



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

(43) Date of publication:  
**04.01.2017 Bulletin 2017/01**

(51) Int Cl.:  
**F28F 9/02** <sup>(2006.01)</sup> **F25B 39/02** <sup>(2006.01)</sup>  
**F25B 39/04** <sup>(2006.01)</sup> **F28D 1/053** <sup>(2006.01)</sup>

(21) Application number: **14879458.9**

(86) International application number:  
**PCT/JP2014/051665**

(22) Date of filing: **27.01.2014**

(87) International publication number:  
**WO 2015/111216 (30.07.2015 Gazette 2015/30)**

(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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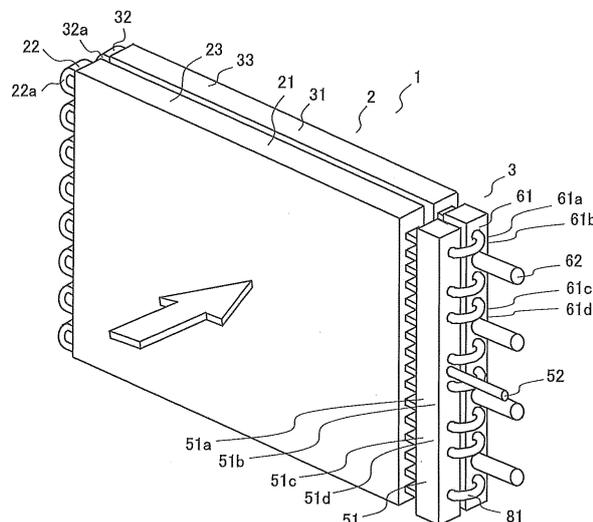
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(54) **LAMINATED HEADER, HEAT EXCHANGER, AND AIR CONDITIONING DEVICE**

(57) A stacking header 3 includes a first plate unit having a first inlet flow path and a first outlet flow path, a second plate unit attached to the first plate unit and having at least a part of a first passing flow path for refrigerant flowing from the first inlet flow path to pass through and at least a part of a second passing flow path for refrigerant

to pass through to the first outlet flow path, and a first pipe connecting an end portion of the first passing flow path not communicating with the first inlet flow path and an end portion of the second passing flow path not communicating with the first outlet flow path, to constitute a first turnback flow path.

FIG. 1



## Description

### Technical Field

**[0001]** The present invention relates to a stacking header, a heat exchanger, and an air-conditioning apparatus.

### Background Art

**[0002]** Some of existing stacking headers include a first plate unit having a plurality of outlet flow paths, and a second plate unit stacked on the first plate unit and having a distribution flow path for distributing refrigerant to the plurality of outlet flow paths (see, for example, Patent Literature 1).

### Citation List

#### Patent Literature

**[0003]** Patent Literature 1: Japanese Unexamined Patent Application Publication No. 6-11291 (Paragraphs [0012] to [0028], Fig. 1 to Fig. 9)

### Summary of Invention

#### Technical Problem

**[0004]** Such an existing stacking header has a single row of outlet flow paths. Thus, for example, when the stacking header is employed for an apparatus such as a heat exchanger including a plurality of heat exchange units aligned in an airflow direction, the refrigerant flowing out of each of the outlet flow paths has to be branched into a plurality of rows in a part of the apparatus other than the stacking header using pipes or other components, leading to complication of the structure of the apparatus for which the stacking header is employed.

**[0005]** The present invention has been accomplished in view of the foregoing problem, and provides a stacking header that eases the complication of the structure of the apparatus for which the stacking header is employed. The present invention also provides a heat exchanger including such a stacking header. Further, the present invention provides an air-conditioning apparatus including such a heat exchanger. Solution to Problem

**[0006]** An embodiment of the present invention provides a stacking header including a first plate unit having a first inlet flow path and a first outlet flow path, a second plate unit attached to the first plate unit and having at least a part of a first passing flow path for refrigerant flowing from the first inlet flow path to pass through and at least a part of a second passing flow path for refrigerant to pass through to the first outlet flow path, and a first pipe connecting an end portion of the first passing flow path not communicating with the first inlet flow path and an end portion of the second passing flow path not com-

municating with the first outlet flow path, to constitute a first turnback flow path.

#### Advantageous Effects of Invention

**[0007]** The stacking header according to the embodiment of the present invention includes the first plate unit having the first inlet flow path and the first outlet flow path, the second plate unit attached to the first plate unit and having at least a part of the first passing flow path for refrigerant flowing from the first inlet flow path to pass through and at least a part of the second passing flow path for refrigerant to pass through to the first outlet flow path, and the first pipe connecting the end portion of the first passing flow path not communicating with the first inlet flow path and the end portion of the second passing flow path not communicating with the first outlet flow path, to constitute the first turnback flow path. Such a configuration eliminates the need to employ pipes or other components to branch the refrigerant into a plurality of rows in the part of the apparatus other than the stacking header, thereby easing the complication of the structure of the apparatus for which the stacking header is employed.

#### 25 Brief Description of Drawings

#### **[0008]**

[Fig. 1] Fig. 1 is a perspective view of a heat exchanger according to Embodiment 1.

[Fig. 2] Fig. 2 is an exploded perspective view of a first-row divisional unit and associated components, in the heat exchanger according to Embodiment 1.

[Fig. 3] Fig. 3 is an exploded perspective view of a second-row divisional unit and associated components, in the heat exchanger according to Embodiment 1.

[Fig. 4] Fig. 4 is a block diagram showing a configuration of an air-conditioning apparatus including the heat exchanger according to Embodiment 1.

[Fig. 5] Fig. 5 is another block diagram showing the configuration of the air-conditioning apparatus including the heat exchanger according to Embodiment 1.

[Fig. 6] Fig. 6 is a schematic cross-sectional view for explaining the details of a first passing flow path and a second passing flow path of the heat exchanger according to Embodiment 1.

[Fig. 7] Fig. 7 is a graph showing a relationship between a flow path length L2 and uniformity of refrigerant, realized when the heat exchanger according to Embodiment 1 acts as evaporator.

[Fig. 8] Fig. 8 is a graph showing a relationship between a flow path length L1 and uniformity of refrigerant, realized when the heat exchanger according to Embodiment 1 acts as condenser.

[Fig. 9] Fig. 9 is a perspective view of a heat exchanger according to Embodiment 2.

[Fig. 10] Fig. 10 is an exploded perspective view of a third-row divisional unit and associated components, in the heat exchanger according to Embodiment 2.

[Fig. 11] Fig. 11 is a perspective view of a heat exchanger according to Embodiment 3.

[Fig. 12] Fig. 12 is an exploded perspective view of a second-row divisional unit and associated components, in the heat exchanger according to Embodiment 3. Description of Embodiments

**[0009]** Hereafter, a stacking header according to the present invention will be described with reference to the drawings.

**[0010]** Configurations described hereafter are merely exemplary, and the configurations of the stacking header according to the present invention are not limited to the description given hereafter. In the drawings, the same or similar components will be given the same reference signs, or may be cited without the reference signs. Minor details of the configuration may be simplified or omitted, as the case may be. Descriptions of the same or similar configurations may be simplified or omitted, as the case may be.

**[0011]** Although the stacking header according to the present invention is utilized to distribute refrigerant flowing into a heat exchanger in the following description, the stacking header according to the present invention may be employed to distribute the refrigerant flowing into a different apparatus. Although the heat exchanger including the stacking header according to the present invention is employed in an air-conditioning apparatus in the following description, the heat exchanger is not limited to the configuration. The heat exchanger may be incorporated in another refrigeration cycle apparatus having a refrigerant circuit. Further, although the heat exchanger including the stacking header according to the present invention is an outdoor heat exchanger of the air-conditioning apparatus in the following description, the heat exchanger is not limited to the configuration. The heat exchanger may be an indoor heat exchanger of the air-conditioning apparatus. In addition, although the air-conditioning apparatus is configured to switch between a heating operation and a cooling operation in the following description, the air-conditioning apparatus is not limited to the configuration. The air-conditioning apparatus may be configured to perform only either of the heating operation and the cooling operation.

#### Embodiment 1

**[0012]** The heat exchanger according to Embodiment 1 will be described.

#### < Configuration of Heat Exchanger >

**[0013]** Hereafter, a configuration of the heat exchanger according to Embodiment 1 will be described.

#### (General Configuration of Heat Exchanger)

**[0014]** Hereafter, a general configuration of the heat exchanger according to Embodiment 1 will be described.

**[0015]** Fig. 1 is a perspective view of the heat exchanger according to Embodiment 1.

**[0016]** As shown in Fig. 1, the heat exchanger 1 includes a heat exchange unit 2 and a stacking header 3.

**[0017]** The heat exchange unit 2 includes a first-row heat exchange unit 21 located on the windward side in the flow direction of air passing through the heat exchange unit 2 (blank arrow in Fig. 1), and a second-row heat exchange unit 31 located on the leeward side in the air flow direction. The first-row heat exchange unit 21 includes a plurality of first-row heat transfer pipes 22, and a plurality of first-row fins 23 joined to the first-row heat transfer pipes 22, for example, by brazing. The second-row heat exchange unit 31 includes a plurality of second-row heat transfer pipes 32, and a plurality of second-row fins 33 joined to the second-row heat transfer pipes 32, for example, by brazing. Although eight each of the first-row heat transfer pipes 22 and the second-row heat transfer pipes 32 are illustrated in Fig. 1 and other drawings, each of the numbers of the first-row heat transfer pipes 22 and the second-row heat transfer pipes 32 is not specifically limited, and may be any number including one. The first-row heat transfer pipe 22 corresponds to the first heat transfer pipe in the present invention. The second-row heat transfer pipe 32 corresponds to the second heat transfer pipe in the present invention.

**[0018]** The first-row heat transfer pipes 22 and the second-row heat transfer pipes 32 are flat pipes, each having a plurality of flow paths aligned in the direction of the major axis. Each of the first-row heat transfer pipes 22 and the plurality of second-row heat transfer pipes 32 is bent in a hair-pin shape between one end portion and the other end portion, to form a corresponding one of turnback sections 22a and 32a. The first-row heat transfer pipes 22 and the second-row heat transfer pipes 32 are arranged in a plurality of columns stacked in a direction intersecting the flow of air passing through the heat exchange unit 2 (blank arrow in Fig. 1). The plurality of first-row heat transfer pipes 22 and the plurality of second-row heat transfer pipes 32 are preferably deviated from each other in a height direction when the heat exchange unit 2 is viewed in the airflow direction. Such a configuration improves the heat exchange efficiency. The respective first end portions and second end portions of the plurality of first-row heat transfer pipes 22 and the plurality of second-row heat transfer pipes 32 are aligned to oppose the stacking header 3.

**[0019]** The stacking header 3 includes a first-row divisional unit 51 and a second-row divisional unit 61 divided in the direction of the stages of the heat exchange unit 2. A non-illustrated pipe is connected to the first-row divisional unit 51 via a joint pipe 52. To the second-row divisional unit 61, a plurality of pipes (not shown) are connected via a plurality of joint pipes 62. The joint pipe

52 and the joint pipe 62 are, for example, round pipes. The first-row divisional unit 51 and the second-row divisional unit 61 may be formed in a unified body. The first-row divisional unit 51 corresponds to the first divisional unit in the present invention, and the second-row divisional unit 61 corresponds to the second divisional unit in the present invention.

**[0020]** The first-row divisional unit 51 has a plurality of first-row outlet flow paths 51 a, a distribution flow path 51 b, a plurality of first-row inlet flow paths 51 c, and a plurality of first-row passing flow paths 51 d. The first-row outlet flow path 51 a corresponds to the second outlet flow path in the present invention. The first-row inlet flow path 51 c corresponds to the first inlet flow path in the present invention. The first-row passing flow path 51 d corresponds to the first passing flow path in the present invention.

**[0021]** One end portion of the first-row heat transfer pipe 22 is connected to the first-row outlet flow path 51 a, and the other end portion of the first-row heat transfer pipe 22 is connected to the first-row inlet flow path 51 c. One end portion of the distribution flow path 51 b is connected to the joint pipe 52, and the other end portions of the distribution flow path 51 b are connected to the plurality of first-row outlet flow paths 51 a. One end portion of the first-row passing flow path 51 d is connected to the first-row inlet flow path 51 c, and the other end portion of the first-row passing flow path 51 d is connected to the U-pipe 81.

**[0022]** The second-row divisional unit 61 has a plurality of second-row outlet flow paths 61 a, a plurality of second-row passing flow paths 61 b, a plurality of second-row inlet flow paths 61 c, and a plurality of junction flow paths 61 d. The second-row outlet flow path 61 a corresponds to the first outlet flow path in the present invention. The second-row passing flow path 61 b corresponds to the second passing flow path in the present invention. The second-row inlet flow path 61 c corresponds to the second inlet flow path in the present invention. The junction flow path 61 d corresponds to the first junction flow path in the present invention.

**[0023]** One end portion of the second-row heat transfer pipe 32 is connected to the second-row outlet flow path 61 a, and the other end portion of the second-row heat transfer pipe 32 is connected to the second-row inlet flow path 61 c. One end portion of the second-row passing flow path 61 b is connected to the U-pipe 81, and the other end portion of the second-row passing flow path 61 b is connected to the second-row outlet flow path 61 a. One end portions of the junction flow path 61 d are connected to the plurality of second-row inlet flow paths 61 c, and the other end portion of the junction flow path 61 d is connected to the joint pipe 62.

**[0024]** The U-pipe 81 may have another shape than the U shape. The U-pipe 81 may be connected to the first-row passing flow path 51 d and the second-row passing flow path 61 b, either directly or via an intermediate member. The U-pipe 81 may be formed of a metal, for

example. The U-pipe 81 corresponds to the first pipe in the present invention. The first-row inlet flow path 51 c, the first-row passing flow path 51 d, the U-pipe 81, the second-row passing flow path 61 b, and the second-row outlet flow path 61 a each correspond to the part of the first turnback flow path in the present invention.

**[0025]** When the heat exchanger 1 acts as evaporator, the refrigerant flows into the distribution flow path 51 b through the joint pipe 52 thus to be distributed to the plurality of first-row outlet flow paths 51 a, and flows into the plurality of first-row inlet flow paths 51 c through the plurality of first-row heat transfer pipes 22. The refrigerant having entered the plurality of first-row inlet flow paths 51 c passes through the plurality of first-row passing flow paths 51 d, the plurality of U-pipes 81, and the plurality of second-row passing flow paths 61 b in this order, and flows into the plurality of second-row outlet flow paths 61 a. The refrigerant having entered the plurality of second-row outlet flow paths 61 a flows into the plurality of second-row inlet flow paths 61 c through the plurality of second-row heat transfer pipes 32, and flows out of the joint pipe 62 after being merged in the junction flow path 61 d.

**[0026]** When the heat exchanger 1 acts as condenser, the refrigerant flows into the junction flow path 61 d through the joint pipe 62 thus to be distributed to the plurality of second-row inlet flow paths 61 c, and flows into the plurality of second-row outlet flow paths 61 a through the plurality of second-row heat transfer pipes 32. The refrigerant having entered the plurality of second-row outlet flow paths 61 a passes through the plurality of second-row passing flow paths 61 b, the plurality of U-pipes 81, and the plurality of first-row passing flow paths 51 d in this order and flows into the plurality of first-row inlet flow paths 51 c. The refrigerant having entered the plurality of first-row inlet flow paths 51 c flows into the plurality of first-row outlet flow paths 51 a through the plurality of first-row heat transfer pipes 22, and flows out of the joint pipe 52 after being merged in the distribution flow path 51 b.

**[0027]** Although Fig. 1 and other drawings represent the case where one joint pipe 52 is provided, in other words, one distribution flow path 51 b is provided, a plurality of sets of the joint pipe 52 and the distribution flow path 51 b may be provided. Likewise, although Fig. 1 and other drawings represent the case where four joint pipes 62 are provided, in other words, four junction flow paths 61 d are provided, a different number of sets of the joint pipe 62 and the junction flow path 61 d may be provided. Providing four sets of the joint pipe 62 and the junction flow path 61 d allows reduction of the width of the second-row divisional unit 61 in the direction of the rows of the heat exchange unit 2. Further, although Fig. 1 and other drawings represent the case where the joint pipe 52, the joint pipes 62, and the U-pipes 81 are connected to the face of the stacking header 3 opposite to the face on the side of the heat exchange unit 2, those pipes may be connected to another face of the stacking header 3.

(Configuration of Stacking Header)

**[0028]** Hereafter, a configuration of the stacking header of the heat exchanger according to Embodiment 1 will be described.

**[0029]** Fig. 2 is an exploded perspective view of the first-row divisional unit and associated components, in the heat exchanger according to Embodiment 1. Fig. 3 is an exploded perspective view of the second-row divisional unit and associated components, in the heat exchanger according to Embodiment 1. Arrows in Fig. 2 and Fig. 3 indicate the flow of the refrigerant realized when the heat exchanger 1 acts as evaporator.

**[0030]** As shown in Fig. 2, the first-row divisional unit 51 includes a first-row first plate unit 53 and a first-row second plate unit 54 stacked on the first-row first plate unit 53. The first-row first plate unit 53 corresponds to a part of the first plate unit in the present invention. The first-row second plate unit 54 corresponds to a part of the second plate unit in the present invention.

**[0031]** The first-row first plate unit 53 includes a plate member 53\_1, and the first-row second plate unit 54 includes a plurality of plate members 54\_1 to 54\_7. The end portions of the first-row heat transfer pipes 22 are supported by a first-row retention member 24, and the plate member 53\_1 and the plurality of plate members 54\_1 to 54\_7 are joined to the first-row retention member 24 via a plurality of plate-shaped clad members 55\_1 to 55\_8, for example, by brazing. A brazing material is applied to one or both surfaces of each of the clad members 55\_1 to 55\_8. The clad members 55\_1 to 55\_8 serve as joint layers between the first-row retention member 24 and the plate members 53\_1 and 54\_1 to 54\_7. In addition, the flow paths formed in the clad members 55\_1 to 55\_8 assure the isolation of the refrigerant in the adjacent flow paths in the plate members 53\_1 and 54\_1 to 54\_7 from each other. The first-row retention member 24, the plate members 53\_1 and 54\_1 to 54\_7, and the clad members 55\_1 to 55\_8 may be, for example, made of aluminum. The first-row retention member 24 and the plate members 53\_1 and 54\_1 to 54\_7 may be directly joined to each other, without the intermediation of the plurality of clad members 55\_1 to 55\_8.

**[0032]** The first-row first plate unit 53 has the plurality of first-row outlet flow paths 51 a and the plurality of first-row inlet flow paths 51 c, aligned in a row. The plurality of first-row outlet flow paths 51 a and the plurality of first-row inlet flow paths 51 c are formed in a shape that fits the outer circumferential shape of the first-row heat transfer pipe 22. The end portions of the first-row heat transfer pipes 22 stick out from the first-row retention member 24, and the first-row first plate unit 53 is joined to the first-row retention member 24 so that the end portions of the first-row heat transfer pipes 22 are inserted into the plurality of first-row outlet flow paths 51 a and the plurality of first-row inlet flow paths 51 c. Alternatively, the end portions of the first-row heat transfer pipes 22 may be directly connected to the plurality of first-row outlet flow

paths 51 a and the plurality of first-row inlet flow paths 51 c, without the intermediation of the first-row retention member 24 supporting the end portions of the first-row heat transfer pipes 22. The end faces of the first-row heat transfer pipes 22 may stick out from the first-row first plate unit 53, or the plurality of first-row outlet flow paths 51 a and the plurality of first-row inlet flow paths 51 c may be connected to the first-row heat transfer pipes 22 via intermediate members, so that the end faces of the first-row heat transfer pipes 22 are located inside the flow paths formed in the intermediate members.

**[0033]** The first-row second plate unit 54 has the distribution flow path 51 b and the plurality of first-row passing flow paths 51 d. The distribution flow path 51 b and the plurality of first-row passing flow paths 51 d are aggregates of flow path segments formed in the plate members 54\_1 to 54\_7 and flow path segments formed in the clad members 55\_2 to 55\_8. One end portion of the distribution flow path 51 b is connected to the joint pipe 52, and the other end portions of the distribution flow path 51 b is connected to the plurality of first-row outlet flow paths 51 a. The distribution flow path 51 b is repeatedly branched in two ways in a region distant from the heat exchange unit 2. Such a configuration improves the distribution uniformity of the refrigerant when the heat exchanger 1 acts as evaporator. The distribution flow path 51 b has a linear shape in a region close to the heat exchange unit 2. One end portion of the first-row passing flow path 51 d is connected to the first-row inlet flow path 51 c, and the other end portion of the first-row passing flow path 51 d is connected to the U-pipe 81. The first-row passing flow path 51 d has a linear shape in a region close to the heat exchange unit 2. Further details of the first-row passing flow path 51 d will be subsequently described.

**[0034]** The joint pipe 52 and the U-pipe 81 may be located in the first-row first plate unit 53. In other words, a part of the distribution flow path 51 b and a part of the first-row passing flow path 51 d may be routed through the first-row first plate unit 53.

**[0035]** As shown in Fig. 3, the second-row divisional unit 61 includes a second-row first plate unit 63 and a second-row second plate unit 64 stacked on the second-row first plate unit 63. The second-row first plate unit 63 corresponds to a part of the first plate unit in the present invention. The second-row second plate unit 64 corresponds to a part of the second plate unit in the present invention.

**[0036]** The second-row first plate unit 63 includes a plate member 63\_1, and the second-row second plate unit 64 includes a plurality of plate members 64\_1 to 64\_7. The end portions of the second-row heat transfer pipes 32 are supported by a second-row retention member 34, and the plate member 63\_1 and the plurality of plate members 64\_1 to 64\_7 are joined to the second-row retention member 34 via a plurality of plate-shaped clad members 65\_1 to 65\_8, for example, by brazing. A brazing material is applied to one or both surfaces of

each of the clad members 65\_1 to 65\_8. The clad members 65\_1 to 65\_8 serve as joint layers between the second-row retention member 34 and the plate members 63\_1 and 64\_1 to 64\_7. In addition, the flow paths formed in the clad members 65\_1 to 65\_8 assure the isolation of the refrigerant in the adjacent flow paths in the plate members 63\_1 and 64\_1 to 64\_7 from each other. The second-row retention member 34, the plate members 63\_1 and 64\_1 to 64\_7, and the clad members 65\_1 to 65\_8 may be, for example, made of aluminum. The second-row retention member 34 and the plate members 63\_1 and 64\_1 to 64\_7 may be directly joined to each other, without the intermediation of the plurality of clad members 65\_1 to 65\_8.

**[0037]** The second-row first plate unit 63 has the plurality of second-row outlet flow paths 61 a and the plurality of second-row inlet flow paths 61 c, aligned in a row. The plurality of second-row outlet flow paths 61 a and the plurality of second-row inlet flow paths 61 c are formed in a shape that fits the outer circumferential shape of the second-row heat transfer pipe 32. The end portions of the second-row heat transfer pipes 32 stick out from the second-row retention member 34, and the second-row first plate unit 63 is joined to the second-row retention member 34 so that the end portions of the second-row heat transfer pipes 32 are inserted into the plurality of second-row outlet flow paths 61 a and the plurality of second-row inlet flow paths 61 c. Alternatively, the end portions of the second-row heat transfer pipes 32 may be directly connected to the plurality of second-row outlet flow paths 61 a and the plurality of second-row inlet flow paths 61 c, without the intermediation of the second-row retention member 34 supporting the end portions of the second-row heat transfer pipes 32. The end faces of the second-row heat transfer pipes 32 may stick out from the second-row first plate unit 63, or the plurality of second-row outlet flow paths 61 a and the plurality of second-row inlet flow paths 61 c may be connected to the second-row heat transfer pipes 32 via intermediate members, so that the end faces of the second-row heat transfer pipes 32 are located inside the flow paths formed in the intermediate members.

**[0038]** The second-row second plate unit 64 has the plurality of second-row passing flow paths 61 b and the plurality of junction flow paths 61 d. The second-row passing flow paths 61 b and the plurality of junction flow paths 61 d are aggregates of flow path segments formed in the plate members 64\_1 to 64\_7 and flow path segments formed in the clad members 65\_2 to 65\_8. One end portion of the second-row passing flow path 61 b is connected to the U-pipe 81, and the other end portion of the second-row passing flow path 61 b is connected to the second-row outlet flow path 61 a. The second-row passing flow path 61 b has a linear shape in a region close to the heat exchange unit 2. Further details of the second-row passing flow path 61 b will be subsequently described. One end portions of the junction flow path 61 d are connected to the plurality of second-row inlet flow

paths 61 c, and the other end portion of the junction flow path 61 d is connected to the joint pipe 62. The junction flow path 61 d merges two flow paths into one. Such a configuration improves the distribution uniformity of the refrigerant when the heat exchanger 1 acts as condenser. The junction flow path 61 d has a linear shape in a region close to the heat exchange unit 2.

**[0039]** The U-pipe 81 and the joint pipe 62 may be located in the second-row first plate unit 63. In other words, a part of the second-row passing flow path 61 b and a part of the junction flow path 61 d may be routed through the second-row first plate unit 63.

< Configuration of Air-conditioning Apparatus Including Heat Exchanger >

**[0040]** Hereafter, a configuration of an air-conditioning apparatus that includes the heat exchanger according to Embodiment 1 will be described.

**[0041]** Fig. 4 and Fig. 5 are block diagrams showing the configuration of the air-conditioning apparatus including the heat exchanger according to Embodiment 1. Fig. 4 represents the case where an air-conditioning apparatus 91 performs a heating operation. Fig. 5 represents the case where the air-conditioning apparatus 91 performs a cooling operation.

**[0042]** As shown in Fig. 4 and Fig. 5, the air-conditioning apparatus 91 includes a compressor 92, a four-way valve 93, an outdoor heat exchanger (heat source-side heat exchanger) 94, an expansion device 95, an indoor heat exchanger (load-side heat exchanger) 96, an outdoor fan (heat source-side fan) 97, an indoor fan (load-side fan) 98, and a controller 99. The compressor 92, the four-way valve 93, the outdoor heat exchanger 94, the expansion device 95, and the indoor heat exchanger 96 are connected via a refrigerant pipe, to form a refrigerant circuit. The four-way valve 93 may be another type of flow switching device.

**[0043]** The outdoor heat exchanger 94 corresponds to the heat exchanger 1. In the outdoor heat exchanger 94, the first-row divisional unit 51 is located on the windward side and the second-row divisional unit 61 is located on the leeward side, in the airflow generated when the outdoor fan 97 is driven. The outdoor fan 97 may be provided either on the windward or leeward side of the heat exchanger 1.

**[0044]** To the controller 99, for example, the compressor 92, the four-way valve 93, the expansion device 95, the outdoor fan 97, the indoor fan 98, and various sensors are connected. The controller 99 switches the flow paths in the four-way valve 93, thereby switching between the heating operation and the cooling operation.

**[0045]** With reference to Fig. 4, the flow of the refrigerant in the heating operation will be described hereafter.

**[0046]** The high-pressure and high-temperature gas refrigerant discharged from the compressor 92 flows into the indoor heat exchanger 96 through the four-way valve 93, and is condensed through heat exchange with air

supplied by the indoor fan 98, thereby heating the indoor air. The condensed refrigerant turns into high-pressure subcooled liquid refrigerant and flows out of the indoor heat exchanger 96, and then turns into low-pressure two-phase gas-liquid refrigerant in the expansion device 95. The low-pressure two-phase gas-liquid refrigerant flows into the outdoor heat exchanger 94, and is evaporated through heat exchange with air supplied by the outdoor fan 97. The evaporated refrigerant turns into low-pressure superheated gas refrigerant and flows out of the outdoor heat exchanger 94, and is then sucked into the compressor 92 through the four-way valve 93. Thus, the outdoor heat exchanger 94 acts as evaporator in the heating operation.

**[0047]** In the outdoor heat exchanger 94, the refrigerant flows into the distribution flow path 51 b of the first-row divisional unit 51 thus to be branched, and flows into the first-row heat transfer pipes 22 of the first-row heat exchange unit 21. The refrigerant having entered the first-row heat transfer pipes 22 sequentially passes through the first-row passing flow paths 51 d, the U-pipes 81, and the second-row passing flow paths 61 b, and flows into the second-row heat transfer pipes 32 of the second-row heat exchange unit 31. The refrigerant having entered the second-row heat transfer pipes 32 flows into the junction flow paths 61 d of the second-row divisional unit 61, thus to be merged.

**[0048]** With reference to Fig. 5, the flow of the refrigerant in the cooling operation will be described hereafter.

**[0049]** The high-pressure and high-temperature gas refrigerant discharged from the compressor 92 flows into the outdoor heat exchanger 94 through the four-way valve 93, and is condensed through heat exchange with air supplied by the outdoor fan 97. The condensed refrigerant turns into high-pressure subcooled liquid refrigerant, and flows out of the outdoor heat exchanger 94 and then turns into low-pressure two-phase gas-liquid refrigerant in the expansion device 95. The low-pressure two-phase gas-liquid refrigerant flows into the indoor heat exchanger 96, and is evaporated through heat exchange with air supplied by the indoor fan 98, thereby cooling the indoor air. The evaporated refrigerant turns into low-pressure superheated gas refrigerant and flows out of the indoor heat exchanger 96, and is then sucked into the compressor 92 through the four-way valve 93. Thus, the outdoor heat exchanger 94 acts as condenser in the cooling operation.

**[0050]** In the outdoor heat exchanger 94, the refrigerant flows into the junction flow paths 61 d of the second-row divisional unit 61 thus to be branched, and flows into the second-row heat transfer pipes 32 of the second-row heat exchange unit 31. The refrigerant having entered the second-row heat transfer pipes 32 sequentially passes through the second-row passing flow paths 61 b, the U-pipes 81, and the first-row passing flow paths 51 d, and flows into the first-row heat transfer pipes 22 of the first-row heat exchange unit 21. The refrigerant having entered the first-row heat transfer pipes 22 flows into the

distribution flow path 51 b of the first-row divisional unit 51, thus to be merged.

**[0051]** In the outdoor heat exchanger 94, the first-row heat exchange unit 21 and the second-row heat exchange unit 31 are aligned side by side in the flow direction of air passing through the heat exchange unit 2 (blank arrow in Fig. 5). The heat exchange amount may be increased, for example, by increase the front-view area of the outdoor heat exchanger 94; however, in this case, the size of the casing incorporating the outdoor heat exchanger 94 is increased. In addition, although the heat exchange amount may be increased by increasing the number of fins, it is difficult to locate the fins in a pitch narrower than 1 mm from the viewpoint of drain efficiency, defrosting performance, and dust resistance, and thus a sufficient increase in heat exchange amount may not be attained. In contrast, increasing the number of rows of the heat transfer pipes as in the case of the outdoor heat exchanger 94 enables the heat exchange amount to be increased without changing the front-view area of the outdoor heat exchanger 94 or the pitch of the fins. Providing two rows leads to an increase heat exchange amount of approximately 50% or more. Further, the front-view area of the outdoor heat exchanger 94, the pitch of the fins, or other factors may additionally be modified.

**[0052]** In addition, the header (stacking header 3) is provided only on one side of the outdoor heat exchanger 94. In the case where the outdoor heat exchanger 94 is bent and disposed along a plurality of faces of the casing incorporating the outdoor heat exchanger 94, to increase the effective volume of the heat exchange unit 2, the end portions of the heat transfer pipe rows are deviated from each other because of differences in curvature radius of the bent portion of each of the rows. Providing the header (stacking header 3) only on one side as in the case of the outdoor heat exchanger 94 allows the degree of designing freedom and production efficiency to be improved, because it suffices that only the end portions of the rows on one side are aligned even when the end portions on the other side are deviated. In this case, further, the heat exchange unit 2 may be bent after the components of the outdoor heat exchanger 94 are attached, leading to further improvement in production efficiency.

**[0053]** Further, the first-row heat transfer pipes 22 are located on the windward side with respect to the second-row heat transfer pipes 32, when the outdoor heat exchanger 94 acts as condenser. In the case where the headers are provided on the respective sides of the outdoor heat exchanger 94, it is difficult to improve the condensing performance by giving a difference in refrigerant temperature in each of the rows. When the first-row heat transfer pipes 22 and the second-row heat transfer pipes 32 are flat pipes, in particular, sufficient degree of freedom in bending work is unable to be secured unlike a circular pipe, and thus it is difficult to give the difference in refrigerant temperature in each of the rows by deforming the flow paths of the refrigerant. However, in the case where the first-row heat transfer pipes 22 and the second-

row heat transfer pipes 32 are connected to the stacking header 3 as in the case of the outdoor heat exchanger 94, the refrigerant temperature naturally becomes different in each of the rows, and thus the flow direction of the refrigerant and the flow direction of air passing through the heat exchange unit 2 can be easily made to oppose without deforming the refrigerant flow path.

< Details of First Passing Flow Path and Second Passing Flow Path >

**[0054]** Hereafter, the details of the first passing flow path and the second passing flow path of the heat exchanger according to Embodiment 1 will be described.

**[0055]** Fig. 6 is a schematic cross-sectional view for explaining the details of the first passing flow path and the second passing flow path of the heat exchanger according to Embodiment 1.

**[0056]** As shown in Fig. 6, the first-row passing flow path 51 d is straight in a section corresponding to a flow path length L1 from the end face of the first-row heat transfer pipe 22. The second-row passing flow path 61 b is straight in a section corresponding to a flow path length L2 from the end face of the second-row heat transfer pipe 32. The section of the flow path length L1 serves as runway for the refrigerant having passed through the U-pipe 81 to flow into the first-row heat transfer pipe 22. The section of the flow path length L2 serves as runway for the refrigerant having passed through the U-pipe 81 to flow into the second-row heat transfer pipe 32. Providing thus the runways allow uniformization of the amount of refrigerant flowing into the inlet port of each of the plurality of flow paths formed in the first-row heat transfer pipe 22 and the second-row heat transfer pipe 32.

**[0057]** Fig. 7 is a graph showing a relationship between the flow path length L2 and the uniformity of the refrigerant, realized when the heat exchanger according to Embodiment 1 acts as evaporator. Fig. 7 shows the relationship between inlet port numbers and the distribution ratio, in other words, a ratio of the refrigerant amount to the total amount of the refrigerant flowing into the inlet ports, under different settings of the flow path length L2. Here, the inlet port number 1 represents the inlet port in the end face of the second-row heat transfer pipe 32 farthest from the first-row heat transfer pipe 22.

**[0058]** As shown in Fig. 7, when the heat exchanger 1 acts as evaporator, in other words, when the refrigerant having passed through the U-pipe 81 flows into the second-row heat transfer pipe 32 through the second-row passing flow path 61 b, the distribution ratio tends to be higher in the inlet ports more distant from the first-row heat transfer pipe 22. When ten inlet ports are provided, the heat exchange performance of the heat exchange unit 2 can be secured by setting the distribution ratio of the inlet ports in a range of  $0.10 \pm 0.03$ . Thus, when the hydraulic equivalent diameter of the flow path in the range of the flow path length L2 is denoted by De, the heat exchange performance of the heat exchange unit 2 can

be secured by setting as flow path length  $L2 \geq 4De$ .

**[0059]** Fig. 8 is a graph showing a relationship between the flow path length L1 and the uniformity of the refrigerant, realized when the heat exchanger according to Embodiment 1 acts as condenser. Fig. 8 shows the relationship between inlet port numbers and the distribution ratio, in other words, a ratio of the refrigerant amount to the total amount of the refrigerant flowing into the inlet ports, under different settings of the flow path length L1. Here, the inlet port number 1 represents the inlet port in the end face of the first-row heat transfer pipe 22 farthest from the second-row heat transfer pipe 32.

**[0060]** As shown in Fig. 8, when the heat exchanger 1 acts as condenser, in other words, when the refrigerant having passed through the U-pipe 81 flows into the first-row heat transfer pipe 22 through the first-row passing flow path 51 d, the distribution ratio tends to be higher in the inlet ports more distant from the second-row heat transfer pipe 32. When ten inlet ports are provided, the heat exchange performance of the heat exchange unit 2 can be secured by setting the distribution ratio of the inlet ports in a range of  $0.10 \pm 0.03$ . Thus, when the hydraulic equivalent diameter of the flow path in the range of the flow path length L1 is denoted by De, the heat exchange performance of the heat exchange unit 2 can be secured by setting as flow path length  $L1 \geq 2De$ .

**[0061]** To be more detailed, when the heat exchanger 1 acts as evaporator, the two-phase gas-liquid refrigerant, in other words, a mixture of liquid phase refrigerant and gas phase refrigerant, which is relatively difficult to be uniformly distributed, passes through the U-pipe 81, and thus the flow path length L2 serving as runway has to be made longer. In contrast, when the heat exchanger 1 acts as condenser, the gas-phase refrigerant, which is relatively easy to be uniformly distributed, passes through the U-pipe 81, and thus the flow path length L1 serving as runway can be made shorter compared with the flow path length L2. Thus, adjusting the number or thickness of the plate members 54\_1 to 54\_7 and 64\_1 to 64\_7, which defines the ranges corresponding to the flow path length L1 and the flow path length L2 in the first-row second plate unit 54 and the second-row second plate unit 64, to make each of the flow path length L1 and the flow path length L2 equal to or larger than  $4De$  allows the heat exchange performance of the heat exchange unit 2 to be secured, both when the heat exchanger 1 acts as evaporator and when the heat exchanger 1 acts as condenser.

**[0062]** In addition, adjusting the number or thickness of the plate members 54\_1 to 54\_7, which defines the range corresponding to the flow path length L1 in the first-row second plate unit 54, to make the flow path length L1 equal to or larger than  $2De$  and shorter than the flow path length L2 also allows the heat exchange performance of the heat exchange unit 2 to be secured, both when the heat exchanger 1 acts as evaporator and when the heat exchanger 1 acts as condenser. Such a configuration contributes to reducing the weight and the

cost of the heat exchanger 1.

< Effects of Heat Exchanger >

**[0063]** Hereafter, the effects of the heat exchanger according to Embodiment 1 will be described.

**[0064]** In the stacking header 3, the first-row inlet flow path 51 c, the first-row passing flow path 51 d, the U-pipe 81, the second-row passing flow path 61 b, and the second-row outlet flow path 61 a constitute the turnback flow path. Thus, for example, when the stacking header 3 is employed for an apparatus such as the heat exchanger 1 having a plurality of rows of heat exchange units (first-row heat exchange unit 21 and second-row heat exchange unit 31) aligned in the airflow direction, there is no need to employ pipes or other components to branch the refrigerant flowing out of the outlet flow path into a plurality of rows in a part of the apparatus other than the stacking header 3, and the complication of the structure of the apparatus for which the stacking header 3 is employed can be eased.

**[0065]** In addition, the turnback flow path is composed of the first-row passing flow path 51 d and the second-row passing flow path 61 b, which are the aggregates of the flow path segments formed in the plate members 54\_1 to 54\_7 and 64\_1 to 64\_7, and the flow path segments formed in the plate-shaped clad members 55\_2 to 55\_8 and 65\_2 to 65\_8, and the U-pipe 81. Thus, the distance between the turnback section and the joint of the first-row passing flow path 51 d and the U-pipe 81 or the joint of the second-row passing flow path 61 b and the U-pipe 81 can be extended to level off the unevenness of the refrigerant amount among the flow paths produced at the turnback section of the turnback flow path (U-shaped section of the U-pipe 81), without increasing the number of stacks in the stacking header 3 or the thickness of the plate members, in other words, by extending the length of the end portions of the U-pipe 81. Thus, uniform refrigerant distribution and reduction in cost and weight can both be achieved. Further, since the turnback section of the turnback flow path is the U-pipe 81, in other words, a pipe structure, the degree of designing freedom of the turnback section, as well as versatility of the stacking header 3 can be improved.

**[0066]** The stacking header 3 is divided into the first-row divisional unit 51 and the second-row divisional unit 61, between the first plate unit having the first-row outlet flow path 51 a, the distribution flow path 51 b, the first-row inlet flow path 51 c, and the first-row passing flow path 51 d, and the second plate unit having the second-row outlet flow path 61 a, the second-row passing flow path 61 b, the second-row inlet flow path 61 c, and the junction flow path 61 d. Such a configuration reduces heat exchange between the refrigerant about to flow into the heat exchange unit 2 and the refrigerant having passed through the heat exchange unit 2, thereby improving the heat exchange efficiency of the heat exchanger 1. The boundary between the first-row divisional

unit 51 and the second-row divisional unit 61 may be either straight or curved. A heat insulation material may be provided between the first-row divisional unit 51 and the second-row divisional unit 61. The division is preferably performed by pressing or a similar method. In this case, the division can be performed at the same time when the flow paths in the plate members 53\_1, 54\_1 to 54\_7, 63\_1, and 64\_1 to 64\_7 and in the clad members 55\_1 to 55\_8 and 65\_1 to 65\_8 are processed, leading to reduction in manufacturing cost. Further, the division of the divisional units is assured, further assuring the reduction of the heat exchange between the refrigerant about to flow into the heat exchange unit 2 and the refrigerant having passed through the heat exchange unit 2.

**[0067]** Further, when the heat exchanger 1 acts as evaporator, the gas-phase refrigerant flows into the second-row inlet flow path 61 c, and hence the flow path cross-sectional area of the junction flow path 61 d has to be made as large as possible, to reduce the pressure loss suffered by the gas refrigerant. Since the heat exchange between the refrigerant about to flow into the heat exchange unit 2 and the refrigerant having passed through the heat exchange unit 2 is reduced because the stacking header 3 is divided into the first-row divisional unit 51 and the second-row divisional unit 61, the junction flow path 61 d can be extended to a region close to the first-row divisional unit 51 to significantly reduce the pressure loss of the gas refrigerant, and consequently the performance level of the stacking header 3, as well as the operation efficiency of the air-conditioning apparatus 91 can be improved.

Embodiment 2

**[0068]** Hereafter, a heat exchanger according to Embodiment 2 will be described.

**[0069]** The description same as or similar to those of Embodiment 1 will be simplified or omitted, as the case may be.

< Configuration of Heat Exchanger >

**[0070]** Hereafter, a configuration of the heat exchanger according to Embodiment 2 will be described.

(General Configuration of Heat Exchanger)

**[0071]** Hereafter, a general configuration of the heat exchanger according to Embodiment 2 will be described.

**[0072]** Fig. 9 is a perspective view of the heat exchanger according to Embodiment 2.

**[0073]** As shown in Fig. 9, the heat exchange unit 2 includes the first-row heat exchange unit 21 located on the windward side in the flow direction of air passing through the heat exchange unit 2 (blank arrow in Fig. 1), the second-row heat exchange unit 31 located on the leeward side of the first-row heat exchange unit 21, and

a third-row heat exchange unit 41 located on the leeward side of the second-row heat exchange unit 31. The third-row heat exchange unit 41 includes a plurality of third-row heat transfer pipes 42, and a plurality of third-row fins 43 joined to the third-row heat transfer pipes 42, for example, by brazing.

**[0074]** The third-row heat transfer pipe 42 is a flat pipe having a plurality of flow paths aligned in the direction of the major axis. Each of the third-row heat transfer pipes 42 is bent in a hair-pin shape between one end portion and the other end portion, to form a turnback section 42a. The third-row heat transfer pipes 42 are arranged in a plurality of columns stacked in a direction intersecting the flow of air passing through the heat exchange unit 2 (blank arrow in Fig. 1). The respective first end portions and second end portions of the plurality of third-row heat transfer pipes 42 are aligned to oppose the stacking header 3.

**[0075]** The stacking header 3 includes the first-row divisional unit 51, the second-row divisional unit 61, and a third-row divisional unit 71, divided in the direction of the stages of the heat exchange unit 2. To the third-row divisional unit 71, a plurality of pipes (not shown) are connected via a plurality of joint pipes 72. Two or more of the first-row divisional unit 51, the second-row divisional unit 61, and the third-row divisional unit 71 may be formed in a unified body. The first-row divisional unit 51 corresponds to the first divisional unit in the present invention, and the second-row divisional unit 61 and the third-row divisional unit 71 each correspond to the second divisional unit in the present invention.

**[0076]** The third-row divisional unit 71 has a plurality of third-row outlet flow paths 71 a, plurality of third-row passing flow paths 71 b, a plurality of third-row inlet flow paths 71 c, and a plurality of junction flow paths 71 d. The third-row outlet flow path 71 a corresponds to the third outlet flow path in the present invention. The third-row passing flow path 71 b corresponds to the third passing flow path in the present invention. The third-row inlet flow path 71 c corresponds to the third inlet flow path in the present invention. The junction flow path 71 d corresponds to the second junction flow path in the present invention.

**[0077]** One end portion of the third-row heat transfer pipe 42 is connected to the third-row outlet flow path 71 a, and the other end portion of the third-row heat transfer pipe 42 is connected to the third-row inlet flow path 71 c. One end portion of the third-row passing flow path 71 b is connected to a branch pipe 82, and the other end portion of the third-row passing flow path 71 b is connected to the third-row outlet flow path 71 a. One end portions of the junction flow path 71 d are connected to the plurality of third-row inlet flow paths 71 c, and the other end portion of the junction flow path 71 d is connected to the joint pipe 72.

**[0078]** The branch pipe 82, instead of the U-pipe 81, is connected to the end portion of the junction flow path 61 d of the second-row divisional unit 61 not communi-

cating with the second-row inlet flow path 61 c. In other words, the branch pipe 82 includes a branch portion to allow communication between the junction flow path 61 d of the second-row divisional unit 61 and two third-row passing flow paths 71 b of the third-row divisional unit 71. Preferably, the branch pipe 82 may be formed by bulge forming. The branch pipe 82 may be connected to the junction flow path 61 d and the third-row passing flow paths 71 b either directly or via an intermediate member. The branch pipe 82 is, for example, made of a metal. The plurality of second-row inlet flow paths 61 c, the junction flow path 61 d, the branch pipe 82, the plurality of third-row passing flow paths 71 b, and the plurality of third-row outlet flow paths 71 a each correspond to a part of the second turnback flow path in the present invention.

**[0079]** When the heat exchanger 1 acts as evaporator, the refrigerant is merged in the junction flow path 61 d and flows into the plurality of third-row outlet flow paths 71 a after passing through the plurality of branch pipes 82 and the plurality of third-row passing flow paths 71 b in this order. The refrigerant having entered the plurality of third-row outlet flow paths 71 a flows into the plurality of third-row inlet flow paths 71 c through the plurality of third-row heat transfer pipes 42, and flows out of the joint pipe 72 after being merged in the junction flow path 71 d.

**[0080]** When the heat exchanger 1 acts as condenser, the refrigerant flows into the junction flow path 71 d through the joint pipe 72 thus to be distributed to the plurality of third-row inlet flow paths 71 c, and flows into the plurality of third-row outlet flow paths 71 a through the plurality of third-row heat transfer pipes 42. The refrigerant having entered the plurality of third-row outlet flow paths 71 a passes through the plurality of third-row passing flow paths 71 b and the plurality of branch pipes 82 in this order and flows into the junction flow path 61 d.

**[0081]** Although Fig. 9 and Fig. 10 represent the case where four branch pipes 82 are provided, in other words, where the junction flow path 61 d merges two flow paths into one, the number of branch pipes 82 may be other than four, provided that the number agrees with the number of flow paths merged by the junction flow path 61 d. Further, although Fig. 9 and Fig. 10 represent the case where the branch pipes 82 are connected to the face of the stacking header 3 opposite to the face on the side of the heat exchange unit 2, branch pipes 82 may be connected to another face of the stacking header 3.

(Configuration of Stacking Header)

**[0082]** Hereafter, a configuration of the stacking header of the heat exchanger according to Embodiment 2 will be described.

**[0083]** Fig. 10 is an exploded perspective view of the third-row divisional unit and associated components, in the heat exchanger according to Embodiment 2. Arrows in Fig. 10 indicate the flow of the refrigerant realized when the heat exchanger 1 acts as evaporator.

**[0084]** As shown in Fig. 10, the third-row divisional unit

71 includes a third-row first plate unit 73 and a third-row second plate unit 74 stacked on the third-row first plate unit 73. The third-row first plate unit 73 and the third-row second plate unit 74 are configured in the same way as the second-row first plate unit 63 and the second-row second plate unit 64. The third-row first plate unit 73 corresponds to a part of the first plate unit in the present invention. The third-row second plate unit 74 corresponds to a part of the second plate unit in the present invention.

**[0085]** Here, the branch pipe 82 may be provided in the third-row first plate unit 73. In other words, a part of the third-row passing flow path 71 b and a part of the junction flow path 71 d may be routed through the third-row first plate unit 73.

#### < Effects of Heat Exchanger >

**[0086]** Hereafter, the effects of the heat exchanger according to Embodiment 2 will be described.

**[0087]** In the stacking header 3, the plurality of second-row inlet flow paths 61 c, the junction flow path 61 d, the branch pipe 82, the plurality of third-row passing flow paths 71 b, and the plurality of third-row outlet flow paths 71 a constitute the turnback flow path. Thus, for example, when the stacking header 3 is employed for an apparatus such as the heat exchanger 1 having three rows of heat exchange units (first-row heat exchange unit 21, second-row heat exchange unit 31, and third-row heat exchange unit 41) aligned in the airflow direction, there is no need to employ pipes or other components to branch the refrigerant flowing out of the outlet flow path into three rows in a part of the apparatus other than the stacking header 3, and the complication of the structure of the apparatus for which the stacking header 3 is employed can be eased. Here, the stacking header 3 may include four or more divisional units, without limitation to three.

**[0088]** In the stacking header 3, the third-row divisional unit 71 has the same configuration as that of the second-row divisional unit 61. Thus, when the third-row divisional unit 71 and the second-row divisional unit 61 are divided from each other, the common components can be employed to cope with the increase in number of rows of the heat exchange unit 2, and when the third-row divisional unit 71 and the second-row divisional unit 61 are formed in a unified body, the common processing steps and common jigs (for example, press die) can be employed to cope with the increase in number of rows of the heat exchange unit 2. Consequently, the cost of the heat exchanger 1 can be reduced.

#### Embodiment 3

**[0089]** Hereafter, a heat exchanger according to Embodiment 3 will be described.

**[0090]** The description same as or similar to those of Embodiment 1 and Embodiment 2 will be simplified or omitted, as the case may be.

#### < Configuration of Heat Exchanger >

**[0091]** Hereafter, a configuration of the heat exchanger according to Embodiment 3 will be described.

#### (General Configuration of Heat Exchanger)

**[0092]** Hereafter, a general configuration of the heat exchanger according to Embodiment 3 will be described.

**[0093]** Fig. 11 is a perspective view of the heat exchanger according to Embodiment 3.

**[0094]** As shown in Fig. 11, the stacking header 3 includes the first-row divisional unit 51, the second-row divisional unit 61 A, and a third-row divisional unit 71, divided in the direction of the stages of the heat exchange unit 2. The second-row divisional unit 61 A has a different configuration from the second-row divisional unit 61 according to Embodiment 2. The first-row divisional unit 51 corresponds to the first divisional unit in the present invention, and the combination of the second-row divisional unit 61 A and the third-row divisional unit 71 corresponds to the second divisional unit in the present invention.

**[0095]** The second-row divisional unit 61 A has plurality of second-row outlet flow paths 61Aa, a plurality of second-row first passing flow paths 61Ab, a plurality of second-row inlet flow paths 61Ac, and a plurality of second-row second passing flow paths 61Ad. The second-row outlet flow path 61Aa corresponds to the first outlet flow path in the present invention. The second-row first passing flow path 61Ab corresponds to the second passing flow path in the present invention. The second-row inlet flow path 61Ac corresponds to the fourth inlet flow path in the present invention. The second-row second passing flow path 61Ad corresponds to the fourth passing flow path in the present invention. The third-row outlet flow path 71 a corresponds to the fourth outlet flow path in the present invention. The third-row passing flow path 71 b corresponds to the fifth passing flow path in the present invention. The third-row inlet flow path 71 c corresponds to the second inlet flow path in the present invention. The junction flow path 71 d corresponds to the first junction flow path in the present invention.

**[0096]** The U-pipe 81, instead of the branch pipe 82, is connected to the end portion of the second-row second passing flow path 61 Ad of the second-row divisional unit 61 A not communicating with the second-row inlet flow path 61 Ac. The U-pipe 81 in this case corresponds to the second pipe in the present invention. The second-row inlet flow path 61 Ac, the second-row second passing flow path 61 Ad, the U-pipe 81, the third-row passing flow path 71 b, and the third-row outlet flow path 71 a each correspond to a part of the third turnback flow path in the present invention.

#### (Configuration of Stacking Header)

**[0097]** Hereafter, a configuration of the stacking header of the heat exchanger according to Embodiment 3 will

be described.

**[0098]** Fig. 12 is an exploded perspective view of the second-row divisional unit and associated components, in the heat exchanger according to Embodiment 3. Arrows in Fig. 12 indicate the flow of the refrigerant realized when the heat exchanger 1 acts as evaporator.

**[0099]** As shown in Fig. 12, the second-row divisional unit 61 A includes a second-row first plate unit 63A and a second-row second plate unit 64A stacked on the second-row first plate unit 63A. The second-row first plate unit 63A corresponds to a part of the first plate unit in the present invention. The second-row second plate unit 64A corresponds to a part of the second plate unit in the present invention.

**[0100]** The second-row first plate unit 63A has the plurality of second-row outlet flow paths 61Aa and the plurality of second-row inlet flow paths 61Ac, aligned in a row. The second-row second plate unit 64A has the plurality of second-row first passing flow paths 61 Ab and the plurality of second-row second passing flow paths 61 Ad. One end portion of the second-row first passing flow path 61Ab is connected to the U-pipe 81, and the other end portion of the second-row first passing flow path 61Ab is connected to the second-row outlet flow path 61 Aa. The second-row first passing flow path 61Ab has a linear shape in a region close to the heat exchange unit 2. One end portion of the second-row second passing flow path 61 Ad is connected to the second-row inlet flow path 61 Ac, and the other end portion of the second-row second passing flow path 61Ad is connected to the U-pipe 81. The second-row second passing flow path 61Ad has a linear shape in a region close to the heat exchange unit 2.

**[0101]** The U-pipe 81 may be provided in the second-row first plate unit 63A. In other words, a part of the second-row first passing flow path 61 Ab and a part of the second-row second passing flow path 61Ad may be routed through the second-row first plate unit 63A.

#### < Effects of Heat Exchanger >

**[0102]** Hereafter, the effects of the heat exchanger according to Embodiment 3 will be described.

**[0103]** In the stacking header 3, the second-row inlet flow path 61Ac, the second-row second passing flow path 61 Ad, the U-pipe 81, the third-row passing flow path 71 b, and the third-row outlet flow path 71 a constitute the turnback flow path. Thus, for example, when the stacking header 3 is employed for an apparatus such as the heat exchanger 1 having three rows of heat exchange units (first-row heat exchange unit 21, second-row heat exchange unit 31, and third-row heat exchange unit 41) aligned in the airflow direction, there is no need to employ pipes or other components to branch the refrigerant flowing out of the outlet flow path into three rows in a part of the apparatus other than the stacking header 3, and the complication of the structure of the apparatus for which the stacking header 3 is employed can be eased. Here,

the stacking header 3 may include four or more divisional units, without limitation to three.

**[0104]** Although Embodiment 1 to Embodiment 3 have been described above, the present invention is not limited to those Embodiments. For example, a part or the whole of each of the Embodiments may be combined as desired.

#### Reference Signs List

#### [0105]

1: heat exchanger, 2: heat exchange unit, 3: stacking header, 21: first-row heat exchange unit, 22: first-row heat transfer pipe, 22a: turnback section, 23: first-row fin, 24: first-row retention member, 31: second-row heat exchange unit, 32: second-row heat transfer pipe, 32a: turnback section, 33: second-row fin, 34: second-row retention member, 41: third-row heat exchange unit, 42: third-row heat transfer pipe, 42a: turnback section, 43: third-row fin, 44: third-row retention member, 51: first-row divisional unit, 51 a: first-row outlet flow path, 51 b: distribution flow path, 51 c: first-row inlet flow path, 51 d: first-row passing flow path, 52: joint pipe, 53: first-row first plate unit, 53\_1: plate member, 54: first-row second plate unit, 54\_1 to 54\_7: plate member, 55\_1 to 55\_8: clad member, 61, 61 A: second-row divisional unit, 61 a, 61 Aa: second-row outlet flow path, 61 b: second-row passing flow path, 61 Ab: second-row first passing flow path, 61 c, 61Ac: second-row inlet flow path, 61 d: junction flow path, 61Ad: second-row second passing flow path, 62: joint pipe, 63, 63A: second-row first plate unit, 63\_1: plate member, 64, 64A: second-row second plate unit, 64\_1 to 64\_7: plate member, 65\_1 to 65\_8: clad member, 71: third-row divisional unit, 71 a: third-row outlet flow path, 71 b: third-row passing flow path, 71 c: third-row inlet flow path, 71 d: junction flow path, 72: joint pipe, 73: third-row first plate unit, 73\_1: plate member, 74: third-row second plate unit, 74\_1 to 74\_7: plate member, 75\_1 to 75\_8: clad member, 81: U-pipe, 82: branch pipe, 91: air-conditioning apparatus, 92: compressor, 93: four-way valve, 94: outdoor heat exchanger, 95: expansion device, 96: indoor heat exchanger, 97: outdoor fan, 98: indoor fan, 99: controller

#### Claims

1. A stacking header comprising:

a first plate unit having a first inlet flow path and a first outlet flow path;  
a second plate unit attached to the first plate unit and having at least a part of a first passing flow path for refrigerant flowing from the first inlet flow path to pass through and at least a part of a

- second passing flow path for refrigerant to pass through to the first outlet flow path; and a first pipe connecting an end portion of the first passing flow path not communicating with the first inlet flow path and an end portion of the second passing flow path not communicating with the first outlet flow path, to constitute a first turn-back flow path.
- 5
2. The stacking header of claim 1, wherein a region of a flow path through which refrigerant passing through the first pipe passes, having a flow path length L to an upstream side from an end face of a heat transfer pipe connected to one of the first inlet flow path and the first outlet flow path located on a downstream side, is straight, and the flow path length L is four times or more as large as a hydraulic equivalent diameter De of the region.
- 10
3. The stacking header of claim 1 or 2, wherein the first plate unit has a plurality of second outlet flow paths and a plurality of second inlet flow paths, and the second plate unit has at least a part of a distribution flow path for distributing refrigerant to the plurality of second outlet flow paths, and at least a part of a first junction flow path for merging refrigerant flowing in from the plurality of second inlet flow paths.
- 15
4. The stacking header of claim 3, wherein the first plate unit and the second plate unit are divided into a first divisional unit having the distribution flow path, the plurality of second outlet flow paths, the first inlet flow path, and the first passing flow path, and a second divisional unit having the second passing flow path, the first outlet flow path, the plurality of second inlet flow paths, and the first junction flow path.
- 20
5. The stacking header of claim 4, wherein an end portion of the first passing flow path communicating with the first inlet flow path and an end portion of the second passing flow path communicating with the first outlet flow path are each a straight section, and the straight section of the first passing flow path is shorter than the straight section of the second passing flow path.
- 25
6. The stacking header of any one of claims 3 to 5, wherein the first plate unit has a plurality of third outlet flow paths and a plurality of third inlet flow paths, the second plate unit has at least a part of each of a plurality of third passing flow paths for allowing refrigerant to pass through one of the plurality of third outlet flow paths, and at least a part of a second junction flow path for merging refrigerant flowing in
- 30
7. The stacking header of any one of claims 3 to 5, wherein the first plate unit has a fourth inlet flow path and a fourth outlet flow path, the second plate unit has at least a part of a fourth passing flow path for refrigerant flowing in from the fourth inlet flow path to pass through, and at least a part of a fifth passing flow path allowing refrigerant to pass through the fourth outlet flow path, and an end portion of the fourth passing flow path not communicating with the fourth inlet flow path and an end portion of the fifth passing flow path not communicating with the fourth outlet flow path communicate with each other via a second pipe to constitute a third turnback flow path.
- 35
8. A heat exchanger comprising:
- the stacking header of any one of claims 3 to 7; a first heat transfer pipe allowing communication between one of the plurality of second outlet flow paths and the first inlet flow path; and a second heat transfer pipe allowing communication between the first outlet flow path and one of the plurality of second inlet flow paths.
- 40
9. The heat exchanger of claim 8, wherein the heat transfer pipe is a flat pipe.
- 45
10. An air-conditioning apparatus comprising the heat exchanger of claim 8 or 9, wherein the distribution flow path causes refrigerant to flow to the plurality of second outlet flow paths when the heat exchanger acts as evaporator.
- 50
11. The air-conditioning apparatus of claim 10, wherein the first heat transfer pipe is located on a windward side with respect to the second heat transfer pipe when the heat exchanger acts as condenser.
- 55

FIG. 1

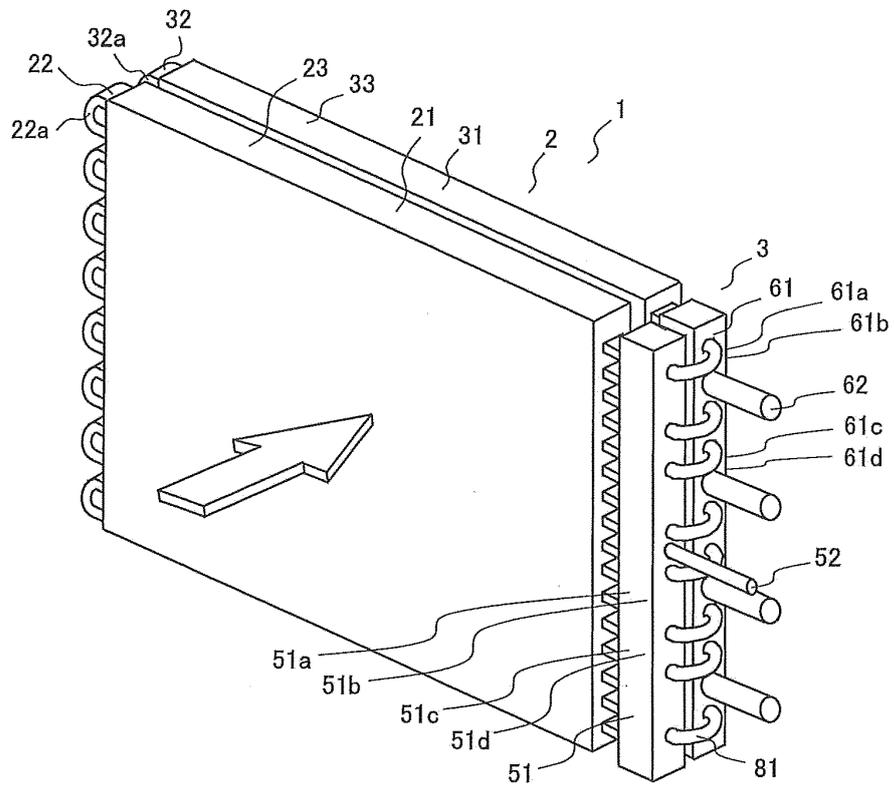


FIG. 2

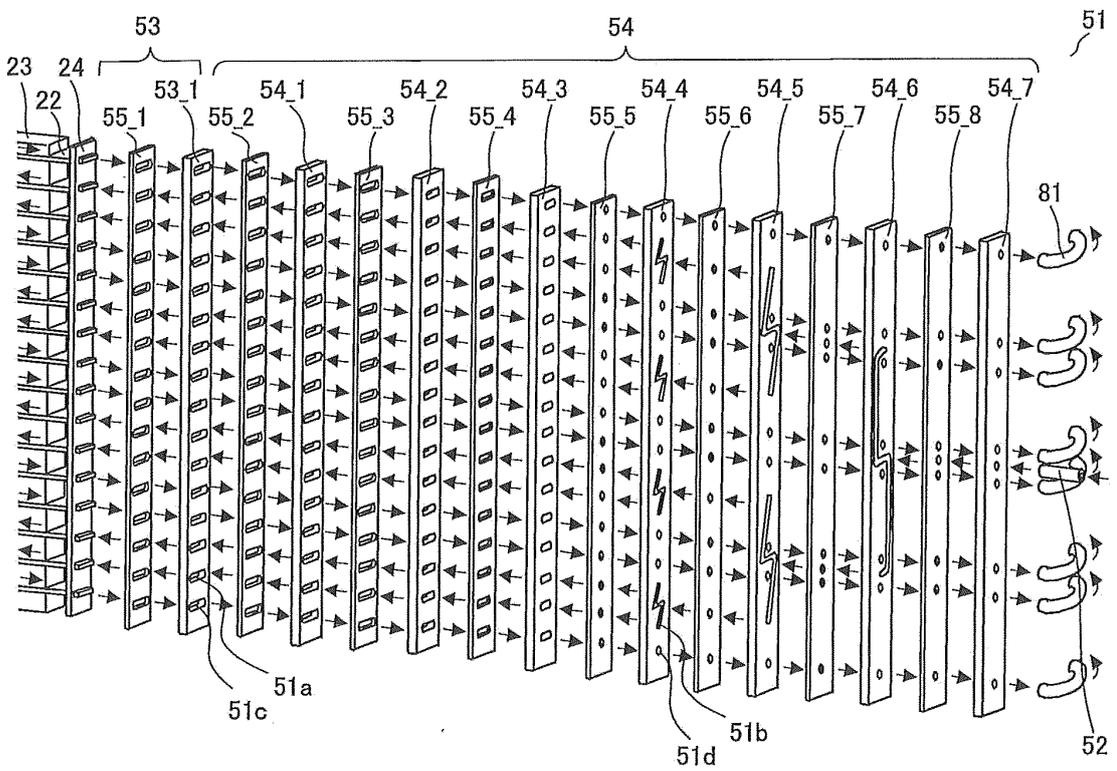


FIG. 3

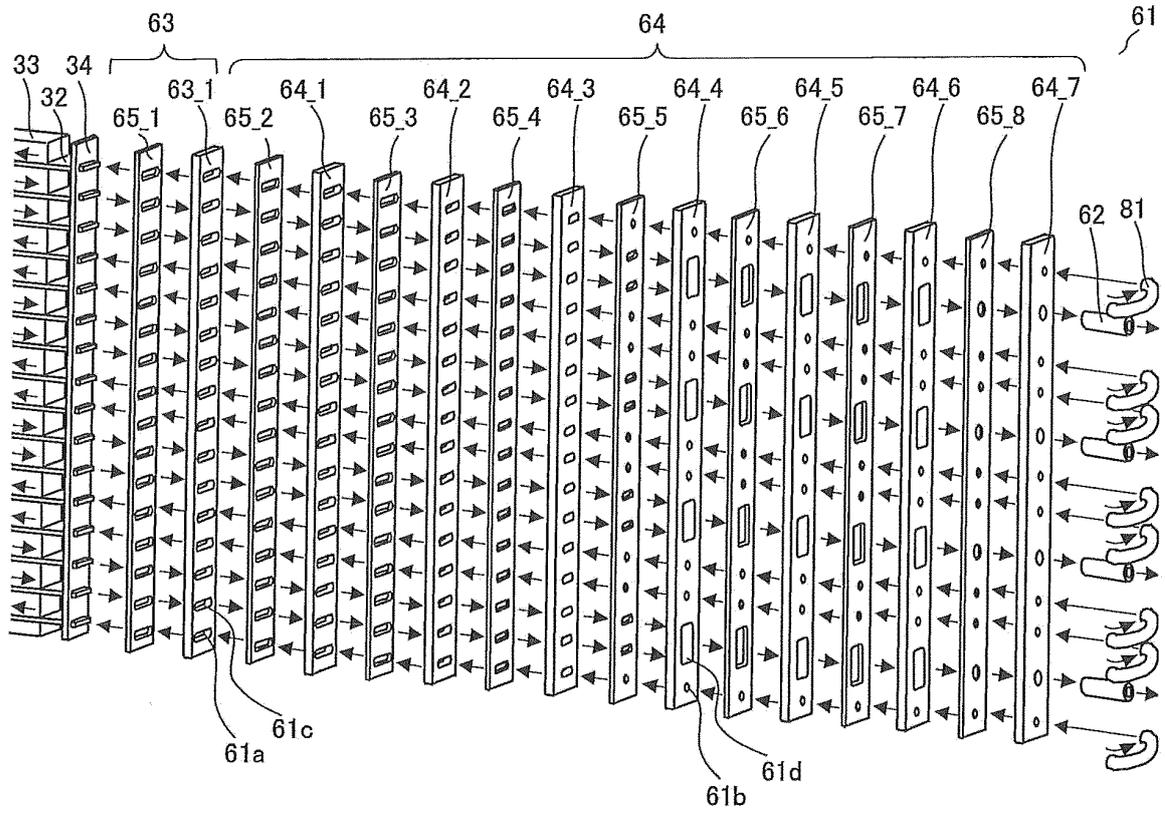


FIG. 4

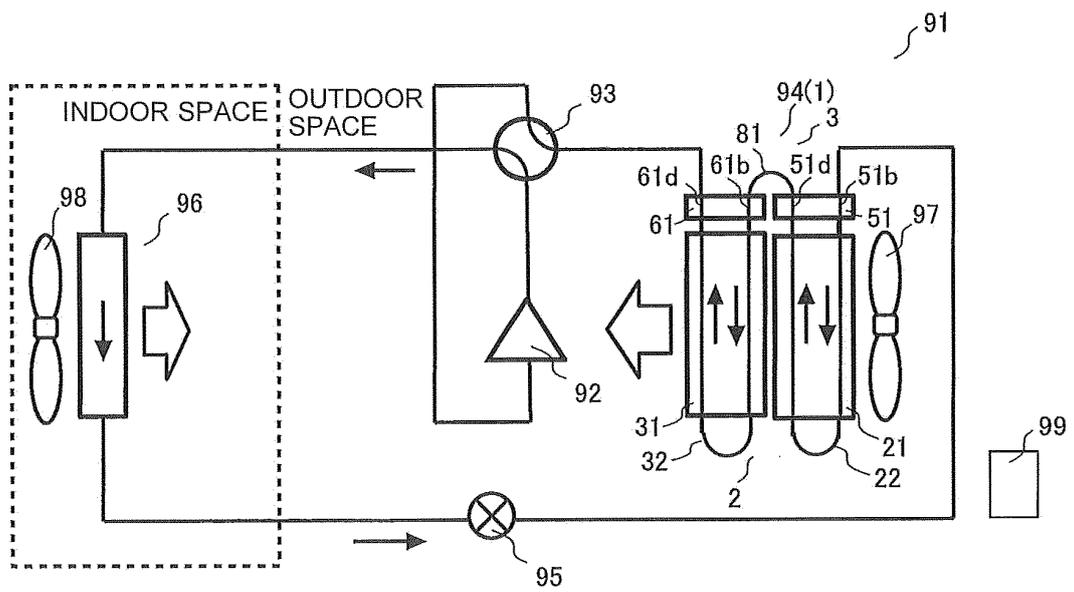


FIG. 5

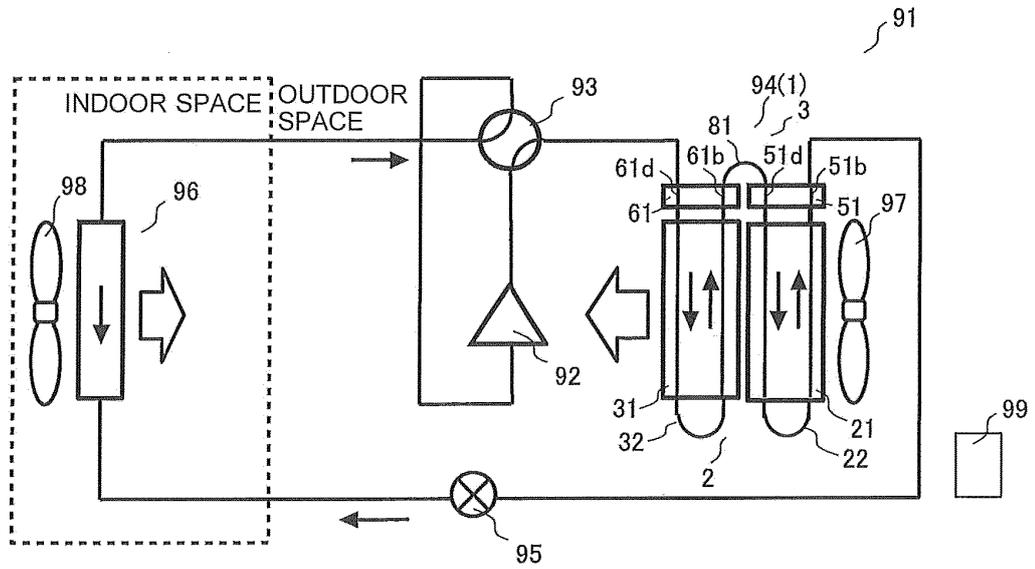


FIG. 6

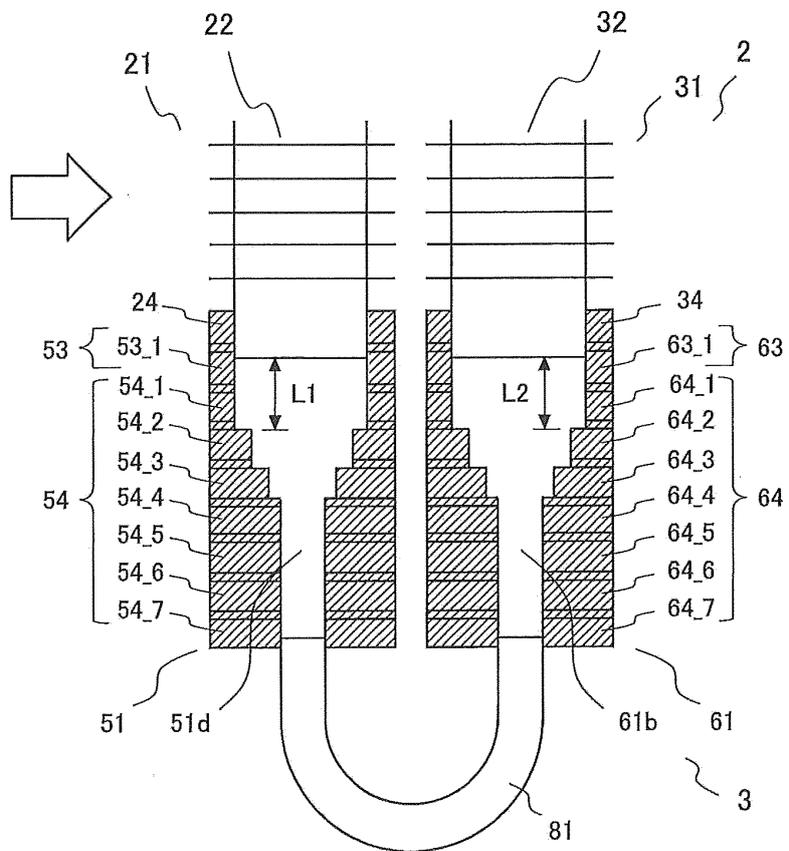


FIG. 7

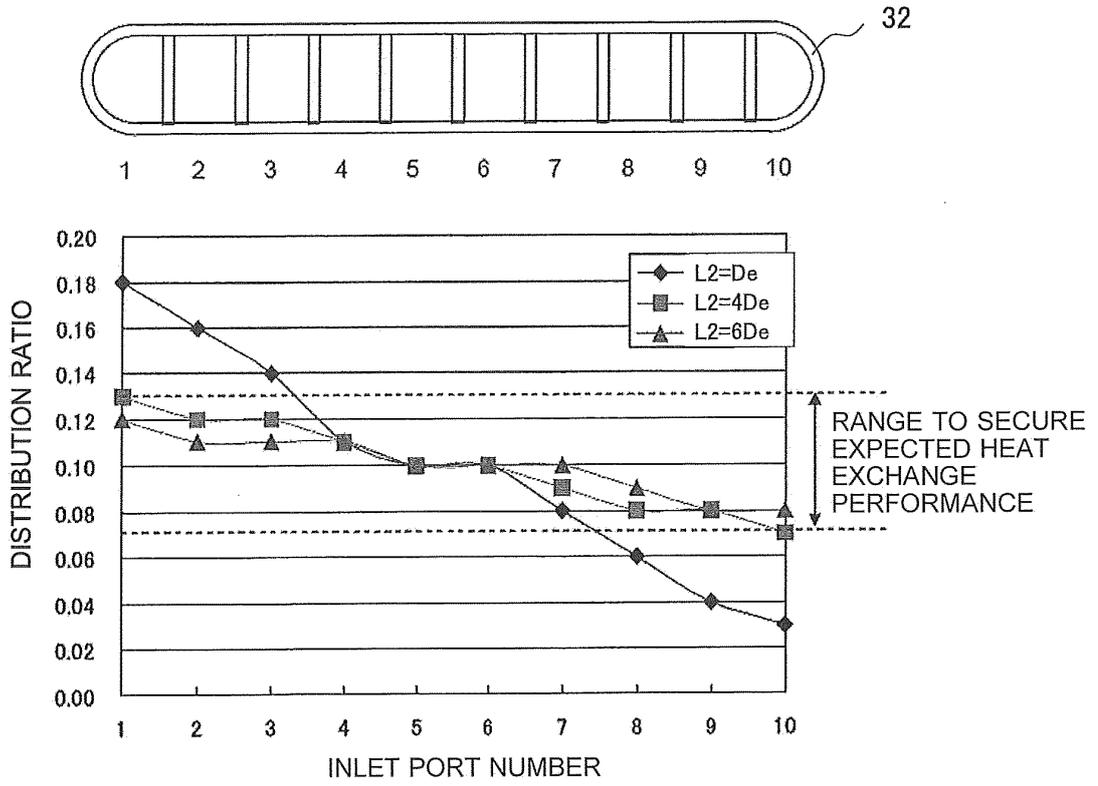


FIG. 8

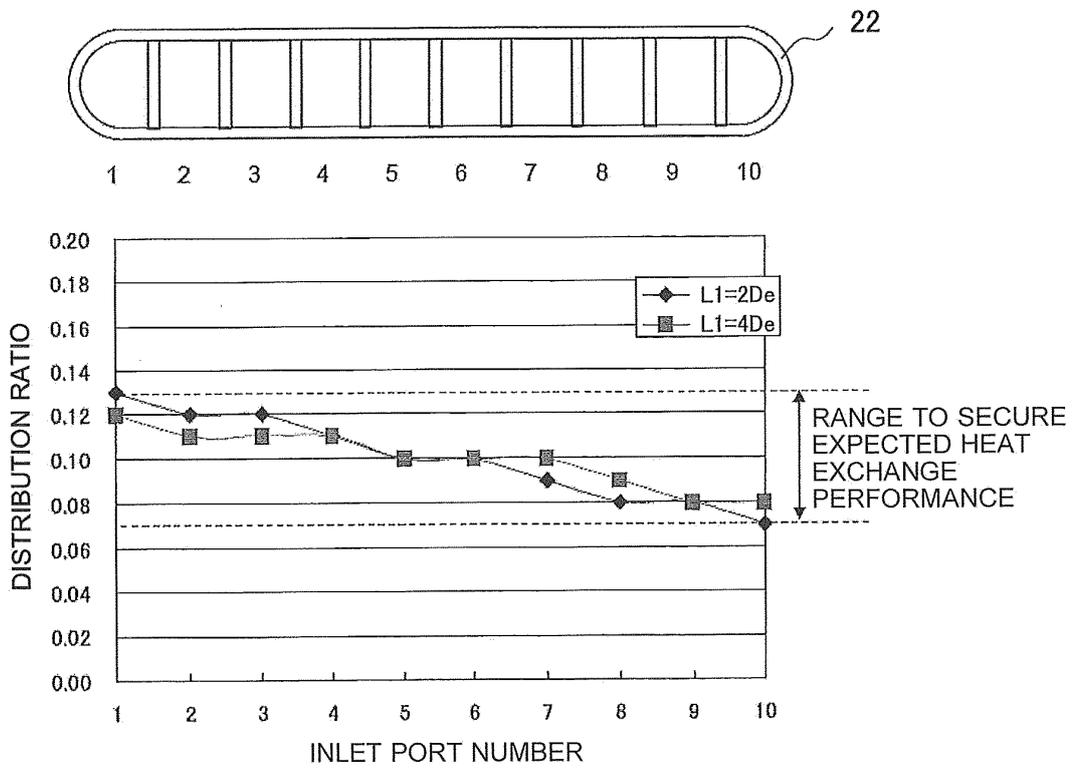


FIG. 9

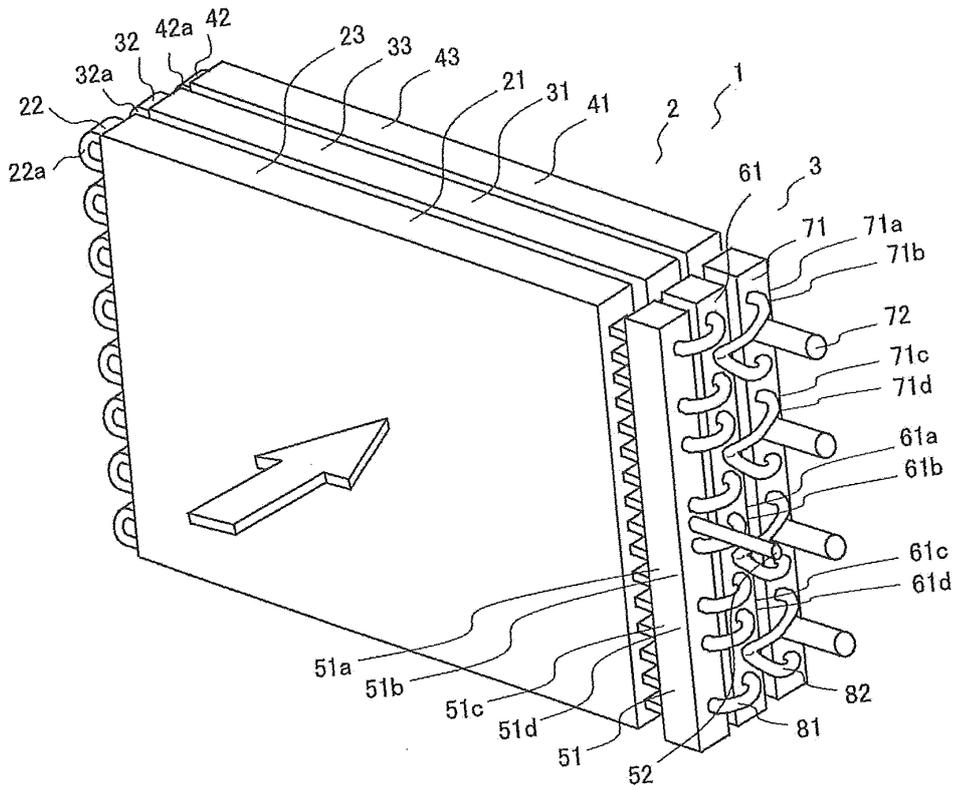


FIG. 10

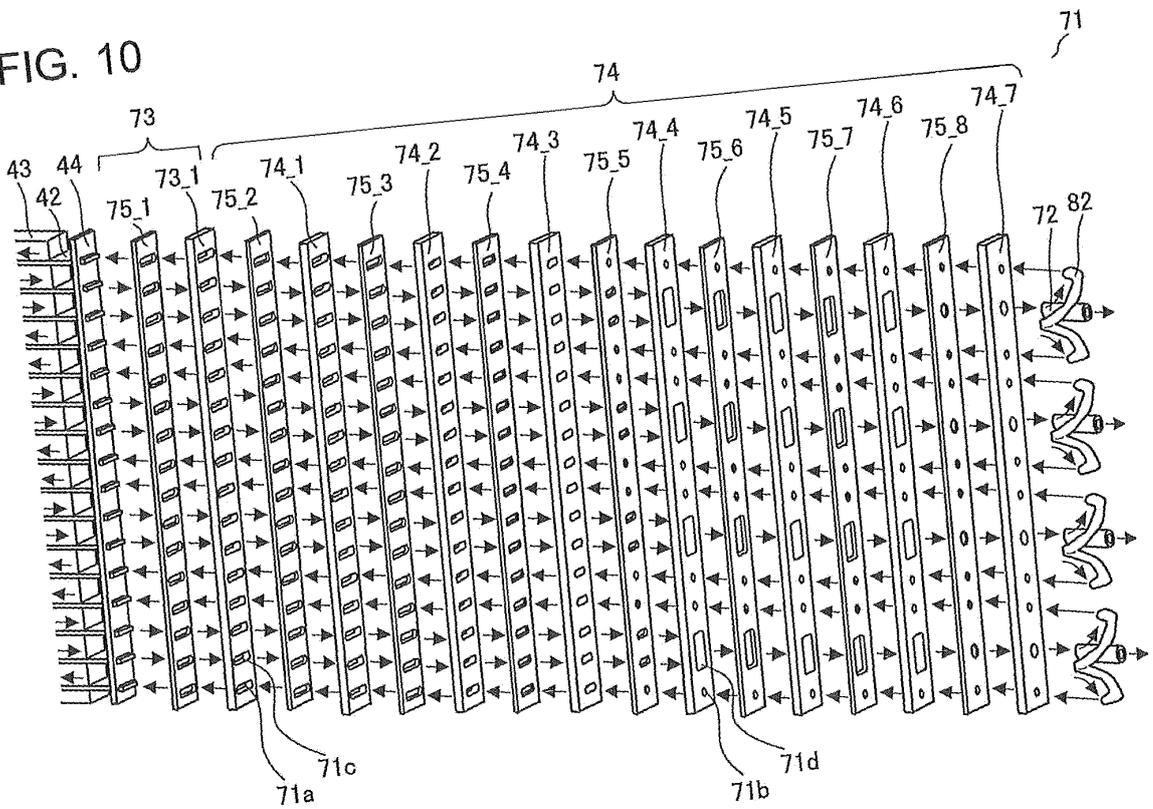


FIG. 11

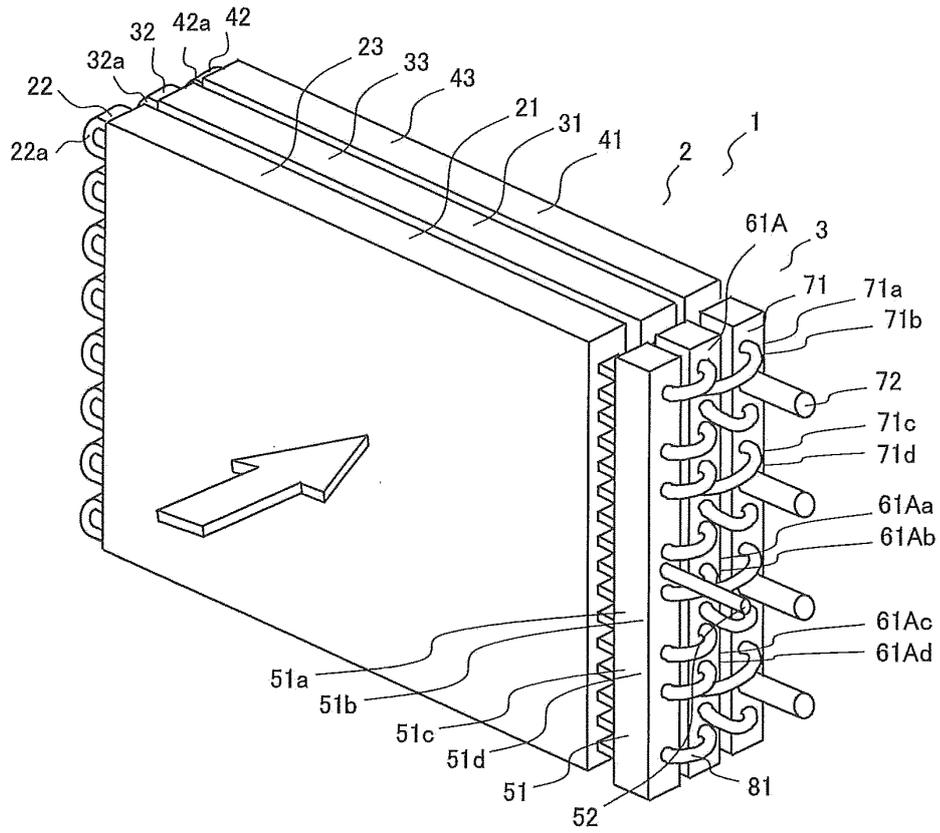
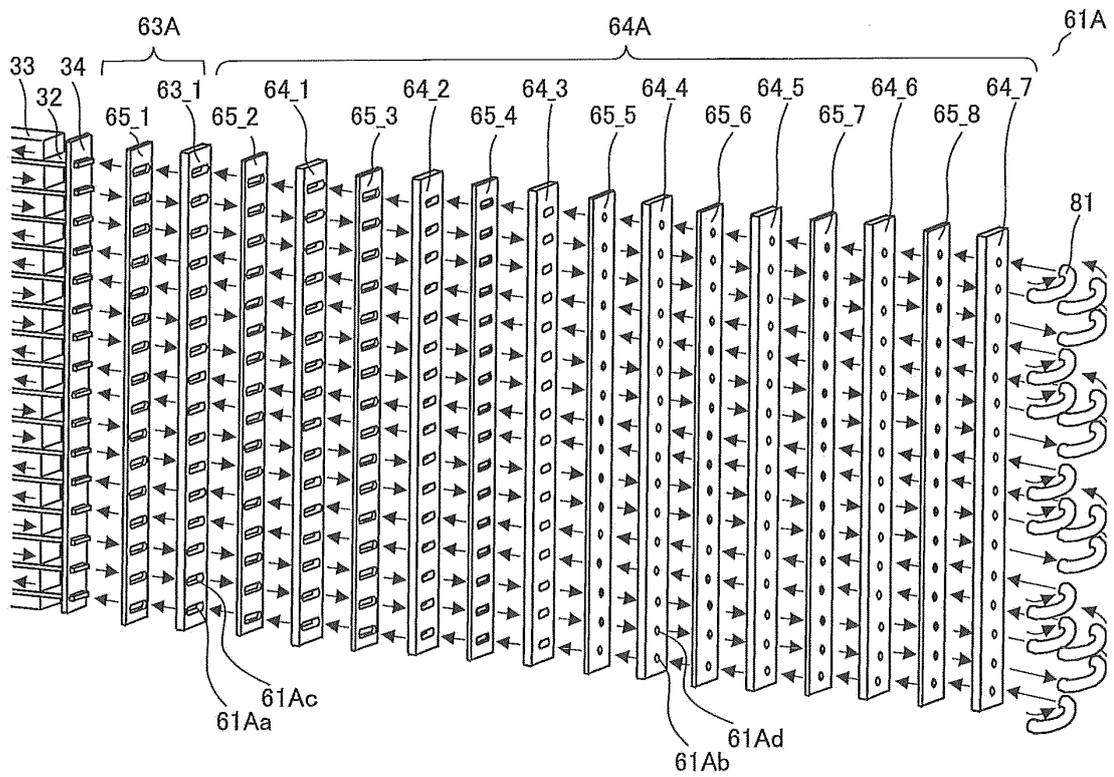


FIG. 12



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/051665

5	A. CLASSIFICATION OF SUBJECT MATTER <i>F28F9/02(2006.01)i, F25B39/02(2006.01)i, F25B39/04(2006.01)i, F28D1/053(2006.01)i</i>	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) <i>F28F9/02, F25B39/02, F25B39/04, F28D1/053</i>	
15	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)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	Y	JP 2004-144395 A (Denso Corp.), 20 May 2004 (20.05.2004), paragraphs [0001] to [0002]; fig. 9, 10 (Family: none)
30	Y	JP 2002-372383 A (Calsonic Kansei Corp.), 26 December 2002 (26.12.2002), paragraph [0005]; fig. 9 (Family: none)
35	Y A	JP 6-11291 A (Nartron Corp.), 21 January 1994 (21.01.1994), paragraphs [0001], [0012] to [0028]; fig. 2, 3 & US 5242016 A
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
	"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
	"O" document referring to an oral disclosure, use, exhibition or other means	
	"P" document published prior to the international filing date but later than the priority date claimed	
50	Date of the actual completion of the international search 11 April, 2014 (11.04.14)	Date of mailing of the international search report 22 April, 2014 (22.04.14)
	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
55	Facsimile No.	Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/051665

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 2012-254725 A (Panasonic Corp.), 27 December 2012 (27.12.2012), paragraphs [0014] to [0021]; fig. 1 (Family: none)	11
A	JP 2010-175241 A (Valeo System Thermiques), 12 August 2010 (12.08.2010), fig. 3 & US 2010/0186934 A1 & FR 2941522 A	1-11
A	JP 2006-10262 A (Denso Corp.), 12 January 2006 (12.01.2006), fig. 2, 3 & US 2005/0284621 A1 & DE 102005029171 A	1-11
A	JP 2005-513403 A (Behr GmbH & Co. KG.), 12 May 2005 (12.05.2005), fig. 1, 2 & JP 2005-513401 A & JP 2005-513402 A & JP 2008-180503 A & US 2005/0006073 A1 & US 2005/0039901 A1 & US 2005/0103486 A1 & US 2009/0126920 A1 & EP 1459025 A & EP 1459026 A & EP 1459027 A & EP 2026028 A2 & WO 2003/054467 A1 & WO 2003/054465 A1 & WO 2003/054466 A1 & DE 10260030 A & DE 10260107 A & DE 10260029 A & DE 50212972 D & DE 50214246 D & DE 50214296 D & CA 2471164 A & BR 215231 A & BR 215235 A & CN 1620589 A & CN 1620590 A & CN 1697958 A & AT 412863 T & ES 2316640 T & AT 458975 T & AT 461407 T & AU 2002358769 A & AU 2002360056 A & AU 2002363887 A & MX PA04006151 A	1-11
A	JP 2001-336896 A (Matsushita Electric Industrial Co., Ltd.), 07 December 2001 (07.12.2001), paragraphs [0073] to [0074]; fig. 12 (Family: none)	6-7

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 6011291 A [0003]