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- **ITO, Daisuke**
Tokyo 100-8310 (JP)
- **UGAJIN, Yuki**
Tokyo 100-8310 (JP)
- **MATSUI, Shigeyoshi**
Tokyo 100-8310 (JP)
- **NAKAMURA, Shin**
Tokyo 100-8310 (JP)

(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

(74) Representative: **Moore, Graeme Patrick et al**
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

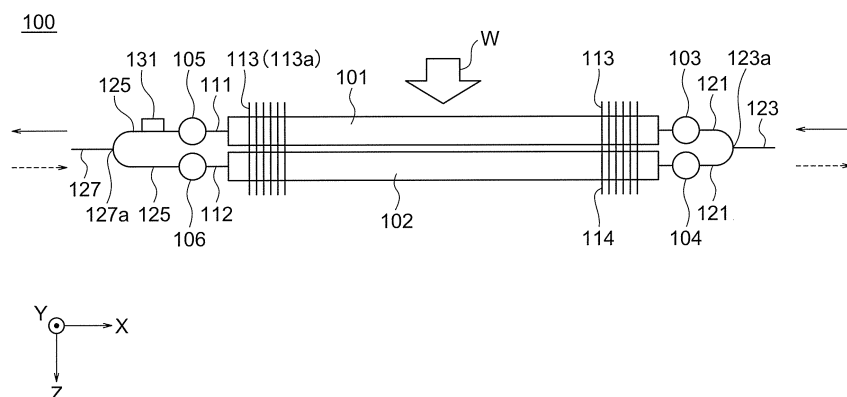
(72) Inventors:
• **HIGASHIUE, Shinya**
Tokyo 100-8310 (JP)
• **ISHIBASHI, Akira**
Tokyo 100-8310 (JP)

(54) **REFRIGERATION CYCLE DEVICE**

(57) A refrigeration cycle device 1 includes a circuit 3 having a compressor 5, an outdoor heat exchanger 100, an expansion unit 7, and an indoor heat exchanger 9. The outdoor heat exchanger 100 includes a fan 100a, a windward row 101, and a leeward row 102. The wind-

ward row 101 includes a first heat transfer pipe 111, and a plurality of first fins 113 intersecting the first heat transfer pipe 111. A first temperature sensor 131 is disposed between the plurality of first fins and a branch portion 125 of a manifold 127.

FIG. 3



Description

Technical Field

[0001] This invention relates to a refrigeration cycle device.

Background Art

[0002] A heat exchanger having a circular heat transfer pipe is available as a heat exchanger forming a refrigeration cycle device. To improve the performance of the heat exchanger, however, it is necessary to reduce the diameter of the heat transfer pipe, and in recent years, a heat exchanger in which a flat perforated pipe is used as the heat transfer pipe has become available.

[0003] When a small diameter circular pipe (with a diameter of 4 mm or the like, for example) or a flat perforated pipe is used as the heat transfer pipe, a flow passage sectional area of the small diameter circular pipe or the flat perforated pipe is smaller than the flow passage sectional area of a normal circular pipe. Therefore, when a heat exchanger is formed from an equal number of passes to a heat exchanger in which a normal circular pipe is used as the heat transfer pipe, pressure loss in the heat transfer pipe increases, leading to a reduction in the operating efficiency of the refrigeration cycle.

[0004] The pressure loss can be reduced by increasing the number of passes in the heat exchanger or reducing the length of a single pass of the heat transfer pipe. In the latter case, however, with a multi-row heat exchanger, refrigerant flowing through the heat exchanger cannot be caused to flow in an opposite direction to the air, and as a result, the efficiency of the heat exchanger decreases. Furthermore, a difference occurs between heat exchange amounts in a windward side row and a leeward side row, and therefore frost forms more easily on the windward side row, particularly when the outside air is at a low temperature. When frost adheres to an outdoor heat exchanger, the frost must be melted by implementing a defrosting operation periodically.

[0005] With respect to the defrosting operation, Japanese Patent Application Publication No. 2008-224135 discloses a technique in which an amount of frost adhered to an outdoor heat exchanger is determined from a temperature difference between an outdoor unit refrigerant temperature detected by refrigerant temperature detecting means of an outdoor unit and an outside air temperature detected by outside air temperature detecting means, and when the amount of adhered frost is determined to be small, a defrosting prohibition time is set to be long.

Citation List

Patent Literature

[0006] [PTL 1] Japanese Patent Application Publica-

tion No. 2008-224135

Summary of Invention

5 Technical Problem

[0007] With the technique disclosed in Japanese Patent Application Publication No. 2008-224135, however, frost forms unevenly on a heat exchanger in which a distributed thermal load exists due to poor distribution of the refrigerant, and in locations where a large amount of frost is formed, not all of the frost melts. When frost remains, a performance reduction may occur during a heating operation implemented after the defrosting operation.

10 **[0008]** This invention has been designed in consideration of the circumstances described above, and an object thereof is to provide a refrigeration cycle device with which an amount of remaining frost can be reduced in a multi-row heat exchanger having a distributed thermal load.

Solution to Problem

25 **[0009]** To achieve the object described above, a refrigeration cycle device according to this invention includes a circuit having a compressor, an outdoor heat exchanger, an expansion unit, and an indoor heat exchanger, the outdoor heat exchanger including a fan, a first heat exchanger, and a second heat exchanger disposed downwind of the first heat exchanger relative to an air flow generated by the fan, the first heat exchanger including a first heat transfer pipe and a plurality of first fins intersecting the first heat transfer pipe, the second heat exchanger including a second heat transfer pipe, the first heat transfer pipe being connected to a first header, the second heat transfer pipe being connected to a second header, and the first header and the second header being connected to a branch portion of a manifold via a branch pipe, wherein a first temperature sensor is disposed between the plurality of first fins and the branch portion of the manifold.

Advantageous Effects of Invention

45 **[0010]** According to this invention, an amount of remaining frost can be reduced in a multi-row heat exchanger having a distributed thermal load.

Brief Description of Drawings

50 **[0011]**

Fig. 1 is a view showing a configuration of a refrigeration cycle device according to a first embodiment of this invention.

Fig. 2 is a perspective view of an outdoor heat exchanger.

Fig. 3 is a plan view illustrating a configuration of the

outdoor heat exchanger.

Fig. 4 is a graph showing a relationship between a temperature of refrigerant passing through the outdoor heat exchanger and a temperature of air during a refrigeration cycle operation.

Fig. 5 is a graph showing the temperature of the refrigerant in the outdoor heat exchanger during a defrosting operation.

Fig. 6 is a similar view to Fig. 3, but relates to a second embodiment of this invention.

Fig. 7 is a similar view to Fig. 3, but relates to a third embodiment of this invention.

Description of Embodiments

[0012] Embodiments of this invention will be described below on the basis of the attached drawings. Note that in the drawings, identical reference numerals are assumed to denote identical or corresponding parts.

First Embodiment

[0013] Fig. 1 is a view showing a configuration of a refrigeration cycle device according to a first embodiment. A refrigeration cycle device 1 includes a circuit 3 through which refrigerant circulates. The circuit 3 includes at least a compressor 5, an outdoor heat exchanger 100, an expansion unit 7, and an indoor heat exchanger 9.

[0014] The refrigeration cycle device 1 is capable of performing both a heating operation and a cooling operation (a defrosting operation), and the circuit 3 is provided with a four-way valve 11 for switching between these operations. Further, in Figs. 1, 3, 6, and 7, a flow of the refrigerant during the cooling operation (the defrosting operation) is indicated by solid line arrows, and a flow of the refrigerant during the heating operation is indicated by dotted line arrows.

[0015] The constituent elements of the circuit 3 will now be described using the flow direction of the refrigerant during the cooling operation as a reference. In other words, in the description and claims of this application, the terms "inlet" and "outlet" are employed using the flow direction of the refrigerant during the cooling operation as a reference.

[0016] First, an outlet of the compressor 5 is connected to an inlet of the outdoor heat exchanger 100 via the four-way valve 11. An outlet of the outdoor heat exchanger 100 is connected to an inlet of the expansion unit 7. The expansion unit 7 is constituted by an expansion valve, for example.

[0017] An outlet of the expansion unit 7 is connected to an inlet of the indoor heat exchanger 9. An outlet of the indoor heat exchanger 9 is connected to an inlet of the compressor 5 via the four-way valve 11.

[0018] A control unit 140 is connected to the four-way valve 11 in order to switch a flow passage of the four-way valve 11, or in other words switch between the heat-

ing operation and the cooling operation (the defrosting operation), as will be described below. Further, the control unit 140 is connected to the compressor 5 in order to control the operation of the compressor 5 appropriately during the heating operation, the cooling operation, and the defrosting operation.

[0019] Furthermore, an arrow W in the drawing denotes a flow of a fluid that exchanges heat with the refrigerant. As a specific example, the arrow W denotes a flow of air that exchanges heat with the refrigerant.

[0020] A fan 9a is provided on a windward side of the indoor heat exchanger 9. A flow of air traveling toward the indoor heat exchanger 9 is actively generated by the fan 9a. The indoor heat exchanger 9 and the fan 9a are housed in a case of an indoor unit 15, and the indoor unit 15 is disposed in an indoor space.

[0021] The outdoor heat exchanger 100 will now be described in detail on the basis of Figs. 1 to 3. Fig. 2 is a perspective view of the outdoor heat exchanger, and Fig. 3 is a plan view illustrating a configuration of the outdoor heat exchanger. Note that in order to prioritize clarity in the drawings, fins to be described below are not shown in Fig. 2, and heat transfer pipes to be described below are not shown in Fig. 3.

[0022] The outdoor heat exchanger 100 includes a fan 100a, a windward row 101 constituting a first heat exchanger, and a leeward row 102 constituting a second heat exchanger. The leeward row 102 is disposed downwind of the windward row 101 relative to an air flow generated by the fan 100a. In other words, the fan 100a is disposed on the windward side of the windward row 101 and the leeward row 102, and the windward row 101 is disposed on the windward side of the leeward row 102.

[0023] A flow of air traveling toward the windward row 101 and the leeward row 102 is actively generated by the fan 100a. The outdoor heat exchanger 100 (the windward row 101, the leeward row 102, and the fan 100a), the compressor 5, the expansion unit 7, the four-way valve 11, and the control unit 140 are housed in a case of an outdoor unit 17.

[0024] The windward row 101 includes windward heat transfer pipes 111 constituting a plurality of first heat transfer pipes, and windward fins 113 constituting a plurality of first fins intersecting the plurality of windward heat transfer pipes 111. The leeward row 102 includes leeward heat transfer pipes 112 constituting a plurality of second heat transfer pipes, and leeward fins 114 constituting a plurality of second fins intersecting the plurality of leeward heat transfer pipes 112. The plurality of windward heat transfer pipes 111 and the plurality of leeward heat transfer pipes 112 are respectively formed from either flat pipes or circular pipes having a diameter not exceeding 4 mm.

[0025] The windward row 101 and the leeward row 102 are arranged in the direction of the flow W of the air that exchanges heat with the refrigerant, or in other words in an arrangement direction Z.

[0026] The windward row 101 is closer to an air intake

surface 17a of the case of the outdoor unit 17 than the leeward row 102. In other words, the leeward row 102 is closer to an air discharge surface 17b provided on the case of the outdoor unit 17 than the windward row 101.

[0027] In the windward row 101, the plurality of windward heat transfer pipes 111 are arranged in a vertical direction Y that is orthogonal to both a lengthwise direction X, and the arrangement direction Z. Similarly, in the leeward row 102, the plurality of leeward heat transfer pipes 112 are arranged in the vertical direction Y that is orthogonal to both the lengthwise direction, or in other words the heat transfer pipe flow direction X, and the arrangement direction Z. Note that the heat transfer pipe flow direction X is orthogonal to both the arrangement direction Z and the vertical direction Y.

[0028] The plurality of windward fins 113 intersect the plurality of windward heat transfer pipes 111 when seen from above. More specifically, the plurality of windward fins 113 respectively extend in the arrangement direction Z that is orthogonal to the heat transfer pipe flow direction X. Similarly, the plurality of leeward fins 114 intersect the plurality of leeward heat transfer pipes 112 when seen from above. More specifically, the plurality of leeward fins 114 respectively extend in the arrangement direction Z that is orthogonal to the heat transfer pipe flow direction X.

[0029] Respective inlet ends of the plurality of windward heat transfer pipes 111 are connected to a shared windward inlet header 103, and respective outlet ends of the plurality of windward heat transfer pipes 111 are connected to a shared windward outlet header 105. Further, respective inlet ends of the plurality of leeward heat transfer pipes 112 are connected to a shared leeward inlet header 104, and respective outlet ends of the plurality of leeward heat transfer pipes 112 are connected to a shared leeward outlet header 106.

[0030] The windward inlet header 103 and the leeward inlet header 104 are connected to a branch portion 123a of an inlet manifold 123 via a plurality of inlet branch pipes 121 (two in the first embodiment). Further, the windward outlet header 105 and the leeward outlet header 106 are connected to a branch portion 127a of an outlet manifold 127 via a plurality of outlet branch pipes 125 (two in the first embodiment).

[0031] The refrigeration cycle device 1 further includes a first temperature sensor 131. The first temperature sensor 131 is disposed between the outlet manifold 127 and a windward fin 113a that is closest to the branch portion 127a of the outlet manifold 127. As a specific example, in the first embodiment, the first temperature sensor 131 is provided in the outlet branch pipe 125 on the windward side between the windward outlet header 105 and the branch portion 127a of the outlet manifold 127. In other words, the first temperature sensor 131 is provided in a position serving as a downstream portion of the windward outlet header 105 and an upstream portion of the branch portion 127a of the outlet manifold 127 in relation to the

flow direction of the refrigerant during the cooling operation. The control unit 140 determines whether or not to terminate the defrosting operation on the basis of a temperature detected by the first temperature sensor 131.

[0032] Next, an operation of the refrigeration cycle device according to the first embodiment will be described. First, the heating operation will be described. During the heating operation, the refrigerant flows in the direction of the dotted line arrows in the drawings. High-pressure, high-temperature gas refrigerant discharged from the compressor 5 passes through the four-way valve 11 so as to flow into the indoor heat exchanger 9. After flowing into the indoor heat exchanger 9, the refrigerant exchanges heat with indoor air so as to be cooled, and then flows into the expansion unit 7 in order to be depressurized. The depressurized, low-temperature refrigerant then flows into the outdoor heat exchanger 100.

[0033] After flowing into the outdoor heat exchanger 100, the refrigerant flows into the windward outlet header 105 and the leeward outlet header 106 through the outlet manifold 127 and the branch portion 127a shown in Fig. 3. The refrigerant that flows into the windward outlet header 105 flows through the plurality of windward heat transfer pipes 111, while the refrigerant that flows into the leeward outlet header 106 flows through the plurality of leeward heat transfer pipes 112. While flowing through the windward heat transfer pipes 111 and the leeward heat transfer pipes 112, the refrigerant is heated by air blown out by the fan 100a, and as a result, the refrigerant evaporates.

[0034] Next, the evaporated refrigerant converges in the windward inlet header 103 and the leeward inlet header 104, and then passes through the branch portion 123a so as to converge again in the inlet manifold 123. After flowing out of the outdoor heat exchanger 100, the refrigerant returns to the compressor 5 through the four-way valve 11. In other words, the outdoor heat exchanger 100 according to the first embodiment includes a plurality of rows arranged in a direction (the arrangement direction Z) that is substantially parallel to the flow of the fluid (air) that exchanges heat with the refrigerant, and the refrigerant is set to flow through all of the heat transfer pipes in an identical direction over the plurality of rows, this direction (the transfer pipe flow direction X) being substantially orthogonal to the flow of the fluid (air) that exchanges heat with the refrigerant. In other words, the outdoor heat exchanger 100 is a multi-row, direct flow type exchanger.

[0035] Here, Fig. 4 shows a relationship between the temperature of the refrigerant flowing through the outdoor heat exchanger and the temperature of the air during the refrigeration cycle operation described above. The abscissa in Fig. 4 shows the arrangement direction Z of Figs. 2 and 3, and the ordinate shows a temperature t.

[0036] As shown in Fig. 4, the refrigerant flowing through the windward row 101 and the refrigerant flowing through the leeward row 102 have substantially identical temperatures. The reason for this is that the refrigerant

flowing through the heat exchanger flows in a saturated condition.

[0037] As regards an air temperature t_a , however, the air exchanges heat with the refrigerant while passing through the windward row 101, leading to a reduction in the temperature thereof. Further, when the temperature of the fins of the heat exchanger or the surfaces of the heat transfer pipes falls to or below a dew point temperature of the air, dew forms on the surfaces of the fins or the surfaces of the heat transfer pipes, leading to a reduction in the humidity of the air. Accordingly, the temperature and humidity of the air that flows into the leeward row 102 are lower than the temperature and humidity of the air that flows into windward row 101.

[0038] The amount of heat exchange that occurs in the heat exchanger is determined by a difference between the temperature of the refrigerant and the temperature or humidity of the air. Therefore, a larger amount of heat exchange occurs in the windward row 101 than in the leeward row 102.

[0039] Furthermore, when the temperature of the air decreases, the temperature of the refrigerant also decreases, and when the temperature of the fins or the heat transfer pipes falls below 0 degrees, water vapor in the air turns into frost that adheres to the heat exchanger. Hence, unless countermeasures of some kind are implemented, a larger amount of frost adheres to the windward row 101 in which a larger amount of heat exchange occurs, leading to an imbalance in the amount of frost formed on the windward row 101 and the leeward row 102.

[0040] In the first embodiment, therefore, the defrosting operation is implemented as follows. During the defrosting operation, the four-way valve 11 shown in Fig. 3 is switched such that the high-temperature, high-pressure refrigerant flows to the outdoor heat exchanger 100. In other words, the refrigerant flows in an opposite direction to the heating operation.

[0041] Fig. 5 shows the temperature of the refrigerant in the outdoor heat exchanger 100 during the defrosting operation. The abscissa in Fig. 5 shows time S , and the ordinate shows a refrigerant temperature T . Further, a solid line in Fig. 5 denotes a temperature $TA1$ detected by the first temperature sensor 131 during the defrosting operation, and a dotted line in Fig. 5 denotes an outlet temperature TB of the leeward heat transfer pipes 112 on the leeward row 102.

[0042] When the defrosting operation starts (at a time SS), high-temperature refrigerant is supplied such that the temperature of the outdoor heat exchanger 100 increases, and in the vicinity of 0 degrees, the frost starts to melt. As the frost melts, the temperature remains at 0 degrees for a while due to the effects of latent heat. When the frost has almost completely melted, the temperature starts to increase again, and at a set defrosting termination temperature T_f , the defrosting operation is terminated.

[0043] Here, however, the temperature of the wind-

ward row 101 to which a large amount of frost is adhered does not increase as easily as the temperature of the leeward row 102. Therefore, if the defrosting operation is terminated at a point where the temperature of the leeward row 102 has increased sufficiently, for example a point (a time SB) where the outlet temperature TB of the leeward row 102 exceeds the defrosting termination temperature T_f , the temperature of the windward row 101 may not yet have increased sufficiently, and as a result, the frost adhered to the windward row 101 may not be removed appropriately.

[0044] Hence, in the first embodiment, the defrosting operation is terminated at a point (a time SA) where the temperature $TA1$ detected by the first temperature sensor 131, which is disposed between the outlet manifold 127 and the windward fin 113a that is closest to the branch portion 127a of the outlet manifold 127, exceeds the defrosting termination temperature T_f . In other words, the defrosting operation is continued until the temperature $TA1$ detected by the first temperature sensor 131 exceeds the defrosting termination temperature T_f . In the first embodiment, therefore, the control unit 140 terminates the defrosting temperature on the basis of the temperature detected by the first temperature sensor 131. As a result, the frost adhered to both the windward row 101 and the leeward row 102 can be melted sufficiently.

[0045] Note that the defrosting termination temperature T_f is preferably set appropriately for each individual outdoor heat exchanger in accordance with configuration conditions and use environment conditions thereof. The defrosting termination temperature T_f may be set within a temperature range of more than 0 degrees and less than 20 degrees, but is preferably set within a temperature range of more than 5 degrees and less than 20 degrees.

[0046] With the refrigeration cycle device according to the first embodiment, as described above, an amount of remaining frost can be reduced in a multi-row heat exchanger having a distributed thermal load.

Second Embodiment

[0047] Next, a second embodiment of this invention will be described on the basis of Fig. 6. Fig. 6 is a similar view to Fig. 3, but relates to the second embodiment. Note that except for the parts to be described below, the second embodiment is assumed to be identical to the first embodiment.

[0048] In the second embodiment, a second temperature sensor 231 is provided. The second temperature sensor 231 is disposed between the outlet manifold 127 and a leeward fin 114a that is closest to the branch portion 127a of the outlet manifold 127. As a specific example, the second temperature sensor 231 is provided in the outlet branch pipe 125 on the leeward side between the leeward outlet header 106 and the branch portion 127a of the outlet manifold 127. The second temperature sensor 231 is also connected to the control unit 140.

[0049] During the defrosting operation according to the second embodiment, the control unit 140 terminates the defrosting operation when a temperature TA2 (note that the temperature TA2 is identical to the aforementioned temperature TB) detected by the second temperature sensor 231 and the temperature TA1 detected by the first temperature sensor 131 both exceed the set defrosting termination temperature Tf. In other words, the defrosting operation is terminated when temperature TA2 > defrosting termination temperature Tf and temperature TA1 > defrosting termination temperature Tf are both satisfied.

[0050] Likewise with the refrigeration cycle device according to the second embodiment, as described above, an amount of remaining frost can be reduced in a multi-row heat exchanger having a distributed thermal load. Moreover, since the refrigerant temperature on the leeward side can also be detected, the frost adhered to the heat exchanger can be melted more reliably.

Third Embodiment

[0051] Next, a third embodiment of this invention will be described on the basis of Fig. 7. Fig. 7 is a similar view to Fig. 3, but relates to the third embodiment. Note that except for the parts to be described below, the third embodiment is assumed to be identical to the first embodiment.

[0052] In the third embodiment, a third temperature sensor 331 is provided. The third temperature sensor 331 is disposed in the outlet manifold 127.

[0053] Likewise with the refrigeration cycle device according to the third embodiment, as described above, an amount of remaining frost can be reduced in a multi-row heat exchanger having a distributed thermal load. Moreover, the temperature in a portion where the outlet branch pipes 125 converge can be detected during the cooling operation, and as a result, appropriate over-cooling control can be implemented on the refrigeration cycle.

[0054] The specific content of this invention was described above with reference to preferred embodiments, but it would be obvious to a person skilled in the art that various amended embodiments may be employed on the basis of the basic technical spirit and teachings of this invention.

[0055] In the above embodiments, an air conditioner is used as the refrigeration cycle device, but this invention is not limited thereto, and may be applied widely to any refrigeration cycle device that includes a refrigeration circuit having a compressor, an expansion unit, an indoor heat exchanger, and an outdoor heat exchanger. Accordingly, this invention may be implemented using a hot water supply device, for example, as the refrigeration cycle device.

[0056] Further, in the above embodiments, the outdoor heat exchanger is a two-row heat exchanger, but this invention is not limited thereto, and may also be applied to a heat exchanger having three or more rows. In this case, the invention is implemented such that the wind-

ward row described above serves as the row furthest toward the windward side in the heat exchanger having three or more rows.

[0057] As long as the first temperature sensor is disposed between the outlet manifold and the windward fin that is closest to the branch portion of the outlet manifold, the configuration of the above embodiments may be taken as merely an example. In another example, the first temperature sensor may be attached to the windward outlet header. Alternatively, the first temperature sensor may be attached to one of the windward heat transfer pipes between the windward outlet header and the windward fin that is closest to the branch portion of the outlet manifold. Furthermore, in this case, the first temperature sensor is preferably attached to a windward heat transfer pipe positioned on the lower side, and most preferably attached to the windward heat transfer pipe in the lowest position.

20 Reference Signs List

[0058]

1	Refrigeration cycle device
3	Circuit
5	Compressor
7	Expansion unit
9	Indoor heat exchanger
100	Outdoor heat exchanger
100a	Fan
101	Windward row
102	Leeward row
103	Windward inlet header
104	Leeward inlet header
105	Windward outlet header
106	Leeward outlet header
111	Windward heat transfer pipe
112	Leeward heat transfer pipe
113	Windward fin
114	Leeward fin
121	Inlet branch pipe
123	Inlet manifold
123a, 127a	Branch portion
125	Outlet branch pipe
127	Outlet manifold
131	First temperature sensor
231	Second temperature sensor
331	Third temperature sensor

Claims

1. A refrigeration cycle device comprising a circuit that includes a compressor, an outdoor heat exchanger, an expansion unit, and an indoor heat exchanger, the outdoor heat exchanger comprising a fan, a first heat exchanger, and a second heat exchanger dis-

posed downwind of the first heat exchanger relative to an air flow generated by the fan,
the first heat exchanger comprising a first heat transfer pipe and a plurality of first fins intersecting the first heat transfer pipe, 5
the second heat exchanger comprising a second heat transfer pipe,
the first heat transfer pipe being connected to a first header, the second heat transfer pipe being connected to a second header, and 10
the first header and the second header being connected to a branch portion of a manifold via a branch pipe,
wherein a first temperature sensor is disposed between the plurality of first fins and the branch portion of the manifold. 15

2. The refrigeration cycle device according to claim 1, wherein
the refrigeration cycle device comprises a control unit, and 20
the control unit is connected to the first temperature sensor in order to determine whether or not to terminate a defrosting operation on the basis of a temperature detected by the first temperature sensor. 25
3. The refrigeration cycle device according to claim 1 or 2, wherein the first temperature sensor is provided in the branch pipe between the first header and the branch portion of the manifold. 30
4. The refrigeration cycle device according to any of claims 1 to 3, wherein
the refrigeration cycle device comprises a plurality of second fins intersecting the second heat transfer pipe, and a second temperature sensor, and 35
the second temperature sensor is disposed between the branch portion of the manifold and a second fin that is, among the plurality of second fins, closest to the branch portion of the manifold. 40
5. The refrigeration cycle device according to any of claims 1 to 3, wherein
the refrigeration cycle device comprises a third temperature sensor, and 45
the third temperature sensor is disposed in the manifold.
6. The refrigeration cycle device according to any one of claims 1 to 5, wherein the first heat transfer pipe and the second heat transfer pipe are respectively formed from either flat pipes 50
or circular pipes having a diameter not exceeding 4 mm. 55

FIG. 1

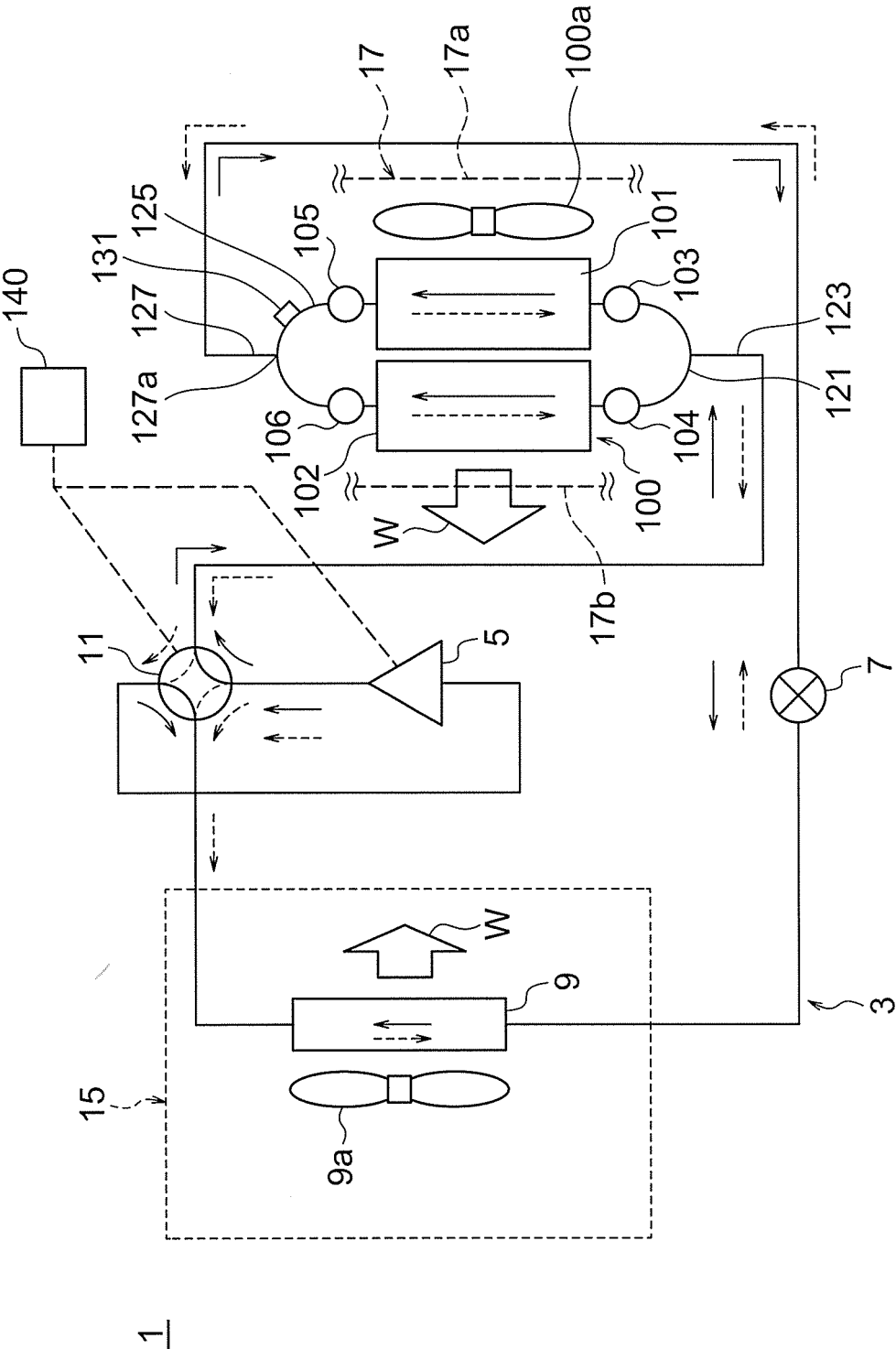
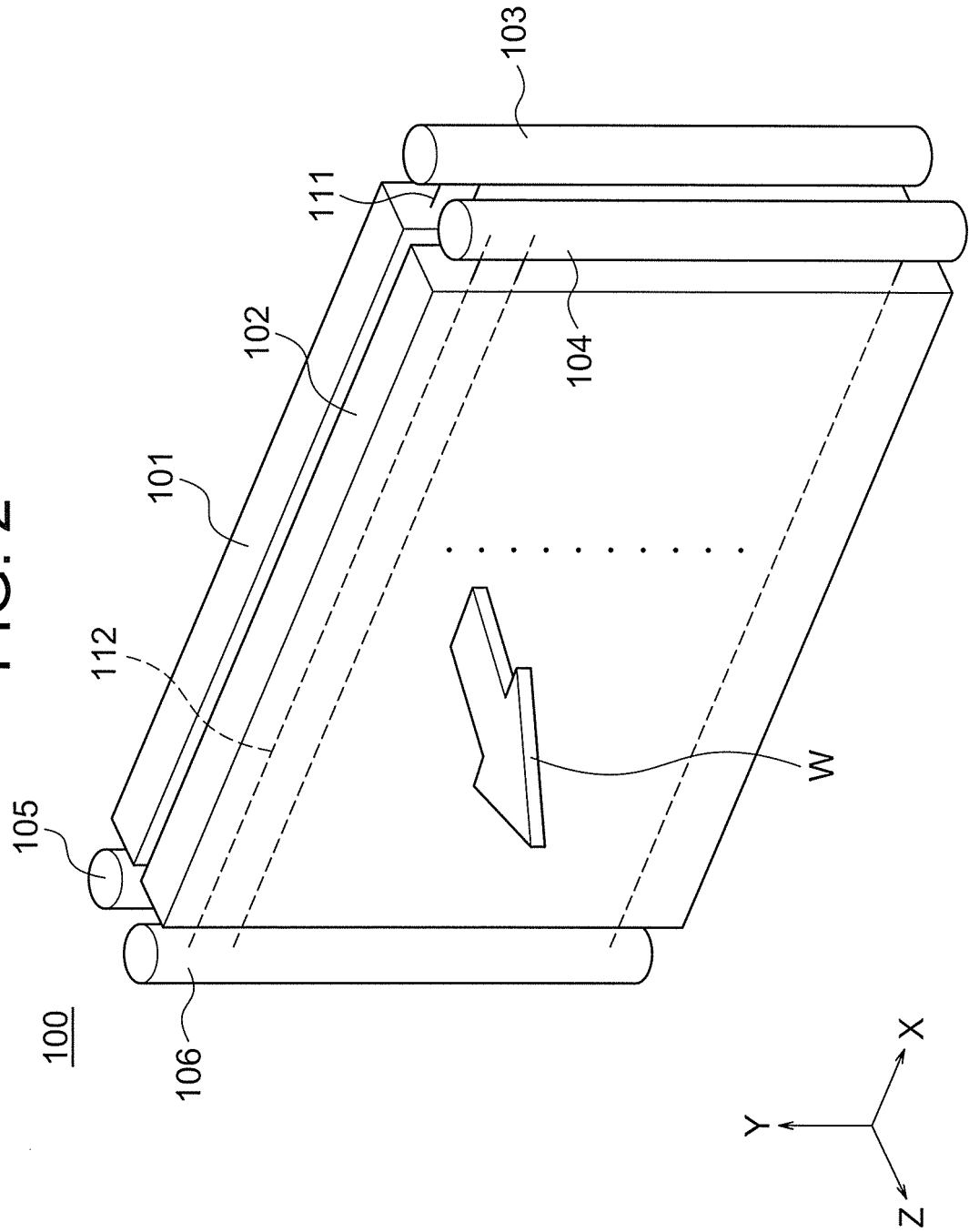


FIG. 2



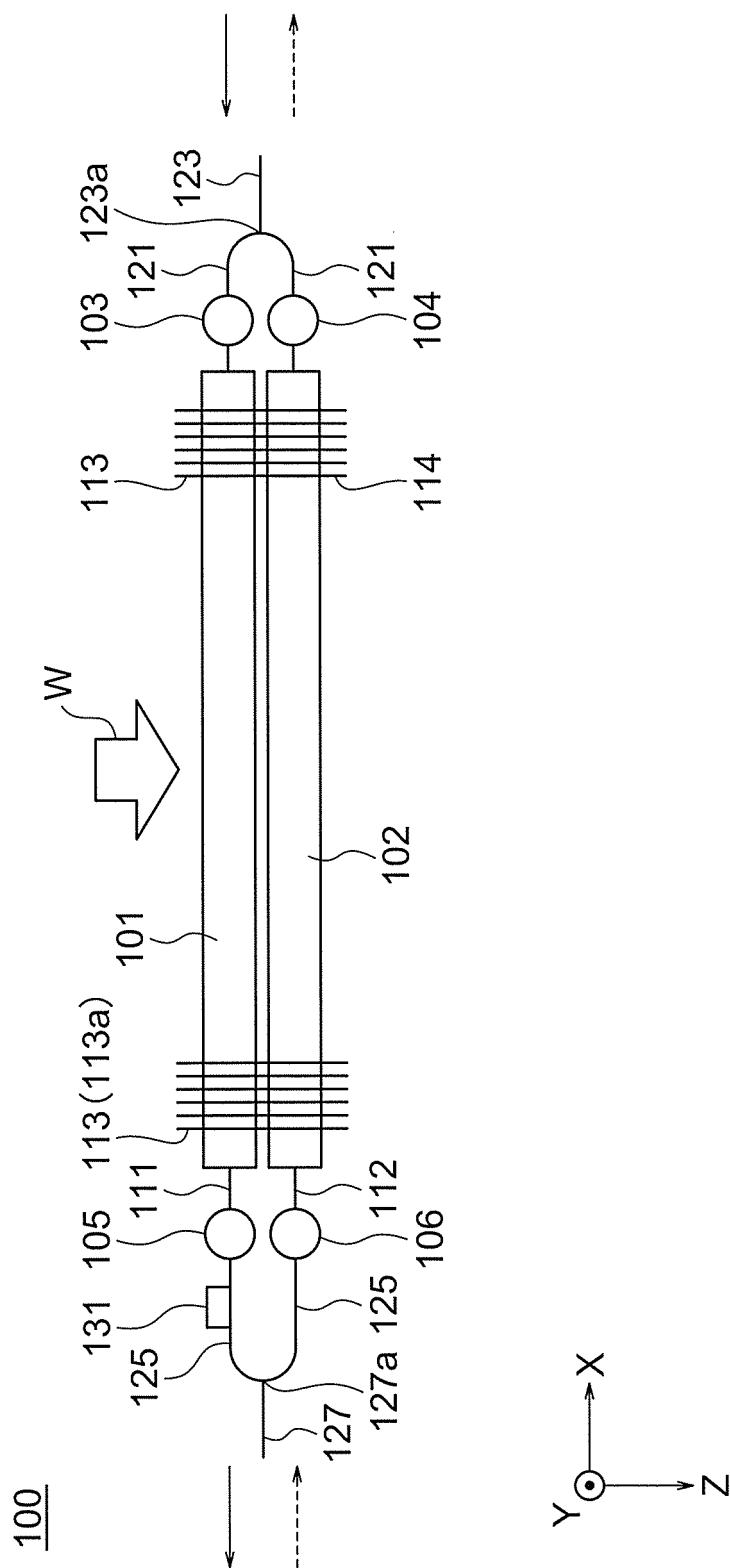


FIG. 4

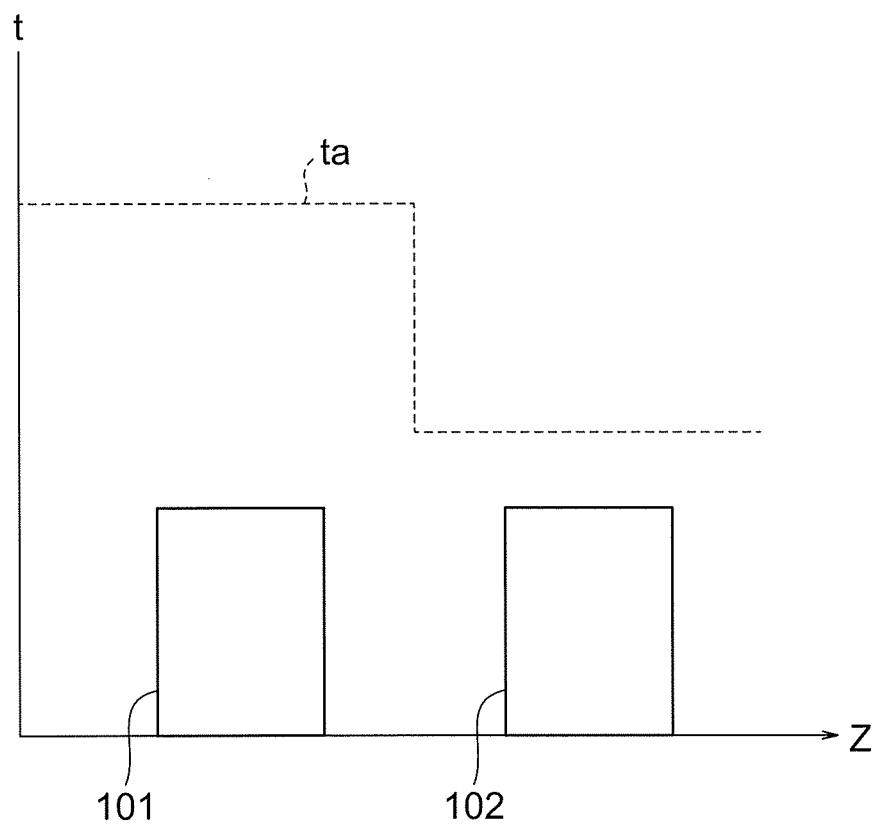


FIG. 5

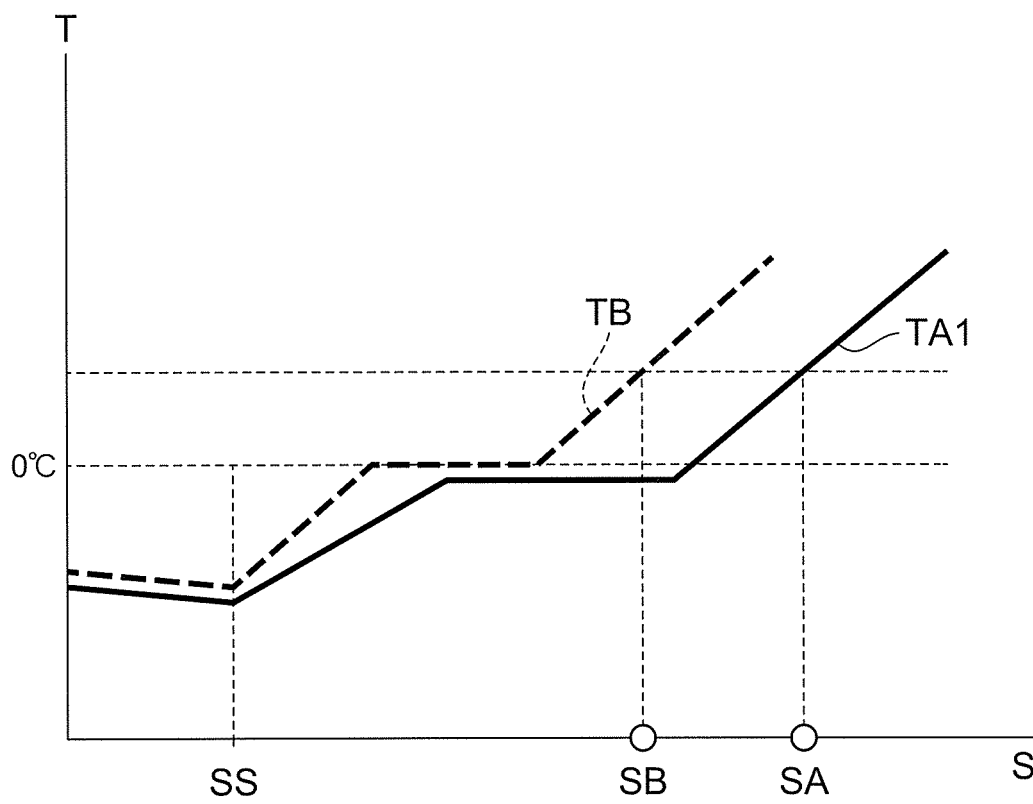


FIG. 6

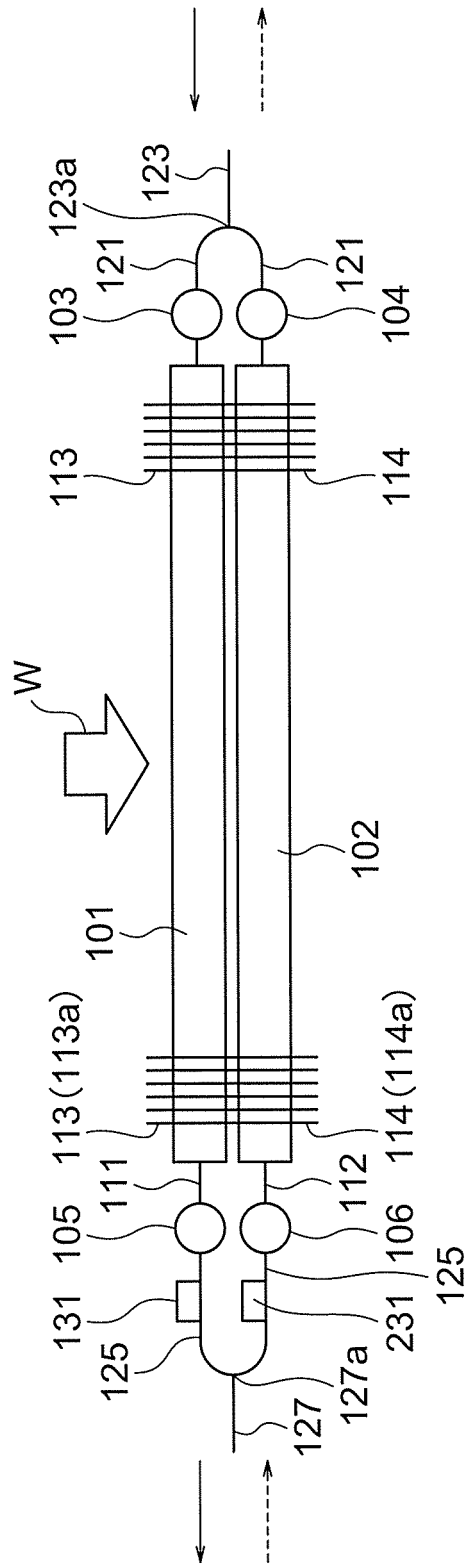
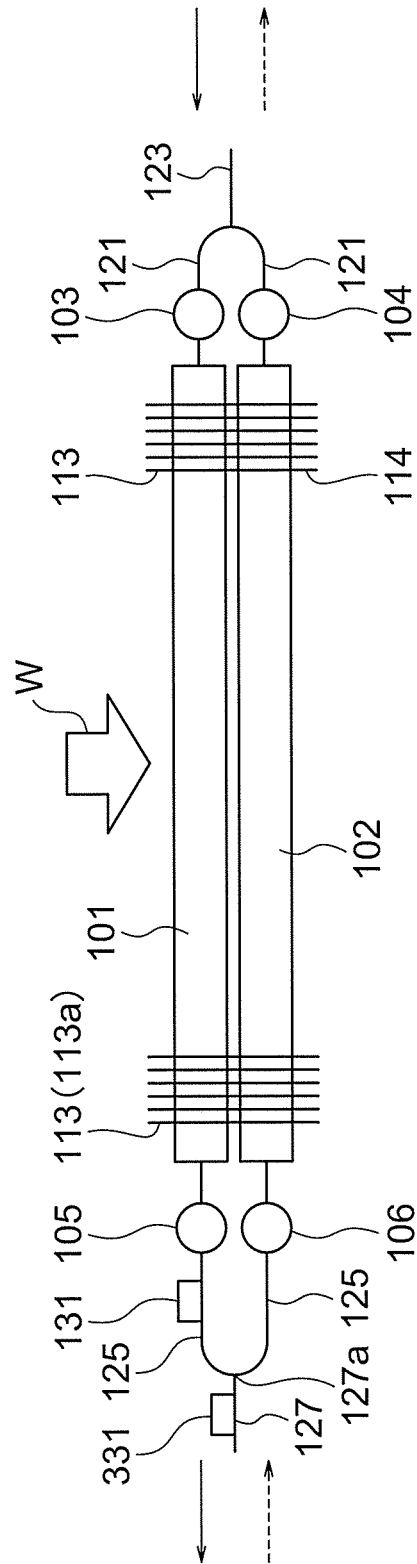


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/052689

A. CLASSIFICATION OF SUBJECT MATTER

F25B47/02(2006.01)i, F25B41/00(2006.01)i, F28D1/053(2006.01)i, F28F9/02(2006.01)i, F28F27/00(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)
F25B47/02, F25B41/00, F28D1/053, F28F9/02, F28F27/00

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 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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	JP 2014-66420 A (Hitachi Appliances, Inc.), 17 April 2014 (17.04.2014), paragraphs [0010] to [0014], [0018]; fig. 1 (Family: none)	1-6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 140694/1985 (Laid-open No. 50467/1987) (Nihon Radiator Co., Ltd.), 28 March 1987 (28.03.1987), page 6, line 9 to page 8, line 9; fig. 1 to 3 (Family: none)	1-6

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

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PCT/JP2015/052689

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 105524/1985 (Laid-open No. 14281/1987) (Toshiba Corp.), 28 January 1987 (28.01.1987), page 6, lines 4 to 16; page 7, line 18 to page 9, line 3; page 10, line 20 to page 13, line 2; fig. 1 (Family: none)	1-6
Y	JP 2006-284134 A (Matsushita Electric Industrial Co., Ltd.), 19 October 2006 (19.10.2006), paragraphs [0003], [0006]; fig. 6 (Family: none)	4, 6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 162593/1986 (Laid-open No. 69963/1988) (Daikin Industries, Ltd.), 11 May 1988 (11.05.1988), page 6, line 10 to page 8, line 15; page 10, lines 9 to 13; fig. 1 to 2, 6 (Family: none)	1-6
A	JP 2005-226866 A (Denso Corp.), 25 August 2005 (25.08.2005), paragraphs [0043] to [0050]; fig. 6 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008224135 A [0005] [0006] [0007]