(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 672 205 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.12.2013 Bulletin 2013/50

(21) Application number: **13170506.3**

(22) Date of filing: **04.06.2013**

(51) Int Cl.:
F25B 9/00 *(2006.01)* ***F25B 13/00*** *(2006.01)*
F25B 39/02 *(2006.01)* ***F25B 49/02*** *(2006.01)*

(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

(30) Priority: **06.06.2012 JP 2012128839**

(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES, LTD.**
Tokyo 108-8215 (JP)

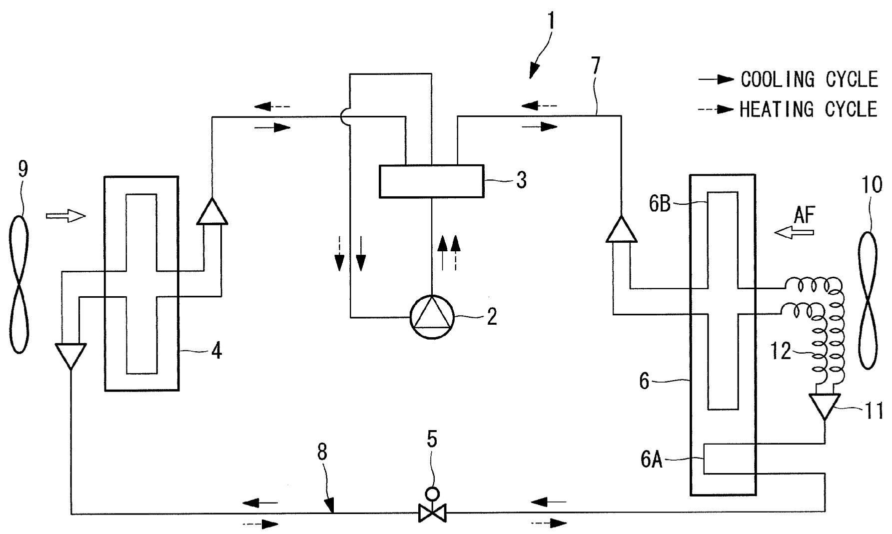
(72) Inventors:
- **Maeno, Masashi**
  TOKYO, 108-8215 (JP)
- **Omura, Minemasa**
  TOKYO, 108-8215 (JP)
- **Aoki, Yasutaka**
  TOKYO, 108-8215 (JP)
- **Yamada, Hiroyuki**
  TOKYO, 108-8215 (JP)

(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158, rue de l'Université
75340 Paris Cedex 07 (FR)

(54) Heat exchanger system

(57) To provide a heat exchanger system that can reliably suppress local frosting near an inlet of a heat-source side heat exchanger serving as an evaporator in a heat cycle, and perform a stable operation. The heat exchanger system includes a refrigeration cycle (8) including a compressor (2), a use side heat exchanger (4), an expansion valve (5), and a heat-source side heat exchanger (6), and in which a non-azeotropic refrigerant mixture having temperature glide is filled in the refrigeration cycle, wherein a part of a refrigerant circuit (6A), (6B) of the heat-source side heat exchanger (6) that serves as an evaporator in a heat cycle extends within the heat exchanger (6), a continuing part of the refrigerant circuit of the heat-source side heat exchanger extends out of the heat exchanger (6) and then connects to a plurality of circuits (6B) via a distribution capillary tube (12), and the refrigerant is circulated in the heat exchanger.

FIG. 1



EP 2 672 205 A2

Description

Technical Field

[0001] The present invention relates to a heat exchanger system in which a non-azeotropic refrigerant mixture having so-called temperature glide is filled in a refrigeration cycle.

Background Art

[0002] It is known that R407C, which is a non-azeotropic refrigerant mixture, and a refrigerant mixture of R32 and R125 have a characteristic that temperature rise is caused along the direction of flow in a vaporization process under a constant pressure (hereafter, referred to as temperature glide). In a heat exchanger system in which the non-azeotropic refrigerant mixture is filled in the refrigeration cycle, refrigerant temperature is the lowest in the vicinity of the inlet of a heat-source side heat exchanger serving as an evaporator (outside heat exchanger) in a heat cycle, and degree of dryness increases as vaporization advances with rising temperature. This causes the temperature to be higher in the outlet side. Therefore, the refrigerant tends to cause local frosting near the inlet of the heat-source side heat exchanger in which the temperature becomes the lowest.

[0003] PTL 1 discloses a system in which, in order to effectively prevent frosting near the refrigerant inlet of the heat-source side heat exchanger serving as an evaporator, heat is exchanged between the refrigerant entering the heat-source side heat exchanger and the refrigerant having passed the heat-source side heat exchanger in a heat exchange section. PTL 1 further discloses the system which raises temperature of the refrigerant entering the heat-source side heat exchanger and prevents frosting by making the flow of the refrigerant a counter flow of the air flow in the heat-source side heat exchanger. Further, PTL 2 discloses a system that suppresses frosting by disposing the refrigerant inlet portion of the heat-source side heat exchanger serving as an evaporator in a domain which is the downstream of the air flow and in which the wind speed is larger than the wind speed of the air flow passing the opening of the unit.

Citation List

Patent Literature

[0004]

{PTL 1}
Japanese Unexamined Patent Application, Publication No. Hei 08-334274
{PTL 2}
Japanese Unexamined Patent Application, Publication No. 2008-256311

Summary of Invention

Technical Problem

[0005] As shown in the above-stated Patent Literatures 1, 2, it is possible to suppress local frosting near the inlet of the heat-source side heat exchanger serving as an evaporator at which the temperature becomes lowest by raising the temperature of the low-temperature refrigerant introduced into the heat-source side heat exchanger by exchanging heat with a superheating refrigerant gas at the outlet, or making the relationship with the air flow to be in a counter flow, or disposing the refrigerant inlet portion to a domain in which the wind speed is large. However, with these configurations, there have been disadvantages that the operation tends to be unstable, since they are subject to effects of the amount of heat exchange, gas volume, or wind speed in the heat-source side heat exchanger.

[0006] The present invention is made in view of the forgoing circumstances, and an object of the present invention is to provide a heat exchanger system that can reliably suppress local frosting near an inlet of a heat-source side heat exchanger serving as an evaporator in a heat cycle, to achieve a stable operation.

Solution to Problem

[0007] To overcome the above-stated disadvantages, the heat exchanger system of the present invention adopts the following solution.
The heat exchanger system according to an aspect of the present invention includes a refrigeration cycle including a compressor, a use side heat exchanger, an expansion valve, a heat-source side heat exchanger, and the like, and in which a non-azeotropic refrigerant mixture having temperature glide is filled in the refrigeration cycle, wherein a part of a refrigerant circuit of the heat-source side heat exchanger serves as an evaporator in a heat cycle, wherein a continuing part of the refrigerant circuit of the heat-source side heat exchanger extends out of the heat exchanger and then connects to a plurality of circuits via a distribution capillary tube so that the refrigerant is circulated in the heat exchanger.

[0008] According to this aspect of the present invention, in a heat exchanger system in which a non-azeotropic refrigerant mixture having temperature glide is filled, a part of a refrigerant circuit of the heat-source side heat exchanger that serves as an evaporator in a heat cycle extends within the heat exchanger, and a part of the refrigerant circuit continuing from that part extends out of the heat exchanger and then connects to a plurality of circuits via a distribution capillary tube, and the refrigerant is circulated in the heat exchanger. Accordingly, it is possible, in a heat cycle in which the heat-source side heat exchanger (outside heat exchanger) serves as an evaporator, by allotting the amount of flow reduction to both of the expansion valve and distribution capillary tube, the refrigerant temperature, which becomes the lowest at the inlet portion of the heat-source side heat exchanger, is raised so that local frosting near the inlet of the outside heat exchanger can be prevented. Accordingly, it is possible to improve the heating capability and coefficient of performance by suppressing frosting, and prevent frequent defrosting operation. Further, since it is possible to raise the lowest temperature of the refrigerant by reducing the amount of refrigerant flow, it is possible to reliably raise the refrigerant temperature without being affected by the outside factor to perform stable operation.

[0009] Further, in the heat exchanger system according to another aspect of present invention, a parallel circuit of a solenoid valve and a capillary tube is provided in an inlet side of the distribution capillary tube.

[0010] According to this aspect of the present invention, a parallel circuit of a solenoid valve and a capillary tube is provided in an inlet side of the distribution capillary tube. Whether the refrigerant is flowed through the solenoid valve or through the capillary tube is controlled depending on the operational state. Therefore, it is possible to adjust the proportion of the amount of flow reduction with respect to the expansion valve through the solenoid valve by opening and closing it, to vary the amount of flow reduction in the capillary tube.

Accordingly, even if the operational state fluctuates, it is possible to appropriately adjust the refrigerant temperature at the inlet of the heat-source side heat exchanger and to improve the heat exchanger performance (evaporator performance) by reliably suppressing local frosting near the inlet of the heat-source side heat exchanger.

[0011] In the heat exchanger system according to another aspect of the present invention, while degree of superheat by the expansion valve is controlled, if a refrigerant temperature at the inlet of the heat-source side heat exchanger that serves as an evaporator is not equal to or greater than a pre-set value, the solenoid valve is closed, and a proportion of amount of reduction can be increased via the capillary tube.

[0012] According to this aspect of the present invention, while degree of superheat by the expansion valve is controlled, if a refrigerant temperature at the inlet of the heat-source side heat exchanger that serves as an evaporator is not equal to or greater than a pre-set value, the solenoid valve is closed, and a proportion of amount of reduction can be increased via the capillary tube. Therefore, in the case where the temperature of the refrigerant at the inlet of the heat-source side heat exchanger does not reach the pre-set value or greater while the degree of superheat of the refrigerant at the outlet of the heat-source side heat exchanger is controlled by the expansion valve, and frosting may possibly occur, it is possible to adjust the refrigerant temperature at the inlet of the heat-source side heat exchanger to the pre-set temperature or greater by flowing the refrigerant through the capillary tube by closing the solenoid valve, increasing the proportion of amount of reduction by adjusting the proportion of allotment of amount of flow reduction with respect to the expansion valve. Accordingly, it is possible to reliably suppress the local frosting near the inlet of the heat-source side heat exchanger, and to improve the heat exchanger performance (evaporator performance).

[0013] Further, as another aspect of the present invention, in the heat exchanger system according to any of the above aspects, the heat-source side heat exchanger is configured so that, in a heat cycle in which the heat-source side heat exchanger serves as an evaporator, a refrigerant flow becomes a counter flow to the air flow blown by the fan.

[0014] According to this aspect of the present invention, the heat-source side heat exchanger is configured so that, in a heat cycle in which the heat-source side heat exchanger serves as an evaporator, a refrigerant flow is in a counter flow with respect to the air flow blown by the fan. By positioning the circuit portion of the inlet side through which low-temperature refrigerant flows by the temperature glide in the downstream side of the heat-source side heat exchanger, it is possible to increase the heat exchanger performance (evaporator performance), as well as suppressing frosting at a tip of the fin, causing the development of the frost to be uniform. Therefore, it is possible to further improve the heat exchanger performance (evaporator performance) and suppress frosting.

[0015] Furthermore, in the heat exchanger system according to another aspect of the present invention, instead of having a part of the refrigerant circuit extending out of the heat-source side heat exchanger, a small heat exchanger is provided having a volume smaller than the heat-source side heat exchanger, at a refrigerant inlet side of the heat-source side heat exchanger that serves as an evaporator in a heat cycle.

[0016] According to this aspect of the present invention, instead of having a part of the refrigerant circuit extending out of the heat-source side heat exchanger in the above heat exchanger system, a small heat exchanger is provided, having a volume smaller than the heat-source side heat exchanger, at a refrigerant inlet side of the heat-source side heat exchanger that serves as an evaporator in a heat cycle. Therefore, in a heat cycle, it is possible to exchange heat of the refrigerant of the lowest temperature with air by the small heat exchanger, and raise the temperature, and supply the refrigerant to the heat-source side heat exchanger. Accordingly, it is possible to improve the heat exchanger performance (evaporator performance) while reliably suppressing frosting on the heat-source side heat exchanger.

[0017] Furthermore, in the heat exchanger system according to another aspect of the present invention, the small heat exchanger is configured so that a fin pitch thereof is coarser or fin width thereof is larger, and a temperature at a tip of the fin becomes higher, in comparison with the heat-source side heat exchanger.

[0018] According to this aspect of the present invention, since the small heat exchanger is configured so that a fin pitch thereof is coarser or fin width thereof is larger and a temperature at a tip of the fin becomes higher than the heat-source side heat exchanger, it is possible, in a heat cycle, to raise the temperature of the refrigerant of the lowest temperature by the small heat exchanger through heat exchange, reduce the amount of heat exchange by the fin configuration, and suppress frosting on the small heat exchanger by preventing frost from precipitating on the fin. Accordingly, it is possible to suppress frosting both on the small heat exchanger and the heat-source side heat exchanger, and stably continue the heating operation.

[0019] Further, as another aspect of the present invention, in the heat exchanger system according to any one of the above, the small heat exchanger is installed in a domain which is in a downstream side, with respect to the air flow blown by the fan, of the heat-source side heat exchanger, and where a wind speed distribution is large.

[0020] According to this aspect of the present invention, the small heat exchanger is installed in a domain which is in a downstream side of the heat-source side heat exchanger, with respect to the air flow blown by the fan, and where a wind speed distribution is large. Therefore, it is possible to make frosting less likely to occur by heating the small heat exchanger in which the refrigerant of the lowest-temperature circulates, by passing the air flow of decreased hygroscopic moisture and large wind speed distribution through the heat-source side heat exchanger. Therefore, it is possible to further stabilize the heating operation by reliably suppressing frosting on the small heat exchanger and the heat-source side heat exchanger.

Advantageous Effects of Invention

[0021] According to the present invention, the proportion of allotment of the amount of flow reduction is borne by both of the expansion valve and the distribution capillary tube in a heat cycle in which the heat-source side heat exchanger serves as an evaporator, and the refrigerant temperature that becomes the lowest at the inlet portion heat-source side heat exchanger can be raised. With this configuration, it is possible to prevent local frosting near the inlet of the heat-source side heat exchanger. Therefore, it is possible to suppress frosting and improve the heating capability and coefficient of performance, as well as preventing frequent defrosting operation. Further, since the lowest temperature of the refrigerant can be raised by the amount of flow reduction of the refrigerant, the refrigerant temperature can be reliably raised, without being affected by the outside factors, making possible to perform a stable operation. Brief Description of Drawings

[0022]

{Fig. 1} Fig 1 is a diagram of a refrigerant circuit of a heat exchanger system according to a first embodiment of the present invention.

{Fig. 2}

Fig. 2 is schematic diagram representing heat-source side heat exchanger and components therearound of the heat exchanger system according to the second embodiment of the present invention.

{Fig. 3}

Fig. 3 is a Mollier diagram for the heat exchanger systems shown in Fig. 1 and Fig. 2.

{Fig. 4}

Fig. 4 is a control flowchart of the solenoid valve of the heat exchanger system shown in Fig. 2.

{Fig. 5}

Fig. 5 is a schematic diagram showing a heat-source side heat exchanger and components therearound of the heat exchanger system according to the third embodiment of the present invention.

{Fig. 6}

Fig. 6 is a schematic diagram showing the heat-source side heat exchanger and components therearound of the heat exchanger system according to the fourth embodiment of the present invention.

{Fig. 7}

Fig. 7 is a schematic diagram of arrangement of the small heat exchanger of the heat exchanger system shown in Fig. 6.

{Description of Embodiments}

[0023] Hereafter, the embodiments of the present invention will be described with reference to the drawings.

First embodiment

[0024] Hereafter, the first embodiment of the present invention will be explained with reference to Fig. 1 and Fig. 3.

Fig. 1 shows a refrigerant circuit of the heat exchanger system according to the first embodiment of the present invention.

The heat exchanger system 1 of the present embodiment includes a closed cycle refrigerant circuit (refrigeration cycle) 8, in which a compressor 2, a four way switching valve 3, a use side heat exchanger (indoor-side heat exchanger) 4, an electrically-driven type expansion valve (EEV) 5, a heat-source side heat exchanger (outside heat exchanger) 6 are connected in this order via the refrigerant pipe 7. In this refrigeration cycle 8, a non-azeotropic refrigerant mixture having so-called temperature glide (for example, R407C, a refrigerant mixture of R32 and R125, etc.) is filled.

[0025] Each of the use side heat exchanger 4 and the heat-source side heat exchanger 6 is configured so that the refrigerant is distributed and circulated in a plurality of circuits, and a use side fan 9 and a heat source side fan 10 that circulate air to each heat exchanger is provided for each heat exchanger. In the heat exchanger system 1, the refrigerant discharged from the compressor 2 flows in a cooling cycle in which the refrigerant circulates in the heat-source side heat exchanger 6, the expansion valve (EEV) 5, the use side heat exchanger 4, the four way switching valve 3, and the compressor 2 in this order via the four way switching valve 3 as shown in the continuous line arrow, to thereby perform the cooling operation. That is, in the cooling operation, the use side heat exchanger 4 that serves as an evaporator absorbs heat from the interior air blown by the use side fan 9, and radiates the heat by the heat-source side heat exchanger 6 to the outdoor air, thereby performing the cooling operation.

[0026] Further, the refrigerant discharged from the compressor 2 flows in the heat cycle in which the refrigerant circulates, via the four way switching valve 3, the use side heat exchanger 4, the expansion valve (EEV) 5, the heat-source side heat exchanger 6, the four way switching valve 3, and the compressor 2 in this order as indicated by the dashed lines arrow, to perform the heating operation. In the heating operation, the heat-source side heat exchanger 6 serves as an evaporator, absorbs heat from the outdoor air blown by the heat source side fan 10 and radiate the heat to the interior air side by the use side heat exchanger 4 to perform the heating operation.

[0027] Further, the heat-source side heat exchanger 6 serving as an evaporator in a heat cycle is configured in the following manner. As shown in Fig. 1, a part of the refrigerant circuit 6A extends within the heat exchanger 6 in the inlet portion, and a part of the refrigerant circuit continuing from that part extends out of the heat exchanger 6 and then connects to a plurality of circuits (refrigerant circuits) 6B via a distributor 11 and a plurality of distribution capillary tube 12. The refrigerant is then circulated within the heat exchanger 6.

[0028] Hence, the present embodiment has a circuit configuration in which, a part of the refrigerant circuit 6A extends within the heat exchanger 6, and a part of the refrigerant circuit continuing from the heat exchanger 6 and reconnecting to a plurality of circuits (refrigerant circuits) 6B via a distributor 11 and a plurality of distribution capillary tube 12, and the refrigerant is then circulated in the heat exchanger 6. Therefore, the amount of flow reduction of the refrigerant is borne by both of the expansion valve (EEV) 5 and the distribution capillary tube 12 in a heat cycle in which the refrigerant discharged from the compressor 2 circulates in the four way switching valve 3, the use side heat exchanger 4, the expansion valve (EEV) 5, the heat-source side heat exchanger 6, the four way switching valve 3 and the compressor 2 in this order. Thus, it is possible to circulate the refrigerant in the heat-source side heat exchanger 6 while raising the refrigerant temperature that is the lowest at the inlet portion thereof.

[0029] Mollier diagram of Fig. 3 illustrates this. That is, the reduction process (expansion process) of the refrigerant is borne by both of the expansion valve (EEV) 5 and the distribution capillary tube 12. The flow of the refrigerant, comparatively loosely regulated by the expansion valve (EEV) 5 in the refrigerant circuit 6A, is circulated in the heat source side in the heat exchanger 6. Then the refrigerant flows outside of the heat exchanger 6, and the refrigerant flow is then regulated by the distribution capillary tube 12 to circulate in the plurality of circuits 6B. With this configuration, the temperature of the refrigerant that normally becomes the lowest temperature in the inlet portion of the heat-source side heat exchanger 6 by reducing the refrigerant flow to the point "a" by the expansion valve (EEV) 5, is set to be comparatively high by regulating the amount of refrigerant flow to point "b" to supply the refrigerant to the heat-source side heat exchanger 6 via a reduction process as in (A).

[0030] Therefore, local frosting near the inlet of the heat-source side heat exchanger 6 can be prevented, and it is possible to improve the heating capability and the coefficient of performance by suppressing the frosting, thereby preventing frequent defrosting operations. Since it is possible to raise the lowest temperature of the refrigerant with the amount of flow reduction of the refrigerant, it is possible to reliably raise the refrigerant temperature without being affected by external factors. Accordingly, it is possible to perform a stable operation.

Second embodiment

[0031] The following will describe a second embodiment of the present invention with reference to Fig. 2 to Fig. 4.

The present embodiment differs from the above-described first embodiment in that a parallel circuit of a solenoid valve and a capillary tube is provided in the inlet side of the distribution capillary tube 12. Other points are same as the first embodiment and the redundant explanations will be omitted.

In the present embodiment, as shown in Fig. 2, the heat-source side heat exchanger (outside heat exchanger) 6 is configured so that a parallel circuit 16 of the solenoid valve 13, the check valve 14 and the capillary tube 15 are connected in a part that is the inlet side of the distributor 11 and a plurality of distribution capillary tubes 12 in the heat cycle.

[0032] The solenoid valve 13 is controlled in the manner as shown in Fig. 4. The solenoid valve 13 is normally in an open state.

Upon operation in the heat cycle, as in step S1, the degree of superheat of the expansion valve (EEV) 5 is controlled. The control of degree of superheat is performed in such a manner as to determine whether the degree of superheat of the refrigerant at an outlet of the heat-source side heat exchanger 6 is the target degree of superheat in step S2, and if NO, the process returns to step S1 and adjust the opening degree of the expansion valve (EEV) 5. When the degree of superheat of the refrigerant at the outlet of the heat-source side heat exchanger 6 becomes the target degree of superheat (degree of superheat of the refrigerant at the outlet equals to the target degree of superheat) and it is determined as YES, the process proceeds to step S3.

[0033] In step S3, it is determined whether the refrigerant temperature at the inlet of the heat-source side heat exchanger 6 detected by the thermal sensor 17 is X degrees centigrade, which is the pre-set temperature, or greater. Here, if the temperature is X degrees centigrade, which is the pre-set temperature, or greater, it is determined as YES, and determined that the allotment of reduction is appropriate, and the process returns to the start point while the solenoid valve 13 is kept in the open state. On the other hand, if, it is determined as NO in step S3, and determined that the refrigerant temperature at the inlet of the heat-source side heat exchanger 6 is not equal to the pre-set temperature, X degrees centigrade, or greater, proceeds to step S4. In step S4, since the solenoid valve 13 is closed, the refrigerant is circulated in the distributor 11 via the capillary tube 15. Therefore, the proportion of amount of reduction by the capillary tubes 12, 15 becomes large.

[0034] Consequently, the degree of superheat of the refrigerant at the outlet of the heat-source side heat exchanger 6 becomes large. As a result, the opening degree of the expansion valve (EEV) 5 becomes large by controlling the degree of superheat, as shown in the Mollier diagram of Fig. 3, the reduction of the expansion valve (EEV) 5 is brought down to the point "c", and the proportion of allotment of the amounts of flow reduction between the expansion valve (EEV) 5 and the capillary tubes 12, 15 are adjusted. Hence, the refrigerant is supplied to the heat-source side heat exchanger 6 via the reduction process as in (B), and the refrigerant temperature at the inlet of the heat-source side heat exchanger 6 is to be adjusted to be the pre-set temperature, X degrees centigrade, , or greater.

[0035] The present embodiment, accordingly, has the following configuration. The parallel circuit 16 of the solenoid valve 13 and the capillary tube 15 is provided in the inlet side of the distribution capillary tube 12. The solenoid valve 13 is opened and closed depending on the operational state to control whether the refrigerant is flowed through the solenoid valve 13, or the refrigerant is flowed through the capillary tube 15. With this configuration, the proportion of allotment of the amount of flow reduction by the capillary tubes 12, 15, with respect to that of the expansion valve (EEV) 5, is adjustable by varying the amount of flow reduction by the capillary tubes 12, 15. Consequently, even if the operational state changes, the refrigerant temperature at the inlet of the heat-source side heat exchanger 6 can be appropriately adjusted, and it is possible to improve the heat exchanger performance (evaporator performance) while reliably suppressing local frosting near the inlet of the heat-source side heat exchanger 6.

[0036] That is, there may be a case in which while the degree of superheat of the refrigerant at the outlet of the heat exchanger 6 in the heat source side is controlled via the expansion valve (EEV) 5, the detection value of the thermal sensor 17, the inlet temperature of the refrigerant of the heat-source side heat exchanger 6, does not become the pre-set temperature, X degrees centigrade, or greater, and frosting may be caused. In such a case, the above-stated embodiment can adjust the refrigerant temperature at the inlet of the heat-source side heat exchanger 6 to the pre-set temperature or greater, by adjusting the proportion of allotment by the capillary tubes 12, 15 with respect to that of the expansion valve (EEV) 5, of amount of flow reduction, by closing the solenoid valve 13 to flow the refrigerant by way of the capillary tube 15, increasing the proportion of amount of reduction by the capillary tubes 12, 15. With this configuration, it possible to reliably suppress local frosting near the inlet of the heat-source side heat exchanger 6, while improving the heat exchanger performance (evaporator performance).

Third embodiments

[0037] The following describes the third embodiment of the present invention with reference to Fig. 5.
The present embodiment differs from the above-described first and second embodiments in that the refrigerant flow in the heat-source side heat exchanger 6, is made to be the counter flow against the air flow from the heat source side fan 10 as described above. Other configurations are same as the first and second embodiments, and the redundant explanations are omitted.
The present embodiment is configured such that, as shown in Fig. 5, in a heat cycle, refrigerant circuit 6A and a plurality of circuits 6B in the heat-source side heat exchanger (outside heat exchanger) 6, is disposed so that the refrigerant flows from the downstream side to the upstream side with respect to the air flow AF from the heat source side fan 10. Consequently, the refrigerant flow is in a counter flow (countercurrent) with respect to the air flow AF.

[0038] Accordingly, it is possible to increase the heat exchanger performance (evaporator performance) while suppressing frosting in the tip-end of the fin, and make the frosting uniform by configuring the heat-source side heat exchanger 6, such that, in a heat cycle in which it serves as an evaporator, the refrigerant flow becomes a countercurrent against the air flow blown by the heat source side fan 10; and disposing the refrigerant circuit portion in the inlet side in which the refrigerant of the low-temperature flows due to temperature glide, in other words, by disposing the refrigerant circuit 6A and a plurality of circuits 6B in the downstream side with respect to the heat-source side heat exchanger 6. Therefore, it is possible to further improve heat exchanger performance (evaporator performance) and suppress frosting.

Fourth embodiment

[0039] The following will describe the fourth embodiment of the present invention with reference to Fig. 6 and Fig. 7.
The present embodiment differs from the above-described first through third embodiments in that a small

heat exchanger 18 is provided instead of the refrigerant circuit 6A of the heat-source side heat exchanger 6. Other configurations are same as the first third embodiments, and the redundant explanations are omitted.

The present embodiment is configured so that, as shown in Fig. 6, in the refrigerant inlet side of the heat-source side heat exchanger (outside heat exchanger) 6 in a heat cycle, a small heat exchanger 18 having a volume smaller than the heat-source side heat exchanger 6 is provided in place of the refrigerant circuit 6A provided in the first to third embodiments.

[0040] The present embodiment is configured such that the distribution capillary tube 12 is connected to the outlet side of the small heat exchanger 18, and the other end of the distribution capillary tube 12 is connected to a plurality of circuits 6B in the heat-source side heat exchanger 6. Further, the small heat exchanger 18 is disposed in the downstream side of the heat-source side heat exchanger 6 in the air flow AF blown from the heat source side fan 10, and the refrigerant flow in the heat-source side heat exchanger 6 is in a counter flow (countercurrent) with respect to the air flow AF described above.

[0041] Furthermore, regarding the small heat exchanger 18, not only it has a smaller capacity than the heat-source side heat exchanger 6, but the fin pitch thereof is coarse or the fin width thereof is large, and the temperature at the end portion of the fin becomes high. As shown in Fig. 7, the small heat exchanger 18 is disposed such that its portion of minimum temperature is located in a domain which is in the downstream side of the heat-source side heat exchanger 6 with respect to the air flow AF blown by the heat source side fan 10, wherein the domain is apart from the end portion of the heat source side fun and the speed distribution of air flow is large.

[0042] Hence, according to the present embodiment, the small heat exchanger 18, having a volume smaller than the heat-source side heat exchanger 6, is installed in the refrigerant inlet side of the heat-source side heat exchanger 6 serving as an evaporator in a heat cycle. Therefore, in a heat cycle, heat is exchanged between the refrigerant of the lowest temperature and the air in the small heat exchanger 18; it is thus possible to supply the refrigerant after the temperature is raised in the heat-source side heat exchanger 6. Accordingly, it is possible to improve the heat exchanger performance (evaporator performance) while reliably suppressing frosting in the heat-source side heat exchanger 6.

[0043] Moreover, the small heat exchanger 18 has a coarse fin pitch or a large fin width and the temperature at the end portion of the fin is higher than that in the heat-source side heat exchanger 6. Therefore, in a heat cycle, it is possible to raise the temperature of the refrigerant of the lowest temperature by heat exchange in the small heat exchanger 18, while suppressing frosting on the small heat exchanger 18 itself, by reducing the amount of heat exchange by the fin configuration and avoiding frosting on the fin. Accordingly, it is possible to suppress frosting on both small heat exchanger 18 and heat-source side heat exchanger 6, and stably continue heating operation.

[0044] Furthermore, since the above-described small heat exchanger 18 is installed so that the portion of the minimum temperature is located in the range in the downstream side of the heat-source side heat exchanger 6, with respect to the air flow AF blown by the heat source side fan 10, and in the domain where the speed distribution of air flow is large. Therefore, it is possible to make frosting less likely occur by heating the small heat exchanger 18 through which the refrigerant with the lowest-temperature circulates. This is done by having the air flow pass through the heat-source side heat exchanger 6 to decrease moisture level with a large speed distribution of air flow. Accordingly, it becomes possible to further stabilize the heating operation by reliably suppressing the frosting on both the small heat exchanger 18 and the heat-source side heat exchanger 6.

[0045] The present invention is not limited to the above-described embodiments, and can be modified within the scope of the gist of the present invention, and appropriate modifications may be possible. For example, while in the above-described embodiments, the use side heat exchanger (indoor-side heat exchanger) 4 is the refrigerant-air heat exchanger, the use side heat exchanger may be a refrigerant-water heat exchanger or the like. Accordingly, the heat exchanger system of the present invention can be widely applied, not only to air conditioners or freezer, but also to chiller or water heaters.

Reference Signs List

[0046]

1	heat exchanger system
2	compressor
4	use side heat exchanger (indoor-side heat exchanger)
5	expansion valve (EEV)
6	heat-source side heat exchanger (outside heat exchanger)
6A	refrigerant circuit
6B	circuit (refrigerant circuit)
8	refrigerant circuit of closed cycle (refrigeration cycle)
10	heat source side fan
12	distribution capillary tube
13	solenoid valve
15	capillary tube
16	parallel circuit
17	thermal sensor
18	small heat exchanger
AF	air flow

Claims

1. A heat exchanger system (1), **characterized in that** it comprises a refrigeration cycle (8) including a compressor (2), a use side heat exchanger (4), an expansion valve, a heat-source side heat exchanger (6), and the like, and in which a non-azeotropic refrigerant mixture having temperature glide is filled in the refrigeration cycle (8),
wherein a part of a refrigerant circuit (6A) of the heat-source side heat exchanger (6) that serves as an evaporator in a heat cycle extends within the heat exchanger, wherein a continuing part of the refrigerant circuit of the heat-source side heat exchanger (6) extends out of the heat exchanger and then connects to a plurality of circuits (6B) via a distribution capillary tube (12), and wherein the refrigerant is circulated in the heat exchanger.

2. The heat exchanger system (1) according to claim 1, wherein a parallel circuit of a solenoid valve (13) and a capillary tube (15) is provided in an inlet side of the distribution capillary tube (12).

3. The heat exchanger system (1) according to claim 2, wherein on a control of degree of superheat by the expansion valve, where a refrigerant temperature at the inlet of the heat-source side heat exchanger (6) that serves as an evaporator is not equal to or greater than a pre-set value, the solenoid valve (13) is closed, and a proportion of amount of reduction can be increased via the capillary tube (12).

4. The heat exchanger system according to any one of claims 1 to 3, wherein the heat-source side heat exchanger (6) is configured so that, in a heat cycle in which the heat-source side heat exchanger (6) serves as an evaporator, a refrigerant flow is in a counter flow with respect to the air flow blown by the fan.

5. The heat exchanger system (1) according to claim 1, wherein, instead of having a part of the refrigerant circuit extending out of the heat-source side heat exchanger (6), a small heat exchanger having a volume smaller than the heat-source side heat exchanger (6) is provided at a refrigerant inlet side of the heat-source side heat exchanger which serves as an evaporator in a heat cycle.

6. The heat exchanger system (1) according to claim 5, wherein the small heat exchanger is configured so that a fin pitch thereof is coarser or fin width thereof is larger, and temperature at a tip of the fin becomes higher, than the heat-source side heat exchanger (6).

7. The heat exchanger system according to claim 5 or 6, wherein the small heat exchanger is installed in a domain which is in a downstream side of the heat-source side heat exchanger (6) with respect to the air flow blown by the fan, and where a wind speed distribution is large.

8. A heat exchanger system (1), **characterized in that** it comprises a refrigeration cycle (8) including a compressor (2), a use side heat exchanger (4), an expansion valve, a heat-source side heat exchanger (6), and the like, and in which a non-azeotropic refrigerant mixture having temperature glide is filled in the refrigeration cycle (8),
wherein, a small heat exchanger having a volume smaller than the heat-source side heat exchanger (6) is provided at a refrigerant inlet side of the heat-source side heat exchanger which serves as an evaporator in a heat cycle, and
wherein a continuing part of the refrigerant circuit of the heat-source side heat exchanger (6) extends out of the heat exchanger and then connects to a plurality of circuits (6B) via a distribution capillary tube (12), and wherein the refrigerant is circulated in the heat exchanger.

FIG. 1

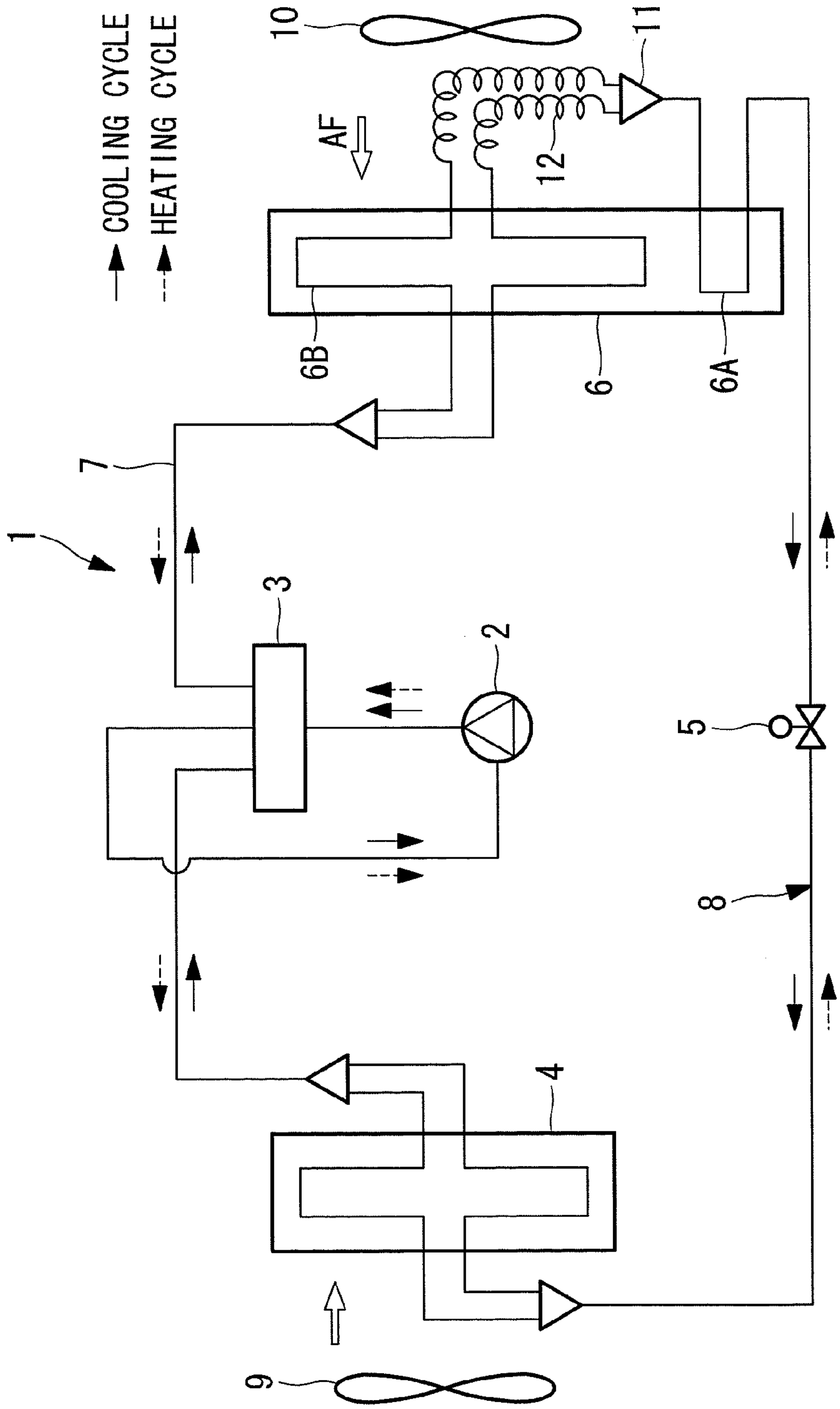


FIG. 2

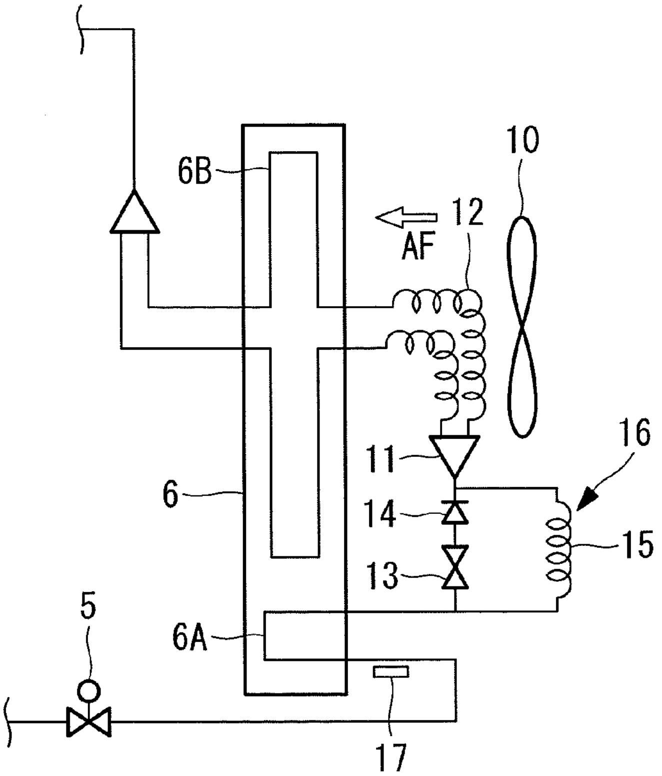


FIG. 3

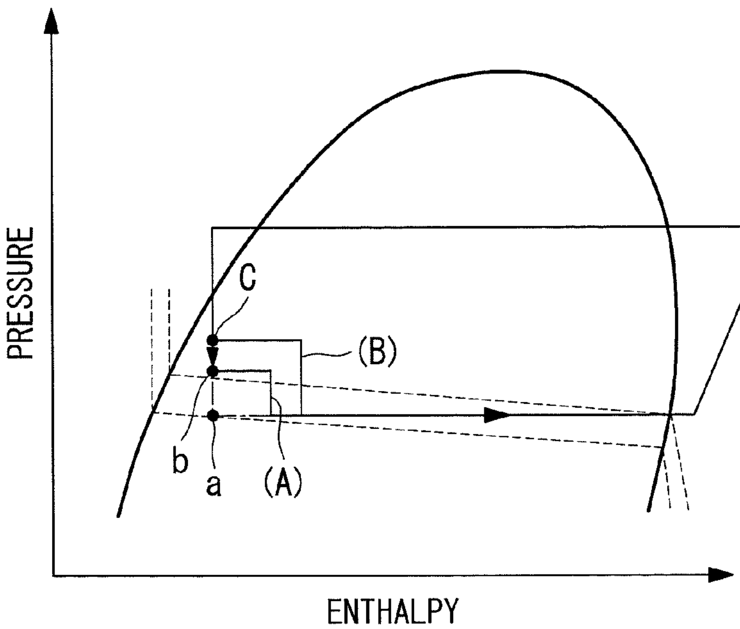


FIG. 4

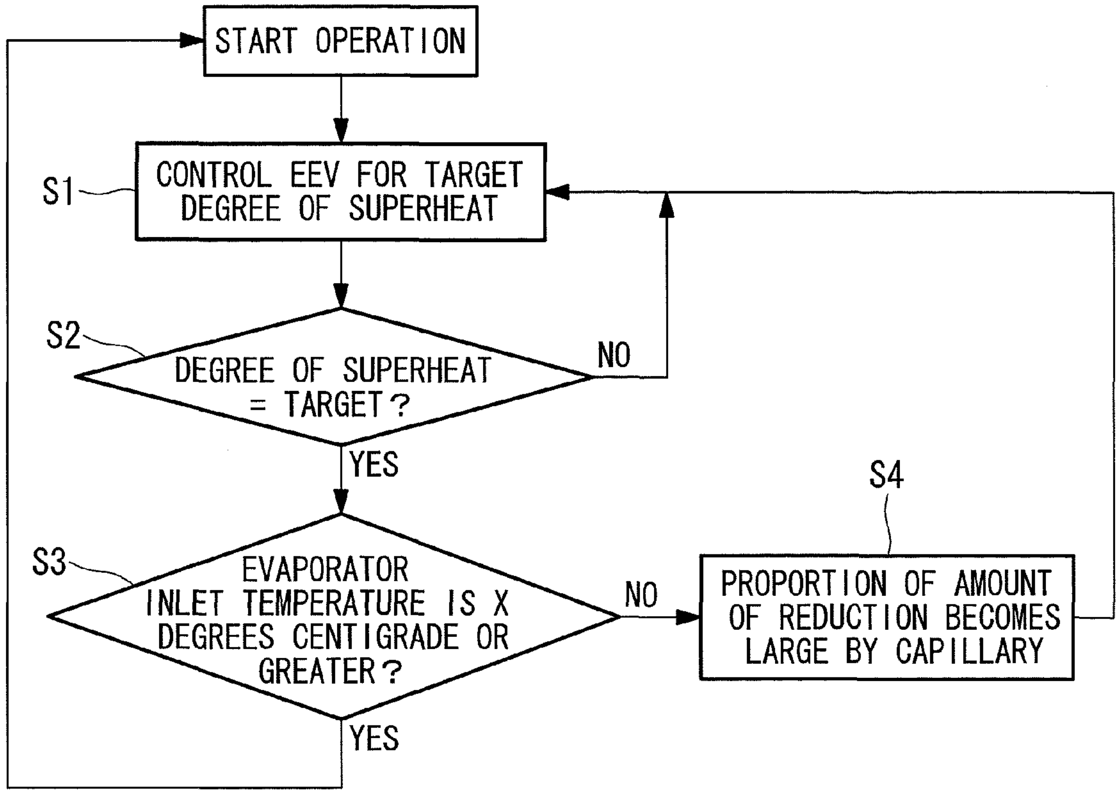

START OPERATION
S1
CONTROL EEV FOR TARGET DEGREE OF SUPERHEAT
S2
DEGREE OF SUPERHEAT = TARGET?
NO
YES
S3
EVAPORATOR INLET TEMPERATURE IS X DEGREES CENTIGRADE OR GREATER?
NO
YES
S4
PROPORTION OF AMOUNT OF REDUCTION BECOMES LARGE BY CAPILLARY

FIG. 5

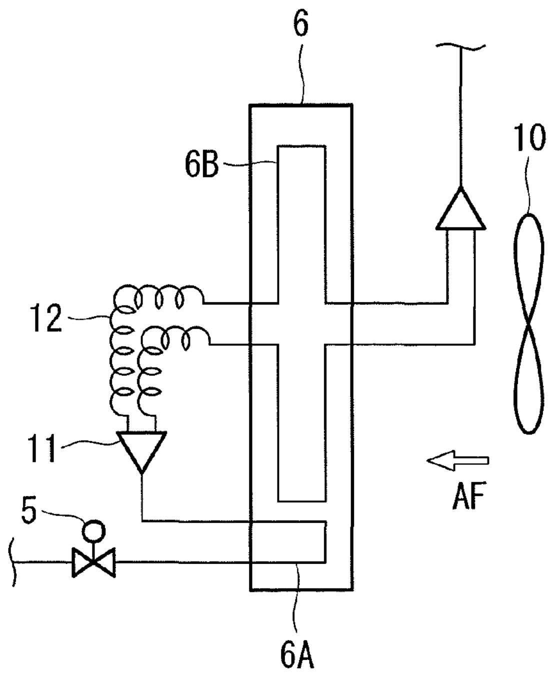

6
6B
10
12
11
5
AF
6A

FIG. 6

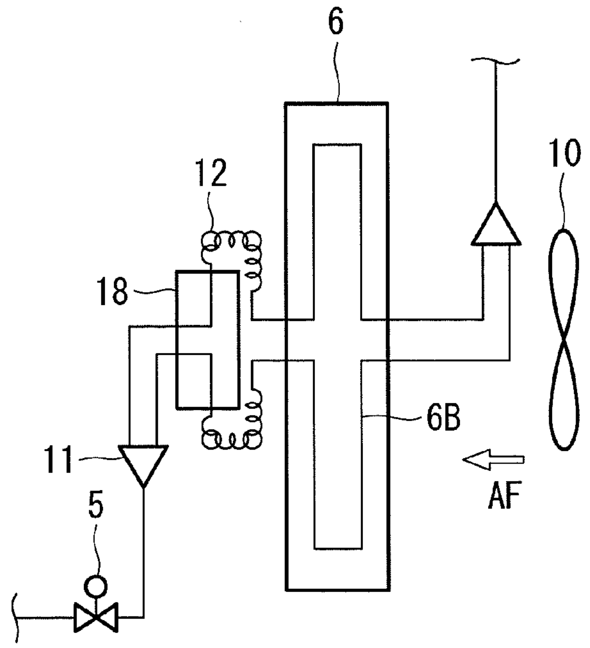
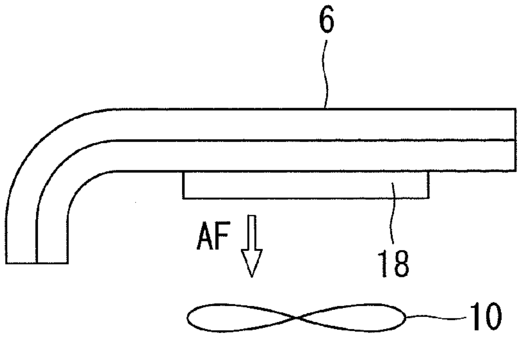


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP HEI08334274 B **[0004]**
- JP 2008256311 A **[0004]**