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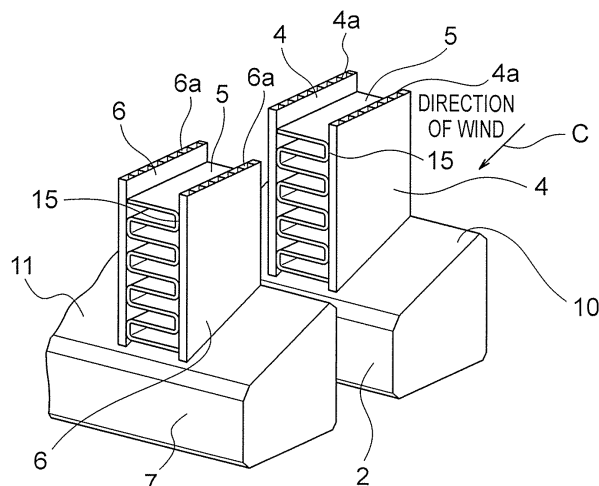
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(54) **HEAT EXCHANGER**

(57) A heat exchanger according to the present invention has: a plurality of heat transfer pipes that are disposed in parallel with spaces therebetween; distribution headers that are respectively connected to lower ends of the plurality of heat transfer pipes so as to com-

municate with the heat transfer pipes and distribute a refrigerant; and fins that are provided in an air duct between the heat transfer pipes adjacent to each other. The distribution headers have top surfaces inclined downward from a windward side to a leeward side.

FIG. 3



Description

Technical Field

[0001] The present invention relates to a heat exchanger in which lower ends of a plurality of heat transfer pipes disposed in parallel with spaces therebetween and extending in a vertical direction are connected by a distribution header for distributing a refrigerant.

Background Art

[0002] There has conventionally been known a heat exchanger tube that has a plurality of flat pipes that are disposed in a traverse direction with spaces therebetween in such a manner that the width direction thereof faces a front-back direction, corrugated fins that are disposed between the respective adjacent flat pipes, and a distribution header that is connected to the lower end of each flat pipe so as to communicate with the flat pipe and distributes a refrigerant, wherein heat exchange takes place between the refrigerant circulating through the flat pipes and air caused to circulate through the corrugated fins by the rotation of a fan (see PTL 1, for example).

Citation List

Patent Literature

[0003] [PTL 1] Japanese Patent Application Laid-Open No. 2006-170601 (Fig. 1)

Summary of Invention

Technical Problem

[0004] A problem that the heat exchanger described above faces is that, in a case where frost formed on the flat pipes and corrugated fins flows down to the top surfaces of the distribution headers, the overall circular arc cross-sectional shape of this top surface where the middle portion thereof in the front-back direction is the highest portion and the sides of the same sag gradually from the highest portion toward the front and back, causes the drops of water flowing along the arc and the direction of the wind to confront each other, making it impossible to drain the water smoothly from the distribution headers.

[0005] The present invention aims to solve such problem and an object thereof is to provide a heat exchanger that has a simple structure and the improved drainage capability of the distribution header and thereby prevents frosting.

Solution to Problem

[0006] A heat exchanger according to the present invention has:

a plurality of heat transfer pipes that are disposed in parallel with spaces therebetween;
distribution headers that are respectively connected to each of lower ends of the plurality of heat transfer pipes so as to communicate with the heat transfer pipes and distributes a refrigerant; and
a plurality of fins that are provided in an air duct between the heat transfer pipes adjacent to each other, wherein the distribution headers have upper surfaces inclined downward from a windward side to a leeward side.

Advantageous Effects of Invention

[0007] According to the heat exchanger of the present invention, because the top surface of each distribution header is inclined downward from the windward side to the leeward side, gravity and the force of the wind can facilitate downward flow of drops of water on the top surface, improving the drainage capability of the distribution headers and anti-frosting performance of the distribution headers themselves.

Brief Description of Drawings

[0008]

Fig. 1 is a circuit diagram showing an air conditioner incorporated with a heat exchanger according to Embodiment 1 of the present invention.

Fig. 2 is a diagram in which the heat exchanger according to Embodiment 1 of the present invention is viewed from the windward side.

Fig. 3 is a perspective view of main portions, showing the heat exchanger shown in Fig. 2.

Fig. 4 is a diagram showing an internal configuration of a distribution header shown in Fig. 3.

Fig. 5 is a flat cross-sectional diagram showing a folded-back header shown in Fig. 2.

Fig. 6 is a diagram showing a state of drops of water on the distribution header shown in Fig. 3.

Fig. 7 is a perspective view of main portions, showing a modification of the heat exchanger according to Embodiment 1 of the present invention.

Fig. 8 is a perspective view of main portions, showing another modification of the heat exchanger according to Embodiment 1 of the present invention.

Fig. 9 is a side view of main portions, showing a behavior of drops of water in the heat exchanger shown in Fig. 8.

Fig. 10 is a side view of main portions, showing a heat exchanger according to Embodiment 2 of the present invention.

Fig. 11 is a side view of main portions, showing a heat exchanger according to Embodiment 3 of the present invention.

Description of Embodiments

[0009] A heat exchanger according to each of the embodiments of the present invention is described herein after with reference to the drawings, wherein the same reference numerals are used to describe the same or relevant members and sections shown in the drawings.

Embodiment 1.

[0010] Fig. 1 is a circuit diagram showing an air conditioner 51 incorporated with a heat exchanger 1 according to Embodiment 1.

[0011] In Fig. 1, the solid arrows each show how a refrigerant flows during a cooling operation, the dotted lines each show how the refrigerant flows during a heating operation, and the chain arrows each show how the refrigerant flows during a defrosting operation.

[0012] The air conditioner 51 has a compressor 52, a four-way valve 53 connected to the compressor 52 by a first solenoid valve 60A, a throttle device 55 connected by a first solenoid valve 60C, a heat source-side heat exchanger 54 connected to the four-way valve 53 by a first solenoid valve 60B, the throttle device 55 connected to the heat source-side heat exchanger 54 by the first solenoid valve 60C, and a load-side heat exchanger 56 having one side connected to the throttle device 55 and the other side connected to the four-way valve 53.

[0013] The air conditioner 51 also has a heat source-side fan 57 facing the heat source-side heat exchanger 54, a load-side fan 58 facing the load-side heat exchanger 56, a second solenoid valve 61, and a controller 59.

[0014] The compressor 52, four-way valve 53, heat source-side heat exchanger 54, throttle device 55, and load-side heat exchanger 56 are connected to one another by refrigerant piping, configuring a refrigerant circulation circuit.

[0015] The compressor 52, four-way valve 53, throttle device 55, heat source-side fan 57, load-side fan 58, first solenoid valves 60A to C, second solenoid valve 61, and various other sensors are connected to the controller 59.

[0016] The controller 59 switches a flow channel of the four-way valve 53, thereby switching between the cooling operation and the heating operation. The heat source-side heat exchanger 54 acts as a condenser in the cooling operation and as an evaporator in the heating operation.

[0017] The load-side heat exchanger 56 acts as an evaporator in the cooling operation and as a condenser in the heating operation.

[0018] The first solenoid valves 60A to C are opened during the cooling operation and the heating operation but are closed during the defrosting operation. The second solenoid valve 61 is closed during the cooling operation and the heating operation but is opened during the defrosting operation.

[0019] The flow of the refrigerant in the cooling operation of the air conditioner 51 is described next.

[0020] The refrigerant in a state of a high pressure and

high temperature gas that is discharged from the compressor 52 flows into the heat source-side heat exchanger 54 through the first solenoid valve 60A, four-way valve 53 and first solenoid valve 60B, turns into a high-pressure liquid refrigerant by being condensed through heat exchange with outside air supplied by the heat source-side fan 57, and flows out of the heat source-side heat exchanger 54.

[0021] The refrigerant in a state of the high pressure liquid that flows out of the heat source-side heat exchanger 54 flows into the throttle device 55 through the first solenoid valve 60C and becomes a low-pressure gas-liquid two-phase refrigerant. The low-pressure gas-liquid two-phase refrigerant that flows out of the throttle device 55 flows into the load-side heat exchanger 56, turns into a low-pressure gaseous refrigerant by being vaporized through heat exchange with indoor air supplied by the load-side fan 58, and flows out of the load-side heat exchanger 56. The low-pressure gaseous refrigerant that flows out of the load-side heat exchanger 56 is suctioned by the compressor 52 through the four-way valve 53.

[0022] The flow of the refrigerant in the heating operation is described next.

[0023] The refrigerant in a state of a high pressure and high temperature gas that is discharged from the compressor 52 flows into the load-side heat exchanger 56 through the first solenoid valve 60A and four-way valve 53, turns into a high-pressure liquid refrigerant by being condensed through heat exchange with the indoor air supplied by the load-side fan 58, and flows out of the load-side heat exchanger 56. The high-pressure liquid refrigerant that flows out of the load-side heat exchanger 56 flows into the throttle device 55 and becomes a low-pressure gas-liquid two-phase refrigerant. The low-pressure gas-liquid two-phase refrigerant that flows out of the throttle device 55 flows into the heat source-side heat exchanger 54 through the first solenoid valve 60C, turns into a low-pressure gaseous refrigerant by being vaporized through heat exchange with the outside air supplied by the heat source-side fan 57, and flows out of the heat source-side heat exchanger 54. The low-pressure gaseous refrigerant that flows out of the heat source-side heat exchanger 54 is suctioned by the compressor 52 through the first solenoid valve 60B and four-way valve 53.

[0024] The flow of the refrigerant in the defrosting operation is described next.

[0025] The refrigerant in a state of a high pressure and high temperature gas that is discharged from the compressor 52 flows into the heat source-side heat exchanger 54 through the second solenoid valve 61, turns into a gas-liquid two-phase or gaseous refrigerant by being subjected to heat exchange while melting frost adhering to the heat source-side heat exchanger 54, and flows out of the heat source-side heat exchanger 54. The high-pressure gas-liquid two-phase or gaseous refrigerant that flows out of the heat source-side heat exchanger 54 flows into the throttle device 55 and becomes a low-pres-

sure gas-liquid two-phase or gaseous refrigerant. The low-pressure gas-liquid two-phase or gaseous refrigerant that flows out of the throttle device 55 passes through the load-side heat exchanger 56. The low-pressure gas-liquid two-phase or gaseous refrigerant that passes through the load-side heat exchanger 56 is suctioned by the compressor 52 through the four-way valve 53.

[0026] Frost adheres gradually to the heat source-side heat exchanger 54 and grows from the direction of the flow of the refrigerant in the heating operation. When defrosting, the air conditioner performs defrosting in the direction of the flow of the refrigeration in the cooling operation, and thus it takes a while to defrost a section where frost grows. However, by performing defrosting in the direction of the flow of the refrigeration in the heating operation as described above, the high-temperature gas can be caused to flow from the section where frost grows, improving the defrosting efficiency and consequently reducing the defrosting time.

[0027] Fig. 2 is a diagram in which the heat exchanger 1 according to Embodiment 1 of the present invention, which is the heat source-side heat exchanger 54 shown in Fig. 1, is viewed from the windward side. Fig. 3 is a perspective view of main portions, showing the heat exchanger 1 shown in Fig. 2. Fig. 4 is a diagram showing internal configurations of distribution headers 2, 7 shown in Fig. 3. Fig. 5 is a flat cross-sectional diagram showing a folded-back header shown in Fig. 2. Note that Fig. 3 only shows corrugated fins 5 held between a pair of flat pipes 4 and corrugated fins 5 held between a pair of flat pipes 6 and does not show the other flat pipes 4, 6 and corrugated fins 5 that are arranged in parallel.

[0028] This heat exchanger 1 has a first distribution header 2 that is disposed in a direction perpendicular to the direction of the wind shown by the arrow C when seen in the vertical direction, a second distribution header 7 provided in parallel with the first distribution header 2, a plurality of first flat pipes 4, which are first heat transfer pipes that have lower ends connected to the first distribution header 2, have upper ends extending vertically, and are disposed at equal intervals, a folded-back header 3 that is provided in such a manner as to face the first distribution header 2 and the second distribution header 7 and has an upper portion of each of the first flat pipes 4 connected thereto, a plurality of second flat pipes 6, which are second heat transfer pipes that have upper ends connected to this folded-back header 3, have lower ends connected to the second distribution header 7, and are disposed at equal intervals, and the corrugated fins 5 that are provided in an air duct between the first flat pipes 4 adjacent to each other and an air duct between the second flat pipes 6 adjacent to each other.

[0029] The first distribution header 2 and the second distribution header 7 are in the same shape and have a rectangular cross section.

[0030] The first distribution header 2 has a refrigerant inflow portion 2A extending in a horizontal direction, to which the refrigerant flows in. The refrigerant piping is

connected to this refrigerant inflow portion 2A. The first distribution header 2 is also provided with a distribution pipe 2B that extends internally in the horizontal direction. A tip end of the refrigerant inflow portion 2A is connected vertically to this distribution pipe 2B.

[0031] The hollow second distribution header 7 has a refrigerant outflow portion 7A extending in the horizontal direction, of which the refrigerant flows out. The refrigerant piping is connected to this refrigerant outflow portion 7A.

[0032] A plurality of holes into which the lower ends of the first flat pipes 4 are inserted are formed in the first distribution header 2.

[0033] A plurality of holes into which the lower ends of the second flat pipes 6 are inserted are formed in the second distribution header 7.

[0034] The first distribution header 2 and the second distribution header 7 have, respectively, inclined surfaces 10, 11 having top surfaces thereof inclined downward from the windward side to the leeward side. The starting points of the inclined surfaces 10, 11 are located higher than upper connecting points of the first flat pipes 4 extending vertically from the first distribution header 2.

[0035] Note that a partition plate may be provided on the inside of each of the distribution headers 2, 7 in order to adjust the distribution ratio of each of the first and second flat pipes 4, 6.

[0036] Holes into which the upper ends of the first flat pipes 4 and second flat pipes 6 are inserted are formed in the folded-back header 3. The first flat pipes 4 and the second flat pipes 6 face each other in a longitudinal direction. A partition wall 8 is provided between a pair of first and second flat pipes 4 and 6 and a pair of first and second flat pipes 4 and 6 adjacent thereto. This partition wall 8 regulates the refrigerant to flow in the direction of the arrow A shown in Fig. 5.

[0037] The first distribution header 2, folded-back header 3, second distribution header 7, first flat pipes 4, second flat pipes 6, corrugated fins 5, and distribution pipe 2B are made of, for example, aluminum. The refrigerant inflow portion 2A and the refrigerant outflow portion 7A may be provided in plurality.

[0038] The first flat pipes 4 and the second flat pipes 6 are flat pipes that internally have a plurality of flow channels 4a, 6a extending individually in the vertical direction. The longitudinal direction of these rectangular first flat pipes 4 and second flat pipes 6 are the vertical direction, and the short direction thereof are positioned along the direction of the wind. The corrugated fins 5 and the first flat pipes 4 are preferably joined together by brazing, as well as the corrugated fins 5 and the second flat pipes 6. It should be noted that, needless to say, the number of first flat pipes 4 and the number of second flat pipes 6 are not limited to the numbers shown in Fig. 2.

[0039] The flow of the refrigerant in the heat exchanger 1 is described next.

[0040] The refrigerant flowing through the refrigerant piping flows into the first distribution header 2 through

the refrigerant inflow portion 2A, is then distributed, and then flows upward through each of the flow channels 4a of the plurality of first flat pipes 4 from the lower ends of the first flat pipes 4. While flowing through the first flat pipes 4, this refrigerant is subjected to heat exchange with air that is circulated through the corrugated fins 5 by the fans.

[0041] The refrigerant that is circulated through the first flat pipes 4 reaches the folded-back header 3, turns back at the folded-back header 3, and flows down each of the flow channels 6a of the second flat pipes 6. While flowing through the first flat pipes 4, this refrigerant is subjected to heat exchange with air that is circulated through the corrugated fins 5 by the fans.

[0042] The refrigerant that flows down each of the second flat pipes 6 joins at the second distribution header 7 and flows out to the refrigerant piping through the refrigerant outflow portion 7A. The direction of the flow of the refrigerant can be reversed.

[0043] The effects of the heat exchanger 1 having the foregoing configuration are described next.

[0044] As shown in Fig. 6, drops of water 12 drained into the first distribution header 2 and the second distribution header 7 flow in the direction of gravity shown by the arrow B, due to the inclined surfaces 10, 11 of the first distribution header 2 and the second distribution header 7. The wind flowing through the heat exchanger 1 flows along the inclined surfaces 10, 11 of the distribution headers 2, 7 as shown by the arrow C; thus, the gravity and the force of the wind facilitate the flow of the drops of water 12. Consequently, the drainage capability improves, resulting in an improvement of anti-frosting performance of the headers 2, 7 themselves.

[0045] Fig. 7 is a perspective view of main portions, showing a modification of the heat exchanger 1 according to Embodiment 1 of the present invention.

[0046] In this modification, the inclined surfaces 10, 11 are in the shape of an arc, sagging from the windward side to the leeward side.

[0047] The starting point of the inclined surface 10 is located higher than the upper connecting points of the first flat pipes 4 extending vertically from the first distribution header 2. The starting point of the inclined surface 11 is located higher than the upper connecting points of the second flat pipes 6 extending vertically from the second distribution header 7.

[0048] The rest of the configuration is the same as that of the heat exchanger 1 shown in Fig. 3.

[0049] In this modification, the drops of water 12 drained into the first distribution header 2 and the second distribution header 7 flow in the direction of gravity due to the inclination of the inclined surfaces 10, 11. In addition, because the inclined surfaces 10, 11 at the top surfaces of the distribution headers 2, 7 have a streamlined shape, the wind flowing through the heat exchanger 1 flows along the distribution headers 2, 7 more as compared to a linear-shaped inclined surface, and thus, the gravity and the force of the wind facilitate the flow of the

drops of water 12.

[0050] Consequently, the drainage capability of the distribution headers 2, 7 improve, resulting in an improvement of their anti-frosting performance.

[0051] Fig. 8 is a perspective view of main portions, showing another modification of the heat exchanger 1 according to Embodiment 1 of the present invention. In this modification, the inclined surfaces 10, 11 at the top surfaces are in the same shape as those shown in Fig. 3; however this modification is different from Embodiment 1 in that the surface of the first distribution header 2 and the surface of the second distribution header 7 that face each other have inclined surfaces 13, 14, respectively, which are configured such that a distance therebetween increases as the inclined surfaces 13, 14 incline downward.

[0052] The rest of the configuration is the same as that of the heat exchanger 1 shown in Fig. 3.

[0053] For example, when a plurality of heat exchangers 1 are arranged in rows, in some cases the distance between each first distribution header 2 and each second distribution header 7 needs to be reduced due to limitations in installation space.

[0054] In such a case, the drops of water 12 flowing down the top surfaces of the first distribution header 2 and second distribution header 7 bridge the space between the first distribution header 2 and the second distribution header 7 due to the surface tension, growing frost on the bridged section.

[0055] In order to cope with this situation, the first distribution header 2 and the second distribution header 7 have, on the surfaces thereof facing each other, the inclined surfaces 13, 14 that are inclined vertically, wherein the distance between the inclined surfaces 13, 14 increases gradually toward the lower side thereof.

[0056] Accordingly, as shown in Fig. 9, the drops of water 12 do not bridge the space between the first distribution header 2 and the second distribution header 7 easily, improving anti-frosting performance of the first distribution header 2 and the second distribution header 7.

Embodiment 2.

[0057] Fig. 10 is a perspective view showing main portions of a heat exchanger according to Embodiment 2 of the present invention.

[0058] In this embodiment, front edge portions of the corrugated fins 5 protrude toward the windward side from the windward end surfaces of the first flat pipes 4 and second flat pipes 6.

[0059] Also, the corrugated fins 5 are inclined gradually downward from the windward side toward the leeward side.

[0060] The rest of the configuration is the same as that of the heat exchanger 1 of Embodiment 1.

[0061] In this embodiment, because the front edge portions of the fins 5 protrude toward the windward side from the windward side of the flat pipes 4, 6, drops of water

12 at the front edge portions of the corrugated fins 5 drip without being transferred to the flat pipes 4, 6, resulting in an improvement of the drainage capability of the corrugated fins 5.

[0062] In addition, the downward inclination of the corrugated fins 5 from the windward side to the leeward side enables drainage of water using both the gravity and the force of the wind, further improving the drainage capability of the corrugated fins 5.

Embodiment 3.

[0063] Fig. 11 is a side view showing main portions of a heat exchanger 1 according to Embodiment 3 of the present invention.

[0064] In this embodiment, the both sides of the fins 5 are brazed by the flat pipes 4, 6 at joint portions 15 and inclined downward from the windward side to the leeward side.

[0065] Moreover, drainage grooves 9, which are inclined along the joint portions 15 between the flat pipes 4, 6 and the corrugated fins 5 and extend linearly, are formed in the flat pipes 4, 6.

[0066] The rest of the configuration is the same as that of the heat exchanger 1 of Embodiment 2.

[0067] In this embodiment, drops of water 12 are transferred from the corrugated fins 5 to the first flat pipes 4 and the second flat pipes 6 and pool in the drainage grooves 9 due to gravity. The drops of water 12 pooling in the drainage grooves 9 are pushed out by both the gravity and the force of the wind, improving the drainage capability of the first flat pipes 4 and second flat pipes 6.

[0068] Each of the foregoing embodiments has described a case where the heat exchanger is used in the air conditioner; however, needless to say, the applications of the heat exchanger are not limited to an air conditioner. For example, the heat exchanger may be used in other refrigeration cycle devices having a refrigerant circulation circuit.

[0069] Each of the foregoing embodiments has also described the case where the air conditioner switches between the cooling operation and the heating operation; however, the present invention is not limited thereto and the air conditioner may perform either the cooling operation or the heating operation.

[0070] The corrugated fins 5 are merely an example; thus, the shape of the fins does not have to be corrugated.

[0071] The first flat pipes 4 and the second flat pipes 6, too, are merely an example; thus, the shape of the pipes does not have to be flat.

Reference Signs List

[0072]

- | | |
|----|----------------------------|
| 1 | Heat exchanger |
| 2 | First distribution header |
| 2A | Refrigerant inflow portion |

- | | | |
|----|--|--|
| 2B | Distribution pipe | |
| 3 | Folded-back header | |
| 4 | First flat pipe (first heat transfer pipe) | |
| 5 | Corrugated fin | |
| 5 | 6 | Second flat pipe (second heat transfer pipe) |
| 7 | Second distribution header | |
| 7A | Refrigerant outflow portion | |
| 8 | Partition wall | |
| 9 | Drainage groove | |
| 10 | 15 | Joint portion |
| 51 | Air conditioner | |
| 52 | Compressor | |
| 53 | Four-way valve | |
| 54 | Heat source-side heat exchanger | |
| 15 | 55 | Throttle device |
| 56 | Load-side heat exchanger | |
| 57 | Heat source-side fan | |
| 58 | Load-side fan | |
| 59 | Controller | |
| 20 | 60A to C | First solenoid valve |
| 61 | Second solenoid valve | |

Claims

1. A heat exchanger, comprising:

a plurality of heat transfer pipes that are disposed in parallel with spaces therebetween; distribution headers that are respectively connected to lower ends of the plurality of heat transfer pipes so as to communicate with the heat transfer pipes and distribute a refrigerant; and a plurality of fins that are provided in an air duct between the heat transfer pipes adjacent to each other, wherein the distribution headers have top surfaces inclined downward from a windward side to a leeward side.

2. The heat exchanger according to claim 1, wherein inclined surfaces, which are the inclined top surfaces, each have an arc shape protruding upward at a middle portion.

3. The heat exchanger according to claim 1 or 2, wherein the distribution headers are arranged at least in two rows toward a direction of wind, and opposing surfaces thereof facing each other are inclined surfaces that are configured such that a distance therebetween increases toward a lower side.

4. The heat exchanger according to any one of claims 1 to 3, wherein end surfaces of the fins on the windward side protrude toward the windward side from end surfaces of the heat transfer pipes on the windward side.

5. The heat exchanger according to any one of claims 1 to 4, wherein the fins are provided to be inclined downward from the windward side to the leeward side. 5
6. The heat exchanger according to any one of claims 1 to 5, wherein grooves that are inclined downward from the windward side to the leeward side are formed on surfaces of joint portions between the heat transfer pipes and the fins. 10
7. The heat exchanger according to any one of claims 1 to 6, wherein the heat transfer pipes are flat pipes which have a plurality of flow channels, and the longitudinal direction of which is a vertical direction. 15
8. The heat exchanger according to any one of claims 1 to 7, wherein the fins are corrugated fins.
9. The heat exchanger according to any one of claims 1 to 8, wherein the heat exchanger is a heat source-side heat exchanger of an air conditioner, and a direction of flow of the refrigerant in the heat source-side heat exchanger is the same in both defrosting and heating. 20 25

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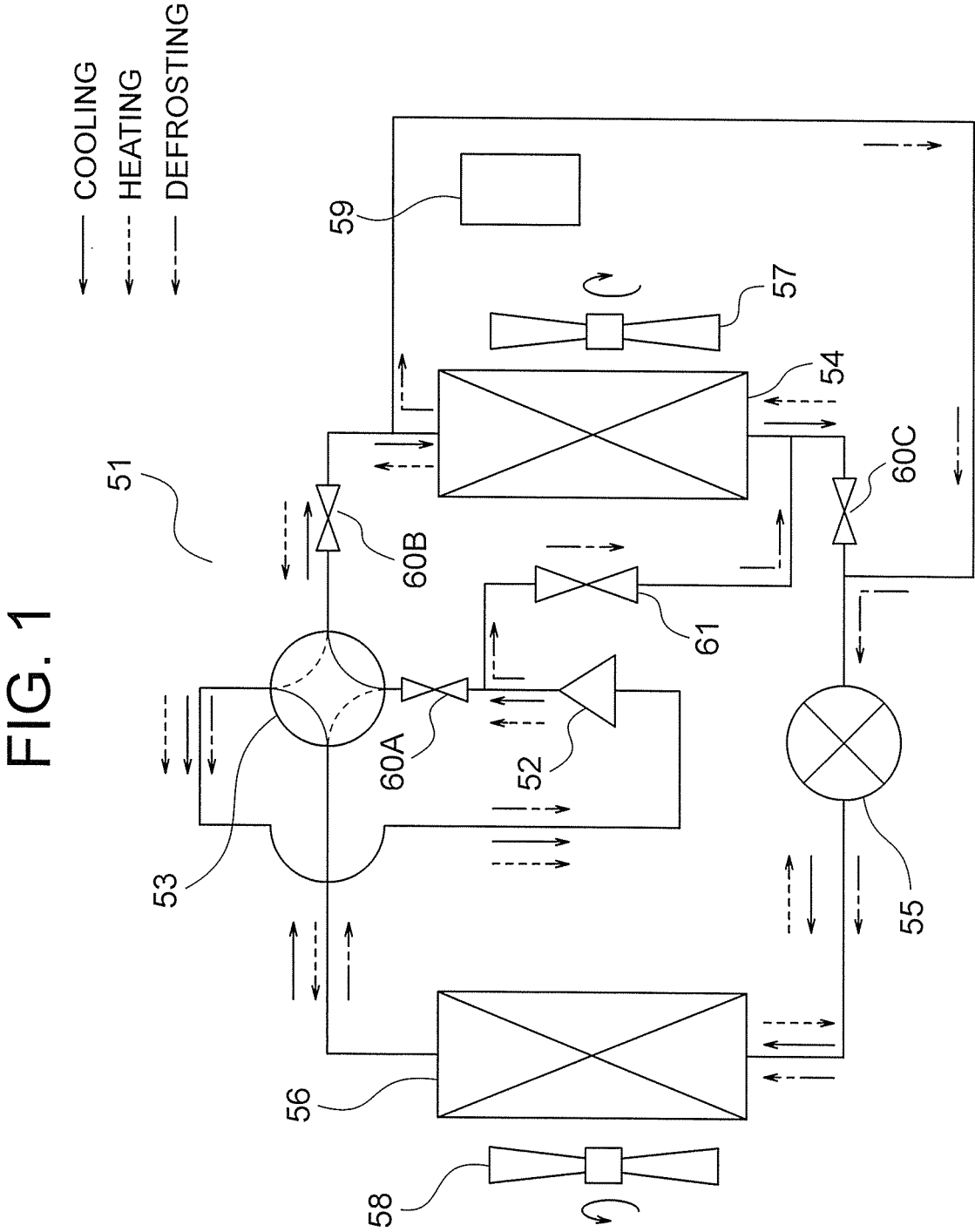


FIG. 2

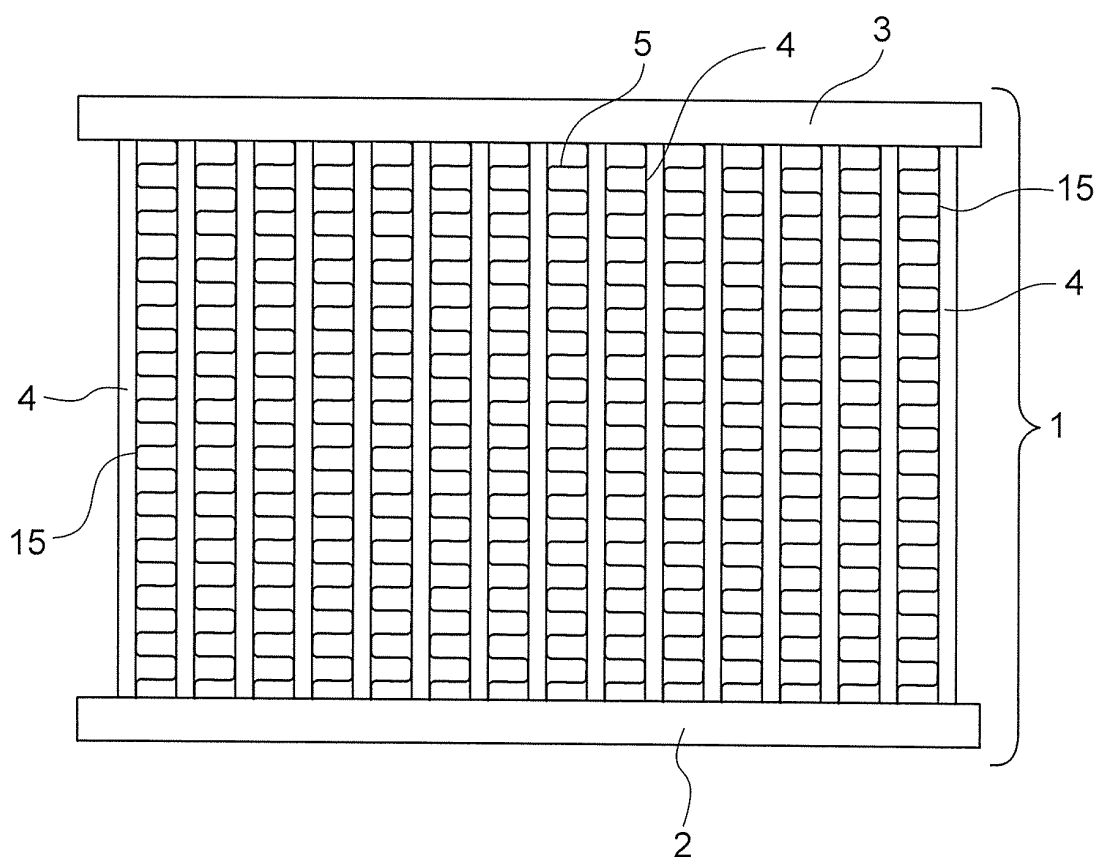


FIG. 3

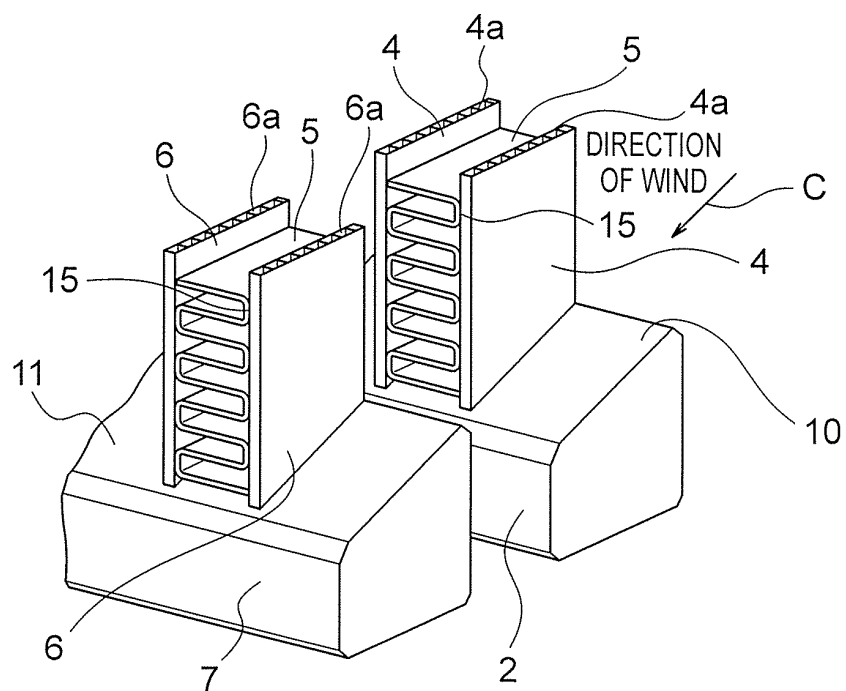


FIG. 4

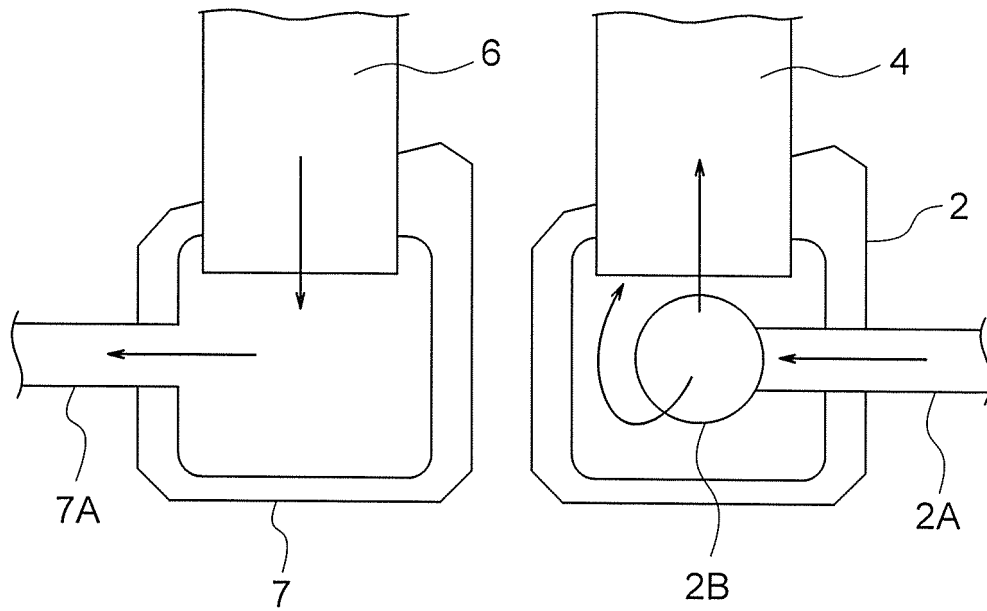


FIG. 5

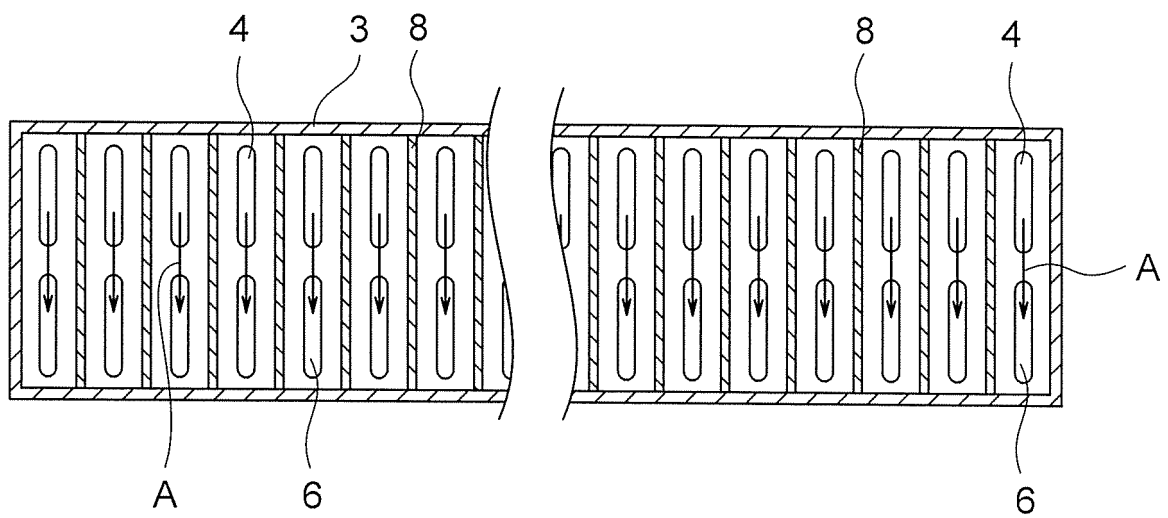


FIG. 6

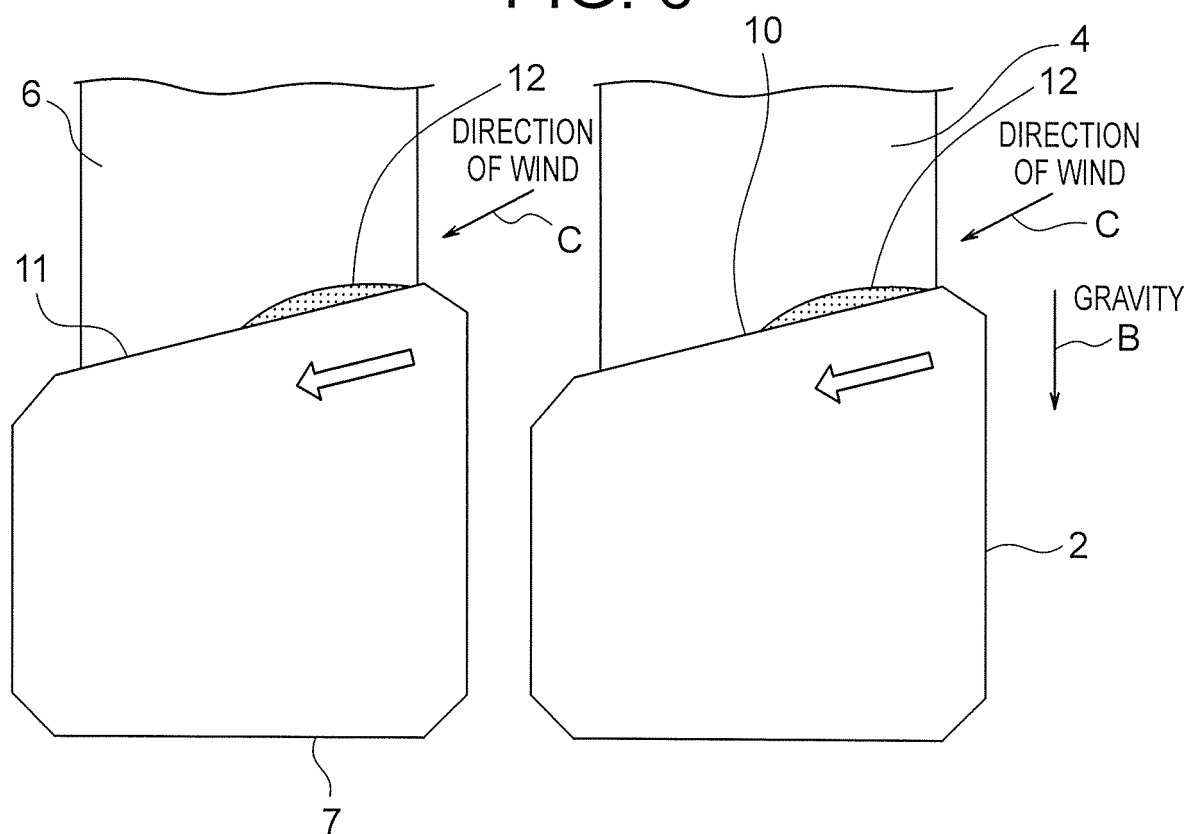


FIG. 7

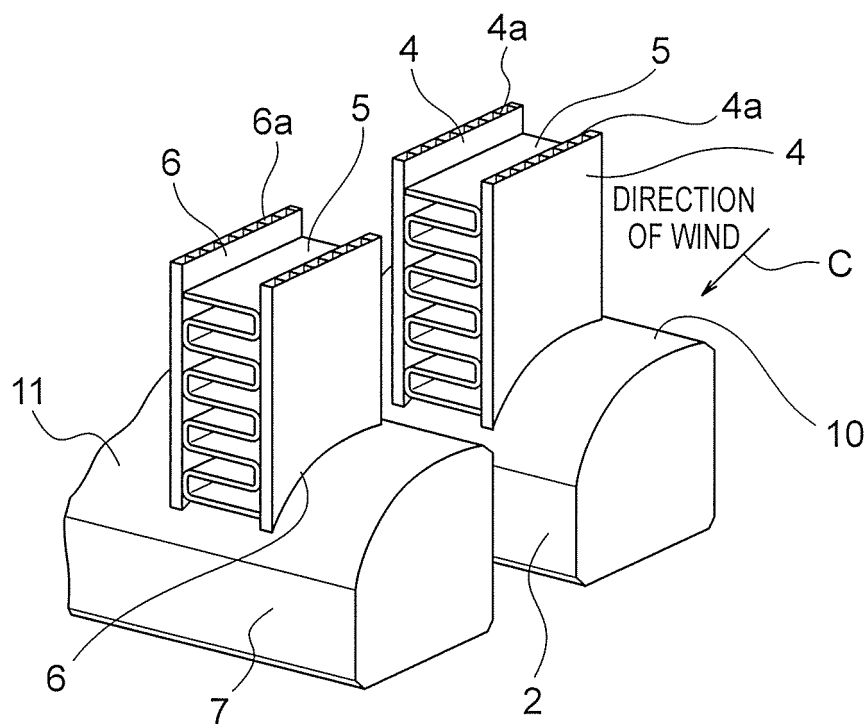


FIG. 8

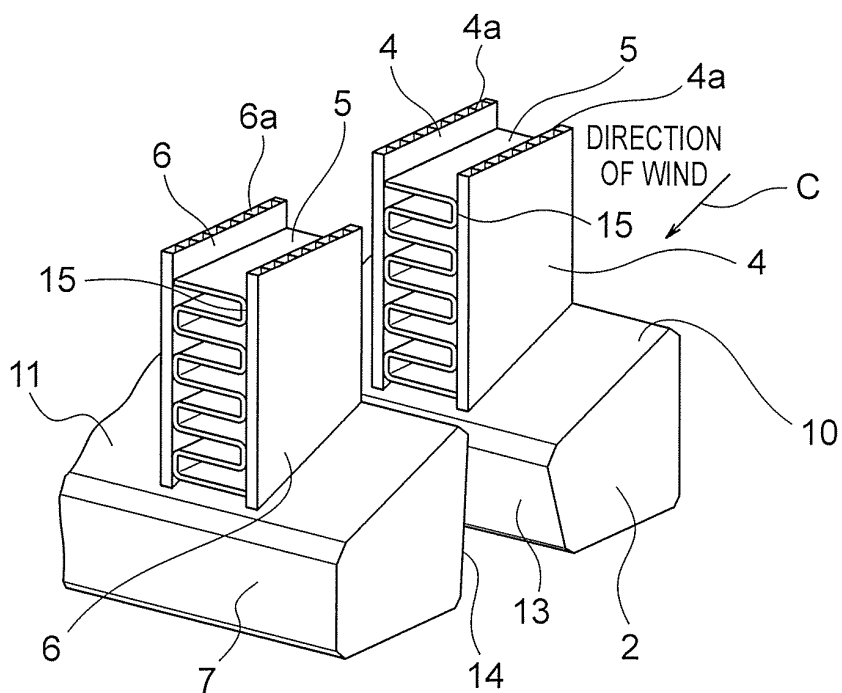


FIG. 9

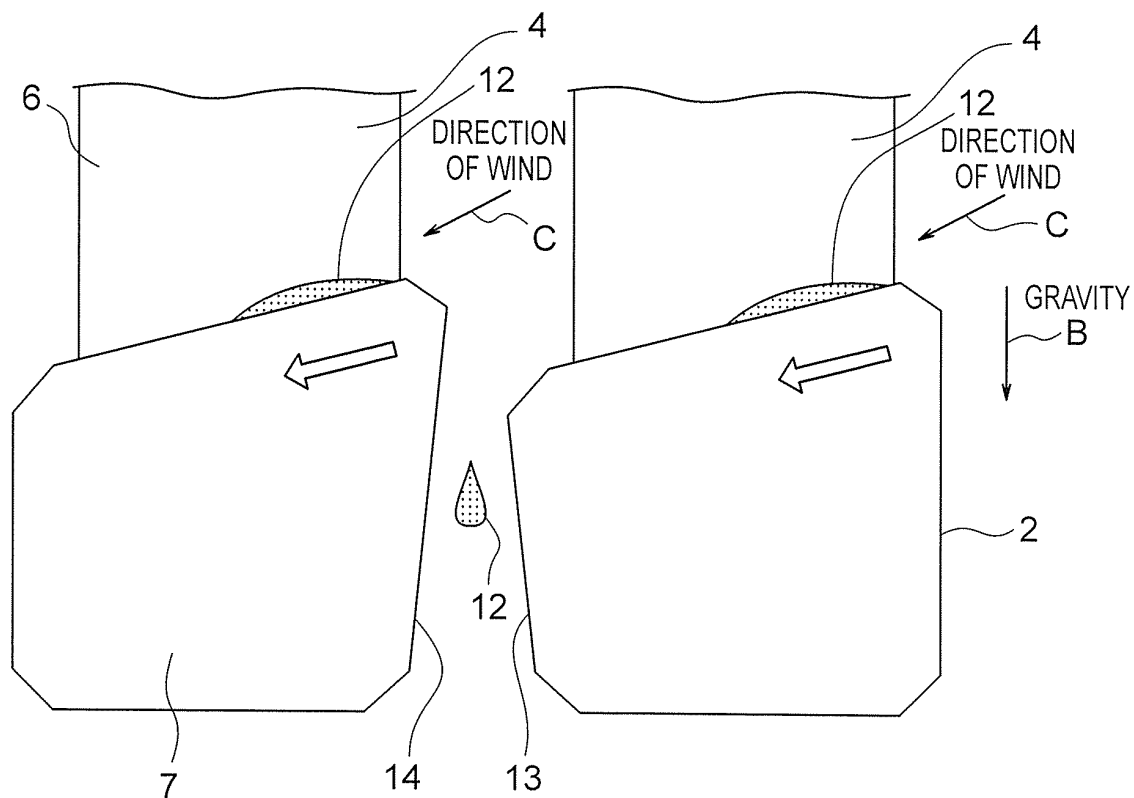


FIG. 10

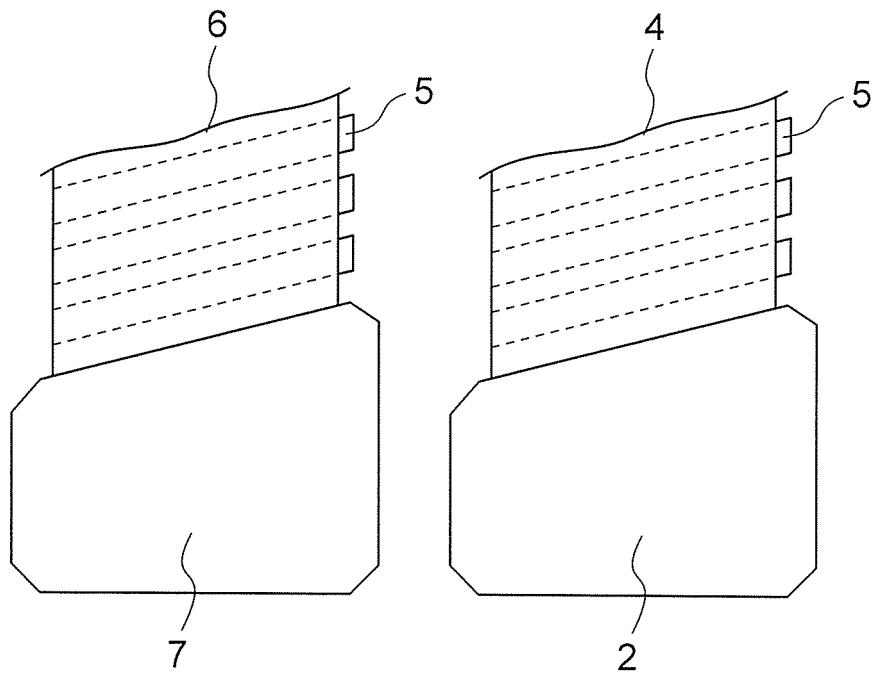
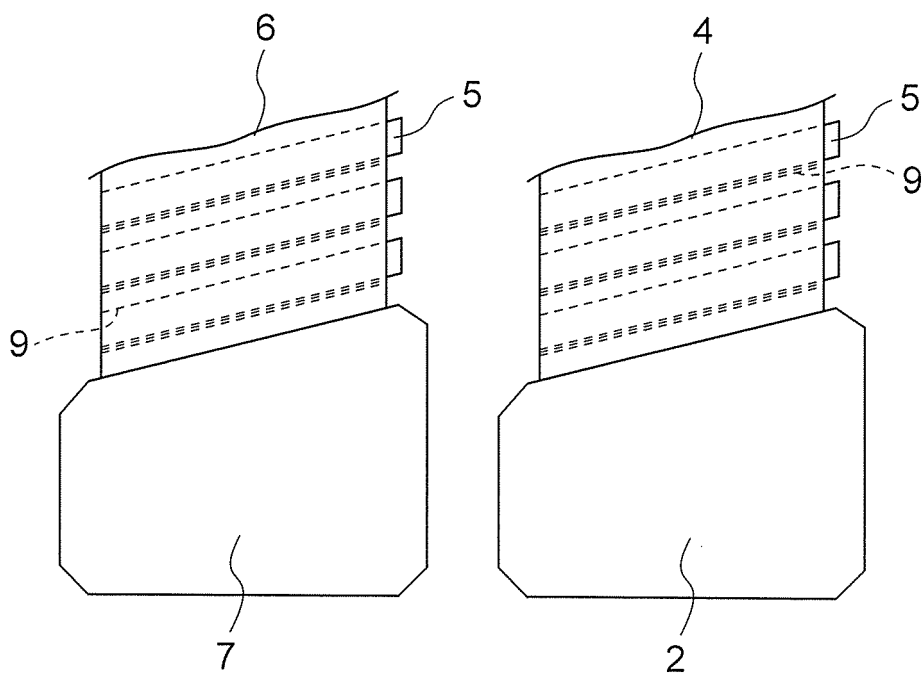


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/065766

A. CLASSIFICATION OF SUBJECT MATTER

F28F9/02(2006.01)i, F25B39/02(2006.01)i, F28D1/053(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)

F28F9/02, F25B39/02, F28D1/053

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	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 101179/1991(Laid-open No. 52581/1993) (Showa Aluminum Corp.), 13 July 1993 (13.07.1993), paragraphs [0020] to [0025]; fig. 4 (Family: none)	1-9
Y	JP 2004-53132 A (Denso Corp.), 19 February 2004 (19.02.2004), claim 3; paragraph [0010]; fig. 7 & US 2004/0016535 A1	1-9

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

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-108583 A (Calsonic Corp.), 23 April 1999 (23.04.1999), paragraph [0028]; fig. 2 (Family: none)	2-9
Y	JP 2006-170601 A (Showa Denko Kabushiki Kaisha), 29 June 2006 (29.06.2006), claims 2, 8; fig. 7 & US 2008/0302131 A1	4-9
Y	JP 2009-299963 A (Sharp Corp.), 24 December 2009 (24.12.2009), paragraphs [0028], [0032]; fig. 2 (Family: none)	5-9
Y	JP 7-190661 A (Hitachi, Ltd.), 28 July 1995 (28.07.1995), paragraphs [0020] to [0021]; fig. 1 (Family: none)	6-9
Y	JP 61-89449 A (Hitachi, Ltd.), 07 May 1986 (07.05.1986), claims; fig. 1 to 5 (Family: none)	9

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Patent documents cited in the description

- JP 2006170601 A [0003]