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(54) **AIR CONDITIONER**

(57) In a supercooling heat exchanger of an air conditioning apparatus for exchanging heat between a high-pressure refrigerant and a low-pressure refrigerant, the refrigerants flow in opposite directions during cooling and heating. Therefore, the high-pressure refrigerant and low-pressure refrigerant flow parallel to each other in either of the operating modes, and heat exchange is less efficient. This problem is resolved by this invention.

In an air conditioning apparatus having a supercooling heat exchanger (13) for exchanging heat between a low-pressure refrigerant and a high-pressure refrigerant, the supercooling heat exchanger (13) is divided into two first and second heat exchangers (13A), (13B); either the first heat exchanger (13A) or the second heat exchanger (13B) is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow countercurrent to each other; and the other heat exchanger, i.e., either the second heat exchanger (13B) or the first heat exchanger (13A), is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow parallel to each other. The heat exchangers (13A, 13B) both have a configuration in which, e.g., a high-pressure liquid refrigerant pipe (15) is wound around the external periphery of a suction pipe (14) for suctioning a low-pressure refrigerant. The heat exchangers are thereby reduced in size.

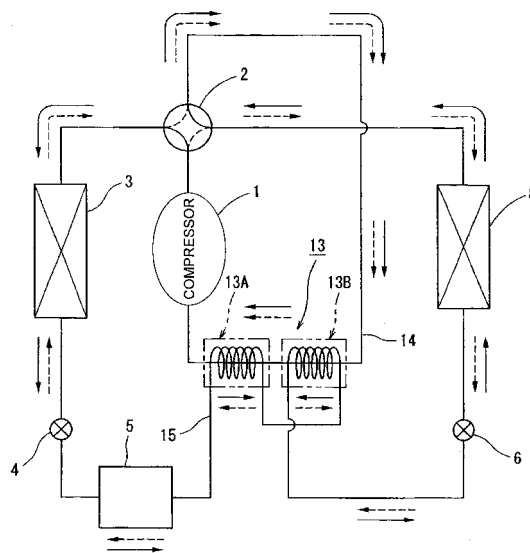


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioning apparatus that uses a supercooling heat exchanger.

BACKGROUND ART

[0002] FIG. 4 shows a configuration of an air conditioning apparatus that uses a conventional supercooling heat exchanger.

[0003] In this air conditioning apparatus, a compressor 1, a four-way switching valve 2, an outdoor-side heat exchanger 3 that functions as a condenser during the cooling operation and as an evaporator during the heating operation, a heating expansion valve 4, a receiver 5, a cooling expansion valve 6, an indoor-side heat exchanger 8 that functions as an evaporator during the cooling operation and as a condenser during the heating operation, and other components are connected sequentially via the four-way switching valve 2, thereby constituting a refrigerating cycle for air conditioning as is shown in the drawing.

[0004] The switching operation of the four-way switching valve 2 allows a refrigerant to be reversibly circulated in the direction shown by solid arrows in the drawing during the cooling operation, and in the direction shown by dashed arrows in the drawing during the heating operation, thereby resulting in cooling and heating, respectively.

[0005] The outdoor-side heat exchanger 3 and the indoor-side heat exchanger 8 are both configured to include numerous refrigerant paths. Therefore, even if the capacity of the flow divider portion to distribute the refrigerant is improved to a maximum, it is difficult to distribute the refrigerant evenly throughout the refrigerant paths.

[0006] In view of this, when the outdoor-side heat exchanger 3 or the indoor-side heat exchanger 8 functions as the evaporator, the amount of pressure reduction in the heating expansion valve 4 or cooling expansion valve 6 is appropriately set so that the refrigerant of the exit side of the outdoor-side heat exchanger 3 or the indoor-side heat exchanger 8 is in appropriately humidified condition. Thus, maximum performance as the evaporator can be guaranteed even if, for example, the refrigerant drifts into the outdoor-side heat exchanger 3 or the indoor-side heat exchanger 8, and therefore the evaporator can be made as compact as possible.

[0007] The performance of the evaporator can be further improved by removing the refrigerant supercooling of the exit side of the condenser, increasing the difference in enthalpy of the evaporator side to reduce circulating volume, and reducing the pressure loss on the evaporator side. This is accomplished by providing a liquid-gas heat exchanger 13 having a double pipe structure, composed of a low-pressure refrigerant suction pipe 14 as

an inner pipe and a high-pressure liquid refrigerant pipe 15 as an outer pipe, as a supercooling heat exchanger.

[0008] In this liquid-gas heat exchanger 13, e.g., the flow rate of the refrigerant, the length of the double pipes, the inside diameter of the outer pipe, and the outside diameter of the inner pipe are set in a predetermined manner appropriately.

[0009] As the liquid-gas heat exchanger 13 is provided in this manner, the refrigerant of the exit side of the evaporator is superheated, backflow into the compressor 1 can be prevented, the refrigerant of the exit side of the condenser is supercooled, and the difference in enthalpy of the evaporator side can be increased to reduce circulating volume. Therefore, the pressure loss can also be reduced, and the evaporator 8 (or the evaporator 3) can be made even more compact (see Patent Document 1 as an example).

[Patent Document 1]

[0010] Japanese Laid-open Patent Publication No. 5-332641 (Specification pg. 1-5, FIGS. 1-5)

DISCLOSURE OF THE INVENTION

<Problems the Invention Is Intended to Solve>

[0011] However, a supercooling heat exchanger in which heat is exchanged between a high-pressure refrigerant and a low-pressure refrigerant as described above has problems in that since the refrigerant flows in opposite directions during cooling and heating, the flows are parallel in either of the operating modes, and heat exchange is less efficient. For example, in the case shown in FIG. 4, the flows are countercurrent to each other during cooling and are parallel to each other during heating, causing heat exchange to be less efficient.

[0012] The present invention was designed in order to resolve such problems, and an object thereof is to provide an air conditioning apparatus comprising a supercooling heat exchanger for exchanging heat between a low-pressure refrigerant and a high-pressure refrigerant, wherein the supercooling heat exchanger is divided into a first heat exchanger and a second heat exchanger, either one of these heat exchangers is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow countercurrent to each other, and the other heat exchanger is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow parallel to each other, whereby the above-described problems with conventional practice are appropriately resolved.

<Means for Solving These Problems>

[0013] To achieve these objects, the present invention is configured with the following means of solving these problems.

(1) Invention of a First Aspect

[0014] The means for solving the problems in accordance with this aspect is an air conditioning apparatus comprising a supercooling heat exchanger 13 for exchanging heat between a low-pressure refrigerant and a high-pressure refrigerant, characterized in that: the supercooling heat exchanger 13 is divided into two first and second heat exchangers 13A, 13B; either the first heat exchanger 13A or the second heat exchanger 13B is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow countercurrent to each other; and the other heat exchanger, i.e., either the second heat exchanger 13B or the first heat exchanger 13A, is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow parallel to each other.

[0015] The supercooling heat exchanger 13 for exchanging heat between a high-pressure refrigerant and a low-pressure refrigerant as previously described has problems in that since the refrigerants flow in opposite directions during cooling and heating, the flows are parallel in either of the operating modes, and heat exchange is less efficient.

[0016] However, as described above, the supercooling heat exchanger 13 is divided into two heat exchangers, i.e., the first heat exchanger 13A and the second heat exchanger 13B, either the first heat exchanger 13A or the second heat exchanger 13B is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow countercurrent to each other, and the other heat exchanger, i.e., either the second heat exchanger 13B or the first heat exchanger 13A is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow parallel to each other, whereby the supercooling heat exchanger 13 can maintain its heat exchange performance without variation even if the direction of refrigerant flow changes during cooling or heating.

(2) Invention of a Second Aspect

[0017] The means for solving the problems in accordance with this aspect is characterized in that, in the configuration of the means for solving the problems in accordance with the invention of the first aspect, the first and second heat exchangers 13A, 13B are both configured by winding a high-pressure liquid refrigerant pipe 15 around the external periphery of a low-pressure refrigerant suction pipe 14.

[0018] Thus, when the first and second heat exchangers 13A, 13B are both configured by winding the high-pressure liquid refrigerant pipe 15 around the low-pressure refrigerant suction pipe 14, the capacity of the heat exchanger itself does not need to be increased, and the supercooling heat exchangers 13A, 13B can be made as small as possible.

(3) Invention of a Third Aspect

[0019] The means for solving the problems in accordance with this aspect is characterized in that, in the configuration of the means for solving the problems in accordance with the invention of the first aspect, the first and second heat exchangers 13A, 13B are both configured by fitting a high-pressure liquid refrigerant pipe 15 around the external periphery of a low-pressure refrigerant suction pipe 14 in a coaxial structure, wherein the high-pressure liquid refrigerant pipe 15 is larger in diameter than the low-pressure refrigerant suction pipe 14.

[0020] Thus, when the first and second supercooling heat exchangers 13A, 13B both have a double-pipe structure in which the high-pressure liquid refrigerant pipe 15 is fitted coaxially over the low-pressure refrigerant suction pipe 14, the structures of the supercooling heat exchangers 13A, 13B themselves are simplified.

<Effect of the Invention>

[0021] According to the present invention, as a result of the above, the supercooling heat exchanger can maintain high heat exchange performance even when the flows of the refrigerants change direction during cooling and heating. As a result, the evaporator can be made more compact.

[0022] In this case, when the each heat exchanger is configured by winding a high-pressure liquid refrigerant pipe around a low-pressure refrigerant suction pipe, the supercooling heat exchanger itself can be made as small as possible.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIG. 1 is a refrigeration circuit diagram showing the configuration of an air conditioning apparatus according to Preferred Embodiment of the present invention;

FIG. 2 is an enlarged view showing the portion of the first and second liquid-gas heat exchangers as relevant parts of the same apparatus;

FIG. 3 is an enlarged view showing a portion of the first and second liquid-gas heat exchangers according to another embodiment of the present invention; and

FIG. 4 is a refrigerant circuit diagram showing the configuration of a conventional example of air conditioning apparatus.

DESCRIPTION OF THE REFERENCE SYMBOLS

[0024]

- 1 Compressor
- 2 Four-way switching valve

- 3 Outdoor-side heat exchanger
- 4, 6 Expansion valves
- 5 Receiver
- 8 Indoor-side heat exchanger
- 13A First heat exchanger
- 13B Second heat exchanger
- 14 Low-pressure refrigerant suction pipe
- 15 High-pressure liquid refrigerant pipe
- 16 Muffler

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] FIGS. 1 and 2 of the attached drawings show the configuration of the entirety and relevant parts of the refrigerant circuits in an air conditioning apparatus according to a preferred embodiment of the present invention.

[0026] First, as shown in FIG. 1, in the air conditioning apparatus of this embodiment, a compressor 1, a four-way switching valve 2, an outdoor-side heat exchanger 3 that functions as a condenser during the cooling operation and as an evaporator during the heating operation, a heating expansion valve 4, a receiver 5, a cooling expansion valve 6, an indoor-side heat exchanger 8 that functions as an evaporator during the cooling operation and as a condenser during the heating operation, and other components are connected sequentially via the four-way switching valve 2, thereby constituting a refrigerating cycle for air conditioning as shown in the drawing.

[0027] The switching operation of the four-way switching valve 2 allows refrigerant to be reversibly circulated in the direction shown by solid arrows in the diagram during the cooling operation, and in the direction shown by dashed arrows in the diagram during the heating operation, thereby resulting in cooling and heating, respectively.

[0028] A liquid-gas heat exchanger 13 is provided in this embodiment as well as the case in FIG. 4 described previously. This liquid-gas heat exchanger 13 comprises a low-pressure refrigerant suction pipe 14 and a high-pressure liquid refrigerant pipe 15, and is used as a supercooling heat exchanger for exchanging heat between low-pressure refrigerant and high-pressure refrigerant.

[0029] As the liquid-gas heat exchanger 13 is provided in this manner, refrigerant of the exit side of the evaporator is superheated, backflow into the compressor 1 can be prevented, the refrigerant of the exit side of the condenser is supercooled, and the difference in enthalpy of the evaporator side can be increased to reduce refrigerant circulating volume, as was described previously. Therefore, pressure loss can also be reduced, and the evaporator (the indoor-side heat exchanger 8 during cooling or the outdoor-side heat exchanger 3 during heating) can be made as compact as possible.

[0030] However, in this embodiment, unlike in the case in FIG. 4 described previously, the liquid-gas heat exchanger 13 is divided into two liquid-gas heat exchangers, i.e., a first liquid-gas heat exchanger 13A and a sec-

ond liquid-gas heat exchanger 13B in which refrigerants flow in mutually opposite directions. The first heat exchanger 13A may, for example, be disposed so that the high-pressure refrigerant and low-pressure refrigerant flow countercurrent to each other, and the second heat exchanger 13B may be disposed so that the high-pressure refrigerant and low-pressure refrigerant flow parallel to each other.

[0031] Therefore, with this configuration, the liquid-gas heat exchanger 13 can maintain its performance without variation as shown in the diagrams, even when the refrigerant flow changes direction during cooling and heating. As a result, the refrigerant of the exit side of the condenser is supercooled without variation during heating, and the difference in enthalpy of the evaporator side can be increased to reduce the circulating volume.

[0032] Moreover, the first and second liquid-gas heat exchangers 13A, 13B are both configured so that the high-pressure liquid refrigerant pipe 15 from the exit side of the condenser that is smaller in diameter than the low-pressure refrigerant suction pipe 14 is wound in a helical structure in mutually opposite directions, for example, as shown in detail in FIG. 2, around the external periphery of the low-pressure refrigerant suction pipe 14. The existing low-pressure refrigerant suction pipe 14 leads from the indoor-side heat exchanger (evaporator) 8 during cooling or from the outdoor-side heat exchanger (evaporator) 3 during heating back to the refrigerant suction inlet in the compressor 1 via the four-way switching valve 2. Therefore, the supercooling heat exchanger 13 itself can have a small capacity and can be made as small in size as possible.

[0033] The improvement in supercooling heat exchange efficiency is effective in contributing to making the evaporators themselves smaller and more compact.

[0034] Furthermore, winding the high-pressure liquid refrigerant pipe 15 around the existing low-pressure refrigerant suction pipe 14 as shown in FIG. 2 makes it possible to inhibit increases in suctioned gas pressure loss, and to prevent the COP from decreasing.

[0035] The reference numeral 16 in FIG. 2 denotes a muffler for gas refrigerant in the low-pressure refrigerant suction pipe 14.

(Other Embodiments)

[0036] In the above embodiment, the divided first and second heat exchangers 13A, 13B have a structure in which a high-pressure liquid refrigerant pipe 15 having a small diameter is helically wound around an existing low-pressure refrigerant suction pipe 14 that goes from the four-way switching valve 2 to the refrigerant suction inlet of the compressor 1, as shown in FIG. 2. In another possible configuration, as shown in FIG. 3, for example, the first and second heat exchangers 13A, 13B have a double-pipe structure in which a high-pressure liquid refrigerant pipe 15 larger in diameter than the low-pressure refrigerant suction pipe 14 is fitted as a coaxial structure

around the external periphery of the low-pressure refrigerant suction pipe 14, and these pipes are disposed so that the refrigerant flows in mutually opposite directions.

[0037] Thus, as the first and second heat exchangers 13A, 13B for supercooling have a double-pipe structure in which the high-pressure liquid refrigerant pipe 15 is fitted as a coaxial structure around the low-pressure refrigerant suction pipe 14, the structure of the supercooling heat exchanger itself is simplified.

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INDUSTRIAL APPLICABILITY

[0038] The present invention can be widely utilized within the field of air conditioning apparatuses that use supercooling heat exchangers.

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Claims

1. An air conditioning apparatus comprising a supercooling heat exchanger (13) for exchanging heat between a low-pressure refrigerant and a high-pressure refrigerant, the air conditioning apparatus **characterized in that:**

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the supercooling heat exchanger (13) is divided into two first and second heat exchangers (13A), (13B);

either the first heat exchanger (13A) or the second heat exchanger (13B) is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow countercurrent to each other; and

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the other heat exchanger, i.e., either the second heat exchanger (13B) or the first heat exchanger (13A), is disposed so that the high-pressure refrigerant and the low-pressure refrigerant flow parallel to each other.

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2. The air conditioning apparatus according to claim 1, **characterized in that** the first and second heat exchangers (13A), (13B) are both configured with a high-pressure liquid refrigerant pipe (15) wound around the external periphery of a low-pressure refrigerant suction pipe (14).

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3. The air conditioning apparatus according to claim 1, **characterized in that** the first and second heat exchangers (13A), (13B) are both configured with a high-pressure liquid refrigerant pipe (15) fitted around the external periphery of a low-pressure refrigerant suction pipe (14) in a coaxial structure, wherein the high-pressure liquid refrigerant pipe (15) is larger in diameter than the low-pressure refrigerant suction pipe (14).

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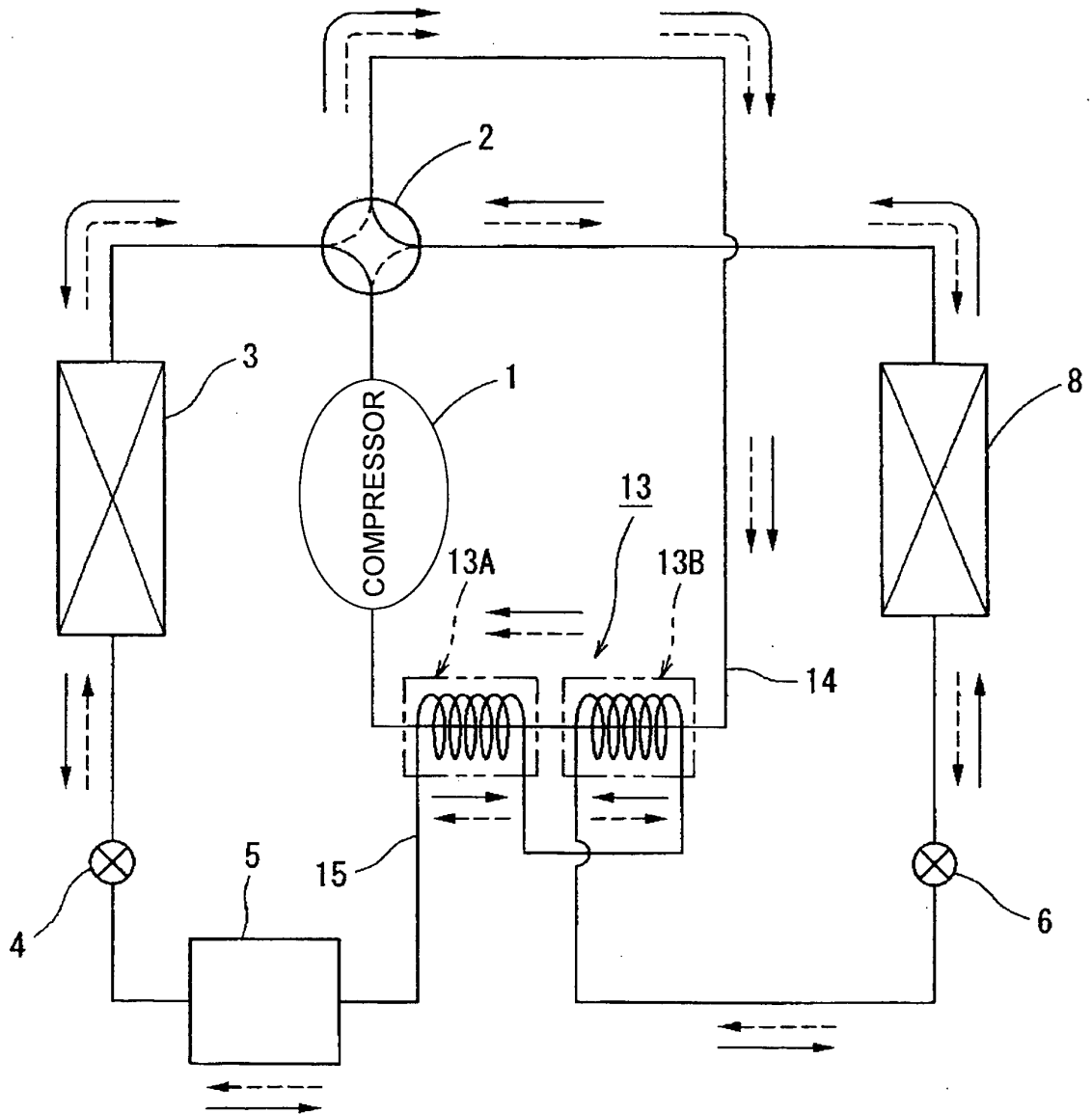


Fig. 1

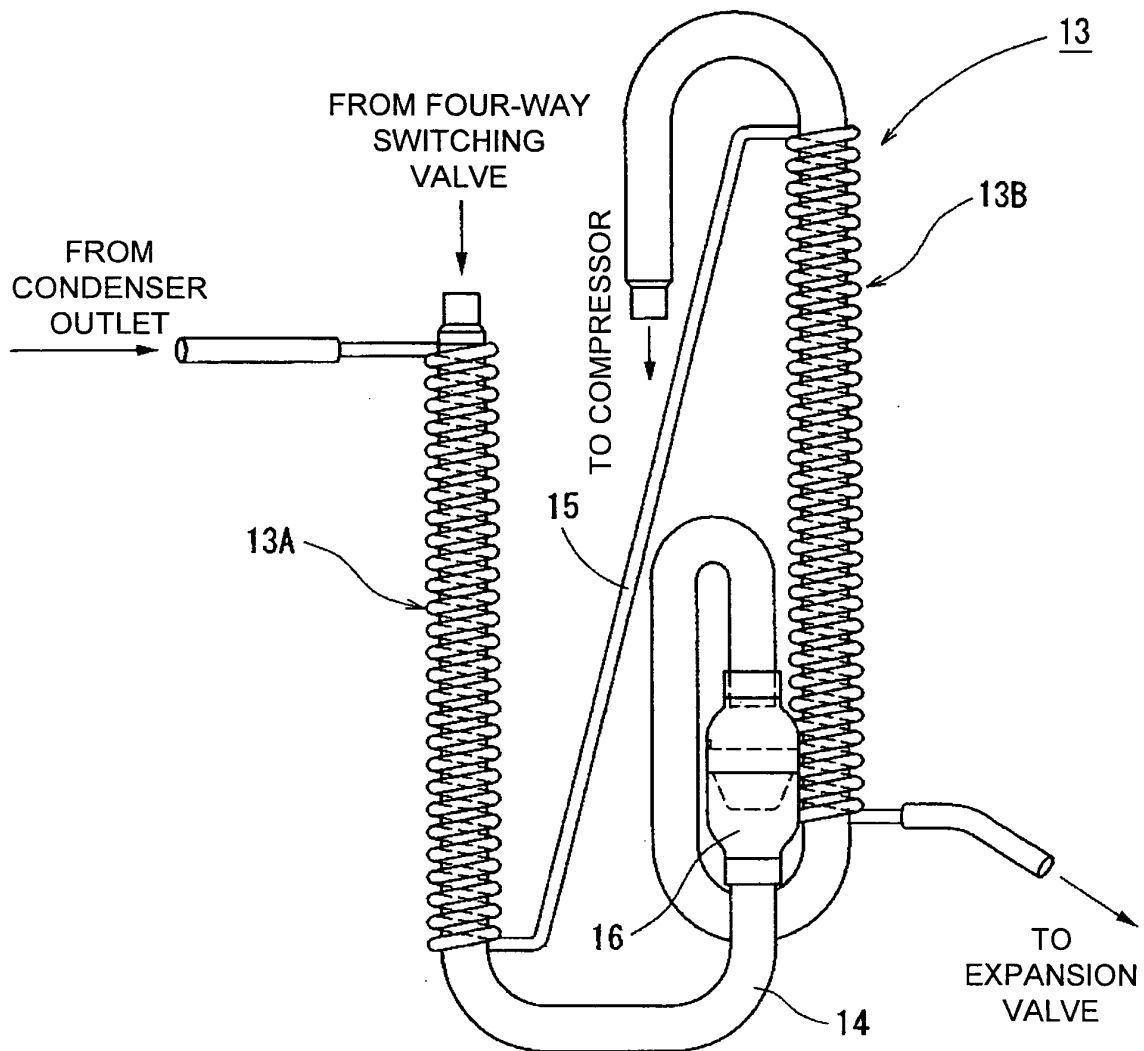


Fig. 2

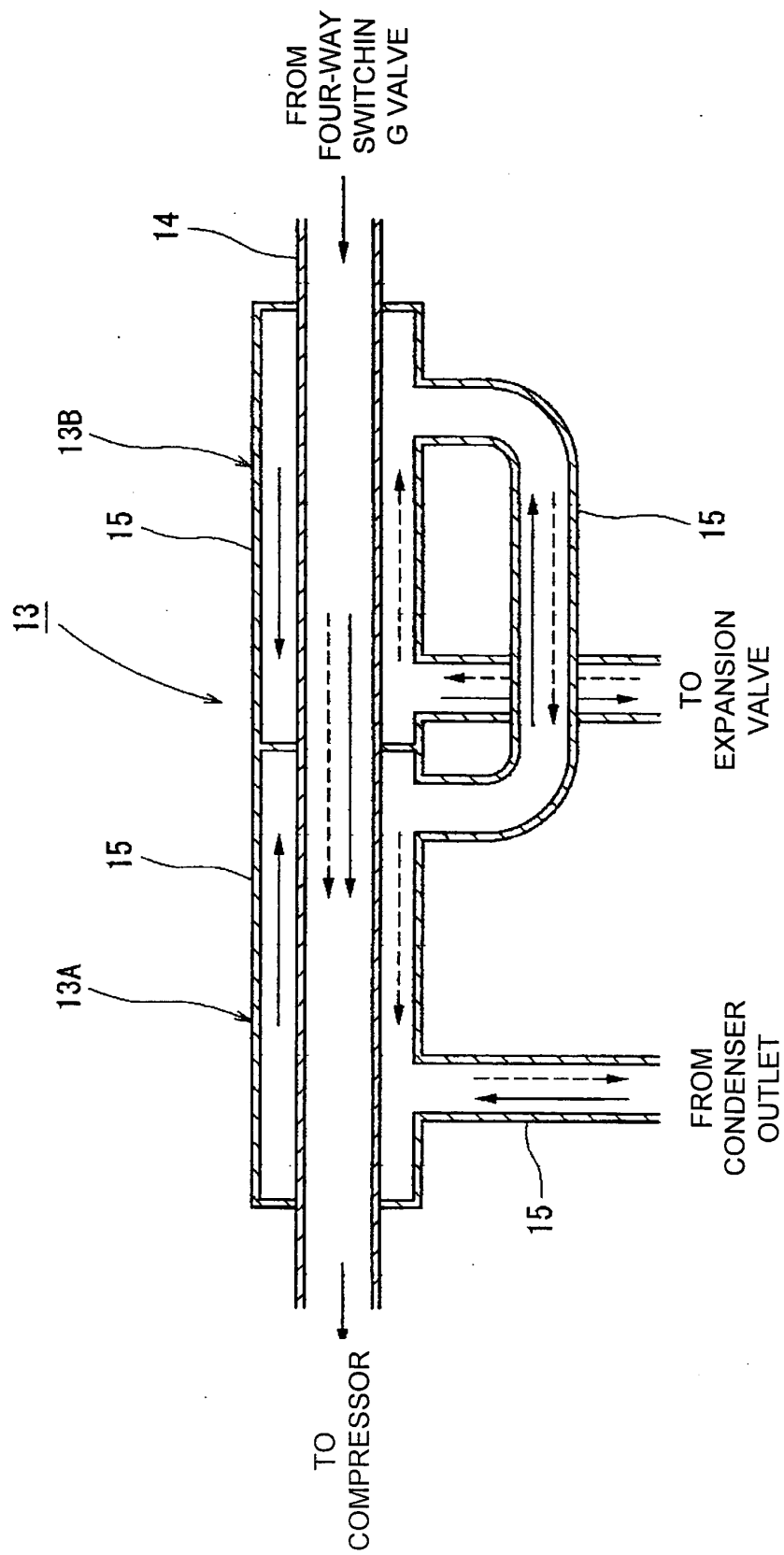


Fig. 3

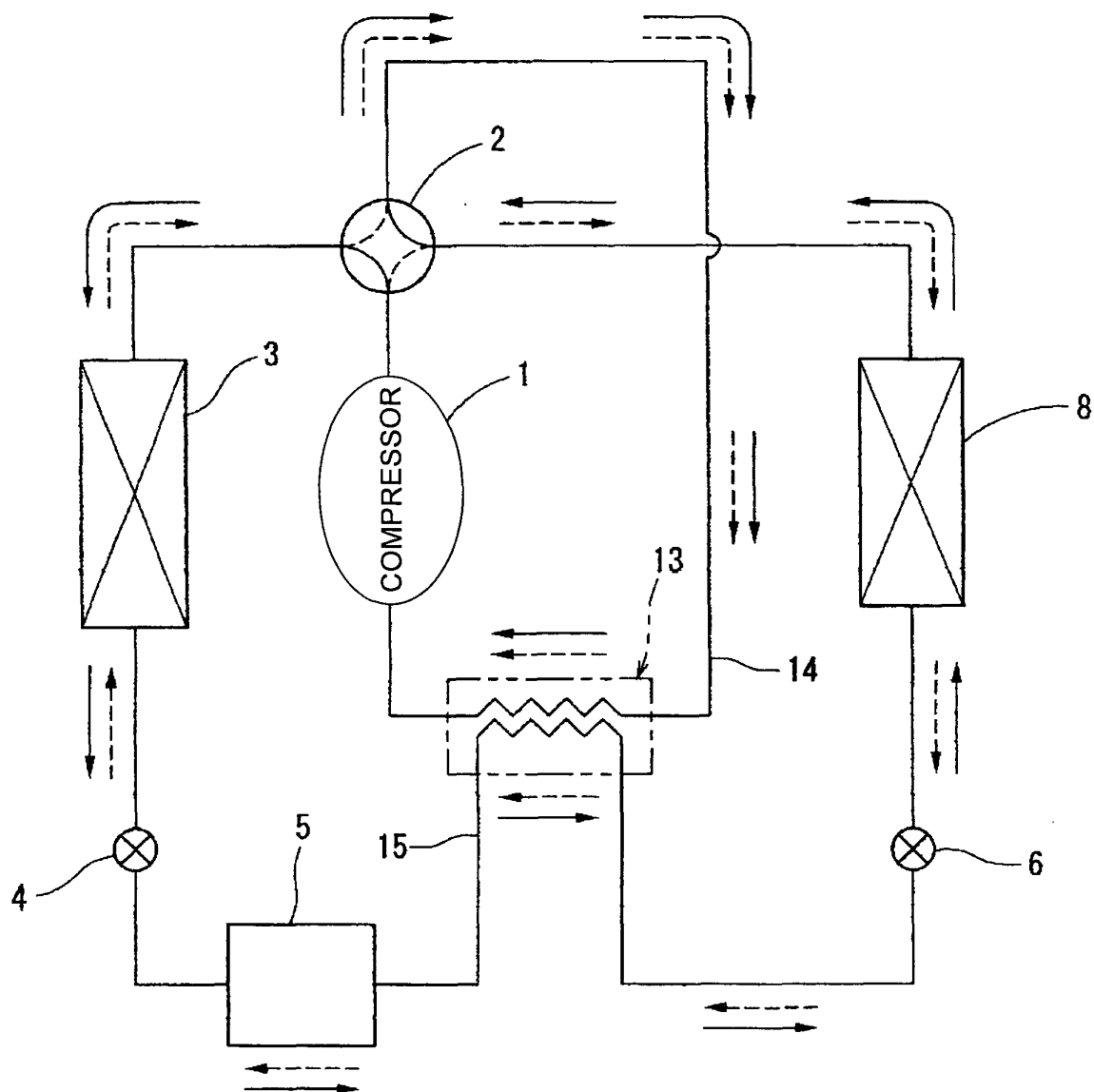


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/318376

A. CLASSIFICATION OF SUBJECT MATTER

F25B1/00(2006.01)i, F25B13/00(2006.01)i, F25B40/00(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, F25B13/00, F25B40/00

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 1996-2006

Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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.
X	JP 6-213518 A (Hitachi, Ltd.), 02 August, 1994 (02.08.94), Par. Nos. [0011] to [0016]; Figs. 1, 5, 6 (Family: none)	1-3
A	JP 2003-194432 A (Matsushita Electric Industrial Co., Ltd.), 09 July, 2003 (09.07.03), Par. Nos. [0008] to [0012]; Fig. 11 (Family: none)	1

☒ 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
08 December, 2006 (08.12.06)Date of mailing of the international search report
19 December, 2006 (19.12.06)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/318376

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 32266/1982 (Laid-open No. 135667/1983) (Matsushita Refrigeration Co.), 12 September, 1983 (12.09.83), Full text; Figs. 1 to 4 (Family: none)	1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5332641 A [0010]