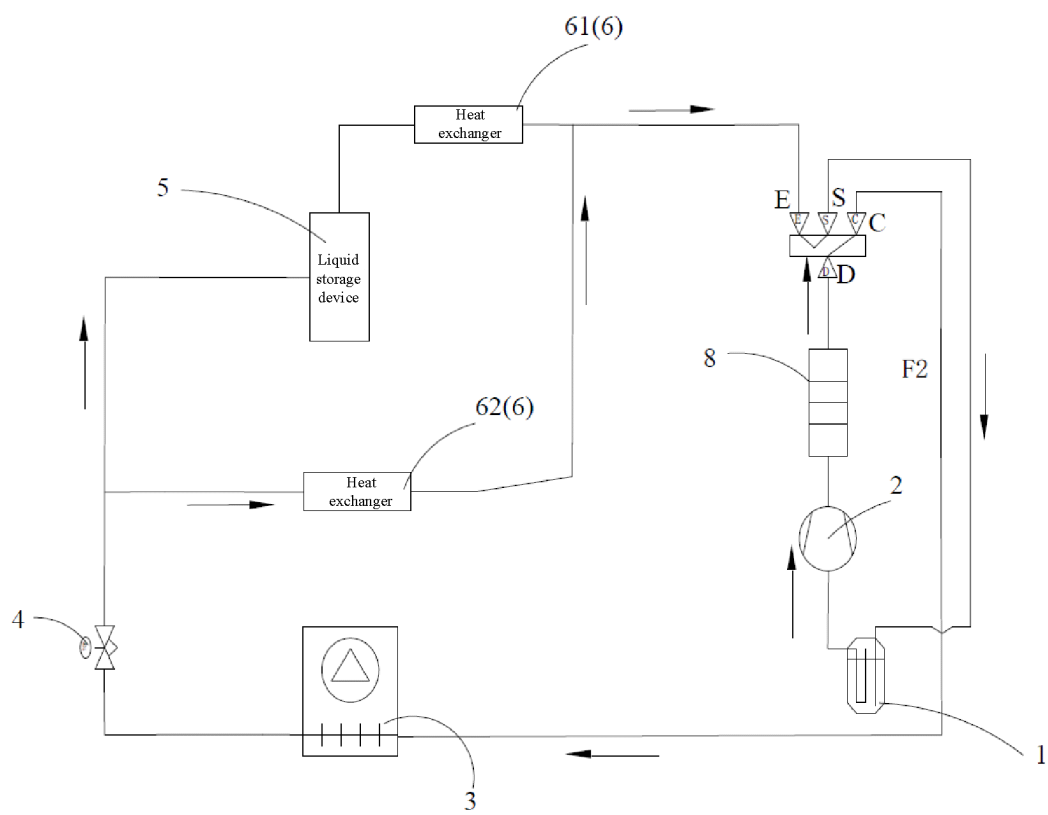


FIG. 27

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/102890

A. CLASSIFICATION OF SUBJECT MATTER

F24F5/00(2006.01)i; F25B13/00(2006.01)i; F24H4/02(2022.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F24F5/-; F25B13/-; F24H4/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, VEN, CNTXT, ENTXT, ENTXTC: 海信, 袁占彪, 吕根贵, 钟文朝, 热泵, 压缩机, 热水, 水箱, 储液, 第二, 电磁阀, 换热器, 节流, 膨胀阀, 气液分离, 热交换器, 蒸发器, 并联, gas fraction, gas-liquid separation, heat exchanger, evaporator, water tank, hot water, temperature, second, two

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 110779233 A (HANGZHOU HONGYAN PIPELINE SYSTEM SCIENCE & TECHNOLOGY CO., LTD.) 11 February 2020 (2020-02-11) description, paragraphs 39-52, and figure 1	1-5, 15
X	CN 202719807 U (ZOU DA) 06 February 2013 (2013-02-06) description, paragraph 24, and figure 1	1-5, 15
A	CN 110388763 A (GD MIDEA HEATING & VENTILATING EQUIPMENT CO., LTD. et al.) 29 October 2019 (2019-10-29) entire document	1-23
A	CN 115992974 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 21 April 2023 (2023-04-21) entire document	1-23
A	CN 201034394 Y (WUXI TONGFANG ARTIFICIAL ENVIRONMENT CO., LTD.) 12 March 2008 (2008-03-12) entire document	1-23

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"D" document cited by the applicant in the international application	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 23 August 2024	Date of mailing of the international search report 28 August 2024
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/102890

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 20230018179 A (LG ELECTRONICS, INC.) 07 February 2023 (2023-02-07) entire document	1-23

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2024/102890

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110779233	A	11 February 2020	CN	211177489	U	04 August 2020
CN	202719807	U	06 February 2013	None			
CN	110388763	A	29 October 2019	None			
CN	115992974	A	21 April 2023	None			
CN	201034394	Y	12 March 2008	None			
KR	20230018179	A	07 February 2023	None			

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202311119252 [0001]
- CN 202311119322 [0001]
- CN 202311119288X [0001]
- CN 202311119275 [0001]
- CN 202311119311 [0001]