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AIR CONDITIONING SYSTEM AND CONTROL METHOD THEREFOR

Abstract

An air conditioning system includes an indoor unit, an outdoor unit, a first expansion valve, a second expansion valve and a controller. The controller is configured to: control the air conditioning system to be switched to a cooling mode, control an indoor expansion valve and the second expansion valve to be closed and control the first expansion valve to be opened when a refrigerant leakage occurring indoors is obtained; control a compressor to be stopped and the first expansion valve to be closed, if the compressor satisfies a first preset condition; control the compressor to be started and the first expansion valve and the indoor expansion valve to be opened, if the refrigerant leakage continues indoors after controlling the compressor to be stopped; and control the compressor to be stopped and the first expansion valve to be closed, if the compressor again satisfies the first preset condition.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of International Application No. PCT/CN2023/105122, filed Jun. 30, 2023, which claims priority to Chinese Patent Application No. 202211427196.3, filed on Nov. 14, 2022. The entire disclosures of the above-identified applications are hereby incorporated herein by reference.

TECHNICAL FIELD
[0002] The present disclosure relates to the field of air conditioning technology, and in particular, to an air conditioning system and a control method therefor.
BACKGROUND
[0003] Based on people's demand for apparent temperature comfort, air conditioners come into thousands of households and become an indispensable electric appliance in people's daily lives. In the operation process of the air conditioners, refrigerant needs to be circulated in a refrigerant circulation pipeline between an outdoor unit and an indoor unit.
SUMMARY
[0004] There are provided an air conditioning system and a control method therefor according to embodiments of the present disclosure. The technical solution is as below:
[0005] In one aspect, an air conditioning system is provided. The air conditioning system includes an indoor unit, an outdoor unit, a first expansion valve, a second expansion valve and a controller. The indoor unit includes an indoor heat exchanger and an indoor expansion valve. The outdoor unit includes a compressor. The indoor unit is connected to the outdoor unit by a gas refrigerant pipe and a liquid refrigerant pipe, respectively. The first expansion valve is disposed on the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit, and is configured to control connection or disconnection of the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit. The second expansion valve is disposed on the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve, and is configured to control connection or disconnection of the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve. The controller is coupled to the indoor heat exchanger, the outdoor heat exchanger, the compressor, the first expansion valve, and the second expansion valve. The controller is configured to: control the air conditioning system to operate in a cooling mode, control the indoor expansion valve and the second expansion valve to be closed and control the first expansion valve to be opened, when information indicating that a refrigerant leakage occurs indoors is acquired, control the compressor to be stopped and control the first expansion valve to be closed, if the controller determines that the compressor satisfies a first preset condition, control the compressor to be started and control the first expansion valve and the indoor expansion valve to be opened, if the controller determines that the refrigerant leakage continues indoors after controlling the compressor to be stopped, and control the compressor to be stopped and control the first expansion valve to be closed, if the controller determines that the compressor again satisfies the first preset condition.
[0006] In another aspect, a control method for an air conditioning system is provided. The air conditioning system includes an indoor unit, an outdoor unit, a first expansion valve, a second

expansion valve and a controller. The indoor unit includes an indoor heat exchanger and an indoor expansion valve. The outdoor unit includes a compressor. The indoor unit is connected to the outdoor unit by a gas refrigerant pipe and a liquid refrigerant pipe, respectively; and the first expansion valve is disposed on the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit, and is configured to control connection or disconnection of the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit. The second expansion valve is disposed on the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve, and is configured to control connection or disconnection of the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve. The refrigerant concentration sensor is configured to detect a concentration of refrigerant indoors. The controller is coupled to the indoor heat exchanger, the outdoor heat exchanger, the compressor, the first expansion valve, the second expansion valve and the refrigerant concentration sensor.

[0007] The control method comprises: controlling the air conditioning system to operate in a cooling mode, control the indoor expansion valve and the second expansion valve to be closed and control the first expansion valve to be opened, when information indicating that a refrigerant leakage occurs indoors is acquired; controlling the compressor to be stopped and controlling the first expansion valve to be closed, if determining that the compressor satisfies a first preset condition; controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if determining that the refrigerant leakage continues indoors after controlling the compressor to be stopped; and controlling the compressor to be stopped and controlling the first expansion valve to be closed, if determining that the compressor again satisfies the first preset condition.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a perspective view of an air conditioning system according to some embodiments.

[0009] FIG. **2** is a schematic view of an air conditioning system according to some embodiments.

[0010] FIG. **3** is a block diagram of an air conditioning system according to some embodiments.

[0011] FIG. **4** is another schematic view of an air conditioning system according to some embodiments.

[0012] FIG. **5** is another block diagram of an air conditioning system according to some embodiments.

[0013] FIG. **6** is a schematic diagram of a cycle of an air conditioning system in a cooling mode, according to some embodiments.

[0014] FIG. **7** is a flowchart of a refrigerant recovery method for an air conditioning system according to some embodiments.

[0015] FIG. **8** is a flowchart of another refrigerant recovery method for an air conditioning system according to some embodiments.

[0016] FIG. **9** is a flowchart of still another refrigerant recovery method for an air conditioning system according to some embodiments.

[0017] FIG. **10** is a schematic diagram of an open/close state of each component in an air conditioning system according to some embodiments.

[0018] FIG. **11** is a schematic diagram of an open/close state of each component in another air conditioning system according to some embodiments.

DETAILED DESCRIPTION

[0019] Some embodiments of the present disclosure will be clearly and completely described in the following with reference to the accompanying drawings. Obviously, the described embodiments are only a part rather than all of the embodiments of the present disclosure. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments provided in the present disclosure shall belong to the scope of protection of the present disclosure.

[0020] Unless the context requires otherwise, throughout the description and claims, the term “comprise” and other forms, such as, the third-person singular form “comprises” and the present participle form “comprising” are to be construed in an inclusive sense, that is, “including, but not limited to”. In the description of the description, the terms “one embodiment”, “some embodiments”, “exemplary embodiments”, “example”, “specific example” or “some examples” and the like are intended to indicate that a particular feature, structure, material, or characteristic associated with the embodiment or example is included in at least one embodiment or example of the present disclosure. The schematic representation of the above terms does not necessarily refer to the same embodiment or example. Furthermore, the particular feature, structure, material, or characteristic may be included in any suitable manner in any one or more embodiments or examples.

[0021] Hereinafter, the terms “first” and “second” are only used for descriptive purposes, and cannot be understood as indicating or implying relative importance or implicitly indicating the number of indicated technical features. Thus, the features defined by “first” and “second” may explicitly or implicitly include one or more of the features. In the description of the embodiments of the present disclosure, “a plurality of” means two or more than two, unless otherwise specified.

[0022] In describing some embodiments, expressions “coupled” and “connected”, along with their derivatives, may be used. The term “connection” should be understood broadly, for example, “connection” may be fixed connection, detachable connection, or integral connection; and may also be direct connections or indirect connections via intervening structures. The term “coupled” indicates, for example, that two or more components are in direct physical or electrical contact. The term “coupled” or “communicatively coupled” may also mean that two or more components are not in direct contact with each other, but yet still co-operate or interact with each other. The embodiments disclosed herein are not necessarily limited to the disclosure herein.

[0023] “A and/or B” comprises the following three combinations: A only, B only, and A and B in combination.

[0024] The use of “adapted to” or “configured to” herein means open and inclusive language that does not exclude devices adapted to or configured to perform additional tasks or steps.

[0025] In addition, the use of “based on” means open and inclusive, in that a process, step, calculation, or other action of ‘based on’ one or more of the stated conditions or values may in practice be based on additional conditions or exceeding the stated values.

[0026] FIG. **1** is a perspective view of an air conditioning system according to some embodiments. As shown in FIG. **1**, an air conditioning system **100** includes an indoor unit **10**, an outdoor unit **20** and a refrigerant pipeline **30**.

[0027] The refrigerant pipeline **30** may also be referred to as circulation pipeline, and the indoor unit **10** and the outdoor unit **20** are connected by means of a refrigerant pipeline **30** to form a circulation loop.

[0028] FIG. **2** is a schematic diagram of an air conditioning system according to some embodiments. As shown in FIG. **2**, the air conditioning system **100** further includes a first expansion valve **101** and a second expansion valve **102**.

[0029] The indoor unit **10**, the second expansion valve **102**, the outdoor unit **20** and the first expansion valve **101** are in sequentially connected in series by means of the refrigerant pipeline **30**.

[0030] The indoor unit **10** includes an indoor heat exchanger **11** and an indoor expansion valve **12**.

[0031] The first expansion valve **101**, the indoor heat exchanger **11**, the indoor expansion valve **12**, and the second expansion valve **102** are sequentially connected in series by means of the refrigerant pipeline **30**.

[0032] The outdoor unit **20** includes a four-way valve **21**, a compressor **22**, an outdoor heat exchanger **23** and an outdoor expansion valve **24**.

[0033] The compressor **22** includes a suction port E and an exhaust port F. The compressor **22** is configured to suck in a low-temperature and low-pressure gas-phase refrigerant from the suction port E, drive a piston to compress the gas-phase refrigerant in the low-temperature and low-pressure state by means of the operation of the motor, and then exhaust a high-temperature and high-pressure gas-phase refrigerant through the exhaust port F, so that the compressor **22** can provide power for a cooling cycle. The suction port E of the compressor **22** is on a low-pressure side, and the exhaust port F of the compressor **22** is on a high-pressure side.
[0034] The indoor heat exchanger **11** performs heat exchange between indoor air and the refrigerant transferred in the indoor heat exchanger **11**, so as to liquefy or vaporize the refrigerant. The outdoor heat exchanger **23** is configured to perform heat exchange between outdoor air and the refrigerant transferred in the outdoor heat exchanger **23**, so as to liquefy or vaporize the refrigerant.
[0035] The indoor expansion valve **12** and the outdoor expansion valve **24** are configured to regulate a flow rate of refrigerant in pipelines of the air conditioning system **100**.
[0036] The compressor **22**, a condenser (the indoor heat exchanger **11** or the outdoor heat exchanger **23**), expansion valves (the indoor expansion valve **12** and the outdoor expansion valve **24**), and an evaporator (the outdoor heat exchanger **23** or the indoor heat exchanger **11**) perform the refrigerant circulation of the air conditioning system **100**. The refrigerant circulation comprises a series of processes, involving compression, condensation, expansion and evaporation, and the supply of the refrigerant to the regulated side in a circulation manner.
[0037] The four-way valve **21** comprises a first port A, a second port B, a third port C and a fourth port D.
[0038] The first port A of the four-way valve **21** is connected to the first expansion valve **101**, a second port B is connected to the suction port E of the compressor **22**, a third port C is connected to the outdoor heat exchanger **23**, and a fourth port D is connected to the exhaust port F of the compressor **22**.
[0039] The refrigerant pipeline **30** includes a gas refrigerant pipe **31** and a liquid refrigerant pipe **32**, and the indoor unit **10** and the outdoor unit **20** are respectively connected by means of the gas refrigerant pipe **31** and the liquid refrigerant pipe **32**.
[0040] The first expansion valve **101** is disposed on the refrigerant pipe **31** between an end of the indoor heat exchanger **11** away from the indoor expansion valve **12** and the outdoor unit **20**, and is configured to be opened when the refrigerant leakage occurs indoors, so that the refrigerant leaked from the indoor unit is recovered to the outdoor unit, and is closed after the refrigerant is recovered, so as to prevent the refrigerant in the outdoor unit from being recovered back to the indoor unit. The second expansion valve **102** is disposed on a liquid refrigerant pipe **32** between the outdoor unit **20** and the indoor expansion valve **12**, and is configured to be closed when the refrigerant leakage occurs indoors so as to prevent the refrigerant of the outdoor unit **20** from continuing to flow to the indoor unit **10**, and is configured to seal the liquid refrigerant pipe between the second expansion valve **102** and the indoor expansion valve **12** so as to store the refrigerant between the second expansion valve **102** and the indoor expansion valve **12**. In some embodiments of the present disclosure, the first expansion valve **101**, the second expansion valve **102** and the indoor expansion valve **12** are electronic expansion valves.
[0041] In some embodiments of the present disclosure, the operation mode of the air conditioning system **100** includes a cooling mode and a heating mode.
[0042] For example, when the air conditioning system **100** operates in a heating mode, the first expansion valve **101**, the indoor expansion valve **12**, the second expansion valve **102** and the outdoor expansion valve **24** are opened, the first port A of the four-way valve **21** is connected to the fourth port D, and the second port B is connected to the third port C. In this case, the indoor heat exchanger **11** serves as a condenser, and the outdoor heat exchanger **23** serves as an evaporator.
[0043] The gas-phase refrigerant in the low-temperature and low-pressure state is compressed by means of the compressor **22** to become a high-temperature and high-pressure gas-phase refrigerant,

and the high-temperature and high-pressure gas-phase refrigerant flows into the indoor heat exchanger **11** through the four-way valve **21**. The indoor heat exchanger **11** condenses the high-temperature and high-pressure gas-phase refrigerant into a liquid-phase refrigerant in a high-pressure state, and the heat is released to the surrounding environment during the condensation process. The indoor expansion valve **12** and the outdoor expansion valve **24** throttle and depressurize the liquid-phase refrigerant in a high-pressure state to become a gas-liquid two-phase refrigerant in a low-pressure state. The outdoor heat exchanger **23** absorbs heat from the surrounding environment and evaporates the gas-liquid two-phase refrigerant in the low-pressure state to form a low-temperature and low-pressure gas-phase refrigerant. The gas-phase refrigerant in a low temperature and a low pressure state returns to the compressor **22** by means of the four-way valve **21** to form a heating cycle.

[0044] FIG. **3** is a block diagram of an air conditioning system according to some embodiments. As shown in FIG. **3**, an air conditioning system **100** further includes a controller **40**.

[0045] In some embodiments of the present disclosure, the controller **40** refers to an apparatus that can generate an operation control signal according to an instruction operation code and a time sequence signal and instruct the air conditioning system **100** to perform a control instruction. The controller **40** is coupled to each component inside the air conditioning system **100** and is configured to control the operation of each component inside the air conditioning system **100**, so that each component of the air conditioning system **100** operates so as to achieve each predetermined function of the air conditioning system **100**.

[0046] For example, the controller **40** is configured in such a way: if it is determined that the compressor **22** satisfies a first preset condition, the controller controls the compressor **22** to be stopped and controls the first expansion valve **101** to be closed. After the compressor **22** is controlled to be stopped, it is determined whether the refrigerant leakage continues indoors, and if the leakage does not occur, it is confirmed that a leakage point is located between the indoor expansion valve **12** and the first expansion valve **101**, and at this time, the refrigerant at the leakage point has been recovered. If the refrigerant leakage continues occurring, it is determined that the leakage point is located between the indoor expansion valve **12** and the second expansion valve **102**, the controller controls the compressor **22** to be started and controls the first expansion valve **101** and the indoor expansion valve **12** to be opened, so as to recover the refrigerant between the indoor expansion valve **12** and the second expansion valve **102**. And if it is determined that the compressor **22** satisfies the first preset condition, the controller controls the compressor **22** to be stopped and controls the first expansion valve **101** to be closed, and the recovery of refrigerant at the indoor unit **10** is completed.

[0047] FIG. **4** is another schematic diagram of an air conditioning system according to some embodiments. As shown in FIG. **4**, the air conditioning system **100** further includes a first cut-off valve **51**, a second cut-off valve **52**, a first refrigerant concentration sensor **53**, a second refrigerant concentration sensor **54**, a first pressure sensor **55**, a second pressure sensor **56**, a third pressure sensor **57** and a temperature sensor **58**. The indoor unit **10** further includes an indoor fan assembly **13**, and the outdoor unit **20** further includes outdoor fan assembly **25**.

[0048] The first cut-off valve **51** is disposed on the gas refrigerant pipe **31** and configured to control connection or disconnection of the gas refrigerant pipe **31**, and the second cut-off valve **52** is disposed on the liquid refrigerant pipe **32** and configured to control connection or disconnection of the liquid refrigerant pipe **32**.

[0049] In some embodiments of the present disclosure, the first refrigerant concentration sensor **53** is disposed indoors and configured to detect a concentration of refrigerant indoors. The second refrigerant concentration sensor **54** is provided in the indoor unit **10** and configured to detect a concentration of refrigerant in the indoor unit **10**. A refrigerant concentration sensor comprises the first refrigerant concentration sensor **53** and/or second refrigerant concentration sensor **54**.

[0050] A first pressure sensor **55** is arranged between the indoor expansion valve **12** and the second

expansion valve **102**, and is configured to detect a pressure value at a connection pipe **70** between the indoor expansion valve **12** and the second expansion valve **102**. The first pressure sensor **55** may be located in the indoor unit **10** or at the liquid refrigerant pipe **32** outside the indoor unit **10**. The second pressure sensor **56** is provided at the exhaust port F of the compressor **22**, and is configured to detect an exhaust pressure value of the compressor **22**. The third pressure sensor **57** is provided at the suction port E of the compressor **22** and is configured to detect a suction pressure value of the compressor **22**.
[0051] A temperature sensor **58** is provided at the exhaust port F of the compressor **22** and is configured to detect an exhaust temperature value of the compressor **22**.
[0052] The indoor fan assembly **13** generates an airflow of indoor air passing through the indoor heat exchanger **11**, and is configured to promote heat exchange between the refrigerant flowing in a heat transfer pipe of the indoor heat exchanger **11** and the indoor air, so as to assist temperature regulation. The outdoor fan assembly **25** generates an air flow of outdoor air passing through the outdoor heat exchanger **23**, and is configured to promote heat exchange between the refrigerant flowing in the heat transfer pipe of the outdoor heat exchanger **23** and the outdoor air.
[0053] FIG. **5** is another block diagram of an air conditioning system according to some embodiments. As shown in FIG. **5**, the air conditioning system **100** further includes a first cut-off valve **51**, a second cut-off valve **52**, a first refrigerant concentration sensor **53**, a second refrigerant concentration sensor **54**, a first pressure sensor **55**, a second pressure sensor **56**, a third pressure sensor **57** and a temperature sensor **58**. The indoor unit **10** further includes an indoor fan assembly **13**, and the outdoor unit **20** further includes outdoor fan assembly **25**.
[0054] In some embodiments of the present disclosure, the air conditioning system **100** includes a memory **59**. The memory **59** is coupled to the controller **40**.
[0055] In some embodiments, the memory **59** is configured to store software programs and data. The controller **40** executes various functions and data processing of the air conditioning system **100** by performing a software program or data stored in the memory **59**. The memory **59** in some embodiments of the present disclosure may store an operation system and various application programs, and may also store codes for performing the method for recovering refrigerant of the air conditioning system **100** provided in some embodiments of the present disclosure.
[0056] As shown in FIG. **5**, in some embodiments of the present disclosure, the indoor unit **10** can further include a remote control apparatus **62** (for example, a remote controller), the remote control apparatus **62** is coupled to the controller **40**, and the remote control apparatus **62** has a function of being in communication with the controller **40**, for example, by using infrared rays or other communication manners. A user may control the air conditioning system **100** by using the remote control apparatus **62**, so as to implement interaction between the user and the air conditioning system **100**.
[0057] In some embodiments, as shown in FIG. **5**, the air conditioning system **100** can further include a communicator **63**. The communicator **63** is electrically connected to the controller **40** and is configured to establish a communication connection with the server. The communicator **63** may include a radio frequency (RF) module, a cellular module, a wireless fidelity (WIFI) module, a GPS module, etc.
[0058] In some embodiments, the air conditioning system **100** may also send its own operation data to the server through the communicator **63**, so that the server calculates, according to the data of the air conditioning system **100**, operation parameters of each component of the air conditioning system **100** in a working process, and then sends the calculated operation parameters to the air conditioning system **100**. The controller **40** controls each component in the air conditioning system **100** to work according to the operation parameters calculated by the server.
[0059] FIG. **6** is a schematic diagram of a circulation of an air conditioning system in a cooling mode according to some embodiments. As shown in FIG. **6**, when the air conditioning system **100** operates in a cooling mode, a first expansion valve **101**, an indoor expansion valve **12**, a second

expansion valve **102** and an outdoor expansion valve **24** are opened, a first port A of a four-way valve **21** is connected to a second port B, and a third port C is connected to a fourth port D. In this case, the outdoor heat exchanger **23** serves as a condenser, and the indoor heat exchanger **11** serves as an evaporator.

[0060] The high-temperature and high-pressure gas-phase refrigerant discharged from the compressor **22** flows into the outdoor heat exchanger **23** via the four-way valve **21**. The outdoor heat exchanger **23** condenses the high-temperature and high-pressure gas-phase refrigerant into the supercooled liquid-phase refrigerant in a medium-temperature and high-pressure state. The second expansion valve **102** and the indoor expansion valve **12** change the medium-temperature and high-pressure supercooled liquid refrigerant into a low-temperature and low-pressure gas-liquid two-phase refrigerant after subjected to throttle and depressurize. The indoor heat exchanger **11** absorbs heat from the surrounding environment and evaporates a low-temperature and low-pressure gas-liquid two-phase refrigerant to form a low-temperature and low-pressure gas-phase refrigerant. After passing through the four-way valve **21**, the low-temperature and low-pressure gas-phase refrigerant returns to the compressor **22** to form a cooling cycle. The arrow in FIG. **6** indicates a direction representing a flow direction of the refrigerant when the air conditioning system **100** is in the cooling mode.

[0061] During the operation of the air conditioning system **100**, the refrigerant is present in the indoor unit **10**, the outdoor unit **20** and the connection pipe **70**. When the connection pipe **70** is long in length, and the refrigerant leakage is detected indoors, the refrigerant in the connection pipe **70** and the indoor unit **10** needs to be completely recovered. Due to the large retention amount of refrigerant in the connection pipe **70**, the refrigerant cannot be completely recovered. If the refrigerant in the connection pipe **70** is not recovered in time and leaks from the connection pipe **70** to the indoor side, the concentration of the refrigerant indoors tends to be too high, and there is a flammable region, thus causing potential troubles.

[0062] To solve the foregoing problem, some embodiments of the present disclosure provide a refrigerant recovery method for an air conditioning system. The method is performed by a controller **40**.

[0063] FIG. **7** is a flowchart of a refrigerant recovery method for an air conditioning system according to some embodiments. As shown in FIG. **7**, in some embodiments of the present disclosure, the method may include steps S**101** to S**107**.

[0064] In S**101**, when information indicating that refrigerant leakage occurs indoors is acquired, controlling the air conditioning system **100** to operate in a cooling mode.

[0065] In S**102**, controlling the indoor expansion valve **12** and the second expansion valve **102** to be closed and controlling the first expansion valve **101** to be opened.

[0066] When acquiring the information indicating that the refrigerant leaks indoors, the controller **40** controls the air conditioning system **100** to be in the point-**0** state shown in FIG. **10**. At this time, the indoor expansion valve **12** and the second expansion valve **102** are closed, and the compressor **22** and the first expansion valve **101** are opened.

[0067] As shown in FIG. **6**, because the air conditioning system **100** operates in the cooling mode, the high-temperature and high-pressure gas-phase refrigerant flowing out from the compressor **22** flows into the outdoor heat exchanger **23** and cannot flow towards the indoor unit **10** anymore. Since both the indoor expansion valve **12** and the second expansion valve **102** are both in a closed state, at this time, the refrigerant between indoor expansion valve **12** and second expansion valve **102** does not flow any more, and the refrigerant between the indoor expansion valve **12** and the first expansion valve **101** flows towards outdoor unit **20**.

[0068] In some embodiments of the present disclosure, since the indoor expansion valve **12**, the second expansion valve **102** and the first expansion valve **101** are all electronic expansion valves, the controller **40** may adjust the opening of the indoor expansion valve **12** and the second expansion valve **102** to a fully closed state, that is, the opening of the indoor expansion valve **12**

and the second expansion valve **102** are both 0 pls. In this way, the refrigerant pipeline between the indoor expansion valve **12** and the second expansion valve **102** is a closed pipeline, and may store the refrigerant in the refrigerant pipeline between the indoor expansion valve **12** and the second expansion valve **102**.
[0069] The pls is the abbreviation for pulse, which refers to a pulse and is an opening unit of the electronic expansion valve.
[0070] In some embodiments of the present disclosure, for example, the controller **40** may adjust the opening of the first expansion valve **101** to a fully open state. In this way, the maximum flowing area of the refrigerant in the gas refrigerant pipe **31** may be achieved, the fastest recovery of the refrigerant may be achieved, and the time for recovering the refrigerant may be reduced.
[0071] In some embodiments of the present disclosure, when the controller **40** controls the indoor expansion valve **12** and the second expansion valve **102** to be closed, and controls the indoor fan assembly **13** to be turned on, in order to evaporate the liquid-phase refrigerant at the indoor unit **10** into a gas-phase refrigerant as far as possible. In this way, the liquid-phase refrigerant entering the compressor may be prevented from causing a liquid strike phenomenon (i.e., insufficient evaporation of the liquid-phase refrigerant in the outdoor unit **20** causes non-evaporated liquid-phase refrigerant to flow into the compressor **22**), thereby affecting the reliability of the compressor **22**. In this way, the heat exchange efficiency between the indoor heat exchanger **11** and the indoor air may be increased, thereby improving the flow rate of refrigerant between the indoor heat exchanger **11** and the indoor expansion valve **12**, reducing the time for recovering the refrigerant, and thus reducing the leakage amount of the refrigerant.
[0072] In some embodiments of the present disclosure, the controller **40** may control the indoor fan assembly **13** to operate at a first preset speed, in which the first preset speed is a speed preset by the air conditioning system **100**. The first preset speed is, for example, a highest speed that the indoor fan assembly **13** can reach, that is, a speed where the indoor fan assembly **13** provides the largest amount of air output per unit time. In this way, the heat exchange efficiency between the indoor heat exchanger **11** and the indoor air is increased, the speed at which the liquid-phase refrigerant is evaporated into a gas-phase refrigerant in the indoor heat exchanger **11** can be accelerated, the refrigerant can be recovered quickly, and the leakage amount of the refrigerant is reduced.
[0073] In other embodiments of the present disclosure, when controlling the indoor expansion valve **12** and the second expansion valve **102** to be closed, the controller **40** may further control the outdoor fan assembly **25** to be opened, so that the refrigerant recovered in the refrigerant pipe **31** between the compressor **22** and the outdoor heat exchanger **23** flows to the liquid refrigerant pipe **32** between the outdoor heat exchanger **23** and the second expansion valve **102**.
[0074] In some embodiments of the present disclosure, the controller **40** may control the outdoor fan assembly **25** to operate at a second preset speed, in which the second preset speed is a mode preset by the air conditioning system **100**. The second preset speed is, for example, a highest speed that the outdoor fan assembly **25** can reach, that is, a speed where the outdoor fan assembly **25** provides the largest amount of air output per unit time. In this way, the heat exchange efficiency between the outdoor heat exchanger **23** and the outdoor air is increased, the speed at which the gas-phase refrigerant is condensed into the liquid-phase refrigerant in the outdoor heat exchanger **23** can be accelerated, the large pressure changes of the refrigerant pipeline between the compressor **22** and the outdoor heat exchanger **23** during refrigerant recovery can be avoided, and the air conditioning system **100** can be ensured to operate normally.
[0075] In step S**103**, when it is determined that the compressor **22** satisfies a first preset condition, controlling the compressor **22** to be stopped and controlling the first expansion valve **101** to be closed.
[0076] In some embodiments of the present disclosure, when the compressor **22** satisfies the first preset condition, the controller **40** determines that the refrigerant in the indoor unit **10** flows into the outdoor unit **20** through the gas refrigerant pipe **31**, that is, the refrigerant recovery may end. In

this case, the controller **40** controls the air conditioning system **100** to be in the M-point state in FIG. **10**, at this time, the indoor expansion valve **12** and the second expansion valve **102** are still in a closed state, and the controller **40** controls the compressor **22** to be stopped and controls the first expansion valve **101** to be closed so as to disconnect the indoor unit **10** from the outdoor unit **20**, thereby preventing the refrigerant at the outdoor unit **20** from flowing back to the indoor unit **10** through the gas refrigerant pipe **31**.
[0077] The controller **40** may adjust the first expansion valve **101** to the fully closed state, that is, the opening of the first expansion valve **101** is adjusted to 0 Pls.
[0078] The first preset condition may include at least one of the following.
[0079] First, the operation time of the compressor **22** after being switched to the cooling mode is greater than a preset time.
[0080] When the preset time is that the refrigerant in the indoor unit **10** flows into the outdoor unit **20**, the content of refrigerant in the indoor unit **10** is lower than the first preset threshold value, and the compressor **22** is switched to the cooling mode during operation. In some embodiments of the present disclosure, the preset time is a time set in advance, for example, 20 min or 25 min.
[0081] It should be noted that, when the content of refrigerant in the indoor unit **10** is lower than the first preset threshold value, it indicates that the refrigerant recovery in the indoor unit **10** is completed. Therefore, if the controller **40** determines that the operation time of the compressor **22** after being switched to the cooling mode is greater than the preset time, it may be determined that the refrigerant in the indoor unit **10** flows into the outdoor unit **20** through the gas refrigerant pipe **31** at this time, and the refrigerant recovery ends.
[0082] For example, if the preset time is 20 min, the controller **40** controls the compressor **22** to stop operating and controls the first expansion valve **101** to be closed after the compressor **22** is switched to the cooling mode for operating for 20 min.
[0083] If it is determined that the air conditioning system **100** does not operate in the cooling mode before refrigerant leakage, the controller **40** switches the operation mode of the air conditioning system **100** to the cooling mode; and if it is determined that the air conditioning system **100** operates in the cooling mode before the refrigerant leakage occurs, the controller **40** does not need to switch the operation mode of the air conditioning system **100**.
[0084] Second, the exhaust pressure value of the compressor **22** is greater than a first preset value.
[0085] The first preset value is an exhaust pressure value of the compressor **22** when the refrigerant in the indoor unit **10** flows into the outdoor unit **20** and the content of refrigerant in the indoor unit **10** is already lower than a first preset threshold value. In some embodiments of the present disclosure, the first preset value is a value set in advance, for example, 3.7 MPa or 3.8 MPa.
[0086] If the controller **40** determines that the exhaust pressure value of the compressor **22** is greater than the first preset value, it may be determined that the refrigerant in the indoor unit **10** flows into the outdoor unit **20** through the gas refrigerant pipe **31** at this time, and the refrigerant recovery ends.
[0087] For example, if the (current) discharge pressure value of the compressor **22** is 3.8 MPa and the first preset value is 3.7 MPa, the controller **40** controls the compressor **22** to stop operating and controls the first expansion valve **101** to be closed.
[0088] Third, the exhaust temperature value of the compressor **22** is greater than a second preset value.
[0089] The second preset value is an exhaust temperature value of the compressor **22** when the refrigerant in the indoor unit **10** flows into the outdoor unit **20** and the content of refrigerant in the indoor unit **10** is already lower than a first preset threshold value. In some embodiments of the present disclosure, the second preset value is a value set in advance, for example, 105° C., 100° C., etc.
[0090] If the controller **40** determines that the exhaust temperature value of the compressor **22** is higher than the second preset value, it may be determined that the refrigerant in the indoor unit **10**

flows into the outdoor unit **20** through the gas refrigerant pipe **31** at this time, and the refrigerant recovery ends. For example, if the second preset value is 105° C. and the (current) exhaust temperature of the compressor **22** is 108° C., the controller **40** controls the compressor **22** to stop operating and controls the first expansion valve **101** to be closed.

[0091] Fourth, the suction pressure value of the compressor **22** is less than a third preset value.

[0092] The third preset value is a suction pressure value of the compressor **22** when the refrigerant in the indoor unit **10** flows into the outdoor unit **20** and the content of refrigerant in the indoor unit **10** is already lower than a first preset threshold value. In some embodiments of the present disclosure, the third preset value is a value set in advance, for example, 0.1 MPa, 0.08 MPa, etc.

[0093] If the controller **40** determines that the suction pressure value of the compressor **22** is lower than the third preset value, it may be determined that the refrigerant in the indoor unit **10** flows into the outdoor unit **20** through the gas refrigerant pipe **31** at this time, and the refrigerant recovery ends.

[0094] For example, the third preset value may be 0.1 MPa, and the (current) suction pressure value of the compressor **22** is 0.08 MPa, and the controller **40** controls the compressor **22** to stop operating and controls the first expansion valve **101** to be closed.

[0095] When the first preset condition satisfies at least one of the above four determination conditions, the refrigerant recovery can end. The present disclosure does not limit the execution order of the four determination conditions. Whether the corresponding determination condition can be executed depends on the operation state of the air conditioning system **100**.

[0096] It should be noted that, the preset time, the first preset value, the second preset value, and the third preset value may also be acquired through experiments.

[0097] In some embodiments of the present disclosure, after controlling the compressor **22** to be stopped, the controller **40** also controls the outdoor fan assembly **25** to be turned off. In this way, the energy consumption of the air conditioning system **100** can be reduced.

[0098] In other embodiments of the present disclosure, the controller **40** controls the indoor fan assembly **13** to be turned off after controlling the compressor **22** to be turned off. In this way, the energy consumption of the air conditioning system **100** can be reduced.

[0099] In S**104**, determining whether the refrigerant leakage continues indoors, if yes, execute S**105**, and if not, execute S**107**.

[0100] In some embodiments of the present disclosure, S**104** can further include: acquiring, by the controller **40**, the concentration of refrigerant indoors by using the first refrigerant concentration sensor **53**, and determining, by the controller **40**, whether the concentration of refrigerant indoors at the current moment is greater than the concentration of refrigerant indoors at the previous moment.

[0101] In some embodiments of the present disclosure, the change of the concentration of refrigerant indoors may indicate whether the refrigerant leakage continues indoors. For example, if the concentration of refrigerant indoors at the current time is greater than the concentration of refrigerant indoors at the previous time, it is indicated that the refrigerant leakage continues indoors. If the concentration of refrigerant indoors at the current time is lower than or equal to the concentration of refrigerant in indoors at the previous time, it is indicated that the refrigerant leakage no longer occurs indoors.

[0102] In other embodiments of the present disclosure, S**104** includes: acquiring, by the controller **40**, through the first pressure sensor **55**, pressure values at the connection pipe **70** between the indoor expansion valve **12** and the second expansion valve **102** at the current moment and at the previous moment, and determining whether the pressure value at the connection pipe **70** at the current moment is less than the pressure value at the previous moment.

[0103] The content of refrigerant in the refrigerant pipeline between the indoor expansion valve **12** and the first expansion valve **101** is already lower than the first preset threshold value, and if the refrigerant leakage continues indoors, the leakage point is located at the connection pipe **70**, for example, at the junction connected to the liquid refrigerant pipe **32** and the connection pipe **70**. The change of the pressure value at the connection pipe **70** may represent the change of the concentration of refrigerant at the connection pipe **70**, and the controller **40** determines whether the refrigerant leakage continues indoors by determining whether the concentration of refrigerant at the connection pipe **70** changes.

[0104] For example, if the concentration of refrigerant at the connection pipe **70** is increased, it is indicated that the refrigerant leakage continues at the connection pipe **70**. And if the concentration of refrigerant at the connection pipe **70** decreases, it is indicated that the refrigerant leakage at the connection pipe **70** is stopped.

[0105] In S**105**, controlling the compressor **22** to be started and controlling the first expansion valve **101** and the indoor expansion valve **12** to be opened.

[0106] When it is determined whether the refrigerant leakage continues indoors, the compressor **22**, the first expansion valve **101** and the indoor expansion valve **12** are in a closed state, and after S**101** and S**102** are completed, the refrigerant between the indoor expansion valve **12** and the first expansion valve **101** is completely recovered, and refrigerant leakage does not occur here anymore.

[0107] Therefore, when the controller **40** determines that the refrigerant leakage continues indoors, it may be determined that the refrigerant leakage point is located at the connection pipe **70** between the indoor expansion valve **12** and the second expansion valve **102**, and the controller **40** controls the air conditioning system **100** to be in the N2-point state shown in FIG. **11**. At this time, the second expansion valve **102** is in the closed state, the controller **40** controls the compressor **22** to be started, controls the first expansion valve **101** and the indoor expansion valve **12** to be opened, and controls the refrigerant at the connection pipe **70** to be recovered to the outdoor unit **20** through the indoor expansion valve **12** and the first expansion valve **101**. In some embodiments of the present disclosure, the controller **40** may adjust the opening of the first expansion valve **101** to a fully open state, so that the refrigerant pipeline has a better flowing capacity.

[0108] After controlling the compressor **22** to be started, the controller **40** may gradually increase the frequency of the compressor **22** until the operation frequency of the compressor **22** reaches the preset operation frequency, and the compressor **22** continues to operate at the preset operation frequency. In this way, the operation of the compressor **22** can be stabilized, and the service life of the compressor **22** can be extended.

[0109] When the air conditioning system **100** operates in the cooling mode, the controller **40** controls the superheat degree of the indoor unit **10** according to the opening of the indoor expansion valve **12**, and the preset superheat degree of the indoor unit **10**, which is maintained in this stage, prevents the compressor **22** from causing the problem of liquid return.

[0110] It should be noted that the superheat degree refers to a difference between an actual temperature of the refrigerant at an outlet of the evaporator and a corresponding saturation temperature at this refrigerant pressure, that is, a difference between the outlet temperature of the evaporator and the evaporation temperature.

[0111] When the air conditioning system **100** operates in the cooling mode, the opening of the indoor expansion valve **12** is less than the maximum opening. For example, if the maximum opening of the indoor expansion valve **12** is 200 Pls, the opening of the indoor expansion valve **12** is 10% of the maximum opening of the expansion valve in the cooling mode, that is, the opening of the indoor expansion valve **12** is 20 Pls. In this case, compared with the fully open state, the flow area of the refrigerant pipeline is reduced, the amount of refrigerant flowing into the indoor unit **10** through the connection pipe **70** is reduced. In order to avoid the liquid impact of the compressor **22**, the opening of the indoor expansion valve **12** should not be larger than the first preset opening. In order to ensure that the recovery of the refrigerant at the connection pipe **70** is completed quickly, the opening of the indoor expansion valve **12** should not be smaller than the second preset opening. The first preset opening refers to an opening of the indoor expansion valve **12** that may cause the liquid-phase refrigerant to enter the compressor **22** without sufficiently evaporating. The second preset opening refers to an opening of the indoor expansion valve **12** which affects the refrigerant recovery rate at the connection pipe **70**. The first preset opening is greater than the second preset opening.

[0112] Therefore, in some embodiments of the present disclosure, the controller **40** may further adjust the opening of the indoor expansion valve **12** to a preset target opening according to the suction pressure value of the compressor **22**.

[0113] When the suction pressure value of the compressor **22** is higher than the preset suction pressure value, the amount of refrigerant in the indoor unit **10** is large, and the opening of the indoor expansion valve **12** remains unchanged. When the suction pressure is reduced, the retention amount of refrigerant in the indoor unit **10** is small, and the controller **40** increases the opening of the indoor expansion valve **12**. A correspondence between the suction pressure value of the compressor **22** and the preset target opening of the indoor expansion valve **12** is stored in the memory **59**. In some embodiments of the present disclosure, the value of the suction pressure value of the compressor **22** may have a negative correlation with the preset target opening of the indoor expansion valve **12**.

[0114] For example, the correspondence between the suction pressure value of the compressor **22** and the preset target opening of the indoor expansion valve **12** may be as shown in Table 1.

TABLE-US-00001 TABLE 1 Suction Pressure Value (Ps) Preset Target Opening 0.7 > Ps ≥ 0.6 MPa 600 pls 0.6 > Ps ≥ 0.5 MPa 800 pls 0.5 > Ps ≥ 0.4 MPa 1100 pls 0.4 > Ps ≥ 0.3 MPa 1500 pls 0.3 > Ps ≥ 0.2 MPa 2000 pls

[0115] The controller **40** acquires the suction pressure value of the compressor **22** by means of the third pressure sensor **57**, acquires a preset target opening of the indoor expansion valve **12** corresponding to the current suction pressure value from the memory **59** according to the suction pressure value, and controls the indoor expansion valve **12** to adjust to the preset target opening.

[0116] For example, if the controller **40** acquires that the suction pressure value of the compressor **22** is 0.5 MPa by means of the third pressure sensor **57**, it can be seen from Table 1 that the controller **40** adjusts the opening of the first expansion valve **101** to 800 pls to increase the circulation area of the pipeline. The retention amount of refrigerant in the connection pipe **70** is supplemented into the indoor unit **10**, and then sucked into the outdoor unit **20** by using the compressor **22**. After a period of time, the controller **40** obtains that the suction pressure value of the compressor **22** becomes 0.49 MPa by means of the third pressure sensor **57**, and adjusts the opening of the first expansion valve **101** to be 1100 Pls according to Table 1. In this way, with the decrease of the suction pressure, the opening of the indoor expansion valve **12** is gradually increased, so that the refrigerant in the connection pipe **70** is recovered to the outdoor unit **20**, and the amount of refrigerant in the connection pipe **70** is lower than the second preset threshold value, so as to ensure the usage reliability of the compressor **22**.

[0117] It should be noted that, when the amount of refrigerant in the connection pipe **70** is lower than the second preset threshold, it is indicated that the refrigerant recovery at the connection pipe **70** is completed.

[0118] In some embodiments of the present disclosure, the controller **40** gradually increases the opening of the indoor expansion valve **12** until the opening of the indoor expansion valve **12** reaches the preset target opening.

[0119] For example, if the preset target opening of the indoor expansion valve **12** is 200 Pls, the controller **40** may increase the opening of the indoor expansion valve **12** at a speed of 20 Pls/s, and the adjustment time is 10 s.

[0120] In some embodiments of the present disclosure, when the first expansion valve **101** and the indoor expansion valve **12** are opened, the controller **40** may further control the indoor fan assembly **13** to be turned on, avoiding liquid-phase refrigerant from entering the compressor **22** and causing a liquid impact, thereby affecting the reliability of the compressor **22**.

[0121] In some embodiments of the present disclosure, the controller **40** may control the indoor fan assembly **13** to operate at a first preset speed.

[0122] In some embodiments of the present disclosure, when controlling the first expansion valve **101** and the indoor expansion valve **12** to be opened, the controller **40** may further control the outdoor fan assembly **25** to be opened, so that the refrigerant recovered in the refrigerant pipe **31** between the compressor **22** and the outdoor heat exchanger **23** flows to the liquid refrigerant pipe **32** between the outdoor heat exchanger **23** and the second expansion valve **102**.
[0123] In some embodiments of the present disclosure, the controller **40** may control the outdoor fan assembly **25** to operate at a second preset speed.
[0124] In step S**106**, when it is determined that the compressor **22** again satisfies a first preset condition, controlling the compressor **22** to be stopped and controlling the first expansion valve **101** to be closed.
[0125] After the indoor expansion valve **12** and the first expansion valve **101** are opened, the refrigerant flows into the gas refrigerant pipe **31** again, so that the compressor **22** does not satisfy the first preset condition any more.
[0126] Therefore, the controller **40** controls the compressor **22** to be started and controls the first expansion valve **101** and the indoor expansion valve **12** to be opened, so as to recover the refrigerant in the gas refrigerant pipe **31** at the indoor unit **10** to the outdoor unit **20**. When the compressor **22** satisfies a first preset condition, it is indicated that the refrigerant in the gas refrigerant pipe **31** at the indoor unit **10** is completely recovered, and at this time, the controller **40** controls the compressor **22** to be stopped and controls the first expansion valve **101** to be closed, so as to prevent the refrigerant at the outdoor unit **20** from flowing back to the indoor unit **10**.
[0127] In some embodiments of the present disclosure, after controlling the compressor **22** to be stopped, the controller **40** also controls the outdoor fan assembly **25** and indoor fan assembly **13** to be turned off.
[0128] S**107**, refrigerant recovery is completed.
[0129] The controller **40** controls the air conditioning system **100** to be in a N1-point state in FIG. **10** or a P-point state in FIG. **11**. At this time, the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12**, and the second expansion valve **102** are all in a closed state.
[0130] By adopting the solutions of some embodiments of the present disclosure, it may be determined that the refrigerant leakage position is at the connection pipe **70** or at the indoor unit **10**, and the refrigerant in the connection pipe **70** and the indoor unit **10** is recovered in time, thereby reducing the leakage amount of the refrigerant.
[0131] In some embodiments of the present disclosure, when the controller **40** acquires that the refrigerant leakage occurs indoors, the operation mode of the air conditioning system **100** may be a heating mode or the like. FIG. **8** is a flowchart of another refrigerant recovery method for an air conditioning system according to some embodiments. As shown in FIG. **8**, S**101** may include steps S**1011** to S**1013**.
[0132] S**1011**: Determining whether a current operation mode of the air conditioning system **100** is a cooling mode. If yes, execute S**1013**. If not, execute S**1012**.
[0133] In some embodiments of the present disclosure, the controller **40** may acquire operation parameter information of the air conditioning system **100**, for example, acquire a current operation mode of the air conditioning system **100**, so as to determine whether the current air conditioning system **100** operates in the cooling mode.
[0134] In other embodiments of the present disclosure, the controller **40** may also determine the current operation mode according to the connection states of the four ports of the four-way valve **21** and the operation frequency of the compressor **22**, so as to determine whether the current air conditioning system **100** operates in the cooling mode. For example, when the controller **40** acquires that the first port A of the four-way valve **21** is connected to the second port B and the third port C is connected to the fourth port D, it can be determined that the air conditioning system **100** operates in the cooling mode. When the controller **40** acquires that the first port A of the four-way valve **21** is connected to the fourth port D and the second port B is connected to the third port

C, it can be determined that the air conditioning system **100** operates in the heating mode.
[0135] In S**1012**, the current operation mode stops operating.
[0136] The controller **40** controls the air conditioning system **100** to stop the current operation mode.
[0137] In S**1013**, controlling the air conditioning system **100** to be operated in a cooling mode.
[0138] When the controller **40** determines that the air conditioning system **100** operates in the cooling mode, there is no need to change the current operation mode of the air conditioning system **100**. When the controller **40** determines that the air conditioning system **100** operates in the non-cooling mode, the controller **40** controls the air conditioning system **100** to adjust the operation mode to the cooling mode.
[0139] FIG. **9** is a flowchart of still another refrigerant recovery method for an air conditioning system according to some embodiments. As shown in FIG. **9**, before step S**101**, the refrigerant recovery method for an air conditioning system **100** can further include S**100**.
[0140] In S**100**, acquiring the concentration of refrigerant indoors at a current moment and at a previous moment, and determining that the refrigerant leakage occurs indoors when it is determined that the concentration of refrigerant at the current moment is greater than the concentration of refrigerant at the previous moment.
[0141] The controller **40** acquires the concentration of refrigerant indoors by means of the first refrigerant concentration sensor **53** and/or the second refrigerant concentration sensor **54**, and determines whether the concentration of refrigerant indoors at the current moment is greater than the concentration of refrigerant indoors at the previous moment.
[0142] For example, if the concentration of refrigerant indoors at the current time is greater than the concentration of refrigerant indoors at the previous time, it is indicated that the refrigerant leakage occurs indoors. If the concentration of refrigerant indoors at the current time is lower than or equal to the concentration of refrigerant in indoors at the previous time, it is indicated that the refrigerant leakage does not occur indoors.
[0143] In some embodiments of the present disclosure, the controller **40** acquires the concentration of refrigerant indoors according to the first refrigerant concentration sensor **53** and/or the second refrigerant concentration sensor **54** at every preset interval, and the preset interval is between the current moment and the previous moment. The preset interval may be 5 s, 10 s, or 30 s, which is not limited in the present disclosure.
[0144] For example, if the preset interval is 30 s, the controller **40** acquires the concentration of refrigerant indoors every 30 s. If the concentration of refrigerant at the current moment is smaller than or equal to the concentration of refrigerant at the previous moment, the controller **40** does not perform an action and may continue acquiring the concentration of refrigerant indoors at the current moment and at the previous moment.
[0145] In this way, the controller **40** may timely acquire information indicating that the refrigerant leakage occurs indoors, and timely recover the refrigerant, so as to reduce the refrigerant leakage indoors.
[0146] FIG. **10** is a diagram of an open or close state of each component in an air conditioning system according to some embodiments. As shown in FIG. **10**, when the controller **40** acquires the information that the refrigerant leakage occurs, the controller **40** controls the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** to be in the 0-point state, at this time, the compressor **22** is in an on state, the first expansion valve **101** is in an open state, the indoor expansion valve **12** is in a closed state, the second expansion valve **102** is in a closed state, so that the refrigerant leaked from the indoor unit **10** is started to be recovered to the outdoor unit **20**. When the compressor **22** satisfies a first preset condition, the controller **40** controls the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** to be in an M-point state. At this time, the recovery of the refrigerant at the indoor unit **10** is completed. Therefore, the compressor **22** is in an off state, the first expansion

valve **101** is in a closed state, the indoor expansion valve **12** is in a closed state, and the second expansion valve **102** is in a closed state. When the controller **40** determines that the refrigerant leakage no longer occurs, it is indicated that the refrigerant leakage position is located at the indoor unit **10**, and the recovery of the refrigerant leaked from the indoor unit **10** is completed. And the controller **40** controls the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** to be in the N1-point state, at this time, the compressor **22** is in an off state, the first expansion valve **101** is in a closed state, and the indoor expansion valve **12** is in a closed state, and the second expansion valve **102** is in a closed state.
[0147] FIG. **11** is a diagram of an open or close state of each component in another air conditioning system according to some embodiments. Points **0** and M in FIG. **11** have the same meanings as points **0** and M in FIG. **10**, which are not described herein again. In FIG. **11**, the controller **40** determines that the refrigerant leakage continues indoors, it is indicated that the refrigerant leakage position is located at the connection pipe **70**, and the controller **40** controls the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** to be in a N2-point state, at this time, the compressor **22** is in an on state, the first expansion valve **101** is in an open state, the indoor expansion valve **12** is in an open state, the second expansion valve **102** is in a closed state, and the refrigerant at the connection pipe **70** is recovered. When the compressor **22** again satisfies a first preset condition, the controller **40** controls the compressor **22**, the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** to be in a P-point state, at this time, the recovery of the refrigerant at the connection pipe **70** is completed, the compressor **22** is in an off state, and the first expansion valve **101**, the indoor expansion valve **12** and the second expansion valve **102** are all in a closed state. In some embodiments of the present disclosure, the indoor expansion valve **12** may also be in an open state at the point P.
[0148] It will be understood by those skilled in the art that the scope of the disclosure of the present application is not limited to the specific embodiments described above, and that certain elements of the embodiments may be modified and substituted without departing from the spirit of the present application. The scope of the present application is limited by the appended claims.

Claims

1. An air conditioning system comprising: an indoor unit comprising an indoor heat exchanger and an indoor expansion valve; an outdoor unit comprising a compressor, the indoor unit being connected to the outdoor unit by a gas refrigerant pipe and a liquid refrigerant pipe, respectively; a first expansion valve disposed on the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit, and configured to control connection or disconnection of the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit; a second expansion valve disposed on the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve, and configured to control connection or disconnection of the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve; and a controller coupled to the indoor heat exchanger, the compressor, the first expansion valve, and the second expansion valve; wherein the controller is configured to: control the air conditioning system to operate in a cooling mode, control the indoor expansion valve and the second expansion valve to be closed and control the first expansion valve to be opened, when information indicating that a refrigerant leakage occurs indoors is acquired; control the compressor to be stopped and control the first expansion valve to be closed, if the controller determines that the compressor satisfies a first preset condition; control the compressor to be started and control the first expansion valve and the indoor expansion valve to be opened, if the controller determines that the refrigerant leakage continues indoors after controlling the compressor to be stopped; and control the compressor to be stopped and control the first expansion valve to be closed, if the controller determines that the compressor again satisfies the first preset condition.
2. The air conditioning system according to claim 1, further comprising: a refrigerant concentration

sensor configured to detect a concentration of refrigerant indoors; wherein before acquiring the information indicating that the refrigerant leakage occurs indoors, the controller is further configured to: acquire concentrations of refrigerant indoors at a current moment and at a previous moment, and determine that the refrigerant leakage occurs indoors if the controller determines that the concentration of refrigerant at the current moment is greater than the concentration of refrigerant at the previous moment.

3. The air conditioning system according to claim 1, further comprising a first pressure sensor arranged between the indoor expansion valve and the second expansion valve, wherein the first pressure sensor is configured to detect a pressure value at a connection pipe between the indoor expansion valve and the second expansion valve; wherein the controller is further configured to: acquire pressure values at the connection pipe between the indoor expansion valve and the second expansion valve at a current moment and at a previous moment; and wherein a step of controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened if the controller determines that the refrigerant leakage continues indoors, comprises one of the following: controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if the controller determines that the pressure value at the connection pipe between the indoor expansion valve and the second expansion valve at the current moment is less than the pressure value at the previous moment; and controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if the controller determines that a concentration of refrigerant at the current moment is greater than a concentration of refrigerant at the previous moment.

4. The air conditioning system according to claim 1, wherein the first preset condition comprises that an operation time of the compressor after being switched to the cooling mode is greater than a preset time.

5. The air conditioning system according to claim 4, further comprising: a second pressure sensor configured to detect an exhaust pressure value of the compressor; and a temperature sensor configured to detect an exhaust temperature value of the compressor; wherein the first preset condition further comprises one of the following: the exhaust pressure value of the compressor being greater than a first preset value; and the exhaust temperature value of the compressor being greater than a second preset value.

6. The air conditioning system according to claim 4, further comprising a third pressure sensor configured to detect a suction pressure value of the compressor; wherein the first preset condition further comprises that the suction pressure value of the compressor is less than a third preset value.

7. The air conditioning system according to claim 1, wherein the indoor expansion valve is an indoor electronic expansion valve; the air conditioning system further comprises a third pressure sensor configured to detect a suction pressure value of the compressor; and wherein controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened further comprises: adjusting the indoor expansion valve to preset target opening according to the suction pressure value of the compressor.

8. The air conditioning system according to claim 7, further comprising a memory storing a correspondence between the suction pressure value and the preset target opening of the indoor expansion valve; wherein adjusting the indoor expansion valve to the preset target opening according to the suction pressure value of the compressor comprises: acquiring a current suction pressure value of the compressor by the third pressure sensor; acquiring a preset target opening of the indoor expansion valve corresponding to the current suction pressure value from the memory; and controlling the indoor expansion valve to adjust to the preset target opening.

9. The air conditioning system according to claim 1, further comprising: an outdoor fan assembly disposed in the outdoor unit and configured to blow air to an outdoor heat exchanger; and an indoor fan assembly disposed in the indoor unit and configured to blow air to the indoor heat exchanger; wherein when controlling the indoor expansion valve and the second expansion valve to be closed, the controller is further configured to: control the outdoor fan assembly and the indoor fan assembly to be turned on; wherein controlling the indoor fan assembly to be turned on comprises: controlling the indoor fan assembly to operate at a first preset speed; and wherein controlling the outdoor fan assembly to be turned on comprises: controlling the outdoor fan assembly to operate at a second preset speed.

10. The air conditioning system according to claim 1, further comprising: an outdoor fan assembly disposed in the outdoor unit and configured to blow air to an outdoor heat exchanger; and an indoor fan assembly disposed in the indoor unit and configured to blow air to the indoor heat exchanger; wherein after controlling the compressor to be stopped, the controller is further configured to: control the outdoor fan assembly and the indoor fan assembly to be turned off.

11. The air conditioning system according to claim 1, further comprising: an outdoor fan assembly disposed in the outdoor unit and configured to blow air to an outdoor heat exchanger; and an indoor fan assembly disposed in the indoor unit and configured to blow air to the indoor heat exchanger; wherein when the first expansion valve and the indoor expansion valve are opened, the controller is further configured to: control the outdoor fan assembly and the indoor fan assembly to be turned on; wherein controlling the indoor fan assembly to be turned on comprises: controlling the indoor fan assembly to operate at a first preset speed; and wherein controlling the outdoor fan assembly to be turned on comprises: controlling the outdoor fan assembly to operate at a second preset speed.

12. A control method for an air conditioning system, wherein the air conditioning system comprises: an indoor unit comprising an indoor heat exchanger and an indoor expansion valve; an outdoor unit comprising a compressor, the indoor unit being connected to the outdoor unit by means of a gas refrigerant pipe and a liquid refrigerant pipe, respectively; a first expansion valve disposed on the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit, and configured to control connection or disconnection of the gas refrigerant pipe between the indoor heat exchanger and the outdoor unit; a second expansion valve disposed on the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve, and configured to control connection or disconnection of the liquid refrigerant pipe between the outdoor unit and the indoor expansion valve; and a controller coupled to the indoor heat exchanger, the compressor, the first expansion valve, and the second expansion valve; wherein the control method comprises: controlling the air conditioning system to operate in a cooling mode, controlling the indoor expansion valve and the second expansion valve to be closed and controlling the first expansion valve to be opened, when information indicating that a refrigerant leakage occurs indoors is acquired; controlling the compressor to be stopped and controlling the first expansion valve to be closed, if determining that the compressor satisfies a first preset condition; controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if determining that the refrigerant leakage continues indoors after controlling the compressor to be stopped; and controlling the compressor to be stopped and controlling the first expansion valve to be closed, if determining that the compressor again satisfies the first preset condition.

13. The control method according to claim 12, wherein the air conditioning system further comprises a refrigerant concentration sensor configured to detect a concentration of refrigerant indoors; wherein before information indicating that a refrigerant leakage occurs indoors is acquired, the method further comprises: acquiring concentrations of refrigerant indoors at a current moment and at a previous moment, and determine that the refrigerant leakage occurs indoors if the controller determines that the concentration of refrigerant at the current moment is greater than the concentration of refrigerant at the previous moment.

14. The control method according to claim 13, wherein the air conditioning system further comprises a first pressure sensor arranged between the indoor expansion valve and the second expansion valve, wherein the first pressure sensor is configured to detect a pressure value at a connection pipe between the indoor expansion valve and the second expansion valve; wherein the method further comprises: acquiring pressure values at the connection pipe between the indoor expansion valve and the second expansion valve at a current moment and at a previous moment; wherein controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened if determining that the refrigerant leakage continues indoors, comprises one of the following: controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if determining that the pressure value at the connection pipe between the indoor expansion valve and the second expansion valve at the current moment is less than the pressure value at the previous moment; and controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened, if determining that the concentration of refrigerant at the current moment is greater than the concentration of refrigerant at the previous moment.

15. The control method according to claim 12, wherein the first preset condition comprises that an operation time of the compressor after being switched to a cooling mode is greater than a preset time.

16. The control method according to claim 12, wherein the air conditioning system further comprises: a second pressure sensor configured to detect an exhaust pressure value of the compressor; and a temperature sensor configured to detect an exhaust temperature value of the compressor; wherein the first preset condition further comprises one of the following: the exhaust pressure value of the compressor being greater than a first preset value; and the exhaust temperature value of the compressor being greater than a second preset value.

17. The control method according to claim 16, wherein the air conditioning system further comprises a third pressure sensor configured to detect a suction pressure value of the compressor; and wherein the first preset condition further comprises that the suction pressure value of the compressor is less than a third preset value.

18. The control method according to claim 16, wherein the indoor expansion valve is an indoor electronic expansion valve; wherein the air conditioning system further comprises a third pressure sensor configured to detect a suction pressure value of the compressor; and wherein controlling the compressor to be started and controlling the first expansion valve and the indoor expansion valve to be opened further comprises: adjusting the indoor expansion valve to preset target opening according to the suction pressure value of the compressor.

19. The control method according to claim 18, wherein the air conditioning system further comprises a memory storing a correspondence between the suction pressure value and the preset target opening of the indoor expansion valve; wherein adjusting the indoor expansion valve to the preset target opening according to the suction pressure value of the compressor comprises: acquiring a current suction pressure value of the compressor by the third pressure sensor; acquiring a preset target opening of the indoor expansion valve corresponding to the current suction pressure value from the memory; and controlling the indoor expansion valve to adjust to the preset target opening.

20. The control method according to claim 12, wherein the air conditioning system further comprises: an outdoor fan assembly disposed in the outdoor unit and configured to blow air to an outdoor heat exchanger; and an indoor fan assembly disposed in the indoor unit and configured to blow air to an indoor heat exchanger; wherein the control method further comprises at least one of: controlling the outdoor fan assembly and the indoor fan assembly to be turned on when controlling the indoor expansion valve and the second expansion valve to be closed; controlling the outdoor fan assembly and the indoor fan assembly to be turned off after controlling the compressor to be stopped; or controlling the outdoor fan assembly and the indoor fan assembly to be turned on when controlling the first expansion valve and the indoor expansion valve to be opened; wherein controlling the indoor fan assembly to be turned on comprises: controlling the indoor fan assembly to operate at a first preset speed; and wherein controlling the outdoor fan assembly to be turned on comprises: controlling the outdoor fan assembly to operate at a second preset speed.