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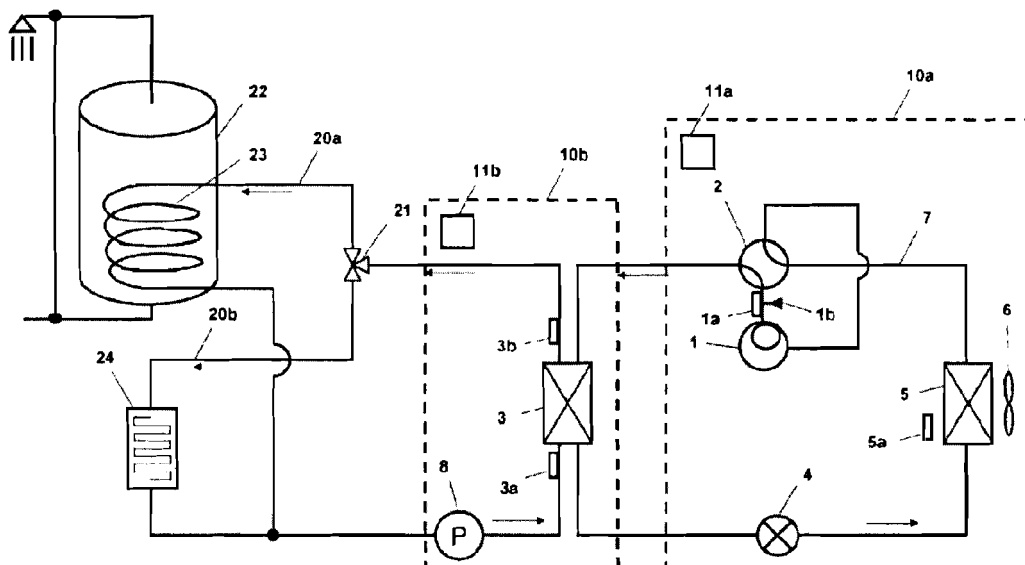
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(57) In a heat pump hydronic heater of the present invention, the control device 11a stops operation of the compressor 1 if the discharge pressure detected by the discharge pressure detecting means 1b is lower than a first set pressure and a discharge superheat degree detected by the discharge superheat degree detecting

means is equal to or higher than a predetermined value when predetermined time is elapsed after the compressor 1 is started, or if the discharge pressure detected by the discharge pressure detecting means 1b is lower than a second set pressure which is set lower than the first set pressure. Therefore, it is possible to enhance usability without erroneously detecting leakage of a refrigerant.

[Fig. 1]



Description

[Technical Field]

[0001] The present invention relates to a heat pump hydronic heater.

[Background Technique]

[0002] Conventionally, heaters using combustible fuel such as oil (petroleum) or gas are frequently utilized but in recent years, heaters utilizing a heat pump technique are abruptly increasing.

[0003] Fig. 3 is a block diagram of a conventional heat pump hydronic heater which can cool and heat. As shown in Fig. 3, the conventional heat pump hydronic heater includes a refrigeration cycle which is formed by annularly connecting a compressor 1, a four-way valve 2, a water-refrigerant heat exchanger 3, a decompressor 4 and an outdoor heat exchanger 5 to one another through a refrigerant pipe 7. The outdoor heat exchanger 5 includes a blast fan 6 for accelerating heat exchange between air and a refrigerant.

The heat pump hydronic heater also includes a water pump 8 for sending, to a cooling/heating terminal 20, cold water or hot water produced by the water-refrigerant heat exchanger 3. The heat pump hydronic heater carries out a heating operation (or hot water supplying operation) or a cooling operation by switching the four-way valve 2. When the heating operation (or hot water supplying operation) is carried out, the water-refrigerant heat exchanger 3 is used as a condenser, and when the cooling operation is carried out, the water-refrigerant heat exchanger 3 is used as an evaporator (see patent document 1 for example).

[Prior Art Document]

[Patent Document]

[0004] [Patent Document 1] Japanese Patent Application Laid-open No.2011-47607

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0005] However, in the case of a separate type heat pump hydronic heater in which a heat exchange unit accommodating the water- refrigerant heat exchanger 3 therein, and a heat pump unit accommodating the compressor 1 and the outdoor heat exchanger 5 therein are disposed indoors and outdoors, respectively, a length of a pipe through which the heat exchange unit and the heat pump unit are connected to each other is not constant depending upon installation conditions. Therefore, it is difficult to precisely determine a temperature range when the evaporator is operated, and leakage of a refrigerant

is erroneously detected.

[0006] The present invention has been accomplished to solve the conventional problem, and it is an object of the invention to provide a heat pump hydronic heater having improved usability in which leakage of a refrigerant is not erroneously detected.

[Means for Solving the Problems]

[0007] To solve the conventional problem, the present invention provides a heat pump hydronic heater including a refrigeration cycle formed by connecting, to one another through a refrigerant pipe, a compressor which compresses a refrigerant, a water-refrigerant heat exchanger which heat-exchanges between the refrigerant and water, a decompressor which decompresses the refrigerant and an outdoor heat exchanger which heat-exchanges between the refrigerant and air, wherein the heat pump hydronic heater comprises discharge pressure detecting means which detects a pressure of the refrigerant discharged from the compressor, discharge superheat degree detecting means which detects a superheat degree of the refrigerant discharged from the compressor, and a control device, and the control device stops operation of the compressor if the discharge pressure detected by the discharge pressure detecting means is lower than a first set pressure and a discharge superheat degree detected by the discharge superheat degree detecting means is equal to or higher than a predetermined value when predetermined time is elapsed after the compressor is started, or if the discharge pressure detected by the discharge pressure detecting means is lower than a second set pressure which is set lower than the first set pressure.

According to this configuration, since the heat pump hydronic heater can accept various lengths of various pipes, it is possible to completely detect leakage of a refrigerant, and it is possible to provide the heat pump hydronic heater having improved usability.

[Effect of the invention]

[0008] According to the present invention, it is possible to provide a heat pump hydronic heater having improved usability in which leakage of a refrigerant is not erroneously detected.

[Brief Description of the Drawings]

[0009]

Fig. 1 is a block diagram of a heat pump hydronic heater according to an embodiment of the present invention;

Fig. 2 is a flowchart of refrigerant leakage detection control of the heat pump hydronic heater; and

Fig. 3 is a block diagram of a conventional heat pump hydronic heater.

[Explanation of Symbols]

[0010]

- 1 compressor
- 1a discharge temperature sensor
- 1b discharge pressure sensor (discharge pressure detecting means)
- 2 four-way valve
- 3 water-refrigerant heat exchanger
- 4 decompressor
- 5 outdoor heat exchanger
- 6 blast fan
- 8 water pump
- 10a heat pump unit
- 10b heat exchange unit
- 11a control device (heat pump unit control device)
- 11b control device (heat exchange unit control device)

[Mode for Carrying Out the Invention]

[0011] A first aspect of the invention provides a heat pump hydronic heater including a refrigeration cycle formed by connecting, to one another through a refrigerant pipe, a compressor which compresses a refrigerant, a water-refrigerant heat exchanger which heat-exchanges between the refrigerant and water, a decompressor which decompresses the refrigerant and an outdoor heat exchanger which heat-exchanges between the refrigerant and air, wherein the heat pump hydronic heater comprises discharge pressure detecting means which detects a pressure of the refrigerant discharged from the compressor, discharge superheat degree detecting means which detects a superheat degree of the refrigerant discharged from the compressor, and a control device, and the control device stops operation of the compressor if the discharge pressure detected by the discharge pressure detecting means is lower than a first set pressure and a discharge superheat degree detected by the discharge superheat degree detecting means is equal to or higher than a predetermined value when predetermined time is elapsed after the compressor is started, or if the discharge pressure detected by the discharge pressure detecting means is lower than a second set pressure which is set lower than the first set pressure. According to this aspect, since the heat pump hydronic heater can meet lengths of various pipes, it is possible to completely detect leakage of a refrigerant, and to provide the heat pump hydronic heater having improved usability. Further, since the compressor does not keep operating in a state where a refrigerant is insufficient, durability of the compressor can be enhanced.

[0012] According to a second aspect of the invention, in the first aspect, when a number of stoppages of operation of the compressor is equal to or higher than a predetermined number, the control device does not restart the compressor and informs this fact. According to this aspect, it is possible to enhance the

durability of the compressor, and to inform a user of abnormalities of the refrigeration cycle.

[0013] An embodiment of the present invention will be described with reference to the drawings. The invention is not limited to the embodiment.

[0014] Fig. 1 is a block diagram of a heat pump hydronic heater according to a first embodiment of the present invention. A configuration of the heat pump hydronic heater will be described using Fig. 1.

[0015] The heat pump hydronic heater of the embodiment includes a refrigeration cycle. The refrigeration cycle is formed by connecting, to one another through a refrigerant pipe 7, a compressor 1 which compresses a refrigerant and discharges a high temperature refrigerant, a water-refrigerant heat exchanger 3 which heat-exchanges between water and a high temperature refrigerant and produces a high temperature water, a decompressor 4 which decompresses a refrigerant, and an outdoor heat exchanger 5 which heat-exchanges between air and a refrigerant. A four-way valve 2 which switches between refrigerant flow paths is provided in the refrigeration cycle. The four-way valve 2 flows a refrigerant from the compressor 1 to the water-refrigerant heat exchanger 3 when a heating operation is carried out, and the four-way valve 2 flows a refrigerant from the compressor 1 to the outdoor heat exchanger 5 when a cooling operation is carried out.

The compressor 1, the decompressor 4 and the outdoor heat exchanger 5 are disposed in a heat pump unit 10a. The water-refrigerant heat exchanger 3 is disposed in a heat exchange unit 10b. The heat pump unit 10a and the heat exchange unit 10b are connected to each other through the refrigerant pipe 7.

[0016] A discharge pipe (refrigerant pipe 7) of the compressor 1 is provided with a discharge temperature sensor 1a which is discharge temperature detecting means for detecting a temperature of a refrigerant discharged from the compressor 1, and a discharge pressure sensor 1b which is pressure detecting means for detecting a pressure of a refrigerant discharged from the compressor 1.

There are also provided a blast fan 6 which sends air to the outdoor heat exchanger 5, and a temperature sensor 5a which is outside air temperature detecting means for detecting a temperature of air sucked into the outdoor heat exchanger 5.

A frequency of the compressor 1 is controlled such that a pressure detected by the discharge pressure sensor 1b does not exceed an operation using range of the compressor 1. As the refrigerant, R410A is used but a fluorocarbon-based refrigerant can also be used. The compressor 1 is of a hermetic type, a motor is disposed on a high pressure side, and a rare-earth magnet is used for the motor. Since an accumulator is not used, the heat pump hydronic heater can be made small in size and light in weight.

[0017] The heat pump hydronic heater includes a cooling/heating terminal 24 (such as a floor heating panel, a

radiator panel and a fan coil unit) which cools and heats an interior of a room. Cold water or hot water produced by the water-refrigerant heat exchanger 3 is made to flow through an interior of the cooling/heating terminal 24, thereby cooling or heating the room.

[0018] The heat pump hydronic heater of the embodiment further includes a hot water supply tank 22 in which hot water to be supplied or used (for shower for example) is stored. High temperature water produced by the water-refrigerant heat exchanger 3 is made to flow through the hot water supply heat exchanger 23 to heat water in the hot water supply tank 22. Hence, a flow path switching valve 21 is provided on the side of an outlet of the water-refrigerant heat exchanger 3. By switching the flow path switching valve 21, water is circulated through a hot water supply water circuit 20a on the side of the hot water supply heat exchanger 23 and through a cooling/heating water circuit 20b on the side of the cooling/heating terminal 24.

[0019] A water pump 8 for circulating water is provided on the side of an inlet of the water-refrigerant heat exchanger 3. A temperature sensor 3a which is entering-water temperature detecting means for detecting an entering-water temperature is provided on the side of the inlet of the water-refrigerant heat exchanger 3. A temperature sensor 3b which is an outgoing-water temperature detecting means for detecting an outgoing-water temperature is provided on the side of an outlet of the water-refrigerant heat exchanger 3.

In a hot water supplying operation or a cooling/heating operation of the heat pump hydronic heater, the water pump 8 is driven, thereby circulating cold water or hot water through the hot water supply heat exchanger 23 or the cooling/heating terminal 24.

In the hot water supplying operation or a heating operation, the refrigeration cycle is operated until it is detected that a temperature of hot water detected by the temperature sensor 3b is higher than a temperature which is set by a remote control (not shown) by a predetermined temperature, and if it is detected that the temperature detected by the temperature sensor 3b is higher than the set temperature by the predetermined temperature, the operation of the refrigeration cycle is stopped.

In the cooling operation, the refrigeration cycle is operated until it is detected that a temperature of cold water detected by the temperature sensor 3b is lower than a temperature which is set by the remote control (not shown) by a predetermined temperature, and if the temperature detected by the temperature sensor 3b is lower than the set temperature by the predetermined temperature, the operation of the refrigeration cycle is stopped.

[0020] In the operation of the refrigeration cycle, an opening degree of the decompressor 4 is controlled so that a discharge temperature detected by the discharge temperature sensor 1a becomes equal to a predetermined temperature. However, since it is necessary to detect a temperature of water circulating through the cooling/heating terminal 24 or the hot water supply heat

exchanger 23 even after the operation of the refrigeration cycle is stopped, the water pump 8 is driven. The water pump 8 may be an AC pump or a DC pump.

[0021] That is, according to the heat pump hydronic heater of the embodiment, of function parts configuring the refrigeration cycle, parts other than the water-refrigerant heat exchanger 3 are accommodated in a casing of the heat pump unit 10a, and the water-refrigerant heat exchanger 3 and the water pump 8 are accommodated in a casing of the heat exchange unit 10b.

In this case, the heat pump unit 10a is disposed outdoors and the heat exchange unit 10b is disposed indoors. According to this configuration, the indoor side and the outdoor side are connected to each other through the refrigerant pipe 7. Hence, even if an outside air temperature is low in winter or the like, since the indoor side and the outdoor side are connected to each other through the refrigerant pipe 7, there is a merit that a possibility of freeze is low as compared with a case where the indoor side and the outdoor side are connected to each other through a water pipe.

Each of the heat pump unit 10a and the heat exchange unit 10b includes control devices 11a and 11b, and the control devices 11a and 11b output operation instructions to devices provided in each of the units.

[0022] In the heat pump hydronic heater configured as described above, refrigerant leakage detection control will be described below.

[0023] Fig. 2 is a flowchart of the refrigerant leakage detection control of the heat pump hydronic heater. The refrigerant leakage detection control according to the embodiment will be described below using Fig. 2.

[0024] If the operation is started, the control device 11a starts the compressor 1 (step 1), and determines whether a predetermined time is elapsed after the compressor is operated (step 2). If the predetermined time is elapsed, the procedure is shifted to step 3.

In step 3, the control device 11a determines whether a pressure detected by the discharge pressure sensor 1b is lower than a second set pressure (lower than first set pressure). If the detected pressure is lower than the second set pressure, the procedure is shifted to step 5 and the compressor 1 is stopped. In step 3, if the detected pressure is equal to or higher than the second set pressure, the procedure is shifted to step 4.

In step 3, it is determined whether a refrigerant leaks. When a refrigerant completely leaks from the refrigeration cycle, since a discharge superheat degree can not precisely be detected, the refrigerant leakage is determined only based on a pressure.

[0025] In step 4, the control device 11a determines whether a pressure detected by the discharge pressure sensor 1b is lower than the first set pressure and whether the discharge superheat degree is equal to or higher than a set superheat degree. If the pressure is lower than the first set pressure and the discharge superheat degree is equal to or higher than the set superheat degree, the procedure is shifted to step 5 and the compressor 1 is

stopped. In step 4, if the pressure is equal to or higher than the first set pressure and the discharge superheat degree is lower than the set superheat degree, the procedure is returned to step 3. In step 4, it is determined whether a refrigerant is halfway leaked.

[0026] Discharge superheat degree detecting means which detects a discharge superheat degree includes the discharge pressure sensor 1b and the discharge pressure sensor 1a. A pressure and a condensation temperature corresponding to that pressure are preset in the control device 11a. A discharge superheat degree is calculated by subtracting a preset condensation temperature corresponding to a pressure detected by the discharge pressure sensor 1b from a temperature detected by the discharge temperature sensor 1a.

If a temperature sensor which can detect the condensation temperature exists on the side of the condenser (water-refrigerant heat exchanger 3 at the time of heating operation and outdoor heat exchanger 5 at the time of cooling operation), the discharge superheat degree may be calculated by subtracting, from the discharge temperature detected by the discharge temperature sensor 1a, a condensation temperature detected by the temperature sensor which can detect the condensation temperature instead of the discharge pressure sensor 1b.

[0027] If leakage of a refrigerant is detected, the compressor 1 is stopped (step 5), and the number of abnormalities are counted up (step 6).

In step 7, the control device 11a determines whether the number of abnormalities reaches a predetermined number. If the number of abnormalities reaches the predetermined number, the system is made to go down, the abnormality is displayed on the remote control (not shown) (step 9). If the number of abnormalities does not reach the predetermined number, a restart of the compressor 1 is waited (step 8), and when three minutes are elapsed, the compressor 1 is restarted (step 1).

[0028] As described above, according to the heat pump hydronic heater of the embodiment, it is possible to reliably detect leakage of a refrigerant without depending upon a length of the connection pipe 7 between the units, and it is possible to safely stop the heat pump hydronic heater before the compressor 1 is damaged, and to inform a user of abnormality.

[Industrial Applicability]

[0029] The present invention provides a heat pump hydronic heater having improved usability in which leakage of a refrigerant is not erroneously detected. Therefore, the invention can be applied not only to a domestic heat pump hydronic heater but also to a heat pump hydronic heater for business use.

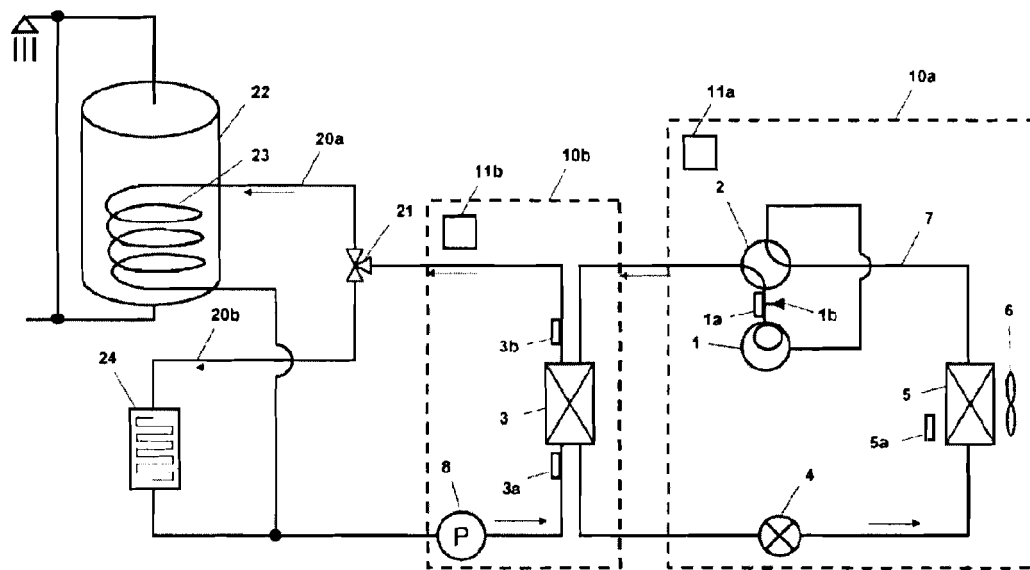
Claims

1. A heat pump hydronic heater including a refrigeration

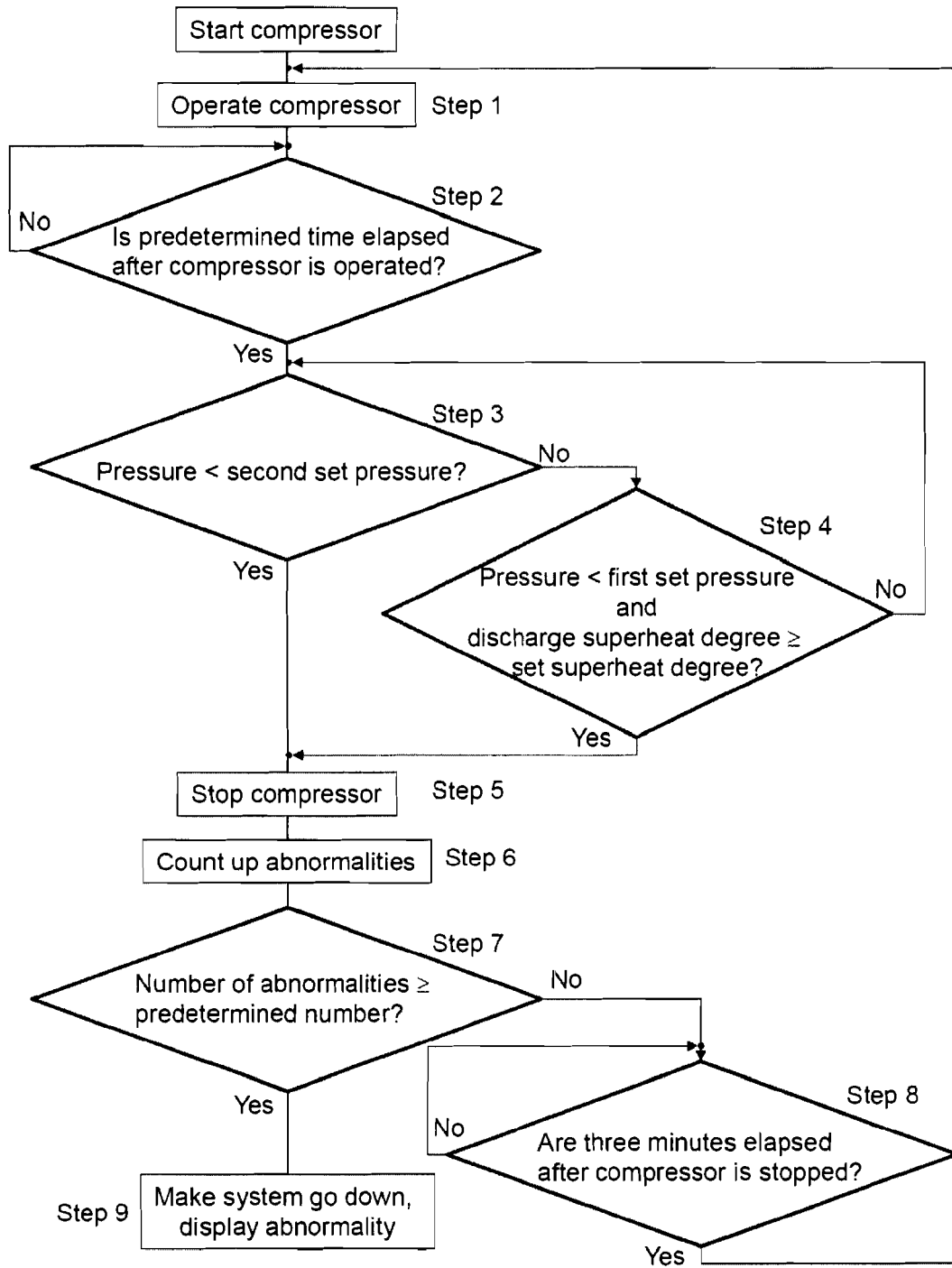
cycle formed by connecting, to one another through a refrigerant pipe, a compressor which compresses a refrigerant, a water-refrigerant heat exchanger which heat-exchanges between the refrigerant and water, a decompressor which decompresses the refrigerant and an outdoor heat exchanger which heat-exchanges between the refrigerant and air, wherein the heat pump hydronic heater comprises discharge pressure detecting means which detects a pressure of the refrigerant discharged from the compressor, discharge superheat degree detecting means which detects a superheat degree of the refrigerant discharged from the compressor, and a control device, and the control device stops operation of the compressor if the discharge pressure detected by the discharge pressure detecting means is lower than a first set pressure and a discharge superheat degree detected by the discharge superheat degree detecting means is equal to or higher than a predetermined value when predetermined time is elapsed after the compressor is started, or if the discharge pressure detected by the discharge pressure detecting means is lower than a second set pressure which is set lower than the first set pressure.

2. The heat pump hydronic heater according to claim 1, wherein when a number of stoppages of operation of the compressor is equal to or higher than a predetermined number, the control device does not restart the compressor and informs this fact.

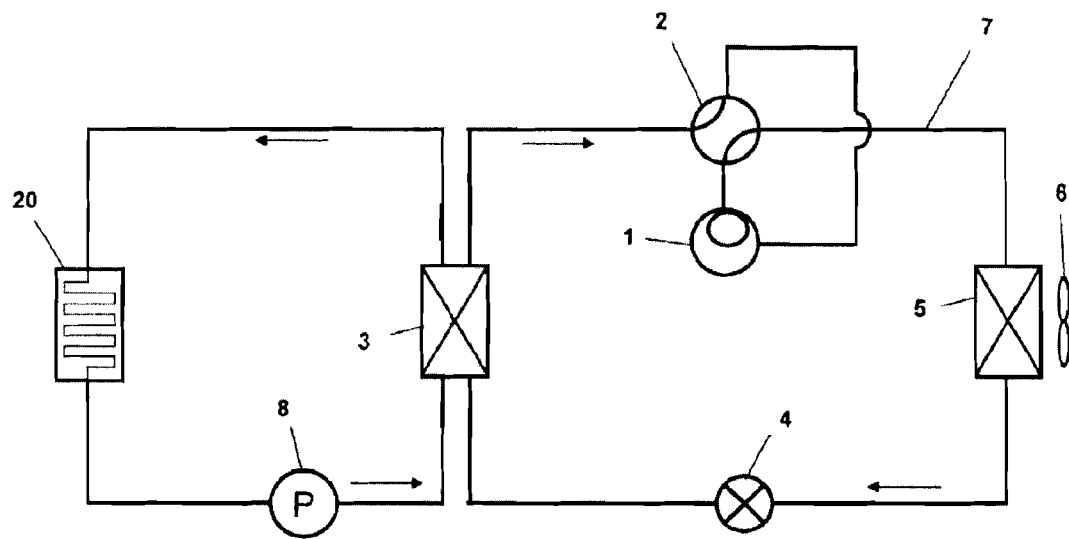
[Fig. 1]



[Fig. 2]



[Fig. 3]



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011047607 A [0004]