



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

(43) Date of publication:
08.02.2017 Bulletin 2017/06

(51) Int Cl.:
F25B 1/00 (2006.01) F25B 7/00 (2006.01)

(21) Application number: **14886496.0**

(86) International application number:
PCT/JP2014/057030

(22) Date of filing: **17.03.2014**

(87) International publication number:
WO 2015/140872 (24.09.2015 Gazette 2015/38)

(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

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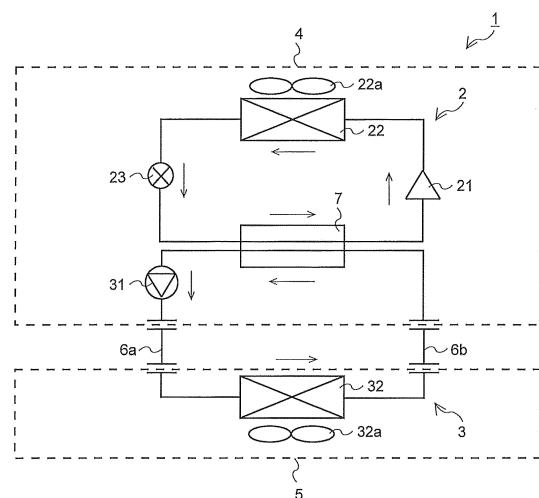
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(54) **REFRIGERATION DEVICE**

(57) A refrigerating apparatus a heat-source side heat medium circuit configured to circulate a heat-source side heat medium therethrough, the heat-source side heat medium circuit being formed by connecting, by piping, a compressor, a heat-source side heat exchanger, an expansion unit, and a cascade heat exchanger configured to exchange heat between the heat medium for heat source and a load-side heat medium; and a load side heat-medium circuit configured to circulate a load-side heat medium therethrough, the load side heat-medium circuit being formed by connecting a pump for conveying the load-side heat medium, a load-side heat exchanger, and the cascade heat exchanger, wherein at least either one of the heat medium for heat source and the heat medium for load is inclusive of HF01123

FIG. 1



Description

Technical Field

[0001] The present invention relates to a refrigerating apparatus in which a plurality of heat medium circuits are configured in multi stages.

Background Art

[0002] Conventionally, a refrigerating apparatus in which a heat-source side heat medium circuit and a load side heat-medium circuit are configured in multi stages has been proposed. Such a refrigerating apparatus with multi-stage configuration uses a refrigerant or water, for example, as a heat medium in the heat-source side heat medium circuit or a load side heat-medium circuit. Patent Literature 1 discloses a refrigeration cycle apparatus in which a heat medium flowing through a high-temperature side circulation circuit, which is a heat medium circuit for a heat-source (heat- source heat medium circuit), is HFO1234yf and a heat medium flowing through a low-temperature side circulation circuit which is a heat-medium circuit for a load (load side heat-medium circuit), is carbon dioxide.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2013-36706 (page 4)

Summary of Invention

Technical Problem

[0004] The refrigeration cycle apparatus disclosed in Patent Literature 1 uses HFO1234yf as a heat medium flowing through the high-temperature side circulation circuit. Since the HFO1234yf is a high boiling-temperature refrigerant with a high boiling point, it is not gasified easily, and gas density at an operating pressure is small. Thus, there is a concern that a pressure loss in a pipe in the high-temperature side circulation circuit increases and power for conveying the refrigerant (power consumption of a compressor) increases. Moreover, the refrigeration cycle apparatus disclosed in Patent Literature 1 uses carbon dioxide as a heat medium flowing through a low-temperature side circulation circuit. The carbon dioxide refrigerant has an operating pressure higher than that of a CFC refrigerant. As a result, a pressure inside the low-temperature side circulation circuit becomes high, which leads to necessity of improvement of pipe strength and to a concern of a cost increase.

[0005] The present invention was made in view of the aforementioned problem and provides a refrigerating apparatus which suppresses power consumption and a

cost. Solution to Problem

[0006] A refrigerating apparatus according to the present invention includes a heat-source side heat medium circuit configured to circulate therethrough a heat-source side heat medium, the heat-source side heat medium circuit being formed by connecting, by piping, a compressor, a heat-source side heat exchanger, an expansion unit, and a cascade heat exchanger configured to exchange heat between the heat-source side heat medium and a load-side heat medium; and a load side heat-medium circuit configured to circulate therethrough a load-side heat medium, the load side heat-medium circuit being formed by connecting, by piping, a pump for conveying the load-side heat medium, a load-side heat exchanger, and the cascade heat exchanger, wherein at least either one of the heat-source side heat medium and the load-side heat medium is inclusive of HF01123.

Advantageous Effects of Invention

[0007] According to the present invention, since at least either one of the heat medium for heat source and the heat medium for load is a refrigerant inclusive of HF01123, an amount of energy consumption can be reduced, and cost reduction can be achieved.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a heat medium circuit diagram showing a refrigerating apparatus 1 according to a first embodiment.

[Fig. 2] Fig. 2 is a graph showing an action of the refrigerating apparatus 1 according to the first embodiment.

[Fig. 3] Fig. 3 is a graph showing an action of a refrigerating apparatus according to Comparative Example 1.

[Fig. 4] Fig. 4 is a graph showing an action of a refrigerating apparatus 100 according to a modification of the first embodiment.

[Fig. 5] Fig. 5 is a graph showing an action of a refrigerating apparatus according to Comparative Example 2.

Description of Embodiments

[0009] An embodiment of a refrigerating apparatus according to the present invention will be described below by referring to the accompanying drawings. The present invention is not limited by the embodiment described below. In the following drawings including Fig. 1, relations in size among constituent members are different from actual ones in some cases.

First Embodiment

[0010] Fig. 1 is a heat medium circuit diagram showing a refrigerating apparatus 1 according to a first embodiment. The refrigerating apparatus 1 will be described on the basis of the Fig. 1. As illustrated in Fig. 1, the refrigerating apparatus 1 includes a heat-source side heat medium circuit 2 on a heat source side and a load side heat-medium circuit 3 on a load side, and they are connected by a cascade heat exchanger 7 and constitute the refrigerating apparatus 1 in two-stage configuration. The refrigerating apparatus 1 is not limited to the two-stage configuration but may have multi-stage configuration.

[0011] The heat-source side heat medium circuit 2 is configured to circulate a heat medium for a heat source (heat-source side heat medium) therethrough and is formed by connecting a compressor 21, a heat exchanger 22 for heat source (heat-source side heat exchanger 22), an expansion unit 23, and the cascade heat exchanger 7. The heat-source side heat medium is a refrigerant inclusive of HF01123. The compressor 21 is configured to compress the heat-source side heat medium, and the heat-source side heat exchanger 22 is configured to exchange heat between the heat-source side heat medium and outside air, for example. Here, a fan 22a for the heat source (heat-source side fan 22a) is provided in the heat-source side heat medium circuit 2, and the heat-source side fan 22a is configured to convey the outside air to the heat-source side heat exchanger 22. The expansion unit 23 is configured to expand the heat-source side heat medium. The heat-source side heat medium may have a single-component refrigerant of only HF01123 or may have a refrigerant mixture inclusive of HF01123.

[0012] The load side heat-medium circuit 3 is configured to circulate a heat medium for a load (load-side heat medium) flowing therethrough and is formed by connecting, by piping, a pump 31, a heat exchanger 32 for load (load-side heat exchanger 32), and the cascade heat exchanger 7 connected by a pipe. The load-side heat medium is a refrigerant inclusive of HF01123 similarly to the heat-source side heat medium. The pump 31 is to convey the load-side heat medium, and the load-side heat exchanger 32 is configured to exchange heat between the load-side heat medium and room air, for example. Here, a fan 32a for load (load-side fan 32a) is provided in the load side heat-medium circuit 3, and the load-side fan 32a is configured to convey the room air to the load-side heat exchanger 32. The load-side heat medium may have a single-component refrigerant of only HF01123 or may have a refrigerant mixture inclusive of HF01123. Alternatively, the load-side heat medium may be water or antifreeze fluid other than the above.

[0013] The heat-source side heat medium circuit 2 and the pump 31 in the load side heat-medium circuit 3 are installed in an outdoor space 4, while the load-side heat exchanger 32 in the load side heat-medium circuit 3 is installed in an indoor space 5. The pump 31 and the load-

side heat exchanger 32 are connected by a first extension pipe 6a. The cascade heat exchanger 7 connecting the heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 and the load-side heat exchanger 32 are connected by a second extension pipe 6b.

[0014] The cascade heat exchanger 7 is configured to connect the heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 as described above and is constituted by a plate heat exchanger or a double-pipe heat exchanger, for example. This cascade heat exchanger 7 is configured to exchange heat between the heat-source side heat medium flowing through the heat-source side heat medium circuit 2 and the load-side heat medium flowing through the load side heat-medium circuit 3. As described above, in the refrigerating apparatus 1 having double-stage configuration by the cascade heat exchanger 7, heat is exchanged between the heat-source side heat medium and the load-side heat medium, and thus, the originally independent heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 can be controlled in cooperation.

[0015] Subsequently, an operation of the refrigerating apparatus 1 according to the first embodiment will be described. In the first embodiment, an operation in a cooling operation will be described as an example.

[0016] First, an operation in the heat-source side heat medium circuit 2 will be described. The compressor 21 suctions the heat-source side heat medium, compresses the heat-source side heat medium and discharges it in a high-temperature and high-pressure gas state. The discharged heat-source side heat medium flows into the heat-source side heat exchanger 22, and the heat-source side heat exchanger 22 condenses the heat-source side heat medium by heat exchange with the outside air supplied from the heat-source side fan 22a. This condensed heat-source side heat medium flows into the expansion unit 23, and the expansion unit 23 reduces the pressure of the condensed heat-source side heat medium. Then, the pressure-reduced heat-source side heat medium flows into the cascade heat exchanger 7, and the cascade heat exchanger 7 evaporates the heat-source side heat medium by heat exchange with the load-side heat medium in the load side heat-medium circuit 3. Then, the evaporated heat-source side heat medium is suctioned by the compressor 21.

[0017] Subsequently, an operation in the load side heat-medium circuit 3 will be described. The pump 31 conveys the load-side heat medium, and the conveyed load-side heat medium flows into the load-side heat exchanger 32. The load-side heat exchanger 32 evaporates the load-side heat medium by heat exchange with the room air supplied from the load-side fan 32a. This evaporated load-side heat medium flows into the cascade heat exchanger 7, and the cascade heat exchanger 7 condenses the load-side heat medium by heat exchange with the heat-source side heat medium in the heat-source side heat medium circuit 2. Then, the condensed and liquefied load-side heat medium flows into the pump 31.

[0018] As described above, in the first embodiment, flowing directions of the heat-source side heat medium and the load-side heat medium in the cascade heat exchanger 7 are counter flows.

[0019] Subsequently, the working of the refrigerating apparatus 1 according to the first embodiment will be described. In the first embodiment, as described above, the refrigerant inclusive of HF01123 is used as the heat-source side heat medium and the load-side heat medium. HF01123 has its gas density higher than the gas density of HFO1234yf by approximately 25%. Thus, in the heat medium circuit with the same circulation amounts of the heat mediums, a flow velocity of flowing becomes slower by using HF01123 as the heat medium rather than by using HFO1234yf, whereby the pressure loss of the pipe in the heat medium circuit can be reduced.

[0020] As described above, since the refrigerant inclusive of HF01123 is used as the heat-source side heat medium and the load-side heat medium in the first embodiment, the pressure loss of the pipe in the heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 can be reduced. Therefore, power for conveying the compressor 21 and the pump 31 can be suppressed, so that the amount of energy consumption can be suppressed.

[0021] A standard boiling point of HF01123 is -51 degrees C and that of carbon dioxide is -78 degrees C. Thus, the heat medium circuit having the same evaporating temperatures of the heat mediums can be operated at a lower pressure by using HF01123 as the heat medium rather than carbon dioxide. Thus, pressure resistance of the pipe in the heat medium circuit does not have to be excessively improved.

[0022] As described above, since the refrigerant inclusive of HF01123 is used as the heat-source side heat medium and the load-side heat medium in the first embodiment, the pressure resistance of element devices such as the pipe in the heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 can be suppressed. Therefore, a cost for manufacturing the refrigerating apparatus 1 can be reduced.

[0023] In the first embodiment, both of the heat-source side heat medium and the load-side heat medium are refrigerants containing HF01123 but it is only necessary that at least either one of the heat-source side heat medium and the load-side heat medium is a refrigerant inclusive of HF01123. In this case, the effect of reducing the amount of energy consumption and cost reduction is exerted in either one of the heat-source side heat medium circuit 2 and the load side heat-medium circuit 3 using the refrigerant inclusive of HF01123.

[0024] Moreover, in the first embodiment, since phase-change heat transfer with favorable heat transfer rate is used in the load-side heat exchanger 32 and the cascade heat exchanger 7 in the load side heat-medium circuit 3, heat exchange performances are improved. Thus, size reduction of the load-side heat exchanger 32 and the cascade heat exchanger 7 can be achieved.

[0025] Furthermore, in the first embodiment, the flow directions in the cascade heat exchanger 7 of the heat-source side heat medium and the load-side heat medium are counter flows. Fig. 2 is a graph showing the action of the refrigerating apparatus 1 according to the first embodiment, and Fig. 3 is a graph showing an action of a refrigerating apparatus according to Comparative Example 1. The working of the refrigerating apparatus 1 (Fig. 2) in which flow directions are counter flows according to the first embodiment will be described in comparison with Comparative Example 1 (Fig. 3) in which flow directions in the cascade heat exchanger 7 are parallel flows. The heat-source side heat medium and the load-side heat medium are both single-component refrigerants only of HF01123.

[0026] In Figs. 2 and 3, a lateral axis indicates the flow direction in which the heat medium flows, and a vertical axis indicates a temperature of the heat medium. If the flow directions in the cascade heat exchanger 7 are counter flows, as illustrated in Fig. 2, a temperature difference ΔT_f between a temperature of the heat-source side heat medium and a temperature of the load-side heat medium is uniform in the flow direction. Therefore, the heat exchange performances in the cascade heat exchanger 7 are high. On the other hand, in the case of Comparative Example 1 in which the flow directions in the cascade heat exchanger 7 are parallel flows, as illustrated in Fig. 3, a temperature difference ΔT_p between a temperature of the heat-source side heat medium and a temperature of the load-side heat medium is non-uniform in the flow direction. Thus, the heat exchange performances in the cascade heat exchanger 7 are low.

[0027] As described above, in the first embodiment, since the flow directions of the heat-source side heat medium and the load-side heat medium in the cascade heat exchanger 7 are counter flows, the heat exchange performances in the cascade heat exchanger 7 are high. Thus, size reduction of the cascade heat exchanger 7 can be achieved.

(Modification)

[0028] Subsequently, a modification of the first embodiment will be described. The modification is different from the first embodiment in a point that the heat-source side heat medium and the load-side heat medium are both refrigerant mixtures containing HF01123 while the others are common with the first embodiment. That is, in the modification, too, the flow directions of the heat-source side heat medium and the load-side heat medium in the cascade heat exchanger 7 are counter flows. Fig. 4 is a graph showing the working of the refrigerating apparatus 100 according to the modification of the first embodiment, and Fig. 5 is a graph showing working of a refrigerating apparatus according to Comparative Example 2. The action of the refrigerating apparatus 100 (Fig. 4) in which the flow directions in the cascade heat exchanger 7 according to the modification are counter flows will be de-

scribed in comparison with Comparative Example 2 (Fig. 5) in which the flow directions in the cascade heat exchanger 7 are parallel flows.

[0029] In the modification, as described above, both the heat-source side heat medium and the load-side heat medium are refrigerant mixtures containing HF01123. The refrigerant added to the HF01123 is an R32 refrigerant, for example. The refrigerant mixture of HF01123 and the R32 refrigerant is a zeotropic refrigerant mixture since their respective boiling points are different. The zeotropic refrigerant mixture has a temperature glide with respect to the flow direction of a heat medium in the heat-source side heat medium circuit 102 and a load side heat-medium circuit 103. Thus, a temperature difference between a temperature of the heat-source side heat medium and a temperature of the load-side heat medium can become non-uniform more easily in the flow direction than the single-component refrigerant.

[0030] In Figs. 4 and 5, a lateral axis indicates the flow direction in which the heat medium flows, and a vertical axis indicates a temperature of the heat medium. If the flow directions in the cascade heat exchanger 7 are counter flows, as illustrated in Fig. 4, the temperature difference ΔT_f between the temperature of the heat-source side heat medium and the temperature of the load-side heat medium is uniform in the flow direction. Therefore, the heat exchange performances in the cascade heat exchanger 7 are high. On the other hand, in the case of Comparative Example 2 in which the flow directions in the cascade heat exchanger 7 are parallel flows, as illustrated in Fig. 5, the temperature difference ΔT_p between a temperature of the heat-source side heat medium and a temperature of the load-side heat medium is non-uniform in the flow direction. Thus, the heat exchange performances in the cascade heat exchanger 7 are low.

[0031] As described above, in the modification, since the flow directions of the heat-source side heat medium and the load-side heat medium in the cascade heat exchanger 7 are counter flows, even if the both heat-source side heat medium and the load-side heat medium are refrigerant mixtures containing HF01123, the heat exchange performances in the cascade heat exchanger 7 are high. Thus, in this modification, too, size reduction of the cascade heat exchanger 7 can be achieved. Reference Signs List

[0032] 1 refrigerating apparatus, 2 heat-source side heat medium circuit, 3 load side heat-medium circuit, 4 outdoor space, 5 indoor space, 6a first extension pipe, 6b second extension pipe, 7 cascade heat exchanger, 21 compressor, 22 heat exchanger for heat source, 22a fan for heat source, 23 expansion unit, 31 pump, 32 heat exchanger for load, 32a fan for load, 100 refrigerating apparatus, 102 heat-source side heat medium circuit, 103 load side heat-medium circuit

Claims

1. A refrigerating apparatus comprising:

- 5 a heat-source side heat medium circuit configured to circulate therethrough a heat-source side heat medium, the heat-source side heat medium circuit being formed by connecting, by piping, a compressor, a heat-source side heat exchanger, an expansion unit, and a cascade heat exchanger configured to exchange heat between the heat-source side heat medium and a load-side heat medium; and
10 a load side heat-medium circuit configured to circulate therethrough a load-side heat medium, the load side heat-medium circuit being formed by connecting, by piping, a pump for conveying the load-side heat medium, a load-side heat exchanger, and the cascade heat exchanger, wherein
15 at least either one of the heat-source side heat medium and the load-side heat medium is inclusive of HF01123.
- 20 2. The refrigerating apparatus of claim 1, being configured to flow the heat-source side heat medium and the load-side heat medium in direction as counter flows in the cascade heat exchanger.
- 25 3. The refrigerating apparatus of claim 1 or 2, wherein the heat-source side heat medium is a refrigerant inclusive of HF01123; and the load-side heat medium is water.
- 30 4. The refrigerating apparatus of claim 1 or 2, wherein the heat-source side heat medium is a refrigerant inclusive of HF01123; and the load-side heat medium is antifreeze fluid.
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FIG. 1

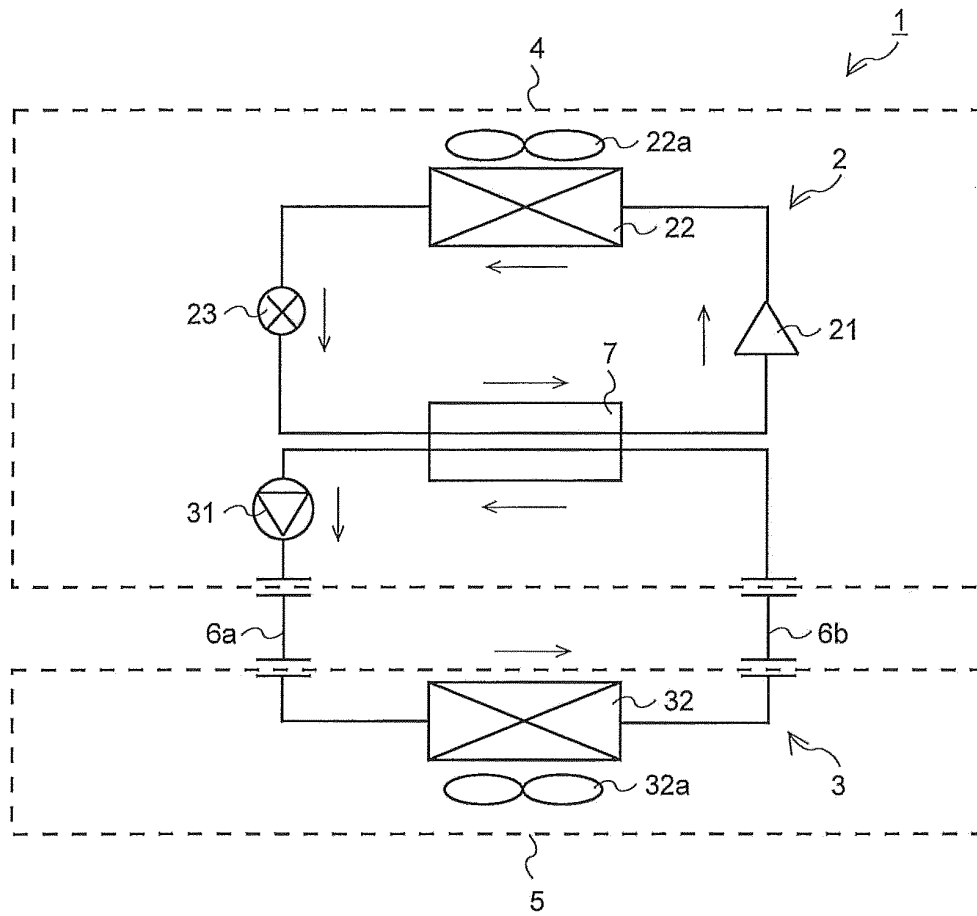


FIG. 2

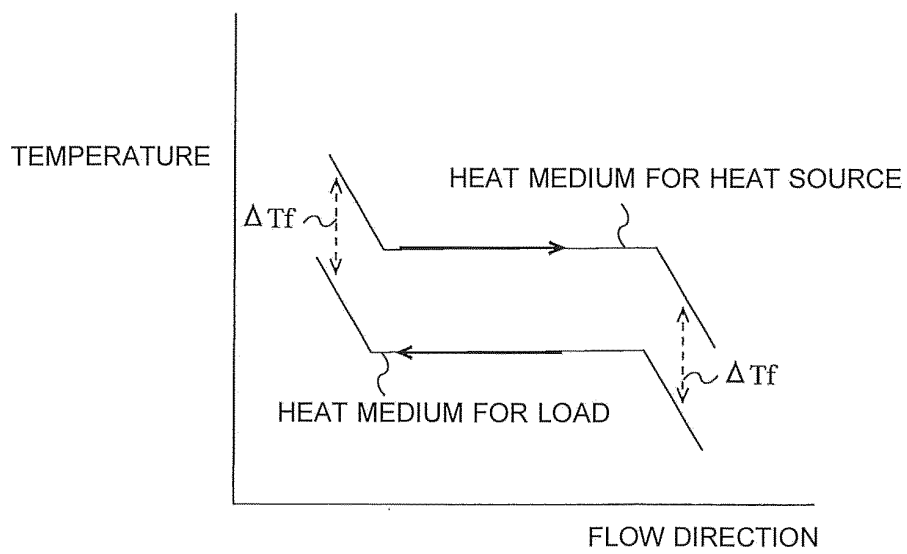


FIG. 3

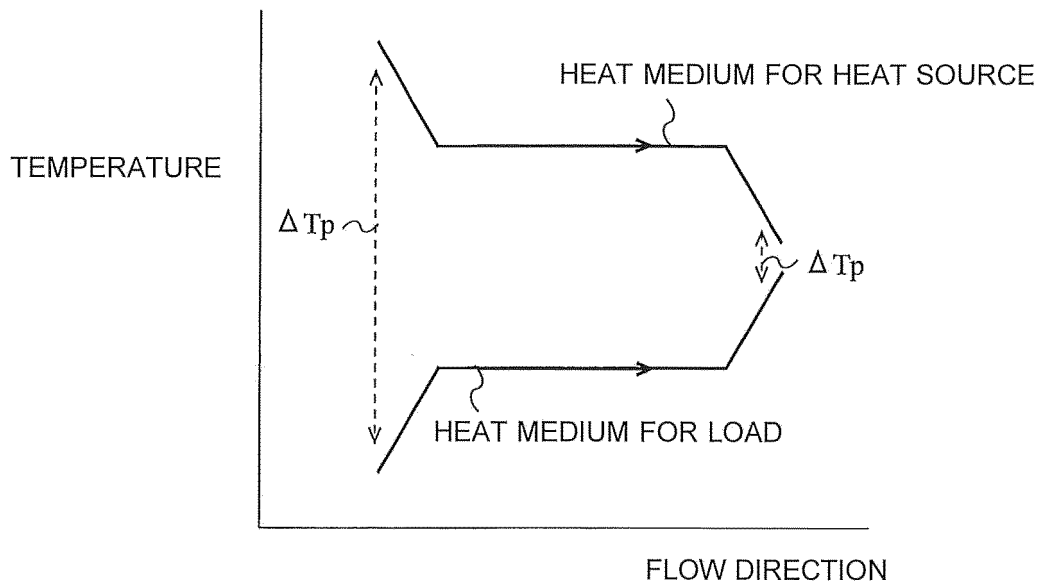


FIG. 4

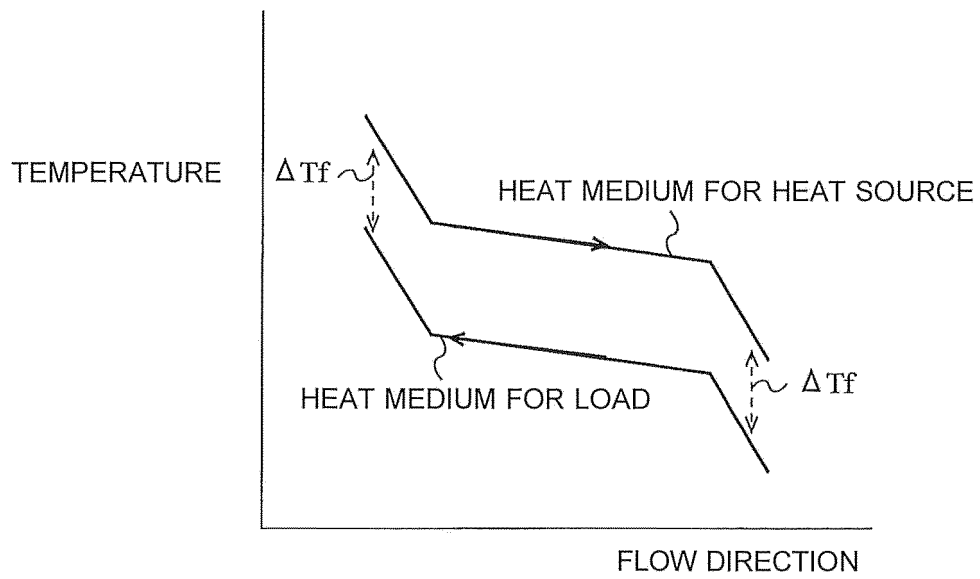
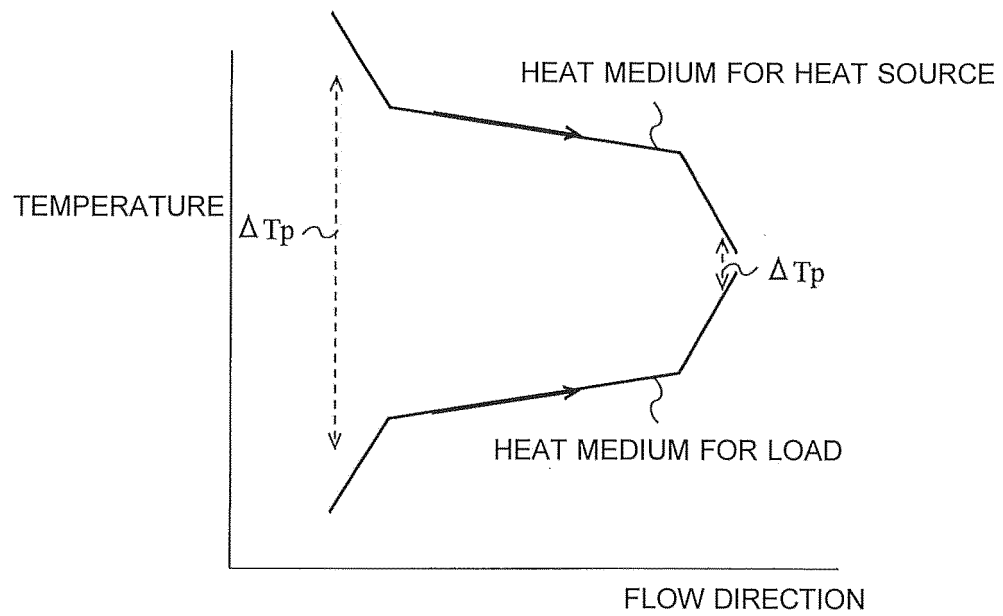


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/057030

A. CLASSIFICATION OF SUBJECT MATTER

F25B1/00(2006.01)i, F25B7/00(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)

F25B1/00, F25B7/00

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2010/131378 A1 (Mitsubishi Electric Corp.), 18 November 2010 (18.11.2010), paragraphs [0013] to [0015]; fig. 1 & US 2012/0042674 A1 & EP 2431675 A1 & CN 102422093 A	1-4
Y	WO 2012/157764 A1 (Asahi Glass Co., Ltd.), 22 November 2012 (22.11.2012), paragraphs [0010], [0086] (Family: none)	1-4

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

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Date of the actual completion of the international search

13 May, 2014 (13.05.14)

Date of mailing of the international search report

20 May, 2014 (20.05.14)

Name and mailing address of the ISA/
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Patent documents cited in the description

- JP 2013036706 A [0003]