



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.07.2021 Bulletin 2021/30

(51) Int Cl.:
F25B 13/00 ^(2006.01) **F25B 41/04** ^(2006.01)
F25B 41/06 ^(2006.01) **F25B 49/02** ^(2006.01)

(21) Application number: **19861762.3**

(86) International application number:
PCT/CN2019/092372

(22) Date of filing: **21.06.2019**

(87) International publication number:
WO 2020/057210 (26.03.2020 Gazette 2020/13)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

- **HE, Jianqi**
Qingdao, Shandong 266101 (CN)
- **GUO, Defang**
Qingdao, Shandong 266101 (CN)
- **WU, Yundong**
Qingdao, Shandong 266101 (CN)
- **SUI, Zhiwei**
Qingdao, Shandong 266101 (CN)
- **LI, Xu**
Qingdao, Shandong 266101 (CN)
- **LIU, Zhisheng**
Qingdao, Shandong 266101 (CN)

(30) Priority: **21.09.2018 CN 201811110339**

(71) Applicants:

- **Qingdao Haier Air-Conditioning Electronic Co., Ltd**
Qingdao, Shandong 266071 (CN)
- **Haier Smart Home Co., Ltd.**
Qingdao, Shandong 266101 (CN)

(74) Representative: **Byrne, Declan**
Andre Roland S.A.
Intellectual Property Services
P.O. Box 5107
1002 Lausanne (CH)

(72) Inventors:

- **MAO, Shoubu**
Qingdao, Shandong 266101 (CN)

(54) **COOLING AND HEATING SWITCHING DEVICE FOR VARIABLE REFRIGERANT FLOW SYSTEM CAPABLE OF HEAT RECOVERY, VARIABLE REFRIGERANT FLOW SYSTEM, AND CONTROL METHOD**

(57) A cooling and heating switching device for a variable refrigerant flow system capable of heat recovery, a variable refrigerant flow system, and a control method. Ends of multiple high-pressure branch pipes of the cooling and heating switching device are respectively connected to ends of multiple low-pressure branch pipes, so as to form multiple connection nodes. The multiple connection nodes are respectively connected to gas pipes of multiple indoor units. Further ends of the multiple high-pressure branch pipes are connected to a high-pressure gas pipe (3). Further ends of the multiple low-pressure branch pipes are connected to a low-pressure gas pipe (2). Ends of multiple branch liquid pipes are respectively connected to ends of multiple liquid sub-pipes, so as to form multiple connection nodes. The

multiple connection nodes are respectively connected to liquid pipes of the multiple indoor units. Further ends of the multiple branch liquid pipes are connected to a main liquid pipe (1). Further ends of the multiple liquid sub-pipes are connected to a main pipe inlet of a sub-cooler (4). A throttling structure is provided on a connection pipe between a cooling branch pipe inlet (C) and a main pipe outlet (B). The cooling branch pipe outlet (B) is connected to the low-pressure gas pipe (2), thereby solving the issue of loud noise caused by a flowing refrigerant in an indoor unit of a variable refrigerant flow capable of heat recovery, and achieving a compact structure and low costs.

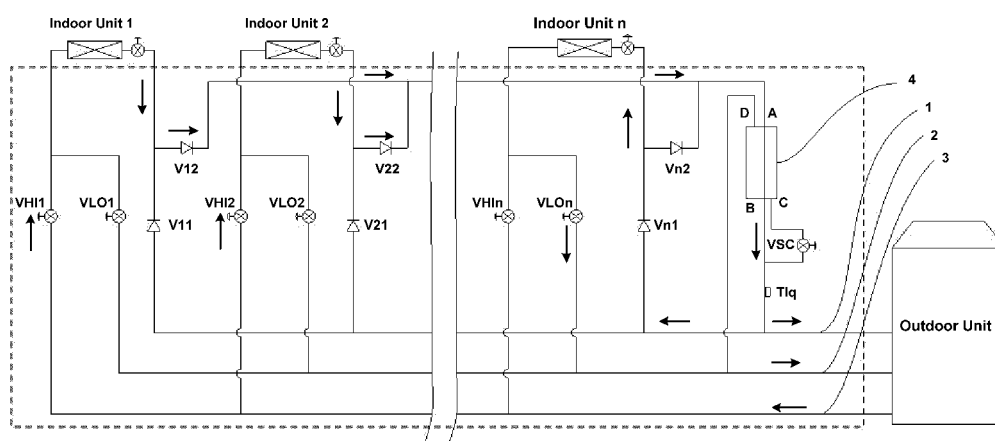


Figure 1

Description

Technical Field

[0001] The present invention belongs to the technical field of air conditioning, and in particular to a cooling-heating switching device for heat-recovery multi-split air conditioning system, a heat-recovery multi-split air conditioning system and a control method.

Background

[0002] With excellent energy-saving performance and flexible and comfortable using experience, the heat-recovery multi-split air conditioning system has gained popularity in the market and sales are increasing year by year. The majority of the heat-recovery multi-split air conditioning system of the prior art has a flow of refrigerant with three pipes: in the simultaneous cooling/heating operation, refrigerant flowing into those indoor units in cooling operation may make a loud flowing sound because of insufficient subcooling as refrigerant flowing out of the liquid pipe from those indoor units in heating operation. In addition, on condition that there is height difference between the indoor units in cooling operation, it is easy to cause an uneven distribution of refrigerant among the indoor units in cooling operation, and the performances of part of the indoor units in cooling operation become progressively worse.

Summary

[0003] The present invention provides a cooling-heating switching device for heat-recovery multi-split air conditioning system aiming at solving the problem of loud flowing sound, which is compact in structure and low in cost.

[0004] To solve the above technical problems, the present invention adopts the following technical solutions.

[0005] A cooling-heating switching device for heat-recovery multi-split air conditioning system includes: a main liquid pipe, a high-pressure gas pipe, a plurality of high-pressure branch pipes, a low-pressure gas pipe, a plurality of low-pressure branch pipes, a subcooler, a plurality of branch liquid pipes and a plurality of liquid distribution pipes; wherein the high-pressure gas pipe is connected to a high-pressure gas pipe of an outdoor unit and the low-pressure gas pipe is connected to a low-pressure gas pipe of the outdoor unit, and the main liquid pipe is connected to the liquid pipe of the outdoor unit; one end of each high-pressure branch pipe is connected to one end of each low-pressure branch pipe in a one-to-one correspondence forming a plurality of connection nodes; the connection nodes are connected to gas pipes of indoor units in a one-to-one correspondence; the other end of each high-pressure branch pipe is connected to the high-pressure gas pipe, and each high-pressure branch

pipe is provided with a valve; the other end of each low-pressure branch pipe is connected to the low-pressure gas pipe, and each low-pressure branch pipe is provided with a valve; one end of each branch liquid pipe is connected to one end of each liquid distribution pipe in a one-to-one correspondence so as to form a plurality of connection points, and the plurality of connection points are connected to the liquid pipe of each indoor unit in a one-to-one correspondence; the other end of each liquid distribution pipe is respectively connected to a main pipe inlet of the subcooler, and each liquid distribution pipe is provided with a valve; and a main pipe outlet of the subcooler is connected to the main liquid pipe; a cooling branch pipe inlet of the subcooler is connected to the main pipe outlet of the subcooler, a throttle structure VSC is disposed in the connection pipe between the cooling branch pipe inlet and the main pipe outlet of the subcooler; a cooling branch pipe outlet of the subcooler is connected to the low-pressure gas pipe.

[0006] Further, the valves on the high-pressure branch pipes are driven by a main control board of the cooling-heating switching device.

[0007] Further, the valves on the low-pressure branch pipes are driven by a main control board of the cooling-heating switching device.

[0008] Further, the valves provided on the branch liquid pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to the main liquid pipe and an outlet of each one-way valve is connected to a liquid pipe of an indoor unit' or, the valves provided on the branch liquid pipes are solenoid valves or electronic expansion valves which are driven by a main control board of the cooling-heating switching device.

[0009] Further, the valves provided on the liquid distribution pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to a liquid pipe of an indoor unit and an outlet of each one-way valve is respectively connected to the main pipe inlet of the subcooler; or, the valves provided on the liquid distribution pipes are solenoid valves or electronic expansion valves, which are driven by a main control board of the cooling-heating switching device.

[0010] Further, the throttling structure is an electronic expansion valve, a thermal expansion valve, a solenoid valve and capillary tube connected in series which is driven by a main control board of the cooling-heating switching device.

[0011] Further, a temperature sensor is provided at a main pipe outlet of the subcooler.

[0012] Based on the design of the above-mentioned the cooling-heating switching device for heat-recovery multi-split air conditioning system, another aspect of the present invention also provides a heat-recovery multi-split air conditioning system including an outdoor unit, a plurality of indoor units and the cooling-heating switching device.

[0013] Based on the design of the above-mentioned the cooling-heating switching device for heat-recovery

multi-split air conditioning system, another aspect of the present invention also provides a control method for the cooling-heating switching device including:

- (1) obtaining a saturation temperature CT corresponding to an outdoor unit high pressure;
- (2) obtaining a temperature TLq at a main pipe outlet of a subcooler;
- (3) calculating an actual subcooling degree SC, $SC=CT-TLq$;
- (4) calculating a difference between a target subcooling degree ST and the actual subcooling degree SC, $\Delta T = ST-SC$;
- (5) Adjusting the throttling structure according to the difference ΔT , and returning to step (1).

[0014] Further, the adjustment of the throttling structure according to the difference ΔT specifically includes:

if the difference $\Delta T > 0$, adjusting the throttling structure to reduce the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler;

if the difference $\Delta T < 0$, adjusting the throttling structure to increase the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler

[0015] Compared with the prior art, the advantages and positive effects of the present invention are: the cooling-heating switching device, the heat-recovery multi-split air conditioning system and the control method disclosed by the present invention provides an effective solution to the loud flowing sound problem of the heat-recovery multi-split air conditioning system in the prior art by means of the incorporation of the subcooler and the throttling structure, with which liquid refrigerant in the main liquid pipe 1 could reach a better subcooling degree so that noise will not occur as flowing into the indoor units, and liquid refrigerant in the main liquid pipe 1 will not vaporize to flash gas due to insufficient subcooling so the problem of unbalanced refrigerant distribution between indoor units working in cooling mode could be prevented. The cooling-heating switching device is compact in structure, low in cost and easy to install by merely adding one subcooler and one throttling structure.

[0016] After reading the specific embodiments of the present invention in conjunction with the accompanying drawings, other features and advantages of the present invention will become clearer.

Brief description of the drawings

[0017]

Fig. 1 is a schematic structural diagram of a cooling-heating switching device for heat-recovery multi-split air conditioning system according to one aspect of the present invention;

Fig. 2 is a schematic structural diagram of a cooling-heating switching device for heat-recovery multi-split air conditioning system according to another aspect of the present invention;

Fig. 3 is a flow chart showing a control method of a cooling-heating switching device for heat-recovery multi-split air conditioning system according to another aspect of the present invention;

Reference number:

[0018]

1. Main Liquid Pipe;
2. Low-pressure Gas Pipe;
3. High-pressure Gas Pipe;
4. Subcooler.

Detailed Description of the invention

[0019] In order to make the objectives, technical solutions and advantages of the present invention clearer, the present invention will be further described in detail below with reference to the accompanying drawings and embodiments.

[0020] A heat-recovery multi-split air conditioning system includes an outdoor unit, a plurality of indoor units and a cooling-heating switching device for heat-recovery multi-split air conditioning system.

[0021] The cooling-heating switching device for heat-recovery multi-split air conditioning system includes a main liquid pipe 1, a high-pressure gas pipe 3, a plurality of high-pressure branch pipes, a low-pressure gas pipe 2, a plurality of low-pressure branch pipes, a subcooler 4, a plurality of branch liquid pipes, a plurality of liquid distribution pipes, etc., as shown in Fig. 1; wherein the high-pressure gas pipe 3 is connected to a high-pressure gas pipe of the outdoor unit and the low-pressure gas pipe 2 is connected to a low-pressure gas pipe of the outdoor unit, and the main liquid pipe 1 is connected to the liquid pipe of the outdoor unit.

[0022] One end of each high-pressure branch pipe is connected to one end of each low-pressure branch pipe in a one-to-one correspondence so as to form a plurality of connection nodes. The connection nodes are connected to gas pipes of indoor units in a one-to-one correspondence.

[0023] The other end of each high-pressure branch pipe is connected to the high-pressure gas pipe 3, and each high-pressure branch pipe is provided with a valve that opens and closes to control the flow in the high-pressure branch pipe.

[0024] The other end of each low-pressure branch pipe is connected to the low-pressure gas pipe 2, and each low-pressure branch pipe is provided with a valve that opens and closes to control the flow in the low-pressure branch pipe.

[0025] One end of each branch liquid pipe is connected to one end of each liquid distribution pipe in a one-to-one correspondence so as to form a plurality of connection points, and the plurality of connection points are connected to the liquid pipe of each indoor unit in a one-to-one correspondence.

[0026] The other end of each branch liquid pipe is respectively connected to the main liquid pipe 1, and each branch liquid pipe is provided with a valve that opens and closes to control the flow in the branch liquid pipe.

[0027] The other end of each liquid distribution pipe is respectively connected to a main pipe inlet A of the subcooler 4, and each liquid distribution pipe is provided with a valve that opens and closes to control the flow in the liquid distribution pipe.

[0028] The subcooler 4 includes a tank body opened with the main pipe inlet A, a main pipe outlet B, a cooling branch pipe inlet C and a cooling branch pipe outlet D; wherein the main pipe inlet A is connected to the main pipe outlet B via a main pipe, the cooling branch pipe inlet C is connected to the cooling branch pipe outlet D via a cooling branch pipe. Refrigerant flowing into the subcooler 4 via the main pipe inlet A exchanges heat with refrigerant flowing into the subcooler 4 via the cooling branch pipe inlet C, which also could be regarded as a heat exchange between the main pipe and the cooling branch pipe.

[0029] The main pipe outlet B of the subcooler 4 is connected to the main liquid pipe 1; the cooling branch pipe inlet C of the subcooler 4 is connected to the main pipe outlet B of the subcooler 4, a throttle structure VSC is disposed in a connection pipe between the cooling branch pipe inlet C of the subcooler 4 and the main pipe outlet B of the subcooler 4; the cooling branch pipe outlet D of the subcooler 4 is connected to the low-pressure gas pipe 2.

[0030] It is assumed that the multi-connection includes n indoor units: indoor unit 1, indoor unit 2,..., indoor unit n-1, indoor unit n, as shown in FIG. 1.

[0031] A valve VHI1 is provided on a high-pressure branch pipe connecting the high-pressure gas pipe 3 to a gas pipe of the indoor unit 1.

[0032] A valve VLO1 is provided on a low-pressure branch pipe connecting the low-pressure gas pipe 2 to the gas pipe of the indoor unit 1.

[0033] A valve V11 is provided on a branch liquid pipe connecting the main liquid pipe 1 to a liquid pipe of the indoor unit 1.

[0034] A valve V12 is provided on a liquid distribution pipe connecting the main pipe inlet A of the subcooler 4 to the liquid pipe of the indoor unit 1.

[0035] A valve VHI2 is provided on a high-pressure branch pipe connecting the high-pressure gas pipe 3 to

a gas pipe of the indoor unit 2.

[0036] A valve VLO2 is provided on a low-pressure branch pipe connecting the low-pressure gas pipe 2 to the gas pipe of the indoor unit 2.

5 **[0037]** A valve V21 is provided on a branch liquid pipe connecting the main liquid pipe 1 to a liquid pipe of the indoor unit 2.

[0038] A valve V22 is provided on a liquid distribution pipe connecting the main pipe inlet A of the subcooler 4 to the liquid pipe of the indoor unit 2.

10 **[0039]** A valve VHI_n is provided on a high-pressure branch pipe connecting the high-pressure gas pipe 3 to a gas pipe of the indoor unit n.

15 **[0040]** A valve VLO_n is provided on a low-pressure branch pipe connecting the low-pressure gas pipe 2 to the gas pipe of the indoor unit n.

[0041] A valve Vn1 is provided on a branch liquid pipe connecting the main liquid pipe 1 to a liquid pipe of the indoor unit n.

20 **[0042]** A valve Vn2 is provided on a liquid distribution pipe connecting the main pipe inlet A of the subcooler 4 to the liquid pipe of the indoor unit n.

[0043] As an example, it assumes that the indoor unit 1 and outdoor unit 2 operate in heating mode while indoor unit 3 and indoor unit n operate in cooling mode.

25 **[0044]** The valves VHI1 and VHI2 on the high-pressure branch pipes open, the valves VLO1 and VLO2 on the low-pressure branch pipes close, the valves V11 and V21 on the branch liquid pipes close and the valves V12 and V22 on the liquid distribution pipes open.

30 **[0045]** The valves VHI3 and VHI_n on the high-pressure branch pipes close, the valves VLO3 and VLO_n on the low-pressure branch pipes open, the valves V31 and Vn1 on the branch liquid pipes open and the valves V32 and Vn2 on the liquid distribution pipes close.

35 **[0046]** A working process includes: the outdoor unit discharges high-temperature and high-pressure refrigerant gas to the high-pressure gas pipe 3. The refrigerant gas in the high-pressure gas pipe 3 respectively enters the indoor unit 1 and the indoor unit 2 through the valves VHI1 and VHI2. Condensed refrigerant from the indoor unit 1 and the indoor unit 2 which are in heating modes flows to the main pipe inlet A of the subcooler 4 through the valves V12 and V22, enters into the subcooler 4, and then flows out through the main pipe outlet B. Refrigerant flowing out from the subcooler 4 is divided into two flows, one passage flows to the main liquid pipe 1 and the other passage flows to the cooling branch inlet C through the throttling structure in which pressure is reduced, enters into the subcooler 4, and then flows out through the cooling branch outlet D, then enters into the low-pressure gas pipe 2. The refrigerant that enters the subcooler 4 through the main pipe inlet A exchanges heat with the refrigerant that enters the subcooler 4 through the cooling branch inlet C. The temperature of the refrigerant that enters the subcooler 4 through the main pipe inlet A decreases while the temperature of the refrigerant that enters the subcooler 4 through the cooling branch inlet C

increases. The throttling structure control the subcooling of the refrigerant flowing out of the main pipe outlet B of the subcooler 4 to a set subcooling degree, that is to say, the liquid refrigerant in the main liquid pipe 1 has a required degree of subcooling. The liquid refrigerant collected in the main liquid pipe 1 is evenly distributed to each refrigerating indoor unit working in cooling mode. A part of the liquid refrigerant enters into the indoor unit n through the valve Vn1, and the other part of the liquid refrigerant enters into the indoor unit 3 through the valve V31. Evaporated gas refrigerant from the indoor unit 3 and from the indoor unit n in cooling mode flows to the low-pressure gas pipe 2 through the valves VLO3 and VLOn, and then flows back to the outdoor unit.

[0047] The cooling-heating switching device for heat-recovery multi-split air conditioning system and the heat-recovery multi-split air conditioning system using the same disclosed by the present embodiment provides an effective solution to the loud flowing sound problem of the heat-recovery multi-split air conditioning system in the prior art by means of the incorporation of the subcooler and the throttling structure, with which liquid refrigerant in the main liquid pipe 1 could reach a required subcooling degree so that noise will not occur as flowing into the indoor units, and liquid refrigerant in the main liquid pipe 1 will not vaporize to flash gas due to insufficient subcooling so the problem of unbalanced refrigerant distribution between indoor units working in cooling mode could be prevented. The cooling-heating switching device is compact in structure, low in cost and easy to install by merely adding one subcooler and one throttling structure.

[0048] The cooling-heating switching device for heat-recovery multi-split air conditioning system provided by the present invention solves the problems of loud flowing sound of refrigerant and unbalanced refrigerant distribution among indoor units working in cooling mode of the heat-recovery multi-split air conditioning system having a flow of refrigerant with three pipes.

[0049] In the present invention, the valves provided on the high-pressure branch pipes are solenoid valves, electronic expansion valves, four-way valves, three-way valves, and the like capable of opening and closing to control the flow, which are driven by a main control board of the cooling-heating switching device for heat-recovery multi-split air conditioning system. Preferably, the valves provided on the high-pressure branch pipes are electronic expansion valves which are easy to control and stable in performance. In the present invention, the valves provided on the low-pressure branch pipes are solenoid valves, electronic expansion valves, four-way valves, three-way valves, and the like capable of opening and closing to control the flow, which are driven by the main control board of the cooling-heating switching device for heat-recovery multi-split air conditioning system. Preferably, the valves provided on the low-pressure branch pipes are electronic expansion valves which are easy to control and stable in performance.

[0050] In the present invention, the valves provided on the branch liquid pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to the main liquid pipe 1 and an outlet of each one-way valve is correspondingly connected to a liquid pipe of an indoor unit; the one-way valve is simple and no further control is required. Alternatively, the valves provided on the branch liquid pipes could be solenoid valves or electronic expansion valves, which are driven by the main control board of the cooling-heating switching device for heat-recovery multi-split air conditioning system, being easy to control and stable in performance.

[0051] In the present invention, the valves provided on the liquid distribution pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to a liquid pipe of an indoor unit and an outlet of each one-way valve is respectively connected to the main pipe inlet A of the subcooler 4; the one-way valve is simple and no further control is required. Alternatively, the valves provided on the liquid distribution pipes could be solenoid valves or electronic expansion valves, which are driven by the main control board of the cooling-heating switching device for heat-recovery multi-split air conditioning system, being easy to control and stable in performance.

[0052] In the present embodiment, the throttling structure is an electronic expansion valve, a thermal expansion valve, a solenoid valve and capillary tube connected in series, and the like to allow restricted flow of the refrigerant, which is driven by the main control board of the cooling-heating switching device for heat-recovery multi-split air conditioning system to control the restricted flow of the refrigerant, being simple in structure, easy to use and install.

[0053] In the present embodiment, a temperature sensor is provided at the main pipe outlet B of the subcooler 4 for the detection of the temperature at the main pipe outlet B.

[0054] It is assumed that a multi-split air conditioning system includes the indoor unit 1 and the indoor unit 2, as shown in Fig.2, wherein the indoor unit 1 working in heating mode and the indoor unit 2 working in cooling mode, the valve VHI1 opens, the valve VLO1 closes, the valve VHI2 closes and the valve VLO2 opens; valves V11, V12, V21, V22 are one-way valves.

[0055] The outdoor unit discharges high-temperature and high-pressure gas refrigerant to the high-pressure gas pipe 3. The high-temperature and high-pressure gas refrigerant in the high-pressure gas pipe 3 enters into the indoor unit 1 through the valve VHI1. Condensed liquid refrigerant from the indoor unit 1 working in heating mode flows to the main pipe inlet A through the way valve V12, enters the subcooler 4 and flows out of the subcooler 4 through the main pipe outlet B. Refrigerant flowing out from the subcooler 4 is divided into two flows, one passage flows to the main liquid pipe 1 and the other passage flows to cooling branch inlet C through the throttling structure in which pressure is reduced, enters into the subcooler 4, and then flows out through the cooling branch

outlet D, then enters into the low-pressure gas pipe 2. A part of liquid refrigerant in the main liquid pipe 1 flows into the indoor unit 2 working in cooling mode through the one-way valve V21. Evaporated gas refrigerant from the indoor unit 2 flows to the low-pressure gas pipe 2 through the valve VLO2 and then back to the outdoor unit.

[0056] The refrigerant suffers pipe friction loss as flowing along the pipes so its pressure gradually decreases ΔT different positions of the pipes as flowing through, indicating as $P_4 > P_2 > P_1 > P_3$. If a pressure of the refrigerant at the inlet of the one-way valve V11 is less than a pressure of the refrigerant at the outlet of the one-way valve V11, or a pressure of the refrigerant at the inlet of the one-way valve V12 is less than a pressure of the refrigerant at the outlet of the one-way valve V12, the one-way valve V11 and one-way valve V12 close; if a pressure of the refrigerant at the inlet of the one-way valve V11 is greater than a pressure of the refrigerant at the outlet of the one-way valve V11, or a pressure of the refrigerant at the inlet of the one-way valve V12 is greater than a pressure of the refrigerant at the outlet of the one-way valve V12, the one-way valve V11 and one-way valve V12 open. With these arrangements, liquid refrigerant from the liquid pipe of the indoor unit 1 only could flow into the subcooler 4 through the one-way valve V12. The refrigerant reaches to a required subcooling degree by the control the throttling structure VSC of the subcooler 4 and flows into the main liquid pipe 1.

[0057] Based on the design of the cooling-heating switching device for heat-recovery multi-split air conditioning system, another aspect of the present invention is to provide a control method of the cooling-heating switching device for heat-recovery multi-split air conditioning system, the controlling method includes following steps, which is shown in Fig. 3.

[0058] Step S1: obtaining a saturation temperature CT corresponding to an outdoor unit high pressure.

[0059] To be specific, the outdoor unit high pressure is a pressure at a gas discharge port of a compressor in the outdoor unit. Based on the outdoor unit high pressure, a corresponding saturation temperature CT could be obtained.

[0060] Step S2: obtaining a temperature TLq at a main pipe outlet of a subcooler.

[0061] The temperature TLq could be obtained by a temperature sensor installed at main pipe outlet.

[0062] Step S3: calculating an actual subcooling degree SC, $SC = CT - TLq$.

[0063] Step S4: calculating a difference between a target subcooling degree ST and the actual subcooling degree SC, $\Delta T = ST - SC$.

[0064] The target subcooling degree ST is a preset target value. When the refrigerant in the main liquid pipe reaches the target subcooling degree ST, noise will not occur as flowing into the indoor units.

[0065] Step S5: Adjusting the throttling structure according to the difference ΔT , and returning to step S1.

[0066] The throttling structure is being adjusted ac-

cording to the difference ΔT until $\Delta T = 0$.

[0067] The control method of the cooling-heating switching device for heat-recovery multi-split air conditioning system of this embodiment provides an effective solution to the loud flowing sound problem of the heat-recovery multi-split air conditioning system in the prior art by means of procedures including: obtaining a saturation temperature CT corresponding to an outdoor unit high pressure; obtaining a temperature TLq at a main pipe outlet of a subcooler; calculating an actual subcooling degree SC, $SC = CT - TLq$; calculating a difference between a target subcooling degree ST and the actual subcooling degree SC, $\Delta T = ST - SC$; adjusting the throttling structure according to the difference ΔT until $\Delta T = 0$; with which liquid refrigerant in the main liquid pipe 1 could reach a better subcooling degree so that noise will not occur as flowing into the indoor units, and liquid refrigerant in the main liquid pipe 1 will not vaporize to flash gas due to insufficient subcooling so the problem of unbalanced refrigerant distribution between indoor units working in cooling mode could be prevented.

[0068] In the present embodiment, the adjusting the throttling structure according to the difference ΔT specifically includes:

If the difference $\Delta T > 0$, adjusting the throttling structure to reduce the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler, so as to increase the temperature TLq at the main pipe outlet preventing the subcooling degree too low to affect the refrigerant flow in the main liquid pipe.

[0069] If the difference $\Delta T < 0$, adjusting the throttling structure to increase the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler, so as to reduce the temperature TLq at the main pipe outlet to lower the subcooling degree.

[0070] The above embodiments are only used to illustrate the technical solutions of the present invention, but not to limit them. Although the present invention has been described in detail with reference to the foregoing embodiments, for those of ordinary skill in the art, the technical solutions of the foregoing embodiments can still be described. The recorded technical solutions are modified, or some of the technical features are equivalently replaced; and these modifications or replacements do not cause the essence of the corresponding technical solutions to deviate from the spirit and scope of the technical solutions claimed by the present invention.

Claims

1. A cooling-heating switching device for heat-recovery multi-split air conditioning system, **characterized in that** includes: a main liquid pipe, a high-pressure gas pipe, a plurality of high-pressure branch pipes, a low-pressure gas pipe, a plurality of low-pressure

branch pipes, a subcooler, a plurality of branch liquid pipes and a plurality of liquid distribution pipes; wherein the high-pressure gas pipe is connected to a high-pressure gas pipe of an outdoor unit and the low-pressure gas pipe is connected to a low-pressure gas pipe of the outdoor unit, and the main liquid pipe is connected to the liquid pipe of the outdoor unit;

one end of each high-pressure branch pipe is connected to one end of each low-pressure branch pipe in a one-to-one correspondence forming a plurality of connection nodes; the connection nodes are connected to gas pipes of indoor units in a one-to-one correspondence;

the other end of each high-pressure branch pipe is connected to the high-pressure gas pipe, and each high-pressure branch pipe is provided with a valve; the other end of each low-pressure branch pipe is connected to the low-pressure gas pipe, and each low-pressure branch pipe is provided with a valve; one end of each branch liquid pipe is connected to one end of each liquid distribution pipe in a one-to-one correspondence so as to form a plurality of connection points, and the plurality of connection points are connected to the liquid pipe of each indoor unit in a one-to-one correspondence;

the other end of each branch liquid pipe is respectively connected to the main liquid pipe 1, and each branch liquid pipe is provided with a valve that opens and closes to control the flow in the branch liquid pipe;

the other end of each liquid distribution pipe is respectively connected to a main pipe inlet of the subcooler, and each liquid distribution pipe is provided with a valve; and

a main pipe outlet of the subcooler is connected to the main liquid pipe; a cooling branch pipe inlet of the subcooler is connected to the main pipe outlet of the subcooler, a throttle structure VSC is disposed in the connection pipe between the cooling branch pipe inlet and the main pipe outlet of the subcooler; a cooling branch pipe outlet of the subcooler is connected to the low-pressure gas pipe.

2. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim 1, **characterized in that** the valves on the high-pressure branch pipes are driven by a main control board of the cooling-heating switching device.

3. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim 1, **characterized in that** the valves on the low-pressure branch pipes are driven by a main control board of the cooling-heating switching device.

4. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim

1, **characterized in that** the valves provided on the branch liquid pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to the main liquid pipe and an outlet of each one-way valve is connected to a liquid pipe of an indoor unit; or, the valves provided on the branch liquid pipes are solenoid valves or electronic expansion valves which are driven by a main control board of the cooling-heating switching device.

5. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim 1, **characterized in that** the valves provided on the liquid distribution pipes are one-way valves, wherein an inlet of each one-way valve is respectively connected to a liquid pipe of an indoor unit and an outlet of each one-way valve is respectively connected to the main pipe inlet of the subcooler; or, the valves provided on the liquid distribution pipes are solenoid valves or electronic expansion valves, which are driven by a main control board of the cooling-heating switching device.

6. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim 1, **characterized in that** the throttling structure is an electronic expansion valve, a thermal expansion valve, a solenoid valve and capillary tube connected in series which is driven by a main control board of the cooling-heating switching device.

7. A cooling-heating switching device for heat-recovery multi-split air conditioning system according to claim 1, **characterized in that** a temperature sensor is provided at a main pipe outlet of the subcooler.

8. A heat-recovery multi-split air conditioning system includes an outdoor unit and a plurality of indoor units, **characterized in that**, further includes a cooling-heating switching device according to any one of claim 1 to claim 7.

9. A control method based on the cooling-heating switching device according to any one of claim 1 to claim 7, **characterized in that**, includes:

- (1) obtaining a saturation temperature CT corresponding to an outdoor unit high pressure;
- (2) obtaining a temperature TLq at a main pipe outlet of a subcooler;
- (3) calculating an actual subcooling degree SC, $SC = CT - TLq$;
- (4) calculating a difference between a target subcooling degree ST and the actual subcooling degree SC, $\Delta T = ST - SC$;
- (5) adjusting the throttling structure according to the difference ΔT , and returning to step (1).

10. A control method according to claim 9, **characterized in that:** the adjustment of the throttling structure according to the difference ΔT includes:

if the difference $\Delta T > 0$, adjusting the throttling structure to reduce the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler;

if the difference $\Delta T < 0$, adjusting the throttling structure to increase the amount of refrigerant flowing in a connection pipe between the cooling branch inlet of the subcooler and the main pipe outlet of the subcooler.

5

10

15

20

25

30

35

40

45

50

55

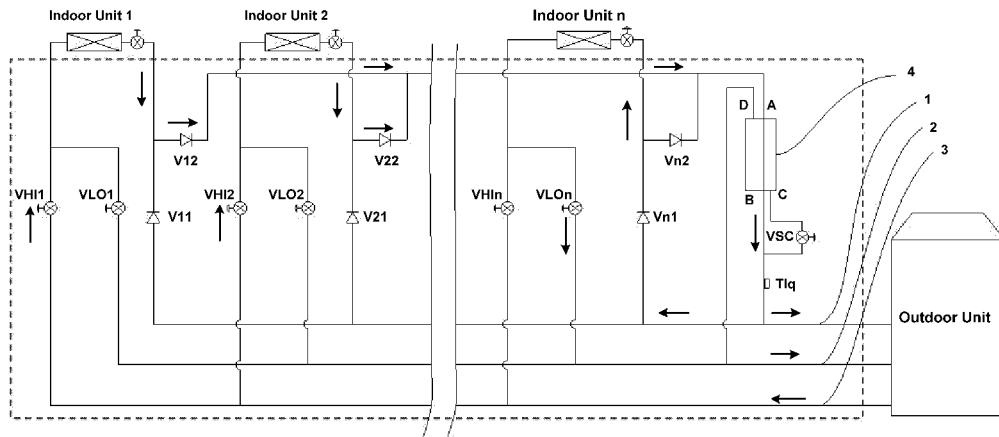


Figure 1

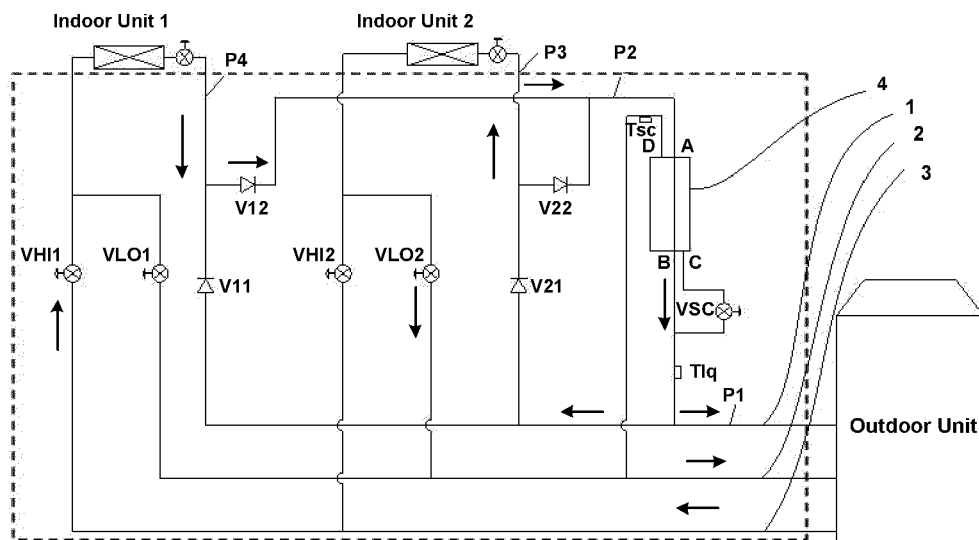


Figure 2

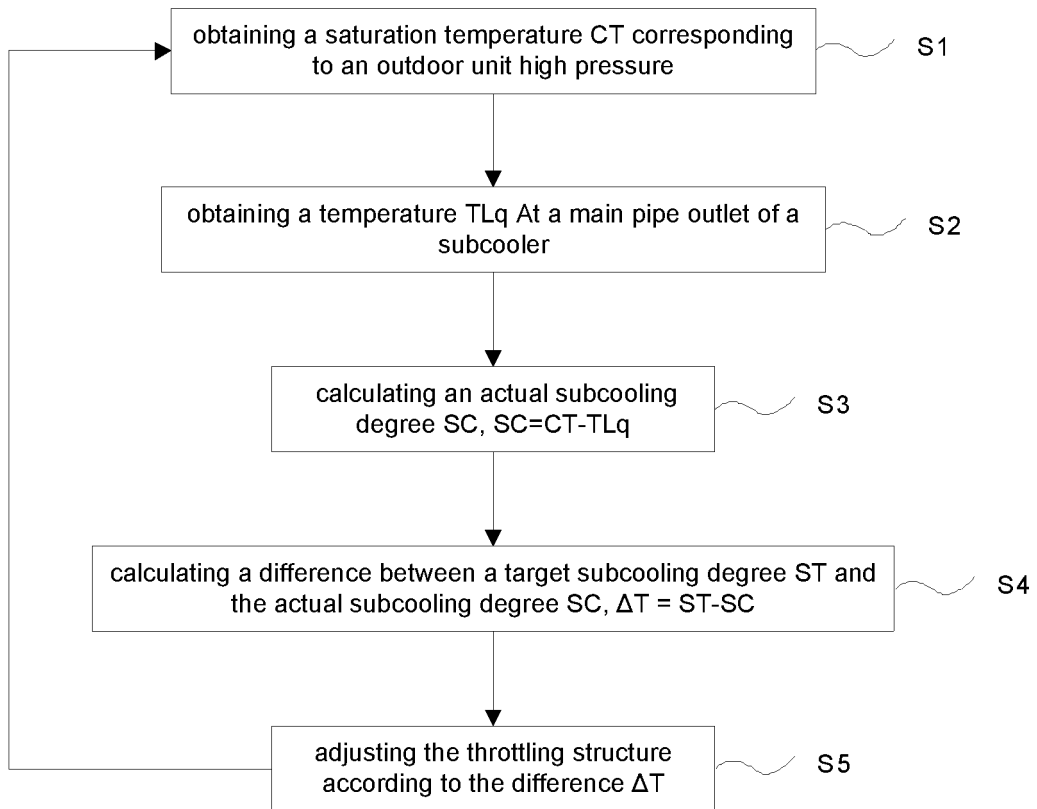


Figure 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/092372

A. CLASSIFICATION OF SUBJECT MATTER

F25B 13/00(2006.01)i; F25B 41/04(2006.01)i; F25B 41/06(2006.01)i; F25B 49/02(2006.01)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)

F25B 13, F25B 41, F25B 49, F24F

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)

CNTXT; DWPI; VEN; CNKI; CNABS: 空调, 室外机, 室内机, 噪音, 热回收, 多联机, 阀, 过冷, 高压, 低压, 液管, 气管, air, condition, outdoor, indoor, noise, heat, recovery, multi, connected, valve, over, cool, super, high, low, pressure, liquid, gas

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 109357429 A (QINGDAO HAIER AIR CONDITIONER ELECTRIC CO., LTD.) 19 February 2019 (2019-02-19) description, paragraphs [0019]-[0060], and figures 1-3	1-10
X	CN 107401849 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. ET AL.) 28 November 2017 (2017-11-28) description, paragraphs [0036]-[0069], and figure 3	1-8
Y	CN 107401849 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. ET AL.) 28 November 2017 (2017-11-28) description, paragraphs [0036]-[0069], and figure 3	9-10
Y	CN 107843037 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. ET AL.) 27 March 2018 (2018-03-27) description, paragraphs [0033]-[0075], and figures 1-5	9-10
X	CN 108036551 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. ET AL.) 15 May 2018 (2018-05-15) description, paragraphs [0044]-[0091], and figure 5	1-8

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	Date of mailing of the international search report
12 July 2019	30 July 2019
Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China	
Facsimile No. (86-10)62019451	Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/092372

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 108036551 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. ET AL.) 15 May 2018 (2018-05-15) description, paragraphs [0044]-[0091], and figure 5	9-10
A	CN 204329177 U (TRANE AIR-CONDITIONING SYSTEMS (CHINA) CO., LTD.) 13 May 2015 (2015-05-13) entire document	1-10
A	CN 104838219 A (MITSUBISHI ELECTRIC CORPORATION) 12 August 2015 (2015-08-12) entire document	1-10
A	CN 207146975 U (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 27 March 2018 (2018-03-27) entire document	1-10
A	CN 102042648 A (QINGDAO HISENSE HITACHI AIR-CONDITIONING SYSTEMS CO., LTD.) 04 May 2011 (2011-05-04) entire document	1-10
A	JP 2009228979 A (MITSUBISHI ELECTRIC CORP.) 08 October 2009 (2009-10-08) entire document	1-10
A	US 2005160763 A1 (LG ELECTRONICS INC.) 28 July 2005 (2005-07-28) entire document	1-10
A	KR 20140094343 A (LG ELECTRONICS INC.) 30 July 2014 (2014-07-30) entire document	1-10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/092372

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 109357429 A	19 February 2019	None	
CN 107401849 A	28 November 2017	None	
CN 107843037 A	27 March 2018	None	
CN 108036551 A	15 May 2018	None	
CN 204329177 U	13 May 2015	None	
CN 104838219 A	12 August 2015	JP WO2014129473 A1	02 February 2017
		CN 104838219 B	15 March 2017
		EP 2960597 A1	30 December 2015
		US 2015316275 A1	05 November 2015
		EP 2960597 A4	02 November 2016
		AU 2014219807 A1	18 June 2015
		WO 2014129473 A1	28 August 2014
		JP 5992089 B2	14 September 2016
		US 10107533 B2	23 October 2018
		AU 2014219807 B2	02 June 2016
		WO 2014128830 A1	28 August 2014
CN 207146975 U	27 March 2018	None	
CN 102042648 A	04 May 2011	CN 102042648 B	03 October 2012
JP 2009228979 A	08 October 2009	None	
US 2005160763 A1	28 July 2005	KR 100539570 B1	29 December 2005
		EP 1559969 B1	18 January 2012
		JP 2005214613 A	11 August 2005
		CN 100523660 C	05 August 2009
		EP 1559969 A1	03 August 2005
		CN 1648558 A	03 August 2005
		KR 20050077139 A	01 August 2005
KR 20140094343 A	30 July 2014	None	

Form PCT/ISA/210 (patent family annex) (January 2015)