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(54) **STACKED HEAT EXCHANGER AND HEAT PUMP SYSTEM HAVING THE SAME INSTALLED THEREIN**

STAPELWÄRMETAUSCHER UND WÄRMEPUMPENSYSTEM, IN DEM DERSELBE INSTALLIERT IST

ECHANGEUR DE CHALEUR EMPILE ET LE SYSTEME DE POMPE A CHALEUR DANS LEQUEL IL EST INSTALLE

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Description

Technical Field

[0001] The present invention relates to a heat exchanger that performs heat exchange between a first refrigerant and a second refrigerant, one of which is a low temperature fluid and the other one of which is a high temperature fluid, and to a heat pump system having the heat exchanger installed therein.

Background Art

[0002] A heat exchanger having the following configuration is available as an example of the related art. In the heat exchanger, a first heat exchanger pipe through which a low temperature fluid flows and a second heat exchanger pipe through which a high temperature fluid flows are alternately stacked on each other. The second heat exchanger pipe is placed so that the flowing direction of the high temperature fluid may be in parallel with the flowing direction of the low temperature fluid.

[0003] At least one of the first and second heat exchanger pipes is constituted by a plurality of heat exchanger pipes which are arranged in the stacking direction. Both ends of the plurality of heat exchanger pipes are bent in directions perpendicular to both of the flowing direction of the fluids and the stacking direction. The plurality of heat exchanger pipes form parallel flow channels, together with an inlet header and an outlet header.

[0004] One of the inlet header and the outlet header is constituted by a tubular header, and the plurality of heat exchanger pipes which form the parallel flow channels are bundled and are connected to the tubular header such that the pipe axis direction of the tubular header is perpendicular to the flowing direction of the fluids in the heat exchanger pipes (for example, see Patent Literature 1).

Citation List

Patent Literature

[0005]

Patent Literature 1: WO2007/122685A1 (Page 28, FIG. 17)

Patent Literature 2: FR 2 859 779 A1

Patent Literature 3: GB 2 447 090 A

Summary of the Invention

Technical Problem

[0006] The heat exchanger disclosed in Patent Literature 1 is formed in a structure in which heat exchanger pipes are stacked on each other, thereby implementing high performance and high efficiency in space utilization.

On the other hand, however, in this structure, at least one of the header pipes through which a refrigerant flows is connected to heat exchanger pipes which are bent in a direction perpendicular to the stacking direction. Accordingly, a step of bending the heat exchanger pipes in the widthwise direction is necessary, and also, a space which cannot be utilized is increased by the provision of a header pipe.

[0007] Patent Literature 2 and Patent Literature 3 are considered to be the closest prior art of the invention according to independent claim. Patent Literature 2 discloses a multichannel flat tube for a heat exchanger comprising a plurality of parallel channels arranged inside a metal casing for defining a path between at least one fluid inlet and at least one fluid outlet. Patent Literature 3 discloses heat exchanger headers used in natural gas liquefaction processes.

[0008] The present invention has been made to solve the above-described problems. It is an object of the present invention to obtain a stacked heat exchanger in which the need to provide a step of bending heat exchanger pipes is eliminated and a space which cannot be utilized because of the provision of a header pipe is not produced, and also to obtain a heat pump system having the heat exchanger installed therein.

Solution to Problem

[0009] According to the invention, the problem is solved by the subject-matter outlined in independent claim. Advantageous further developments of the invention are set forth in dependent claims.

[0010] A stacked heat exchanger according to the present invention includes:

a plurality of first heat exchanger pipes each having a flat shape and including therein a first refrigerant flow channel through which a first refrigerant flows; a plurality of second heat exchanger pipes each having a flat shape, the plurality of second heat exchanger pipes and the plurality of first heat exchanger pipes being alternately stacked on each other in the state in which adjacent first and second heat exchanger pipes abut against each other, a plurality of second heat exchanger pipes each including therein a second refrigerant flow channel through which a second refrigerant, having a temperature different from a temperature of the first refrigerant, flows; two sets of first communication holes formed to pass through the first heat exchanger pipes and the second heat exchanger pipes so that the first refrigerant flow channels communicate with each other and so that the first refrigerant flow channels communicate with an outside in one of two outermost heat exchanger pipes, each of which is one of the plurality of first heat exchanger pipes or one of the plurality of second heat exchanger pipes, positioned at both ends of the stacking structure in a stacking direction;

two sets of second communication holes formed to pass through the first heat exchanger pipes and the second heat exchanger pipes so that the second refrigerant flow channels communicate with each other and so that the second refrigerant flow channels communicate with an outside in one of the two outermost heat exchanger pipes;

closing means that closes openings formed at both ends of the first refrigerant flow channel of each of the plurality of first heat exchanger pipes and the second refrigerant flow channel of each of the plurality of second heat exchanger pipes in a direction through which the refrigerants flow;

first blocking means that serves as a block such that the first communication holes formed in each of the second heat exchanger pipes do not communicate with the second refrigerant flow channel; and second blocking means that serves as a block such that the second communication holes formed in each of the first heat exchanger pipes do not communicate with the first refrigerant flow channel, wherein two of the first communication holes formed in the outermost heat exchanger pipes and allowing the refrigerant flow channels within the outermost heat exchanger pipes to communicate with the outside serve as an inlet and an outlet of the first refrigerant, two of the second communication holes formed in the outermost heat exchanger pipes and allowing the refrigerant flow channels within the outermost heat exchanger pipes to communicate with the outside serve as an inlet and an outlet of the second refrigerant, heat exchange between the first refrigerant and the second refrigerant is performed on abutting surfaces of the first heat exchanger pipes and the second heat exchanger pipes, the closing means includes a heat-exchanger-pipe fitting portion through which a fitting-portion communication hole is formed, the heat-exchanger-pipe fitting portion is fit into part of each of the first refrigerant flow channels and part of each of the second refrigerant flow channels, the first blocking means is constituted by the heat-exchanger-pipe fitting portion which is fit into each of the second refrigerant flow channels, and the fitting-portion communication hole of each of the heat-exchanger-pipe fitting portion communicates with the associated one of the first communication holes, and the second blocking means is constituted by the heat-exchanger-pipe fitting portion which is fit into each of the first refrigerant flow channels, and the fitting-portion communication hole of each of the heat-exchanger-pipe fitting portion communicates with the associated one of the second communication holes.

Advantageous Effects of the Invention

[0011] According to the present invention, first refrigerant flow channels of first heat exchanger pipes are

caused to communicate with each other through the use of a first port, which is an inlet of a first refrigerant, and second refrigerant flow channels of second heat exchanger pipes are caused to communicate with each other through the use of a second port, which is an inlet of a second refrigerant. With this configuration, the provision of a header pipe is made unnecessary, and thus, a space which cannot be utilized can be eliminated, and the entire stacked heat exchanger can be formed in a compact size.

Brief Description of the Drawings

[0012]

- FIG. 1 is a perspective view illustrating a heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention.
- FIG. 2 is a drawing comprising three views constituted by a top view, a sectional view taken along line A-A of the top view, and a side view of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention.
- FIG. 3 is a drawing comprising three views illustrating a capping 8 which is fit into a heat-exchanger-pipe end portion of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention.
- FIG. 4 is a sectional view of a principal portion of heat exchanger pipes, illustrating the configuration of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention.
- FIG. 5 shows views of a manufacturing method of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention.
- FIG. 6 is a perspective view illustrating a heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2 not forming part of the present invention.
- FIG. 7 is a drawing comprising three views constituted by a top view, a sectional view taken along line B-B of the top view, and a side view of the heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2.
- FIG. 8 shows views of a manufacturing method of the heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2.
- FIG. 9 shows sectional views of heat exchanger pipes of a stacked heat exchanger according to Embodiment 3 of the present invention.
- FIG. 10 is a diagram illustrating a heat pump system according to Embodiment 4 of the present invention utilizing heating energy of a heat ex-

- changer.
- FIG. 11 is a diagram illustrating another mode of the heat pump system according to Embodiment 4 of the present invention.
- FIG. 12 is a diagram illustrating another mode of the heat pump system according to Embodiment 4 of the present invention.
- FIG. 13 is a diagram illustrating another mode of the heat pump system according to Embodiment 4 of the present invention.

Description of Embodiments

Embodiment 1

Structure of Heat Exchanger 10

[0013] FIG. 1 is a perspective view illustrating a heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention. FIG. 2 is a drawing comprising three views constituted by a top view, a sectional view taken along line A-A of the top view, and a side view of the heat exchanger 10. FIG 3 is a drawing comprising three views illustrating a capping 8 which is fit into a heat-exchanger-pipe end portion of the heat exchanger 10.

[0014] The configuration of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1, will be described below with reference to FIGs. 1 to 3. The following description will be given in accordance with the top, down, right, and left directions in FIG. 1.

[0015] As shown in FIGs. 1 and 2, the heat exchanger 10 is configured such that a plurality of rectangular first heat exchanger pipes 1 and a plurality of rectangular second heat exchanger pipes 2 are alternately stacked on each other. The first and second heat exchanger pipes 1 and 2 each have a refrigerant flow channel having a rectangular cross section through which a refrigerant flows.

[0016] The first and second heat exchanger pipes 1 and 2 have substantially the same length in a direction in which refrigerants flow through the refrigerant flow channels and also have substantially the same width in the widthwise direction of the refrigerant flow channels.

[0017] Among the refrigerant flow channels, rectangular refrigerant flow channels which pass through first heat exchanger pipe end portions 5 positioned at both ends of the first heat exchanger pipes 1 are referred to as first refrigerant flow channels 1a, while rectangular refrigerant flow channels which pass through second heat exchanger pipe end portions 6 positioned at both ends of the second heat exchanger pipes 2 are referred to as second refrigerant flow channels 2a. The first refrigerant flow channels 1a positioned at the first heat exchanger pipe end portions 5 and the second refrigerant flow channels 2a positioned at the second heat exchanger pipe end portions 6 are each closed by a capping 8.

[0018] As shown in FIG. 3, the capping 8 has a rectan-

gular heat-exchanger-pipe fitting portion 8a which is vertically provided on one surface of the capping 8. The heat-exchanger-pipe fitting portion 8a is vertically provided in such a manner that it is displaced toward one side from the center in the longitudinal direction of the capping 8.

[0019] When closing the first and second refrigerant flow channels 1a and 2a positioned at the first and second heat exchanger pipe end portions 5 and 6, respectively, with the covers 8, the heat-exchanger-pipe fitting portions 8a are fit into the first and second refrigerant flow channels 1a and 2a.

[0020] In this case, the heat-exchanger-pipe fitting portions 8a which will be fit into the first refrigerant flow channels 1a positioned at the first heat exchanger end portions 5 are fit into the first refrigerant flow channels 1a such that they are all displaced toward the same side from the center in the longitudinal direction of the capping 8.

[0021] In contrast, the heat-exchanger-pipe fitting portions 8a which will be fit into the second refrigerant flow channels 2a positioned at the second heat exchanger end portions 6 are fit into the second refrigerant flow channels 2a such that they are all displaced from the center in the longitudinal direction of the capping 8 toward the side opposite to the side in which the heat-exchanger-pipe fitting portions 8a are fit into the first refrigerant flow channels 1a.

[0022] The first and second heat exchanger pipes 1 and 2 have substantially the same length in a direction in which refrigerants flow through the refrigerant flow channels and also have substantially the same width in the widthwise direction of the refrigerant flow channels. However, the first and second heat exchanger pipes 1 and 2 are not restricted to this configuration, and may have different lengths and different widths.

[0023] The capping 8 and the heat exchanger 10 respectively correspond to "closing means" and "a stacked heat exchanger" of the present invention. The heat-exchanger-pipe fitting portions 8a fit into the second refrigerant flow channels 2a and the heat-exchanger-pipe fitting portions 8a fit into the first refrigerant flow channels 1a respectively correspond to "first blocking means" and "second blocking means" of the present invention.

[0024] As shown in FIGs. 1 and 2, on the top surface of the topmost heat exchanger pipe (the first heat exchanger pipe 1 in FIGs. 1 and 2) of the stacking structure of the first and second heat exchanger pipes 1 and 2, tubular first ports 3 and tubular second ports 4 are brazed with a brazing filler material 21 made of, for example, an aluminum-silicon alloy. The first ports 3 communicate with the first refrigerant flow channels 1a of the first heat exchanger pipes 1, and the second ports 4 communicate with the second refrigerant flow channels 2a of the second heat exchanger pipes 2.

[0025] This will be discussed later. One first port 3 is provided at a refrigerant inlet and the other first port 3 is provided at a refrigerant outlet. One second port 4 is provided at the refrigerant inlet and the other second port 4 is provided at the refrigerant outlet. The first and second

ports 3 and 4 are connected to, for example, a refrigerant circuit, disposed in a heat pump system.

[0026] As shown in FIGs. 1 and 2, the topmost heat exchanger pipe of the stacking structure of the heat exchanger pipes is a first heat exchanger pipe 1. However, the stacking structure is not restricted to this configuration, and needless to say, a second heat exchanger pipe 2 may be used as the topmost heat exchanger pipe of the stacking structure.

[0027] As shown in FIGs. 1 and 2, the first and second ports 3 and 4 are provided on the topmost heat exchanger pipe of the stacking structure of the heat exchanger pipes. However, the stacking structure is not restricted to this configuration, and instead of providing the first and second ports 3 and 4, communication holes formed in the topmost heat exchanger pipe may be used as connection ports, and pipes of, for example, a refrigerant circuit, in a heat pump system may be directly connected to these connection ports.

[0028] A description will now be given, with reference to FIGs. 2 and 3, of a structure in which the first port 3 and the first refrigerant flow channels 1a of the stacked first heat exchanger pipes 1 communicate with each other, and a structure in which the second port 4 and the second refrigerant flow channels 2a of the stacked second heat exchanger pipes 2 communicate with each other. Part (a) of FIG. 2 is a top view of the heat exchanger 10 according to Embodiment 1, part (b) of FIG. 2 is a sectional view taken along line A-A of part (a) of FIG. 2, and part (c) of FIG. 2 is a side view of the heat exchanger 10.

[0029] As shown in part (b) of FIG. 2, first communication holes 3a pass through the top and bottom surfaces of the topmost first heat exchanger pipe 1, and the first port 3 communicates with the first refrigerant flow channel 1a through the first communication hole 3a formed on the top surface of the first heat exchanger pipe 1. The first communication hole 3a formed on the bottom surface of the first heat exchanger pipe 1 communicates with a first communication hole 3b formed through the top surface of the second heat exchanger pipe 2 positioned right under this first heat exchanger pipe 1. Here, the above-stated heat-exchanger-pipe fitting portion 8a of the capping 8 is fit into the second refrigerant flow channel 2a of the second heat exchanger pipe 2 which communicates with this first communication hole 3b. However, as shown in FIG. 3, a communication hole 8b is formed through the heat-exchanger-pipe fitting portion 8a. This communication hole 8b and the first communication hole 3b formed on the top surface of the second heat exchanger pipe 2 communicate with each other, and these holes also communicate with a first communication hole 3b formed through the bottom surface of the second heat exchanger pipe 2. Further, as in the topmost first heat exchanger pipe 1, first communication holes 3a pass through the top and bottom surfaces of the first heat exchanger pipe 1 positioned right under this second heat exchanger pipe 2. The first communication hole 3b

formed on the bottom surface of the second heat exchanger pipe 2 positioned right above this first heat exchanger pipe 1 communicates with the first refrigerant flow channel 1a through the first communication hole 3a formed on the top surface of this first heat exchanger pipe 1.

[0030] That is, the first port 3 communicates with the first refrigerant flow channel 1a of the topmost first heat exchanger pipe 1, and this first refrigerant flow channel 1a communicates with, via the second heat exchanger pipe 2 positioned immediately under this first refrigerant flow channel 1a, the first refrigerant flow channel 1a of the first heat exchanger pipe 1 under the second heat exchanger pipe 2. The lower layers of the first and second heat exchanger pipes 1 and 2 have a structure similar to the above-described structure. That is, the first port 3 and the first refrigerant flow channels 1a of the first heat exchanger pipes 1 sequentially communicate with each other, but they are shielded from the second refrigerant flow channels 2a of the second heat exchanger pipes 2 by the provision of the heat-exchanger-pipe fitting portions 8a of the covers 8. However, a first communication hole 3a is formed only on the top surface of the bottommost first heat exchanger pipe 1 (the second bottommost heat exchanger pipe in part (b) of FIG. 2) of the stacking structure of the first and second heat exchanger pipes 1 and 2. In this structure, a refrigerant flowing from one of the two first ports 3 (hereinafter referred to as a "first refrigerant") flows through the first refrigerant flow channels 1a of the first heat exchanger pipes 1 of the stacking structure and flows out of the other first port 3.

[0031] Second communication holes 4a pass through the top and bottom surfaces of the topmost first heat exchanger pipe 1, and the second port 4 communicates with the first refrigerant flow channel 1a through the second communication hole 4a formed on the top surface of the first heat exchanger pipe 1. Here, the above-stated heat-exchanger-pipe fitting portion 8a of the capping 8 is fit into the first refrigerant flow channel 1a of the first heat exchanger pipe 1 which communicates with this second communication hole 4a. However, as shown in FIG. 3, the communication hole 8b is formed through the heat-exchanger-pipe fitting portion 8a. This communication hole 8b and the second communication hole 4a formed on the top surface of the first heat exchanger pipe 1 communicate with each other, and these holes also communicate with a second communication hole 4a formed through the bottom surface of the first heat exchanger pipe 1. Further, second communication holes 4b pass through the top and bottom surfaces of the second heat exchanger pipe 2 positioned right under this first heat exchanger pipe 1. The second communication hole 4a formed on the bottom surface of the first heat exchanger pipe 1 positioned right above this second heat exchanger pipe 2 communicates with the second refrigerant flow channel 2a through the second communication hole 4b formed on the top surface of this second heat exchanger pipe 2. The second communication hole 4b formed on

the bottom surface of the second heat exchanger pipe 2 communicates with a second communication hole 4a formed through the top surface of the first heat exchanger pipe 1 positioned right under this second heat exchanger pipe 2. As in the above-described case, the heat-exchanger-pipe fitting portion 8a of the capping 8 is fit into the first refrigerant flow channel 1a of the first heat exchanger pipe 1 which communicates with this second communication hole 4a, and the communication hole 8b is formed in and passes through the heat-exchanger-pipe fitting portion 8a. This communication hole 8b and the second communication hole 4a formed on the top surface of the first heat exchanger pipe 1 communicate with each other, and these holes also communicate with a second communication hole 4a formed through the bottom surface of the first heat exchanger pipe 1. Further, second communication holes 4b pass through the top and bottom surfaces of the second heat exchanger pipe 2 positioned right under this first heat exchanger pipe 1. The second communication hole 4a formed on the bottom surface of the first heat exchanger pipe 1 positioned right above this second heat exchanger pipe 2 communicates with the second refrigerant flow channel 2a through the second communication hole 4b formed on the top surface of this second heat exchanger pipe 2.

[0032] That is, the second port 4 communicates with the second refrigerant flow channel 2a of the second heat exchanger pipe 2 immediately under the topmost first heat exchanger pipe 1, and this second refrigerant flow channel 2a communicates with, via the first heat exchanger pipe 1 positioned immediately under this second refrigerant flow channel 2a, the second refrigerant flow channel 2a of the second heat exchanger pipe 2 under this first heat exchanger pipe 1. The lower layers of the first and second heat exchanger pipes 1 and 2 have a structure similar to the above-described structure. That is, the second port 4 and the second refrigerant flow channels 2a of the second heat exchanger pipes 2 sequentially communicate with each other, but they are shielded from the first refrigerant flow channels 1a of the first heat exchanger pipes 1 by the provision of the heat-exchanger-pipe fitting portions 8a of the covers 8. However, a second communication hole 4b is formed only on the top surface of the bottommost second heat exchanger pipe 1 (the bottommost heat exchanger pipe in part (b) of FIG. 2) of the stacking structure of the first and second heat exchanger pipes 1 and 2. In this structure, a refrigerant flowing from one of the two second ports 4 (hereinafter referred to as a "second refrigerant") flows through the second refrigerant flow channels 2a of the second heat exchanger pipes 2 of the stacking structure and flows out of the other second port 4.

[0033] The stacking structure of the first and second heat exchanger pipes 1 and 2 is configured, as shown in FIG. 1, such that four first heat exchanger pipes 1 and four second heat exchanger pipes 2 are alternately stacked on each other. However, the stacking structure is not restricted to this configuration, and any number of

first heat exchanger pipes 1 and second heat exchanger pipes 2 may be alternately stacked on each other.

[0034] Additionally, the number of first heat exchanger pipes 1 and the number of second heat exchanger pipes 2 stacked on each other do not have to be the same. For example, the number of first heat exchanger pipes 1 may be smaller than or may be larger than the number of second heat exchanger pipes 2 by one.

[0035] As shown in part (b) of FIG. 2, the first and second refrigerant flow channels 1a and 2a having a rectangular cross section are formed in the first and second heat exchanger pipes, respectively. However, the cross section of the first and second refrigerant flow channels 1a and 2a is not restricted to a rectangular shape, and may be formed in another shape, such as an elliptical shape.

[0036] As shown in FIG. 3, the heat-exchanger-pipe fitting portion 8a is formed in a rectangular shape. However, the heat-exchanger-pipe fitting portion 8a is not restricted to this shape, and may be formed in a different shape as long as the communication hole 8b can be formed in the heat-exchanger-pipe fitting portion 8a.

[0037] As shown in FIGS. 1 and 2, the top surfaces of the first and second heat exchanger pipes 1 and 2 are formed in a rectangular shape. However, they are not restricted to this shape. For example, the four corners of the rectangular shape may be rounded, or the top surfaces of the first and second heat exchanger pipes 1 and 2 may be formed, for example, in a parallelogram. Alternatively, the configurations may be changed appropriately depending on the position of the heat exchanger 10 installed in, for example, a heat pump system.

[0038] As shown in FIG. 2, the first communication holes 3a formed in the first heat exchanger pipes 1, the first communication holes 3b formed in the second heat exchanger pipes 2, and the communication holes 8b of the heat-exchanger-pipe fitting portions 8a fit into the second refrigerant flow channels 2a have the same diameter and are formed concentrically in the stacking direction.

[0039] However, these holes are not restricted to this configuration. Instead, they may be formed such that they do not have the same diameter or such that they are not concentric in the stacking direction, and they may be formed in any manner as long as the first refrigerant flow channels 1a of the first heat exchanger pipes 1 can communicate with each other.

[0040] Also, the second communication holes 4a formed in the first heat exchanger pipes 1, the second communication holes 4b formed in the second heat exchanger pipes 2, and the communication holes 8b of the heat-exchanger-pipe fitting portions 8a fit into the first refrigerant flow channels 1a have the same diameter and are formed concentrically in the stacking direction.

[0041] Similarly, however, these holes are not restricted to this configuration. Instead, they may be formed such that they do not have the same diameter or such that they are not concentric in the stacking direction, and they may be formed in any manner as long as the second

refrigerant flow channels 2a of the second heat exchanger pipes 2 can communicate with each other. Additionally, the above-described holes are not restricted to a circular shape, and may be formed in another shape, such as a rectangular shape.

[0042] The communication hole 8b corresponds to a "fitting-portion communication hole" of the present invention.

Manufacturing Method for Heat Exchanger 10

[0043] FIG. 4 is a sectional view illustrating a principal portion of the heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1 of the present invention. FIG. 5 shows views of a manufacturing method of the heat exchanger 10.

[0044] The first and second heat exchanger pipes 1 and 2 of the heat exchanger 10 of Embodiment 1 shown in FIGs. 1 and 2 are manufactured in the following manner. The first and second heat exchanger pipes 1 and 2 are made of a material having a high thermal conductivity, such as an aluminum alloy, copper, stainless, or the like. A sheet is bended by means of, for example, roll-forming, and then, joints, which are both ends of this sheet, are electric-resistance welded (welded). Alternatively, a cylinder is processed by means of roll-forming or press-forming or is processed by means of extrusion forming or pultrusion forming.

[0045] In the stacking structure of the first and second heat exchanger pipes 1 and 2 shown in FIG. 4, the first and second heat exchanger pipes 1 and 2 are bonded to each other at their abutting surfaces by means of brazing utilizing a brazing filler material 21 made of, for example, an aluminum-silicon alloy.

[0046] As shown in part (a) of FIG. 5, as stated above, the heat-exchanger-pipe fitting portions 8a of the capping 8 are fit into openings of the first refrigerant flow channels 1a positioned at the first heat transfer pipe end portions 5 at both ends of the first heat exchanger pipes 1 and into openings of the second refrigerant flow channels 2a positioned at the second heat transfer pipe end portions 6 at both ends of the second heat exchanger pipes 2, thereby closing the openings by the covers 8.

[0047] In this case, the heat-exchanger-pipe fitting portions 8a are brazed to the inner surfaces of the first refrigerant flow channels 1a and the second refrigerant flow channels 2a by using a brazing filler material 21, and also, the bonding surfaces of the first and second heat exchanger pipe end portions 5 and 6 and the covers 8 are bonded to each other by means of brazing utilizing a brazing filler material 21.

[0048] With this configuration, refrigerants do not leak from the first and second heat exchanger pipe end portions 5 and 6. Additionally, by brazing the heat-exchanger-pipe fitting portions 8a to the inner surfaces of the first and second refrigerant flow channels 1a and 2a, the first refrigerant flow channels 1a and the second refrigerant flow channels 2a are preventing from communicating

with each other, and thus, the first refrigerant flowing through the first refrigerant flow channels 1a and the second refrigerant flowing through the second refrigerant flow channels 2a are not mixed with each other.

[0049] As shown in part (b) of FIG. 5, on the top surface of the first heat exchanger pipe 1 which is the topmost heat exchanger pipe of the stacking structure of the first and second heat exchanger pipes 1 and 2, two tubular first ports 3 and two tubular second ports 4 are provided by means of brazing with a brazing filler material (not shown).

[0050] Then, as stated above, the first ports 3 are configured such that they communicate with all the first refrigerant flow channels 1a of the first heat exchanger pipes 1, and the second ports 4 are configured such that they communicate with all the second refrigerant flow channels 2a of the second heat exchanger pipes 2.

[0051] By using the above-described method, the heat exchanger 10, which is a stacked heat exchanger, is fabricated.

Heat Exchange Operation of Heat Exchanger 10

[0052] The heat exchanger 10, which is a stacked heat exchanger according to Embodiment 1, is installed in a heat pump system utilizing heating energy or cooling energy. For example, in the case of an operation utilizing heating energy, a heat exchange operation is performed as follows. A high-temperature first refrigerant flowing from a refrigerant circuit flows into the heat exchanger 10 through one of the first ports 3, flows through the first refrigerant flow channels 1a of the first heat exchanger pipes 1, and then, flows out of the other first port 3. A second refrigerant flowing from a use side circuit flows into the heat exchanger 10 through one of the second ports 4, flows through the second refrigerant flow channels 2a of the second heat exchanger pipes 2, and then, flows out of the other second port 4.

[0053] In this case, the first refrigerant and the second refrigerant flow through the first refrigerant flow channels 1a of the first heat exchanger pipes 1 and the second refrigerant flow channels 2a of the second heat exchanger pipes 2, respectively, in opposite directions or in parallel with each other, thereby performing heat exchange between the first refrigerant and the second refrigerant at wall surfaces of the first and second heat exchanger pipes 1 and 2.

[0054] In the heat exchanger 10 according to Embodiment 1, the flow channel area of the first refrigerant flow channels 1a of the first heat exchanger pipes 1 and the flow channel area of the second refrigerant flow channels 2a of the second heat exchanger pipes 2 do not necessarily have to be the same.

[0055] If there is a difference in the thermal physical property value, such as specific heat or density, the flow rate, pressure conditions, or cleanliness level between the first refrigerant and the second refrigerant, the flow channel area may be made different between the first

refrigerant flow channels 1a and the second refrigerant flow channels 2a.

[0056] For example, if a carbon dioxide or fluorocarbon refrigerant is used as the first refrigerant, and if, for example, tap water which is not subjected to sufficient water quality control, is used as the second refrigerant, the flow channel area of the second refrigerant flow channels 2a may be made larger than that of the first refrigerant flow channels 1a in order to improve heat exchange performance or to inhibit an increase in a pressure drop caused by the adhesion of scale to the inner surfaces of the refrigerant flow channels.

Advantages of Embodiment 1

[0057] The heat exchanger disclosed in Patent Literature 1 has a space which cannot be utilized because of the provision of a header pipe used for distributing a refrigerant over heat exchanger pipes, thereby decreasing efficiency in space utilization. However, as in the above-described configuration, the first refrigerant flow channels 1a of the first heat exchanger pipes 1 communicate with each other through the first ports 3, while the second refrigerant flow channels 2a of the second heat exchanger pipes 2 communicate with each other through the use of the second ports 4. Accordingly, it is not necessary to provide a header pipe, thereby making it possible to eliminate a space which cannot be utilized and to form the entire heat exchanger 10 in a compact size.

[0058] In the heat exchanger disclosed in Patent Literature 1, it is necessary to bend heat exchanger pipes bonded to the header pipe. However, concerning the heat exchanger pipes (first and second heat exchanger pipes 1 and 2) of the heat exchanger 10 according to Embodiment 1, bending is not necessary, and only hole drilling is sufficient, thereby implementing high machinability,

[0059] By alternately stacking the first heat exchanger pipes 1 and the second heat exchanger pipes 2 on each other, heat exchange efficiency between the first refrigerant and the second refrigerant can be improved. Moreover, by setting the lengths of the first heat exchanger pipes 1 and the second heat exchanger pipes 2 in a direction in which refrigerants flow through their refrigerant flow channels to be substantially the same and by setting the widths of the first heat exchanger pipes 1 and the second heat exchanger pipes 2 in the widthwise direction of the refrigerant flow channels to be substantially the same, heat exchange between the first refrigerant and the second refrigerant can be more effectively performed, and also, the entire heat exchanger 10 can be formed in a compact size.

[0060] On the top surface of the topmost heat exchanger pipe (the first heat exchanger pipe 1 in FIGs. 1 and 2) of the stacking structure of the heat exchanger 10, the two first ports 3 are disposed at positions diagonal to each other and the two second ports 4 are disposed at positions diagonal to each other near the covers 8 which are provided at the ends of the refrigerant flow channels

of the heat exchanger pipes.

[0061] Accordingly, the flow channel lengths of the first and second refrigerant flow channels 1a and 2a through which refrigerants flow can be substantially maximized, thereby further enhancing heat exchange efficiency between the first refrigerant and the second refrigerant.

[0062] However, the positions of the first ports 3 and the second ports 4 are not restricted to the above-described positions, and may be changed appropriately depending on the position of the heat exchanger 10 installed in, for example, a heat pump system. In this case, it is necessary that the first ports 3 communicate with the communication holes 8b of the heat-exchanger-pipe fitting portions 8a fit into the second refrigerant flow channels 2a and that the second ports 4 communicate with the communication holes 8b of the heat-exchanger-pipe fitting portions 8a fit into the first refrigerant flow channels 1a.

[0063] As shown in FIGs. 1 and 2, the two first ports 3 and the two second ports 4 are disposed on the top surface of the topmost heat exchanger pipe of the stacking structure of the heat exchanger 10. However, the positions of the first and second ports 3 and 4 are not restricted. For example, one of the two first ports 3 may be disposed on the top surface of the topmost heat exchanger pipe of the stacking structure, while the other first port 3 may be disposed on the bottom surface of the bottommost heat exchanger pipe of the stacking structure.

[0064] As in the two first ports 3, the positions of the two second ports 4 are not restricted, either. Moreover, the first ports 3 and the second ports 4 do not have to be disposed on the same surface. For example, the two first ports 3 may be disposed on the top surface of the topmost heat exchanger pipe of the stacking structure, while the two second ports 4 may be disposed on the bottom surface of the bottommost heat exchanger pipe of the stacking structure.

[0065] By brazing the heat-exchanger-pipe fitting portions 8a to the inner surfaces of the first and second refrigerant flow channels 1a and 2a, the first refrigerant flow channels 1a and the second refrigerant flow channels 2a are shielded from each other and do not communicate with each other, and thus, the first refrigerant flowing through the first refrigerant flow channels 1a and the second refrigerant flowing through the second refrigerant flow channels 2a can be prevented from being mixed with each other.

Embodiment 2

Structure of Heat Exchanger 10a

[0066] FIG. 6 is a perspective view illustrating a heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2, which does not form part of the present invention.

[0067] FIG. 7 is a three-view drawing constituted by a top view, a sectional view taken along line B-B of the top

view, and a side view of the heat exchanger 10a. The configuration of the heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2, will be described below with reference to FIGs. 6 and 7 by focusing on points different from those of the configuration of the heat exchanger 10 according to Embodiment 1.

[0068] As shown in FIGs. 6 and 7, the heat exchanger 10a is configured such that a plurality of rectangular first heat exchanger pipes 1 and a plurality of rectangular second heat exchanger pipes 2 are alternately stacked on each other. The first and second heat exchanger pipes 1 and 2 each have a refrigerant flow channel having a rectangular cross section through which a refrigerant flows. The first and second heat exchanger pipes 1 and 2 have substantially the same length in a direction in which refrigerants flow through the refrigerant flow channels and also have substantially the same width in the widthwise direction of the refrigerant flow channels.

[0069] Among the refrigerant flow channels, rectangular refrigerant flow channels which pass through first heat exchanger pipe end portions 5 positioned at both ends of the first heat exchanger pipes 1 are referred to as first refrigerant flow channels 1a, while rectangular refrigerant flow channels which pass through second heat exchanger pipe end portions 6 positioned at both ends of the second heat exchanger pipes 2 are referred to as second refrigerant flow channels 2a.

[0070] The first and second heat exchanger pipes 1 and 2 have substantially the same length in a direction in which refrigerants flow through the refrigerant flow channels and also have substantially the same width in the widthwise direction of the refrigerant flow channels. However, the first and second heat exchanger pipes 1 and 2 are not restricted to this configuration, and may have different lengths and different widths.

[0071] The heat exchanger 10a corresponds to "a stacked heat exchanger" not forming part of the present invention.

[0072] The first heat exchanger pipe 1 has a pressed portion 9a in an area having a predetermined length from the first heat exchanger pipe end portion 5 toward inward of the first heat exchanger pipe 1. As viewed from the penetrating direction of the first refrigerant flow channel 1a, the pressed portion 9a is formed by pressing, in the vertical direction in FIG. 6, a portion from one end to a point on the way to the other end in the longitudinal direction of the first refrigerant flow channel 1a.

[0073] By the provision of this pressed portion 9a, part of the opening of the first refrigerant flow channel 1a is closed. In the first heat exchanger pipe end portion 5 positioned opposite to the first heat exchanger pipe end portion 5 in which this pressed portion 9 is formed, another pressed portion 9a is formed in a similar manner. In this case, the two pressed portions 9a are formed at positions diagonal to each other, as viewed from the top surface of the first heat exchanger pipe 1.

[0074] A central portion sandwiched between the two pressed portions 9a of the first heat exchanger pipe 1 is

pressed in the vertical direction in FIG. 6 to such a degree as not to press and eliminate the first refrigerant flow channel 1a inside the first heat exchanger pipe 1. As a result, the other end which has not been pressed when forming the pressed portion 9a projects to a level higher than the central portion, thereby forming a projecting portion 9b.

[0075] This projecting portion 9b is formed for each of the two pressed portions 9a, and the two projecting portions 9b are disposed at positions diagonal to each other, as viewed from the top surface of the first heat exchanger pipe 1. In a manner similar to the first heat exchanger pipe 1, concerning the second heat exchanger pipe 2, a pressed portion 9c and a projecting portion 9d are formed at each side of the second heat exchanger pipe end portions 6. As stated above, part of the opening of the first refrigerant flow channel 1a of the first heat exchanger pipe 1 is closed by the pressed portion 9a.

[0076] However, the first refrigerant flow channel 1a corresponding to the projecting portion 9b is opened, and inside of this opening, a first refrigerant auxiliary flow channel 1b which communicates with the first refrigerant flow channel 1a is formed.

[0077] Similarly, part of the opening of the second refrigerant flow channel 2a of the second heat exchanger pipe 2 is closed by the pressed portion 9c, while the second refrigerant flow channel 2a corresponding to the projecting portion 9d is opened, and inside of this opening, a second refrigerant auxiliary flow channel 2b which communicates with the second refrigerant flow channel 2a is formed.

[0078] Concerning the stacking structure of the first heat exchanger pipes 1 and the second heat exchanger pipes 2, the first heat exchanger pipe 1 and the second heat exchanger pipe 2 are stacked on each other such that the pressed portion 9a of the first heat exchanger pipe 1 and the projecting portion 9d of the second heat exchanger pipe 2 overlap each other and such that the projecting portion 9b of the first heat exchanger pipe 1 and the pressed portion 9c of the second heat exchanger pipe 2 overlap each other. In this case, the pressed portion 9a and the projecting portion 9d are brazed to each other by using a brazing filler material 21, and similarly, the projecting portion 9b and the pressed portion 9c are brazed to each other by using a brazing filler material 21.

[0079] As shown in FIGs. 6 and 7, on the top surfaces of the projecting portions 9b formed at both ends (the first heat exchanger pipe end portions 5 in FIGs. 6 and 7) of the topmost heat exchanger pipe (the first heat exchanger 1 in FIGs. 6 and 7) of the stacking structure of the first and second heat exchanger pipes 1 and 2, tubular first ports 3 which communicate with the first refrigerant auxiliary flow channels 1b, which will be discussed later, are brazed by using a brazing filler material 21, and on the top surface of the pressed portions 9a, tubular second ports 4 which communicate with the second refrigerant auxiliary flow channels 2b, which will be discussed later, are brazed by using a brazing filler material 21.

[0080] One first port 3 is provided at a refrigerant inlet and the other first port 3 is provided at a refrigerant outlet. One second port 4 is provided at the refrigerant inlet and the other second port 4 is provided at the refrigerant outlet. The first and second ports 3 and 4 are connected to, for example, a refrigerant circuit, disposed in a heat pump system.

[0081] A description will now be given, with reference to FIGs. 6 and 7, of a structure in which the first ports 3 and the first refrigerant flow channels 1a of the stacked first heat exchanger pipes 1 communicate with each other and a structure in which the second ports 4 and the second refrigerant flow channels 2a of the stacked second heat exchanger pipes 2 communicate with each other. Part (a) of FIG. 7 is a top view of the heat exchanger 10a according to Embodiment 2, part (b) of FIG. 7 is a sectional view taken along line B-B of part (a) of FIG. 7, and part (c) of FIG. 7 is a side view of the heat exchanger 10a.

[0082] As shown in part (b) of FIG. 7, first communication holes 3c pass through the top and bottom surfaces of the projecting portion 9b formed on the topmost first heat exchanger pipe 1, and the first port 3 communicates with the first refrigerant auxiliary flow channel 1b formed inside the projecting portion 9b through the first communication hole 3c formed on the top surface of the projecting portion 9b. This first refrigerant auxiliary flow channel 1b communicates with the first refrigerant flow channel 1a of the first heat exchanger pipe 1.

[0083] The first communication hole 3c formed on the bottom surface of the projecting portion 9b communicates with a first communication hole 3d formed through the pressed portion 9c of the second heat exchanger pipe 2 positioned right under the projecting portion 9b of the first heat exchanger pipe 1.

[0084] As stated above, this pressed portion 9c closes part of the opening of the second refrigerant flow channel 2a of the second heat exchanger pipe 2, and thus, the first communication hole 3d does not communicate with the second refrigerant flow channel 2a. Further, as in the projecting portion 9b formed on the topmost heat exchanger pipe 1, first communication holes 3c pass through the top and bottom surfaces of the projecting portion 9b of the first heat exchanger pipe 1 positioned right under the pressed portion 9c of this second heat exchanger pipe 2.

[0085] The above-described first communication hole 3d communicates with, via the first communication hole 3c formed on the top surface of the projecting portion 9b, the first refrigerant auxiliary flow channel 1b formed inside the projecting portion 9b, and also communicates with the first refrigerant flow channel 1a of the first heat exchanger pipe 1.

[0086] That is, the first port 3 communicates with the first refrigerant flow channel 1a of the topmost first heat exchanger pipe 1, and this first refrigerant flow channel 1a communicates with, via the second heat exchanger pipe 2 positioned immediately under this first refrigerant

flow channel 1a, the first refrigerant flow channel 1a of the first heat exchanger pipe 1 under the second heat exchanger pipe 2. The lower layers of the first and second heat exchanger pipes 1 and 2 have a structure similar to the above-described structure.

[0087] That is, the first port 3 and the first refrigerant flow channels 1a of the first heat exchanger pipes 1 sequentially communicate with each other, but they are shielded from the second refrigerant flow channels 2a of the second heat exchanger pipes 2 by the provision of the pressed portions 9c formed in these second heat exchanger pipes 2. However, a first communication hole 3c is formed only on the top surface of the pressed portion 9a of the bottommost first heat exchanger pipe 1 (the second bottommost heat exchanger pipe in part (b) of FIG. 7) of the stacking structure of the first and second heat exchanger pipes 1 and 2.

[0088] In this structure, a first refrigerant flowing from one of the two first ports 3 flows through the first refrigerant auxiliary flow channels 1b and the first refrigerant flow channels 1a of the first heat exchanger pipes 1 of the stacking structure and flows out of the other first port 3.

[0089] A second communication hole 4c passes through the pressed portion 9a formed in the topmost first heat exchanger pipe 1, and the second port 4 communicates with this second communication hole 4c. Second communication holes 4d are formed on the top and bottom surfaces of the projecting portion 9d formed on the second heat exchanger pipe 2 positioned immediately under the pressed portion 9a of the first heat exchanger pipe 1, and the second communication hole 4c of the pressed portion 9a formed in the first heat exchanger pipe 1 immediately above this second heat exchanger pipe 2 communicates with, via the second communication hole 4d formed on the top surface of this projecting portion 9d, the second refrigerant auxiliary flow channel 2b formed inside the projecting portion 9d.

[0090] This second refrigerant auxiliary flow channel 2b communicates with the second refrigerant flow channel 2a of the second heat exchanger pipe 2. The second communication hole 4d formed on the bottom surface of the projecting portion 9d communicates with a second communication hole 4c formed through the pressed portion 9a of the first heat exchanger pipe 1 positioned right under the projecting portion 9d of the second heat exchanger pipe 2.

[0091] Further, second communication holes 4d pass through the top and bottom surfaces of the projecting portion 9d of the second heat exchanger pipe 2 positioned right under the pressed portion 9a of this first heat exchanger pipe 1. The above-described second communication hole 4c communicates with, via the second communication hole 4d formed on the top surface of the projecting portion 9d, the second refrigerant auxiliary flow channel 2b formed inside the projecting portion 9d, and also communicates with the second refrigerant flow channel 2a of the second heat exchanger pipe 2.

[0092] That is, the second port 4 communicates with the second refrigerant flow channel 2a of the second heat exchanger pipe 2 immediately under the topmost first heat exchanger pipe 1, and this second refrigerant flow channel 2a communicates with, via the first heat exchanger pipe 1 positioned immediately under this second refrigerant flow channel 2a, the second refrigerant flow channel 2a of the second heat exchanger pipe 2 under the first heat exchanger pipe 1. The lower layers of the first and second heat exchanger pipes 1 and 2 have a structure similar to the above-described structure.

[0093] That is, the second port 4 and the second refrigerant flow channels 2a of the second heat exchanger pipes 2 sequentially communicate with each other, but they are shielded from the first refrigerant flow channels 1a of the first heat exchanger pipes 1 by the provision of the pressed portions 9a formed in these first heat exchanger pipes 1. However, a second communication hole 4d is formed only on the top surface of the pressed portion 9c of the bottommost second heat exchanger pipe 2 (the bottommost heat exchanger pipe in part (b) of FIG. 7) of the stacking structure of the first and second heat exchanger pipes 1 and 2.

[0094] In this structure, a second refrigerant flowing from one of the two second ports 4 flows through the second refrigerant auxiliary flow channels 2b and the second refrigerant flow channels 2a of the second heat exchanger pipes 2 of the stacking structure and flows out of the other second port 4.

[0095] As shown in FIG. 6 and part (b) of FIG. 7, the first and second refrigerant auxiliary flow channels 1b and 2b having a rectangular cross section are formed in the first and second heat exchanger pipes 1 and 2, respectively. However, the cross section of the first and second refrigerant auxiliary flow channels 1b and 2b is not restricted to a rectangular shape, and may be formed in another shape, such as an elliptical shape.

[0096] As shown in FIG. 7, the first communication holes 3c formed in the projecting portions 9b and the first communication holes 3d formed in the pressed portions 9c have the same diameter and are formed concentrically in the stacking direction. However, these holes are not restricted to this configuration. Instead, they may be formed such that they do not have the same diameter or such that they are not concentric in the stacking direction, and they may be formed in any manner as long as the first refrigerant flow channels 1a of the first heat exchanger pipes 1 can communicate with each other.

[0097] Similarly, the second communication holes 4c formed in the pressed portions 9a and the second communication holes 4d formed in the projecting portions 9d have the same diameter and are formed concentrically in the stacking direction. However, these holes are not restricted to this configuration. Instead, they may be formed such that they do not have the same diameter or such that they are not concentric in the stacking direction, and they may be formed in any manner as long as the second refrigerant flow channels 2a of the second heat

exchanger pipes 2 can communicate with each other. Additionally, the above-described holes are not restricted to a circular shape, and may be formed in another shape, such as a rectangular shape.

Manufacturing Method for Heat Exchanger 10a

[0098] FIG. 8 shows views of a manufacturing method of the heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2.

[0099] The first and second heat exchanger pipes 1 and 2 of the heat exchanger 10a of Embodiment 2 shown in FIG. 8 are manufactured in the following manner. The first and second heat exchanger pipes 1 and 2 are made of a material having a high thermal conductivity, such as an aluminum alloy, copper, stainless, or the like.

[0100] A sheet is bended by means of, for example, roll-forming, and then, joints, which are both ends of this sheet, are electric-resistance welded (welded). Alternatively, a cylinder is processed by means of roll-forming or press-forming or is processed by means of extrusion forming or pultrusion forming.

[0101] Then, in an area having a predetermined length from the first heat exchanger pipe end portion 5 toward inward of the first heat exchanger pipe 1, as viewed from the penetrating direction of the first refrigerant flow channel 1a, a portion from one end to a point on the way to the other end in the longitudinal direction of the first refrigerant flow channel 1a is pressed in the vertical direction in FIG. 8, thereby forming the pressed portion 9a.

[0102] By the provision of this pressed portion 9a, part of the opening of the first refrigerant flow channel 1a is closed. In the first heat exchanger pipe end portion 5 positioned opposite to the first heat exchanger pipe end portion 5 in which this pressed portion 9 is formed, another pressed portion 9a is formed in a similar manner. In this case, the two pressed portions 9a are disposed at positions diagonal to each other, as viewed from the top surface of the first heat exchanger pipe 1.

[0103] A central portion sandwiched between the two pressed portions 9a of the first heat exchanger pipe 1 is pressed in the vertical direction in FIG. 8 to such a degree as not to press and eliminate the first refrigerant flow channel 1a inside the first heat exchanger pipe 1.

[0104] As a result, the other end which has not been pressed when forming the pressed portion 9a projects to a level higher than the central portion, thereby forming a projecting portion 9b. This projecting portion 9b is formed for each of the two pressed portions 9a, and the two projecting portions 9b are disposed at positions diagonal to each other, as viewed from the top surface of the first heat exchanger pipe 1.

[0105] In a manner similar to the first heat exchanger pipe 1, concerning the second heat exchanger pipe 2, a pressed portion 9c corresponding to the pressed portion 9a and a projecting portion 9d corresponding to the projecting portion 9b are formed at each side of the second heat exchanger pipe end portions 6.

[0106] At this stage, the pressed portion 9a closes part of the opening of the first refrigerant flow channel 1a of the first heat exchanger pipe 1. In contrast, the first refrigerant flow channel 1a corresponding to the projecting portion 9b is opened, and inside of this opening, the first refrigerant auxiliary flow channel 1b which communicates with the first refrigerant flow channel 1a is formed.

[0107] Similarly, the pressed portion 9c closes part of the opening of the second refrigerant flow channel 2a of the second heat exchanger pipe 2, while the second refrigerant flow channel 2a corresponding to the projecting portion 9d is opened, and inside of this opening, the second refrigerant auxiliary flow channel 2b which communicates with the second refrigerant flow channel 2a is formed.

[0108] Then, in the state in which the pressed portion 9a and the projecting portion 9b are formed in the first heat exchanger pipe 1, as stated above, and in the state in which the pressed portion 9c and the projecting portion 9d are formed in the second heat exchanger pipe 2, as stated above, a stacking structure of the first heat exchanger pipes 1 and the second heat exchanger pipes 2 is formed in the following manner.

[0109] The first heat exchanger pipe 1 and the second heat exchanger pipe 2 are stacked on each other such that the pressed portion 9a of the first heat exchanger pipe 1 and the projecting portion 9d of the second heat exchanger pipe 2 overlap each other and such that the projecting portion 9b of the first heat exchanger pipe 1 and the pressed portion 9c of the second heat exchanger pipe 2 overlap each other.

[0110] In this case, the central portions of the first and second heat exchanger pipes 1 and 2 are bonded to each other by brazing utilizing a brazing filler material 21. Then, the pressed portion 9a and the projecting portion 9d are brazed to each other by using a brazing filler material 21, and similarly, the projecting portion 9b and the pressed portion 9c are brazed to each other by using a brazing filler material 21.

[0111] As stated above, if a gap is produced between the pressed portion 9a and the projecting portion 9d or between the projecting portion 9b and the pressed portion 9c when bonding the central portions of the first and second heat exchanger pipes 1 and 2, the pressed portion 9a and the projecting portion 9d or the projecting portion 9b and the pressed portion 9c may be brazed by filling this gap with a brazing filler material 21.

[0112] Similarly, if a gap is produced between the central portions of the first and second heat exchanger pipes 1 and 2 when bonding the pressed portion 9a and the projecting portion 9d and the projecting portion 9b and the pressed portion 9c, the central portions of the first and second heat exchanger pipes 1 and 2 may be brazed by filling this gap with a brazing filler material 21.

[0113] As shown in part (a) of FIG. 8, the opening of the projecting portion 9b of the first heat exchanger pipe 1 and the opening of the second projecting portion 9d of the second heat exchanger pipe 2 are each closed by a

cover 13. This cover 13 has, as shown in part (a) of FIG. 8, a parallelepiped heat-exchanger-pipe fitting portion 13a which is vertically provided on one surface of the cover 13.

[0114] When closing the openings of the projecting portions 9b of the first heat exchanger pipes 1 and the openings of the projecting portions 9d of the second heat exchanger pipes 2 with the covers 13, as stated above, the heat-exchanger-pipe fitting portions 13a of the covers 13 are fit into the openings, and then, the covers 13 are bonded to the openings by using a brazing filler material 21, thereby closing the openings. With this configuration, refrigerants do not leak from the openings of the projecting portions 9b and 9d.

[0115] As shown in part (b) of FIG. 8, on the top surface of each of the projecting portions 9b formed on the first heat exchanger pipe 1, which is the topmost heat exchanger pipe of the stacking structure of the first and second heat exchanger pipes 1 and 2, a tubular first port 3 is brazed by using a brazing filler material (not shown), and on the top surface of each of the pressed portions 9a formed on the first heat exchanger pipe 1, a tubular second port 4 is brazed by using a brazing filler material.

[0116] As stated above, the first ports 3 communicate with the first refrigerant auxiliary flow channels 1b and the first refrigerant flow channels 1a of all the first heat exchanger pipes 1, and the second ports 4 communicate with the second refrigerant auxiliary flow channels 2b and the second refrigerant flow channels 2a of all the second heat exchanger pipes 2.

[0117] By using the above-described method, the heat exchanger 10a, which is a stacked heat exchanger, is fabricated.

[0118] The projecting portion 9b of the first heat exchanger pipe 1 is formed by pressing a central portion sandwiched between the two pressed portions 9a of the first heat exchanger pipe 1 in the vertical direction in FIG. 8 to such a degree as not to press and eliminate the first refrigerant flow channel 1a inside the first heat exchanger pipe 1. However, the formation of the projecting portion 9b is not restricted to the above-described manner.

[0119] When the pressed portion 9a is formed, the opening of the first refrigerant flow channel 1a, which has not been closed, positioned at the first heat exchanger pipe end portion 5 may be expanded from inward to outward, thereby forming the projecting portion 9b. The same applies to the formation of the projecting portion 9d of the second heat exchanger pipe 2.

[0120] As shown in part (a) of FIG. 8, in the first heat exchanger pipe 1, the projecting portion 9b is formed such that it is vertically projected to a level higher than the central portion sandwiched between the two pressed portions 9a. However, the projecting portion 9b is not restricted to this configuration. The projecting portion 9b may be formed such that it is not vertically projected to a level higher than the central portion of the first heat exchanger pipe 1, and instead, the top surface and the bottom surface of the central portion may be respectively

formed substantially flush with the top surface and the bottom surface of the projecting portion 9b.

[0121] The same applies to the formation of the projecting portion 9d of the second heat exchanger pipe 2. In this case, when stacking the first heat exchanger pipe 1 and the second heat exchanger pipe 2 on each other, a gap is produced between the pressed portion 9a and the projecting portion 9d and between the projecting portion 9b and the pressed portion 9c. However, the pressed portion 9a and the projecting portion 9d and the projecting portion 9b and the pressed portion 9c may be bonded to each other by filling the gaps with a brazing filler material 21.

[0122] As shown in part (a) of FIG. 8, the opening of the projecting portion 9b of the first heat exchanger pipe 1 and the opening of the projecting portion 9d of the second heat exchanger pipe 2 are closed by the covers 13. However, the configuration in which the openings are closed is not restricted to this configuration. An end portion of the opening of the projecting portion 9b may be pressed to cover the opening to such a degree as not to eliminate the first refrigerant auxiliary flow channel 1b inside the projecting portion 9b.

[0123] The same applies to the opening of the projecting portion 9d of the second heat exchanger pipe 2. With this configuration, the provision of the covers 13 is not necessary, thereby making it possible to decrease the number of parts and to reduce the weight of the heat exchanger 10a.

[0124] The covers 13 correspond to "closing means" of the present invention.

Heat Exchange Operation of Heat Exchanger 10a

[0125] The heat exchanger 10a, which is a stacked heat exchanger according to Embodiment 2, is installed in a heat pump system utilizing heating energy or cooling energy. For example, in the case of an operation utilizing heating energy, a heat exchange operation is performed as follows.

[0126] A high-temperature first refrigerant flowing from a refrigerant circuit flows into the heat exchanger 10a through one of the first ports 3 and further into the first refrigerant auxiliary flow channels 1b inside the projecting portions 9b of the first heat exchanger pipes 1, flows through the first refrigerant flow channels 1a of the first heat exchanger pipes 1 and the first refrigerant auxiliary flow channels 1b inside the projecting portions 9b positioned on the other side, and then, flows out of the other first port 3.

[0127] A second refrigerant flowing from a use side circuit flows into the heat exchanger 10a through one of the second ports 4 and further into the second refrigerant auxiliary flow channels 2b inside the projecting portions 9d of the second heat exchanger pipes 2, flows through the second refrigerant flow channels 2a and the second refrigerant auxiliary flow channels 2b inside the projecting portions 9d positioned on the other side, and then, flows

out of the other second port 4.

[0128] In this case, the first refrigerant and the second refrigerant flow through the first refrigerant flow channels 1a of the first heat exchanger pipes 1 and the second refrigerant flow channels 2a of the second heat exchanger pipes 2, respectively, in opposite directions or in parallel with each other, thereby performing heat exchange between the first refrigerant and the second refrigerant at wall surfaces of the first and second heat exchanger pipes 1 and 2.

Advantages of Embodiment 2

[0129] The heat exchanger disclosed in Patent Literature 1 has a space which cannot be utilized because of the provision of a header pipe used for distributing a refrigerant over heat exchanger pipes, thereby decreasing efficiency in space utilization. However, as in the above-described configuration, the first refrigerant flow channels 1a of the first heat exchanger pipes 1 communicate with each other through the use of the first ports 3, while the second refrigerant flow channels 2a of the second heat exchanger pipes 2 communicate with each other through the use of the second port 4.

[0130] Accordingly, it is not necessary to provide a header pipe, thereby making it possible to reduce the generation of a space which cannot be utilized and to form the entire heat exchanger 10a in a compact size.

[0131] By alternately stacking the first heat exchanger pipes 1 and the second heat exchanger pipes 2 on each other, heat exchange efficiency between the first refrigerant and the second refrigerant can be improved. Moreover, by setting the lengths of the first heat exchanger pipes 1 and the second heat exchanger pipes 2 in a direction in which refrigerants flow through their refrigerant flow channels to be substantially the same and by setting the widths of the first heat exchanger pipes 1 and the second heat exchanger pipes 2 in the widthwise direction of the refrigerant flow channels to be substantially the same, heat exchange between the first refrigerant and the second refrigerant can be more effectively performed, and also, the entire heat exchanger 10a can be formed in a compact size.

[0132] On the topmost heat exchanger pipe (the first heat exchanger pipe 1 in FIGs. 6 and 7) of the stacking structure of the heat exchanger 10a, the two first ports 3 are disposed on the top surfaces of the projecting portions 9b which are formed at positions diagonal to each other and the two second ports 4 are disposed on the top surfaces of the pressed portions 9a which are formed at positions diagonal to each other.

[0133] Accordingly, the flow channel lengths of the first and second refrigerant flow channels 1a and 2a through which refrigerants flow can be substantially maximized, thereby further enhancing heat exchange efficiency between the first refrigerant and the second refrigerant.

[0134] However, the positions of the first ports 3 and the second ports 4 are not restricted to the above-de-

scribed positions, and may be changed appropriately depending on the position of the heat exchanger 10a installed in, for example, a heat pump system.

[0135] As shown in FIGs. 6 and 7, the two first ports 3 and the two second ports 4 are disposed on the top surface of the topmost heat exchanger pipe of the stacking structure of the heat exchanger 10a. However, the positions of the first and second ports 3 and 4 are not restricted. For example, one of the two first ports 3 may be disposed on the top surface of the topmost heat exchanger pipe of the stacking structure, while the other first port 3 may be disposed on the bottom surface of the bottommost heat exchanger pipe of the stacking structure.

[0136] As in the two first ports 3, the positions of the two second ports 4 are not restricted, either. Moreover, the first ports 3 and the second ports 4 do not have to be disposed on the same surface. For example, the two first ports 3 may be disposed on the top surface of the topmost heat exchanger pipe of the stacking structure, while the two second ports 4 may be disposed on the bottom surface of the bottommost heat exchanger pipe of the stacking structure.

[0137] By forming the pressed portions 9a for the openings of the first refrigerant flow channels 1a of the first heat exchanger pipes 1 and by forming the pressed portions 9c for the openings of the second refrigerant flow channel 2a of the second heat exchanger pipes 2, the first refrigerant flow channels 1a and the second refrigerant flow channels 2a are shielded from each other and do not communicate with each other.

[0138] Thus, the first refrigerant flowing through the first refrigerant flow channels 1a and the second refrigerant flowing through the second refrigerant flow channels 2a can be prevented from being mixed with each other.

Embodiment 3

[0139] FIG. 9 shows sectional views of heat exchanger pipes of a stacked heat exchanger according to Embodiment 3 of the present invention. The configurations of the heat exchanger pipes of the stacked heat exchanger according to Embodiment 3 will be described below with reference to FIG. 9.

[0140] The cross sections of all the heat exchanger pipes shown in parts (a) through (d) of FIG. 9 have flat shapes. The cross section of a heat exchanger pipe 14a shown in part (a) of FIG. 9 has a rectangular shape, and the cross section of a refrigerant flow channel inside the heat exchanger pipe 14a also has a rectangular shape. Both ends of a longitudinal heat exchanger pipe 14b shown in part (b) of FIG. 9 in cross section are rounded, and the cross section of a refrigerant flow channel inside the heat exchanger pipe 14b is configured similarly.

[0141] The top surfaces and the bottom surfaces of both the heat exchanger pipes 14a and 14b are flat, and when a stacking structure of the heat exchanger pipes 14a or 14b is formed, the heat exchanger pipes 14a or

14b can be bonded in close contact with each other, thereby improving heat exchange efficiency.

[0142] Both ends of a longitudinal heat exchanger pipe 14c shown in part (c) of FIG. 9 in cross section are rounded, and the cross section of a refrigerant flow channel inside the heat exchanger pipe 14c is configured similarly. However, unlike the heat exchanger pipe 14b, in the heat exchanger pipe 14c, a plurality of linear grooves 15 are formed on the inner wall surface of the refrigerant flow channel in a direction from one opening to the other opening of the heat exchanger pipe 14c.

[0143] By the formation of these grooves 15, the area of the inner wall surface of the heat exchanger pipe 14c is increased, thereby improving efficiency in heat exchange with a refrigerant flowing through an adjacent heat exchanger pipe. Additionally, as stated above, the grooves 15 are formed in a direction from one opening to the other opening of the heat exchanger pipe 14c, thereby reducing a pressure drop in a refrigerant. Needless to say, the above-described advantages obtained by the heat exchanger pipes 14a and 14b are also obtained by the heat exchanger pipe 14c.

[0144] As stated above, on the inner wall surface of the refrigerant flow channel of the heat exchanger pipe 14c, the grooves 15 are formed in a direction from one opening to the other opening of the heat exchanger pipe 14c. However, the grooves 15 are not restricted to this configuration. For example, the grooves 15 may be formed in a wavy line shape or an oblique lines shape. With this configuration, the area of the inner wall surface of the heat exchanger pipe 14c is increased, thereby improving efficiency in heat exchange with a refrigerant flowing through an adjacent heat exchanger pipe. At the same time, turbulence is generated in the flow of a refrigerant, thereby improving heat exchange efficiency.

[0145] Both ends of a longitudinal heat exchanger pipe 14d shown in part (d) of FIG. 9 in cross section are rounded, and the cross section of a refrigerant flow channel inside the heat exchanger pipe 14d is configured similarly. However, unlike the heat exchanger pipe 14b, in the heat exchanger pipe 14d, a corrugated plate 16 is inserted into a refrigerant flow channel inside the heat exchanger pipe 14d. The corrugated plate 16 is inserted such that the ridge direction of the waveforms of the corrugated plate 16 is a direction from one opening to the other opening of the heat exchanger pipe 14d.

[0146] The projections of the waveforms of the corrugated plate 16 abut against the inner wall surface of the heat exchanger pipe 14d. By inserting this corrugated plate 16, a refrigerant flowing through a refrigerant flow channel contacts the corrugated plate 16 as well as the inner wall surface, thereby transferring heating energy or cooling energy to the inner wall surface via this corrugated plate 16.

[0147] Thus, advantages similar to those obtained by an increased area of the inner surface wall of the heat exchanger pipe 14c, that is, the effect of improving efficiency in heat exchange with a refrigerant flowing through

an adjacent heat exchanger pipe, is obtained. Needless to say, the above-described advantages obtained by the heat exchanger pipes 14a and 14b are also obtained by the heat exchanger pipe 14d.

[0148] Any one of the heat exchanger pipes 14a through 14d shown in FIG. 9 is used as each of the first and second exchanger pipes 1 and 2 in the heat exchanger 10 according to Embodiment 1 or the heat exchanger 10a according to Embodiment 2. Accordingly, the following advantages can be obtained. The heat exchanger 10 and the heat exchanger 10a obtained by using any one of the heat exchanger pipes 14a through 14d shown in FIG. 9 as each of the first and second exchanger pipes 1 and 2 in the heat exchanger 10 according to Embodiment 1 or the heat exchanger 10a according to Embodiment 2 will be collectively referred to as a "heat exchanger 10b".

[0149] The heat exchanger 10b based on the heat exchanger 10 according to Embodiment 1 corresponds to a "stacked heat exchanger" of the present invention.

Advantages of Embodiment 3

[0150] The top surfaces and the bottom surfaces of all the heat exchanger pipes 14a through 14d shown in FIG. 9 are flat, and when a stacking structure of the heat exchanger pipes 14a, 14b, 14c, or 14d is formed, the heat exchanger pipes 14a, 14b, 14c, or 14d can be bonded in close contact with each other, thereby improving heat exchange efficiency.

[0151] As shown in part (c) of FIG. 9, the grooves 15 are formed on the inner wall surface of a refrigerant flow channel of the heat exchanger pipe 14c, and thus, the area of the inner wall surface of the heat exchanger pipe 14c is increased, thereby improving efficiency in heat exchange with a refrigerant flowing through an adjacent heat exchanger pipe. Additionally, the grooves 15 are formed in a direction from one opening to the other opening of the heat exchanger pipe 14c, thereby reducing a pressure drop in a refrigerant.

[0152] If the grooves 15 are formed in a wavy line shape or an oblique line shape, the area of the inner wall surface of the heat exchanger pipe 14c is increased. As a result, efficiency in heat exchange with a refrigerant flowing through an adjacent heat exchanger pipe is improved, and at the same time, turbulence is generated in the flow of a refrigerant, thereby improving heat exchange efficiency.

[0153] As shown in part (d) of FIG. 9, by inserting the corrugated plate 16 into a refrigerant flow channel inside the heat exchanger pipe 14d, a refrigerant flowing through the refrigerant flow channel contacts the corrugated plate 16 as well as the inner wall surface, thereby transferring heating energy or cooling energy to the inner wall surface via this corrugated plate 16. Thus, the effect of improving efficiency in heat exchange with a refrigerant flowing through an adjacent heat exchanger pipe is obtained.

Embodiment 4

Configuration of Heat Pump System

[0154] FIG. 10 is a diagram illustrating a heat pump system according to Embodiment 4 of the present invention utilizing heating energy of a heat exchanger. A description will now be given, with reference to FIG. 10, of a configuration in which the heat exchanger 10 according to Embodiment 1, which serves as a stacked heat exchanger for performing heat exchange between a first refrigerant and a second refrigerant, is mounted.

[0155] As shown in FIG. 10, the heat pump system according to Embodiment 4 includes a first refrigerant circuit 100 through which a first refrigerant flows, a second refrigerant circuit 101 through which a second refrigerant flows, and the heat exchanger 10 which performs heat exchange between the first refrigerant and the second refrigerant.

[0156] The first refrigerant circuit 100 is formed by sequentially connecting a compressor 31, the heat exchanger 10, an expansion valve 33, and an outdoor heat exchanger 34 through the use of refrigerant pipes. A fan 39 is disposed near the outdoor heat exchanger 34. The fan 39 sends outside air to the outdoor heat exchanger 34 so that heat exchange between the outside air and the first refrigerant flowing through the outdoor heat exchanger 34 can be performed. As the first refrigerant flowing through the first refrigerant circuit 100, for example, R410A, another fluorocarbon refrigerant, or a natural refrigerant, such as carbon dioxide or hydrocarbon, may be used.

[0157] The second refrigerant circuit 101 is formed by sequentially connecting a pump 36, a use side heat exchanger 35, and the heat exchanger 10 through the use of refrigerant pipes. Among these elements, the use side heat exchanger 35 is used as a radiator, a floor heater, or the like. As the second refrigerant flowing through the second refrigerant circuit 101, for example, a fluorocarbon refrigerant, a natural refrigerant, such as carbon dioxide or hydrocarbon, tap water, distilled water, or brine may be used.

[0158] The outdoor heat exchanger 34 corresponds to a "heat source side heat exchanger" of the present invention.

Operation of Heat Pump System

[0159] An operation of the heat pump system according to Embodiment 4 will now be described below with reference to FIG. 10. In the first refrigerant circuit 100, a high-temperature high-pressure gaseous first refrigerant which has been compressed in and discharged from the compressor 31 flows into the heat exchanger 10. The first refrigerant flowing into the heat exchanger 10 performs heat exchange, within the heat exchanger 10, with a second refrigerant which flows in a direction opposite to or in parallel with the flowing direction of the first re-

frigerant, thereby transferring heat to the second refrigerant and then flowing out of the heat exchanger 10.

[0160] The first refrigerant flowing out of the heat exchanger 10 flows into the expansion valve 33 and is expanded and decompressed by this expansion valve 33, thereby being transformed into a low-temperature low-pressure first refrigerant. This low-temperature low-pressure first refrigerant flows into the outdoor heat exchanger 34 and performs heat exchange with outside air which is sent from the fan 39 through the rotation operation of the fan 39, thereby being transformed into a low-temperature low-pressure gaseous first refrigerant and then flowing out of the outdoor heat exchanger 34. The gaseous first refrigerant flowing out of the outdoor heat exchanger 34 flows into the compressor 31 and is compressed again.

[0161] Meanwhile, in the second refrigerant circuit 101, the second refrigerant flowing into the heat exchanger 10 performs heat exchange, within the heat exchanger 10, with the first refrigerant which flows in a direction opposite to or in parallel with the flowing direction of the second refrigerant, thereby being heated by the first refrigerant and then flowing out of the heat exchanger 10.

[0162] The second refrigerant flowing out of the heat exchanger 10 circulates within the second refrigerant circuit 101 through the use of the pump 36 and flows into the use side heat exchanger 35. The second refrigerant flowing into the use side heat exchanger 35 transfers heat to the outside and then flows out of the use side heat exchanger 35. The second refrigerant flowing out of the use side heat exchanger 35 flows into the heat exchanger 10 and is heated again.

[0163] If water is used as the second refrigerant flowing through the second refrigerant circuit 101, it is desirable that portions of the heat exchanger 10 which contact water have a corrosion resistance to water, for example, the second heat exchanger pipes 2 and the second ports 4 of the heat exchanger 10 be formed of a corrosion-resistant material.

[0164] In the heat pump system shown in FIG. 10, the heat exchanger 10 according to Embodiment 1 is mounted. However, a heat exchanger installed in the heat pump system is not restricted to the heat exchanger 10. The heat exchanger 10a according to Embodiment 2 or the heat exchanger 10b according to Embodiment 3 may be mounted.

Advantages of Embodiment 4

[0165] As in the above-described configuration, by mounting the heat exchanger 10, 10a, or 10b having a stacking structure of the first heat exchanger pipes 1 and the second heat exchanger pipes 2, it is possible to obtain a heat pump system in which heat exchange efficiency between a first refrigerant and a second refrigerant is improved.

[0166] Needless to say, advantages discussed in Embodiment 1 through Embodiment 3 can also be obtained

by Embodiment 4.

[0167] The heat pump system according to Embodiment 4 is not restricted to the configuration shown in FIG. 10, and may be configured, for example, as shown in FIGs. 11 through 13.

[0168] FIG. 11 is a diagram illustrating another mode of the heat pump system according to Embodiment 4. As in the heat pump system shown in FIG. 10, the heat pump system shown in FIG. 11 also utilizes heating energy of a heat exchanger.

[0169] In the heat pump system shown in FIG. 11, the use side heat exchanger 35 in the heat pump system shown in FIG. 10 is installed within a tank 38. The configurations of the other portions are similar to those of the heat pump system shown in FIG. 10. The second refrigerant heated in the heat exchanger 10 flows through the use side heat exchanger 35, thereby cooling water within the tank 38 and collecting cooled water.

[0170] As in the heat pump system shown in FIG. 11 and the above-described heat pump system shown in FIG. 10, by causing the use side heat exchanger 35 to perform a heating operation or a hot-water supply operation by utilizing heating energy of the heat exchanger 10, the energy-saving effect can be enhanced, compared with a heating system or a hot-water supply system using a known boiler as a heat source.

[0171] FIG. 12 is a diagram illustrating another mode of the heat pump system according to Embodiment 4. The heat pump system shown in FIG. 12 utilizes cooling energy of a heat exchanger.

[0172] In the heat pump system shown in FIG. 12, by changing the positions of the suction inlet and the discharge outlet of the compressor 31 opposite to those of the heat pump system shown in FIG. 10, the flowing direction of a refrigerant in the first refrigerant circuit 100 is reversed. In order to form a cooling system, the use side heat exchanger 35 is used as an air heat exchanger or a cold water panel. The configurations of the other portions are similar to those of the heat pump system shown in FIG. 10.

[0173] In the heat pump system shown in FIG. 12, in the first refrigerant circuit 100, a high-temperature high-pressure gaseous first refrigerant which has been compressed in and discharged from the compressor 31 flows into the outdoor heat exchanger 34. The first refrigerant flowing into the outdoor heat exchanger 34 performs heat exchange with outside air which is sent from the fan 39 through the rotation operation, thereby transferring heat to outside air and then flowing out of the outdoor heat exchanger 34.

[0174] The first refrigerant flowing out of the outdoor heat exchanger 34 flows into the expansion valve 33 and is expanded and decompressed by this expansion valve 33, thereby being transformed into a low-temperature low-pressure first refrigerant. This low-temperature low-pressure first refrigerant flows into the heat exchanger 10 and performs heat exchange, within the heat exchanger 10, with a second refrigerant which flows in a direction

opposite to or in parallel with the flowing direction of the first refrigerant, thereby receiving heat from the second refrigerant and being transformed into a low-temperature low-pressure gaseous first refrigerant.

[0175] The gaseous first refrigerant then flows out of the heat exchanger 10. This gaseous first refrigerant flowing out of the heat exchanger 10 flows into the compressor 31 and is compressed again.

[0176] In the second refrigerant circuit 101, the second refrigerant flowing into the heat exchanger 10 performs heat exchange, within the heat exchanger 10, with the first refrigerant which flows in a direction opposite to or in parallel with the flowing direction of the second refrigerant. The second refrigerant is cooled by the first refrigerant and then flows out of the heat exchanger 10.

[0177] The second refrigerant flowing out of the heat exchanger 10 circulates within the second refrigerant circuit 101 through the use of the pump 36 and flows into the use side heat exchanger 35. The second refrigerant flowing into the use side heat exchanger 35 cools, for example, outside air, and then flows out of the use side heat exchanger 35. The second refrigerant flowing out of the use side heat exchanger 35 flows into the heat exchanger 10 and is cooled again.

[0178] In a manner similar to the heat pump system shown in FIG. 11, a tank 38 may be installed in the heat pump system shown in FIG. 12, and the use side heat exchanger 35 may be installed within this tank 38. In this case, water within the tank 38 can be cooled and cooled water can be collected by using the use side heat exchanger 35.

[0179] FIG. 13 is a diagram illustrating another mode of the heat pump system according to Embodiment 4. The heat pump system shown in FIG. 13 utilizes heating energy or cooling energy of a heat exchanger.

[0180] In the heat pump system shown in FIG. 13, a four-port valve 32 is added to the first refrigerant circuit 100 in the heat pump system shown in FIG. 10. More specifically, the first refrigerant circuit 100 is formed by sequentially connecting the compressor 31, the four-port valve 32, the heat exchanger 10, the expansion valve 33, the outdoor heat exchanger 34, the four-port valve 32, and the compressor 31 through the use of refrigerant pipes. The configurations of the other portions are similar to those of the heat pump system shown in FIG. 10. In this configuration, by switching between the flow channels of the four-port valve 32, heating energy of the heat exchanger 10 can be utilized, as in the heat pump system shown in FIG. 10, or cooling energy of the heat exchanger 10 can be utilized, as in the heat pump system shown in FIG. 12.

[0181] In a manner similar to the heat pump system shown in FIG. 11, a tank 38 may be installed in the heat pump system shown in FIG. 13, and the use side heat exchanger 35 may be installed within this tank 38. In this case, by switching between the flow channels of the four-port valve 32, a second refrigerant heated in the heat exchanger 10 is caused to circulate within the use side

heat exchanger 35, thereby heating water within the tank 38 and collecting heated water. Alternatively, a second refrigerant cooled in the heat exchanger 10 is caused to circulate within the use side heat exchanger 35, thereby cooling water within the tank 38 and collecting cooled water.

[0182] In the heat pump systems shown in FIGs. 11 through 13, the heat exchanger 10 according to Embodiment 1 is mounted. However, a heat exchanger installed in the heat pump systems is not restricted to the heat exchanger 10. The heat exchanger 10a according to Embodiment 2 or the heat exchanger 10b according to Embodiment 3 may be mounted, which however does not form part of the present invention.

List of Reference Signs

[0183]

1	first heat exchanger pipe
1a	first refrigerant flow channel
1b	first refrigerant auxiliary flow channel
2	second heat exchanger pipe
2a	second refrigerant flow channel
2b	second refrigerant auxiliary flow channel
3	first port
3a	first communication hole
3b	first communication hole
3c	first communication hole
3d	first communication hole
4	second port
4a	second communication hole
4b	second communication hole
4c	second communication hole
4d	second communication hole
5	first heat exchanger pipe end portion
6	second heat exchanger pipe end portion
8	cover
8a	heat-exchanger-pipe fitting portion
8b	communication hole
9a	pressed portion
9b	projecting portion
9c	pressed portion
9d	projecting portion
10	heat exchanger
10a	heat exchanger
10b	heat exchanger
13	cover
13a	heat-exchanger-pipe fitting portion
14a	heat exchanger pipe
14b	heat exchanger pipe
14c	heat exchanger pipe
14d	heat exchanger pipe
15	groove
16	corrugated plate
21	brazing filler material
31	compressor
32	four-port valve

33 expansion valve
 34 outdoor heat exchanger
 35 use side heat exchanger
 36 pump
 38 tank
 39 fan
 100 first refrigerant circuit
 101 second refrigerant circuit

Claims

1. A stacked heat exchanger (10, 10a) comprising:

- a plurality of first heat exchanger pipes (1) each having a flat shape and including therein a first refrigerant flow channel (1a) through which a first refrigerant flows; 15
- a plurality of second heat exchanger pipes (2) each having a flat shape, the plurality of second heat exchanger pipes (2) and the plurality of first heat exchanger pipes (1) being alternately stacked on each other in the state in which adjacent first and second heat exchanger pipes (1, 2) abut against each other, the plurality of second heat exchanger pipes (2) each including therein a second refrigerant flow channel (2a) through which a second refrigerant, having a temperature different from a temperature of the first refrigerant, flows; 20
- two sets of first communication holes (3a-3d) formed to pass through the first heat exchanger pipes (1) and the second heat exchanger pipes (2) so that the first refrigerant flow channels (1a) communicate with each other and so that the first refrigerant flow channels (1a) communicate with an outside in one of two outermost heat exchanger pipes, each of which is one of the plurality of first heat exchanger pipes (1) or one of the plurality of second heat exchanger pipes (2), positioned at both ends of the stacking structure in a stacking direction; 25
- two sets of second communication holes (4a-4d) formed to pass through the first heat exchanger pipes (1) and the second heat exchanger pipes (2) so that the second refrigerant flow channels (2a) communicate with each other and so that the second refrigerant flow channels (2a) communicate with an outside in one of the two outermost heat exchanger pipes; 30
- closing means (8) that closes openings formed at both ends of the first refrigerant flow channel (1a) of each of the plurality of first heat exchanger pipes (1) and the second refrigerant flow channel (2a) of each of the plurality of second heat exchanger pipes (2) in a direction through which the refrigerants flow; 35
- first blocking means that serves as a block such 40

that the first communication holes (3b, 3d) formed in each of the second heat exchanger pipes (2) do not communicate with the second refrigerant flow channel (2a); and

- second blocking means that serves as a block such that the second communication holes (4a, 4c) formed in each of the first heat exchanger pipes (1) do not communicate with the first refrigerant flow channel (1a),
- wherein two of the first communication holes (3a, 3c) formed in the one of the outermost heat exchanger pipes and allowing the refrigerant flow channels within the one of the outermost heat exchanger pipes to communicate with the outside serve as an inlet and an outlet of the first refrigerant,
- wherein two of the second communication holes (4a, 4c) formed in the one of the outermost heat exchanger pipes and allowing the refrigerant flow channels within the one of the outermost heat exchanger pipes to communicate with the outside serve as an inlet and an outlet of the second refrigerant, and
- wherein heat exchange between the first refrigerant and the second refrigerant is performed on abutting surfaces of the first heat exchanger pipes (1) and the second heat exchanger pipes (2);
- wherein the closing means (8) includes a heat-exchanger-pipe fitting portion (8a) through which a fitting-portion communication hole (8b) is formed, wherein the heat-exchanger-pipe fitting portion (8a) is fit into part of each of the first refrigerant flow channels (1a) and part of each of the second refrigerant flow channels (2a);
- wherein the first blocking means is constituted by the heat-exchanger-pipe fitting portion (8a) which is fit into each of the second refrigerant flow channels (2a), and the fitting-portion communication hole (8b) of each of the heat-exchanger-pipe fitting portion (8a) communicates with the associated one of the first communication holes (3b); and
- wherein the second blocking means is constituted by the heat-exchanger-pipe fitting portion (8a) which is fit into each of the first refrigerant flow channels (1a), and the fitting-portion communication hole (8b) of each of the heat-exchanger-pipe fitting portion (8a) communicates with the associated one of the second communication holes (4b).

2. The stacked heat exchanger (10, 10a) of claim 1, wherein the first heat exchanger pipes (1) and the second heat exchanger pipes (2) have the same length in the direction in which the refrigerants flow through the refrigerant flow channels of the first heat exchanger pipes (1) and the second heat exchanger 55

pipes (2), and have the same width in a widthwise direction of the refrigerant flow channels.

3. The stacked heat exchanger (10, 10a) of any one of claims 1 or 2,
wherein the first communication holes (3a-3d) and the second communication holes (4a-4d) are formed near both ends, in a direction in which the refrigerants flow, of the refrigerant flow channels of the first heat exchanger pipes (1) and the second heat exchanger pipes (2). 5 10
4. The stacked heat exchanger (10, 10a) of claim 3, wherein the two sets of first communication holes (3a-3d) are formed at positions diagonal to each other in the first heat exchanger pipe (1) and the second heat exchanger pipe (2), as viewed from the stacking direction, and the two sets of second communication holes (4a-4d) are formed at positions diagonal to each other in the first heat exchanger pipe (1) and the second heat exchanger pipe (2), as viewed from the stacking direction. 15 20
5. The stacked heat exchanger (10, 10a) of any one of claims 1 to 4,
wherein the first refrigerant flow channel (1a) of the first heat exchanger pipe (1) or the second refrigerant flow channel (2a) of the second heat exchanger pipe (2) has a plurality of grooves on an inner wall surface of the first refrigerant flow channel (1a) or the second refrigerant flow channel (2a). 25 30
6. The stacked heat exchanger (10, 10a) of any one of claims 1 to 4,
wherein a corrugated plate is placed in the first refrigerant flow channel (1a) of the first heat exchanger pipe (1) or the second refrigerant flow channel (2a) of the second heat exchanger pipe (2); and wherein a ridge direction of waveforms of the corrugated plate coincides with the direction in which the refrigerant flow through the first refrigerant flow channel (1a) or the second refrigerant flow channel (2a), and projections of the waveforms abut against an inner wall surface of the first refrigerant flow channel (1a) or the second refrigerant flow channel (2a). 35 40 45
7. The stacked heat exchanger (10, 10a) of any one of claims 1 to 6,
wherein the first refrigerant is R410A, a fluorocarbon refrigerant, or a natural refrigerant, such as carbon dioxide or hydrocarbon; and wherein the second refrigerant is water or brine. 50
8. A heat pump system comprising:
- a first refrigerant circuit (100) that is constituted by a refrigerant circuit which is formed by sequentially connecting a compressor (31), the 55

stacked heat exchanger (10, 10a) of any one of patent claims 1 to 7, an expansion device, and a heat source side heat exchanger through refrigerant pipes, and through which the first refrigerant flows; and

- a second refrigerant circuit (101) that is constituted by a refrigerant circuit which is formed by sequentially connecting, through refrigerant pipes, a pump (36), a use side heat exchanger (35), and the stacked heat exchanger (10, 10a), and through which the second refrigerant flows.

9. A heat pump system of claim 8, further comprising a tank (38) containing therein the use side heat exchanger (35), wherein water within the tank is heated or cooled by using the use side heat exchanger (35).

20 Patentansprüche

1. Stapelwärmetauscher (10, 10a), welcher Folgendes aufweist:

- eine Vielzahl erster Wärmetauscherrohre (1), welche jeweils eine flache Form aufweisen und jeweils einen ersten Kältemittelströmungskanal (1a) beinhalten, durch welchen ein erstes Kältemittel strömt;

- eine Vielzahl zweiter Wärmetauscherrohre (2), welche jeweils eine flache Form aufweisen, wobei die Vielzahl zweiter Wärmetauscherrohre (2) und die Vielzahl erster Wärmetauscherrohre (1) in dem Zustand, in welchem nebeneinander liegende erste und zweite Wärmetauscherrohre (1, 2) aneinander stoßen, abwechselnd übereinander gestapelt sind, wobei die Vielzahl zweiter Wärmetauscherrohre (2) jeweils einen zweiten Kältemittelströmungskanal (2a) beinhalten, durch welchen ein zweites Kühlmittel, dessen Temperatur sich von der des ersten Kühlmittels unterscheidet, strömt;

- zwei Gruppen von ersten Verbindungslöchern (3a-3d), welche so gestaltet sind, dass sie durch die ersten Wärmetauscherrohre (1) und die zweiten Wärmetauscherrohre (2) verlaufen, so dass die ersten Kältemittelströmungskanäle (1a) miteinander kommunizieren und so dass die ersten Kältemittelströmungskanäle (1a) mit der Außenseite in einem von zwei äußersten Wärmetauscherrohren kommuniziert, wobei diese jeweils eines aus der Vielzahl erster Wärmetauscherrohre (1) oder eines aus der Vielzahl zweiter Wärmetauscherrohre (2) sind und sich an beiden Enden der Stapelstruktur in Stapelrichtung angeordnet befinden;

- zwei Gruppen von zweiten Verbindungslöchern (4a-4d), welche so gestaltet sind, dass sie

durch die ersten Wärmetauscherrohre (1) und die zweiten Wärmetauscherrohre (2) verlaufen, so dass die zweiten Kältemittelströmungskanäle (2a) miteinander kommunizieren und so dass die zweiten Kältemittelströmungskanäle (2a) mit einer Außenseite von zwei äußersten Wärmetauscherrohren kommunizieren;

- eine Verschlusseinrichtung (8), welche Öffnungen verschließt, die an beiden Enden des ersten Kältemittelströmungskanals (1a) von jedem aus der Vielzahl erster Wärmetauscherrohre (1) und des zweiten Kältemittelströmungskanal (2a) von jedem aus der Vielzahl zweiter Wärmetauscherrohre (2) in einer Kältemittelströmungsrichtung ausgebildet sind;

- eine erste Sperreinrichtung, welche als Sperre dient, so dass die in jedem der zweiten Wärmetauscherrohre (2) ausgebildeten ersten Verbindungsöffnungen (3b, 3d) nicht mit dem zweiten Kältemittelströmungskanal (2a) kommunizieren; und

- eine zweite Sperreinrichtung, welche als Sperre dient, so dass die in jedem der ersten Wärmetauscherrohre (1) ausgebildeten zweiten Verbindungsöffnungen (4a, 4c) nicht mit dem ersten Kältemittelströmungskanal (1a) kommunizieren,

- wobei zwei der ersten Verbindungsöffnungen (3a, 3c), welche in dem einen der äußersten Wärmetauscherrohre ausgebildet sind und es ermöglichen, dass die Kältemittelströmungskanäle innerhalb von dem einen der äußersten Wärmetauscherrohre mit der Außenseite kommunizieren, als Einlass und Auslass für das erste Kältemittel dienen,

- wobei zwei der zweiten Verbindungsöffnungen (4a, 4c), welche in einem der äußersten Wärmetauscherrohre ausgebildet sind und es ermöglichen, dass die Kältemittelströmungskanäle innerhalb von dem einen der äußersten Wärmetauscherrohre mit der Außenseite kommunizieren, als Einlass und Auslass für das zweite Kältemittel dienen, und

- wobei der Wärmeaustausch zwischen dem ersten Kältemittel und dem zweiten Kältemittel an aneinanderstoßenden Flächen der ersten Wärmetauscherrohre (1) und der zweiten Wärmetauscherrohre (2) erfolgt;

- wobei die Verschlusseinrichtung (8) ein Wärmetauscherrohr-Passstück (8a) aufweist, durch welches ein für das Passstück vorgesehenes Verbindungsloch (8b) ausgebildet ist, wobei das Wärmetauscherrohr-Passstück (8a) jeweils in einen Teil des ersten Kältemittelströmungskanals (1a) und einen Teil des zweiten Kältemittelströmungskanals (2a) eingepasst ist;

- wobei die erste Sperreinrichtung durch das Wärmetauscherrohr-Passstück (8a) gebildet

wird, welches in jeden der zweiten Kältemittelströmungskanäle (2a) eingepasst ist, und das für das Passstück vorgesehene jeweilige Verbindungsloch (8b) des Wärmetauscherrohr-Passstücks (8a) mit dem jeweils zugehörigen der ersten Verbindungsöffnungen (3b) kommuniziert; und

- wobei die zweite Sperreinrichtung durch das Wärmetauscherrohr-Passstück (8a) gebildet wird, welches in jeden der ersten Kältemittelströmungskanäle (1a) eingepasst ist, und das für das Passstück vorgesehene jeweilige Verbindungsloch (8b) des Wärmetauscherrohr-Passstücks (8a) mit dem jeweils zugehörigen der zweiten Verbindungsöffnungen (4b) kommuniziert.

2. Stapelwärmetauscher (10, 10a) gemäß Anspruch 1, wobei die ersten Wärmetauscherrohre (1) und die zweiten Wärmetauscherrohre (2) in der Richtung, in welcher die Kältemittel durch den Kältemittelströmungskanal der ersten Wärmetauscherrohre (1) und der zweiten Wärmetauscherrohre (2) strömen, dieselbe Länge aufweisen, und in einer Breitenrichtung des Kältemittelströmungskanals dieselbe Breite aufweisen.
3. Stapelwärmetauscher (10, 10a) gemäß einem der Ansprüche 1 bis 2, wobei die ersten Verbindungsöffnungen (3a-3d) und die zweiten Verbindungsöffnungen (4a-4d) in der Kältemittelströmungsrichtung in der Nähe der beiden Enden der Kältemittelströmungskanäle der ersten Wärmetauscherrohre (1) und der zweiten Wärmetauscherrohre (2) ausgebildet sind.
4. Stapelwärmetauscher (10, 10a) gemäß Anspruch 3, wobei die beiden Gruppen von ersten Verbindungsöffnungen (3a-3d), von der Stapelrichtung aus gesehen, an diagonal zueinander liegenden Positionen in dem ersten Wärmetauscherrohr (1) und dem zweiten Wärmetauscherrohr (2) ausgebildet sind, und wobei die beiden Gruppen von zweiten Verbindungsöffnungen (4a-4d), von der Stapelrichtung aus gesehen, an diagonal zueinander liegenden Positionen in dem ersten Wärmetauscherrohr (1) und dem zweiten Wärmetauscherrohr (2) ausgebildet sind.
5. Stapelwärmetauscher (10, 10a) gemäß einem der Ansprüche 1 bis 4, wobei der erste Kältemittelströmungskanal (1a) des ersten Wärmetauscherrohrs (1) oder der zweite Kältemittelströmungskanal (2a) des zweiten Wärmetauscherrohrs (2a) auf einer Innenwandfläche des ersten Kältemittelströmungskanals (1a) oder des zweiten Kältemittelströmungskanals (2a) eine Vielzahl von Nuten aufweist.

6. Stapelwärmetauscher (10, 10a) gemäß einem der Ansprüche 1 bis 4, wobei eine Wellplatte in dem ersten Kältemittelströmungskanal (1a) des ersten Wärmetauscherrohrs (1) oder in dem zweiten Kältemittelströmungskanal (2a) des zweiten Wärmetauscherrohrs (2) angeordnet ist; und wobei die Firstrichtung von Wellenformen der Wellplatte mit der Richtung, in welcher das Kältemittel durch den ersten Kältemittelströmungskanal (1a) oder den zweiten Kältemittelströmungskanal (2a) strömt, zusammenfällt, und Vorsprünge der Wellenformen gegen eine Innenwandfläche des ersten Kältemittelströmungskanals (1a) oder des zweiten Kältemittelströmungskanals (2a) anstoßen. 5 10 15
7. Stapelwärmetauscher (10, 10a) gemäß einem der Ansprüche 1 bis 6, wobei das erste Kältemittel R410A, ein Fluorkohlenwasserstoff-Kältemittel oder ein natürliches Kältemittel, wie etwa Kohlendioxid oder Kohlenwasserstoff, ist; und wobei das zweite Kältemittel Wasser oder Salzlake ist. 20
8. Wärmepumpensystem, welches Folgendes aufweist: 25
- einen ersten Kältekreislauf (100), welcher aus einem Kältekreislauf besteht, der durch sequentielles Verbinden eines Kompressors (31), des Stapelwärmetauschers (10, 10a) gemäß einem der Patenansprüche 1 bis 7, einer Expansionsvorrichtung und eines wärmequellenseitigen Wärmetauschers durch Kältemittelrohre gebildet wird, und durch welchen das erste Kältemittel strömt; und 30
 - einen zweiten Kältemittelkreislauf (101), welcher aus einem Kältekreislauf besteht, der durch sequentielles Verbinden einer Pumpe (36), eines nutzungsseitigen Wärmetauschers (35) und des Stapelwärmetauschers (10, 10a) durch Kältemittelrohre gebildet wird, und durch welchen das zweite Kältemittel strömt. 35 40
9. Wärmepumpensystem gemäß Anspruch 8, welches darüber hinaus einen Tank (38) aufweist, in dem der nutzungsseitige Wärmetauscher (35) enthalten ist, in dem das im Tank enthaltene Wasser unter Einsatz des nutzungsseitigen Wärmetauschers (35) aufgeheizt oder gekühlt wird. 45 50

Revendications

1. Échangeur de chaleur du type empilé (10, 10a) comprenant : 55
- une pluralité de premiers tubes d'échangeur de chaleur (1) ayant chacun une forme plate et

incluant à l'intérieur un premier canal d'écoulement de réfrigérant (1a) à travers lequel un premier réfrigérant s'écoule ;

- une pluralité de deuxièmes tubes d'échangeur de chaleur (2) ayant chacun une forme plate, la pluralité de deuxièmes tubes d'échangeur de chaleur (2) et la pluralité de premiers tubes d'échangeur de chaleur (1) étant empilés en alternance les uns sur les autres dans l'état dans lequel les premiers et deuxièmes tubes d'échangeur de chaleur adjacents (1, 2) sont en butée les uns contre les autres, la pluralité de deuxièmes tubes d'échangeur de chaleur (2) incluant chacun à l'intérieur un deuxième canal d'écoulement de réfrigérant (2a) à travers lequel s'écoule un deuxième réfrigérant, ayant une température différente d'une température du premier réfrigérant ;
- deux groupes de premiers trous de communication (3a-3d) formés pour passer à travers les premiers tubes d'échangeur de chaleur (1) et les deuxièmes tubes d'échangeur de chaleur (2) de sorte que les premiers canaux d'écoulement de réfrigérant (1a) communiquent les uns avec les autres et de sorte que les premiers canaux d'écoulement de réfrigérant (1a) communiquent avec un extérieur dans un tube parmi les deux tubes d'échangeur de chaleur les plus à l'extérieur, dont chacun est un tube parmi la pluralité de premiers tubes d'échangeur de chaleur (1) ou parmi la pluralité de deuxièmes tubes d'échangeur de chaleur (2), positionné aux deux extrémités de la structure d'empilement dans une direction d'empilement ;
- deux groupes de deuxièmes trous de communication (4a-4d) formés pour passer à travers les premiers tubes d'échangeur de chaleur (1) et les deuxièmes tubes d'échangeur de chaleur (2) de sorte que les deuxièmes canaux d'écoulement de réfrigérant (2a) communiquent les uns avec les autres et de sorte que les deuxièmes canaux d'écoulement de réfrigérant (2a) communiquent avec un extérieur dans un tube parmi les deux tubes d'échangeur de chaleur les plus à l'extérieur ;
- des moyens de fermeture (8) qui ferment des ouvertures formées aux deux extrémités du premier canal d'écoulement de réfrigérant (1a) de chaque tube parmi la pluralité de premiers tubes d'échangeur de chaleur (1) et du deuxième canal d'écoulement de réfrigérant (2a) de chaque tube parmi la pluralité de deuxièmes tubes d'échangeur de chaleur (2) dans une direction à travers laquelle les réfrigérants s'écoulent ;
- des premiers moyens de blocage qui servent de blocage de sorte que les premiers trous de communication (3b, 3d) formés dans chaque tube parmi les deuxièmes tubes d'échangeur de

chaleur (2) ne communiquent pas avec le deuxième canal d'écoulement de réfrigérant (2a) ; et

- des deuxièmes moyens de blocage qui servent de blocage de sorte que les deuxièmes trous de communication (4a, 4c) formés dans chaque tube parmi les premiers tubes d'échangeur de chaleur (1) ne communiquent pas avec le premier canal d'écoulement de réfrigérant (1a),

- dans lequel deux des premiers trous de communication (3a, 3c), formés dans l'un des tubes d'échangeur de chaleur les plus à l'extérieur et permettant aux canaux d'écoulement de réfrigérant à l'intérieur dudit un des tubes d'échangeur de chaleur les plus à l'extérieur de communiquer avec l'extérieur, servent d'entrée et de sortie du premier réfrigérant,

- dans lequel deux des deuxièmes trous de communication (4a, 4c), formés dans l'un des tubes d'échangeur de chaleur les plus à l'extérieur et permettant aux canaux d'écoulement de réfrigérant à l'intérieur dudit un des tubes d'échangeur de chaleur les plus à l'extérieur de communiquer avec l'extérieur, servent d'entrée et de sortie du deuxième réfrigérant, et

- dans lequel un échange de chaleur entre le premier réfrigérant et le deuxième réfrigérant est effectué sur des surfaces en butée des premiers tubes d'échangeur de chaleur (1) et des deuxièmes tubes d'échangeur de chaleur (2) ;

- dans lequel les moyens de fermeture (8) incluent une portion d'engagement de tube d'échangeur de chaleur (8a) à travers laquelle un trou de communication de portion d'engagement (8b) est formé, dans lequel la portion d'engagement de tube d'échangeur de chaleur (8a) est engagée dans une partie de chacun des premiers canaux d'écoulement de réfrigérant (1a) et dans une partie de chacun des deuxièmes canaux d'écoulement de réfrigérant (2a) ;

- dans lequel les premiers moyens de blocage sont constitués par la portion d'engagement de tube d'échangeur de chaleur (8a) qui est engagée dans chacun des deuxièmes canaux d'écoulement de réfrigérant (2a), et le trou de communication de portion d'engagement (8b) de chacune des portions d'engagement de tube d'échangeur de chaleur (8a) communique avec le trou associé parmi les premiers trous de communication (3b) ; et

- dans lequel les deuxièmes moyens de blocage sont constitués par la portion d'engagement de tube d'échangeur de chaleur (8a) qui est engagée dans chacun des premiers canaux d'écoulement de réfrigérant (1a), et le trou de communication de portion d'engagement (8b) de chacune des portions d'engagement de tube d'échangeur de chaleur (8a) communique avec

le trou associé parmi les deuxièmes trous de communication (4b).

2. Échangeur de chaleur du type empilé (10, 10a) selon la revendication 1, dans lequel les premiers tubes d'échangeur de chaleur (1) et les deuxièmes tubes d'échangeur de chaleur (2) ont la même longueur dans la direction dans laquelle les réfrigérants s'écoulent à travers les canaux d'écoulement de réfrigérant des premiers tubes d'échangeur de chaleur (1) et des deuxièmes tubes d'échangeur de chaleur (2), et ont la même largeur dans une direction dans le sens de la largeur des canaux d'écoulement de réfrigérant.
3. Échangeur de chaleur du type empilé (10, 10a) selon l'une quelconque des revendications 1 et 2, dans lequel les premiers trous de communication (3a-3d) et les deuxièmes trous de communication (4a-4d) sont formés près des deux extrémités, dans une direction dans laquelle les réfrigérants s'écoulent, des canaux d'écoulement de réfrigérant des premiers tubes d'échangeur de chaleur (1) et des deuxièmes tubes d'échangeur de chaleur (2).
4. Échangeur de chaleur du type empilé (10, 10a) selon la revendication 3, dans lequel les deux groupes de premiers trous de communication (3a-3d) sont formés à des positions diagonales les unes par rapport aux autres dans le premier tube d'échangeur de chaleur (1) et dans le deuxième tube d'échangeur de chaleur (2), vus depuis la direction d'empilement, et les deux groupes de deuxièmes trous de communication (4a-4d) sont formés à des positions diagonales les unes par rapport aux autres dans le premier tube d'échangeur de chaleur (1) et dans le deuxième tube d'échangeur de chaleur (2), vus depuis la direction d'empilement.
5. Échangeur de chaleur du type empilé (10, 10a) selon l'une quelconque des revendications 1 à 4, dans lequel le premier canal d'écoulement de réfrigérant (1a) du premier tube d'échangeur de chaleur (1) ou le deuxième canal d'écoulement de réfrigérant (2a) du deuxième tube d'échangeur de chaleur (2) a une pluralité de rainures sur une surface de paroi intérieure du premier canal d'écoulement de réfrigérant (1a) ou du deuxième canal d'écoulement de réfrigérant (2a).
6. Échangeur de chaleur du type empilé (10, 10a) selon l'une quelconque des revendications 1 à 4, dans lequel une plaque ondulée est placée dans le premier canal d'écoulement de réfrigérant (1a) du premier tube d'échangeur de chaleur (1) ou dans le deuxième canal d'écoulement de réfrigérant (2a) du deuxième tube d'échangeur de chaleur (2) ; et dans lequel une direction de crête des formes d'onde

de la plaque ondulée coïncide avec la direction dans laquelle le réfrigérant s'écoule à travers le premier canal d'écoulement de réfrigérant (1a) ou le deuxième canal d'écoulement de réfrigérant (2a), et des projections des formes d'onde sont en butée contre une surface de paroi intérieure du premier canal d'écoulement de réfrigérant (1a) ou du deuxième canal d'écoulement de réfrigérant (2a).

7. Échangeur de chaleur du type empilé (10, 10a) selon l'une quelconque des revendications 1 à 6, dans lequel le premier réfrigérant est du R410A, un réfrigérant fluorocarboné ou un réfrigérant naturel tel que dioxyde de carbone ou hydrocarbure ; et dans lequel le deuxième réfrigérant est de l'eau ou une saumure.

8. Système de pompe à chaleur comprenant :

- un premier circuit de réfrigérant (100) qui est constitué par un circuit de réfrigérant qui est formé en connectant séquentiellement, au moyen de tubes de réfrigérant, un compresseur (31), l'échangeur de chaleur du type empilé (10, 10a) selon l'une quelconque des revendications 1 à 7, un dispositif d'expansion et un échangeur de chaleur côté source de chaleur, et à travers lequel le premier réfrigérant s'écoule ; et
- un deuxième circuit de réfrigérant (101) qui est constitué par un circuit de réfrigérant qui est formé en connectant séquentiellement, au moyen de tubes de réfrigérant, une pompe (36), un échangeur de chaleur côté utilisation (35) et l'échangeur de chaleur du type empilé (10, 10a), et à travers lequel le deuxième réfrigérant s'écoule.

9. Système de pompe à chaleur selon la revendication 8, comprenant en outre un réservoir (38) contenant à l'intérieur l'échangeur de chaleur côté utilisation (35), dans lequel de l'eau à l'intérieur du réservoir est chauffée ou refroidie en utilisant l'échangeur de chaleur côté utilisation (35).

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FIG. 1

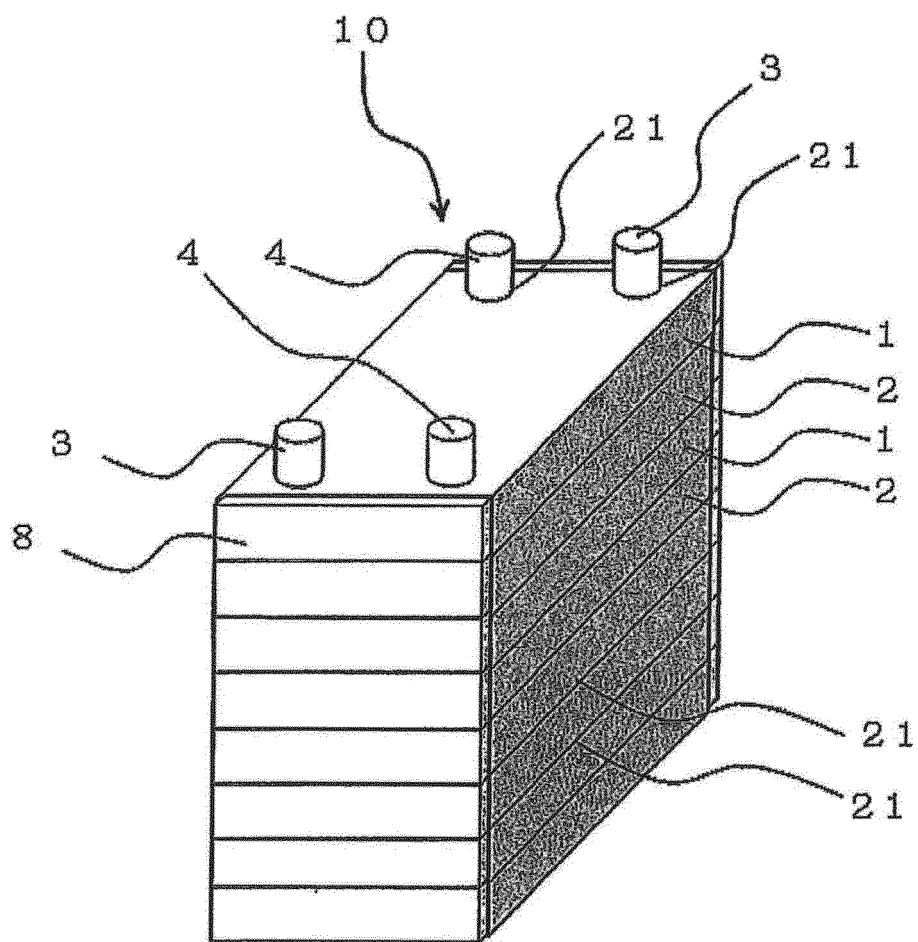


FIG. 2

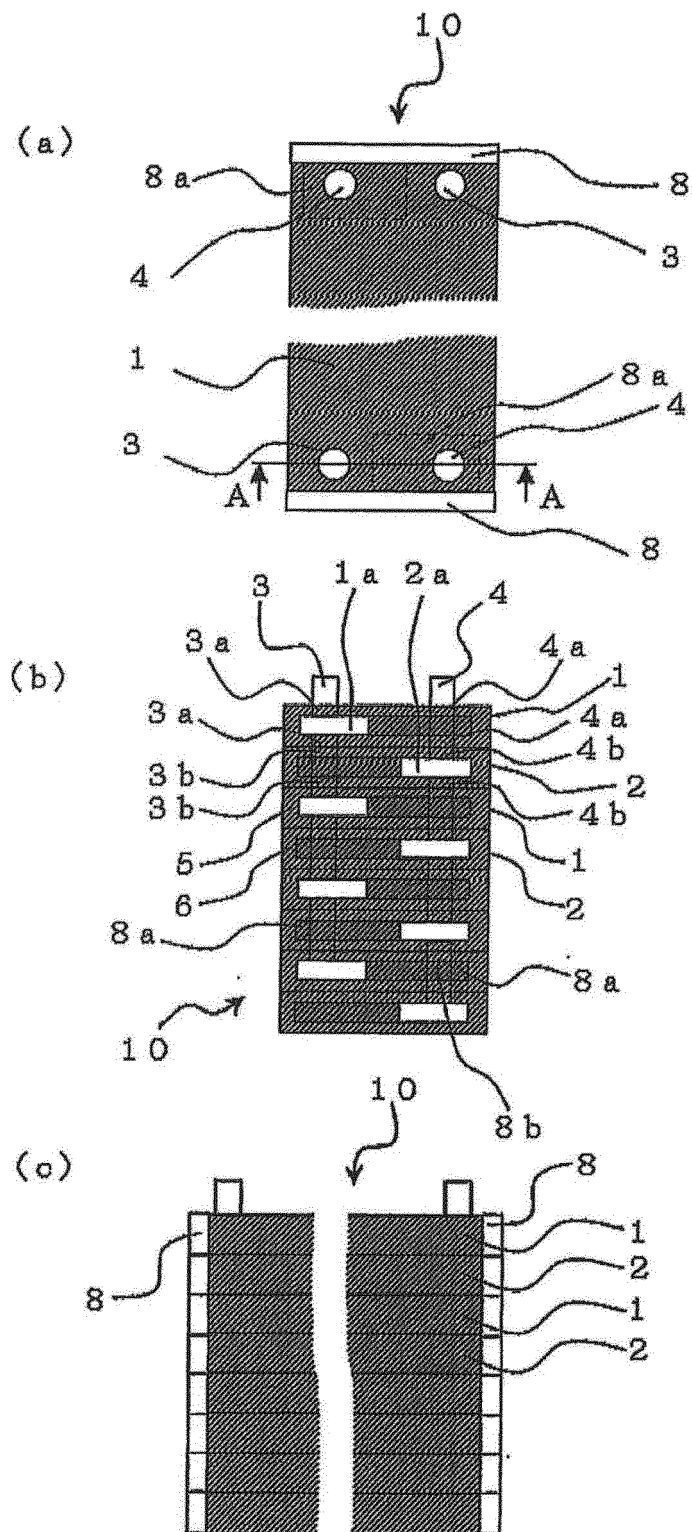


FIG. 3

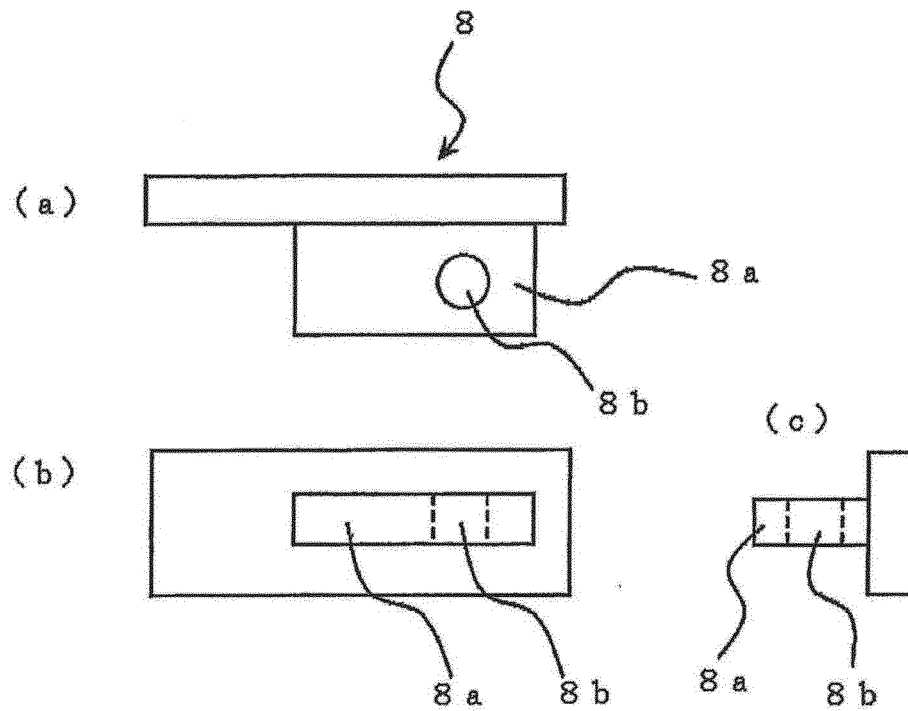


FIG. 4

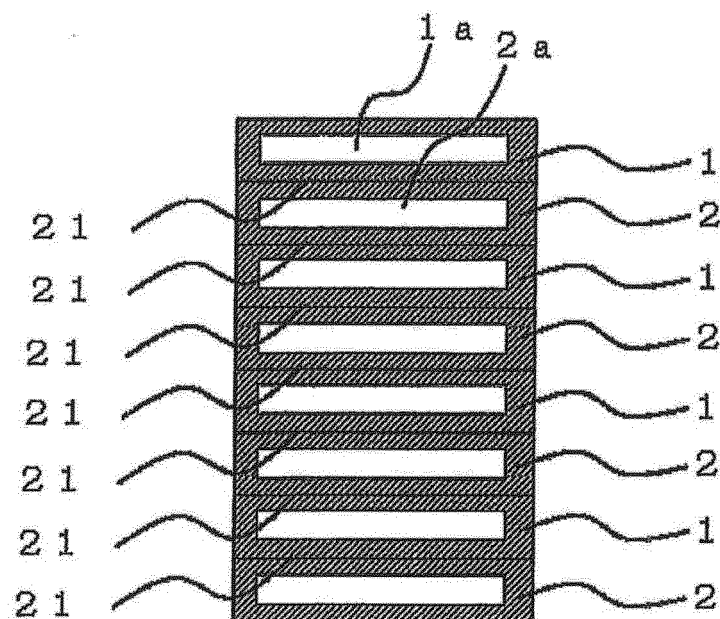


FIG. 5

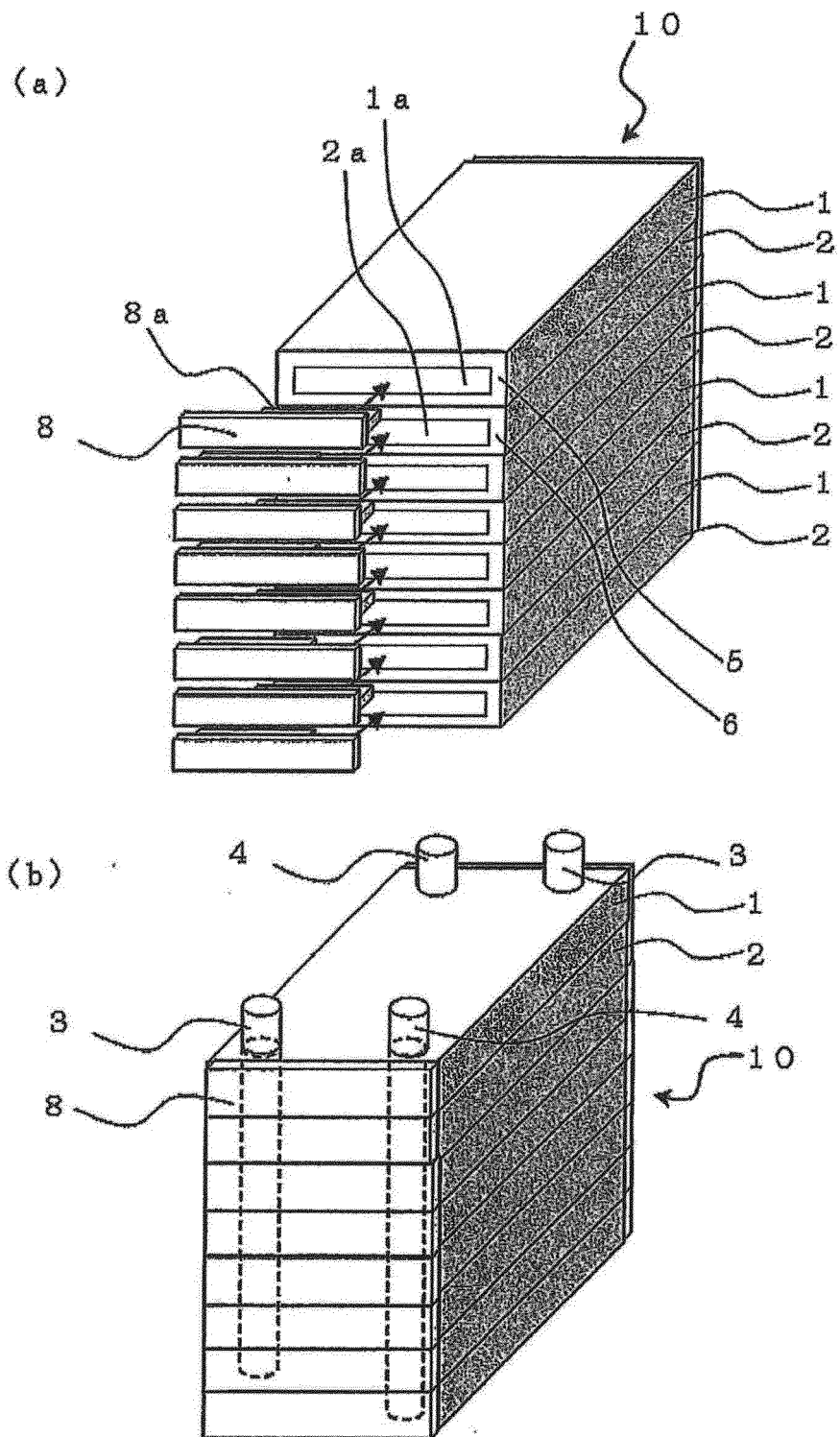


FIG. 6

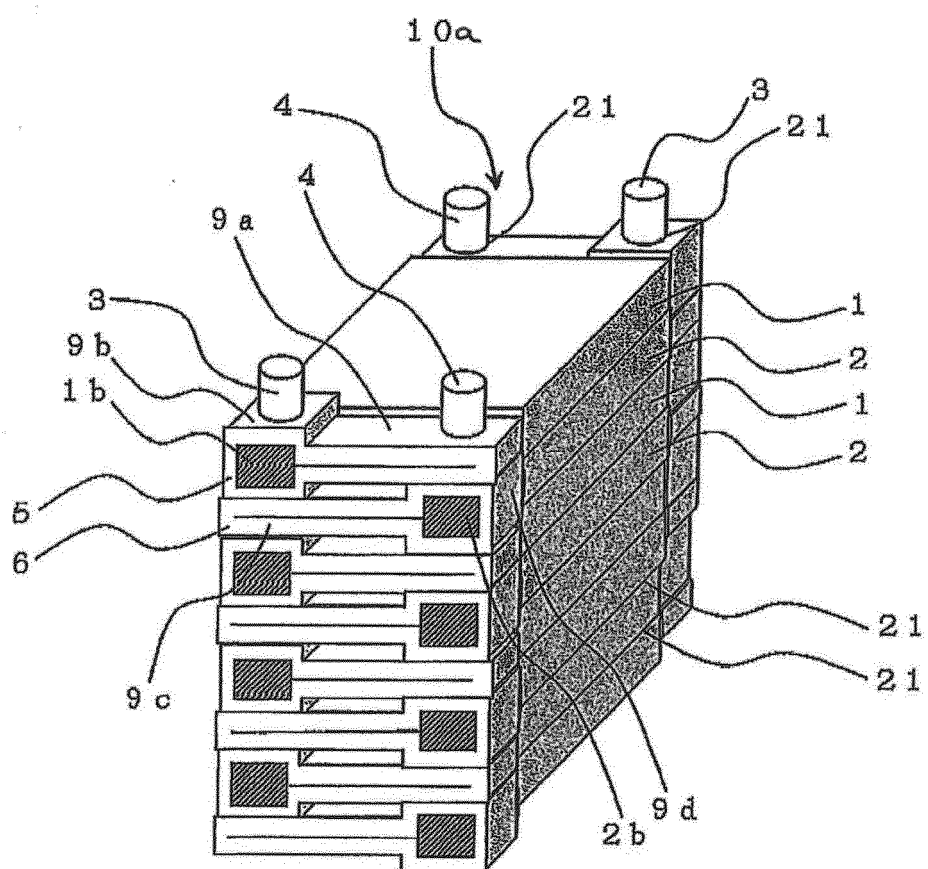


FIG. 7

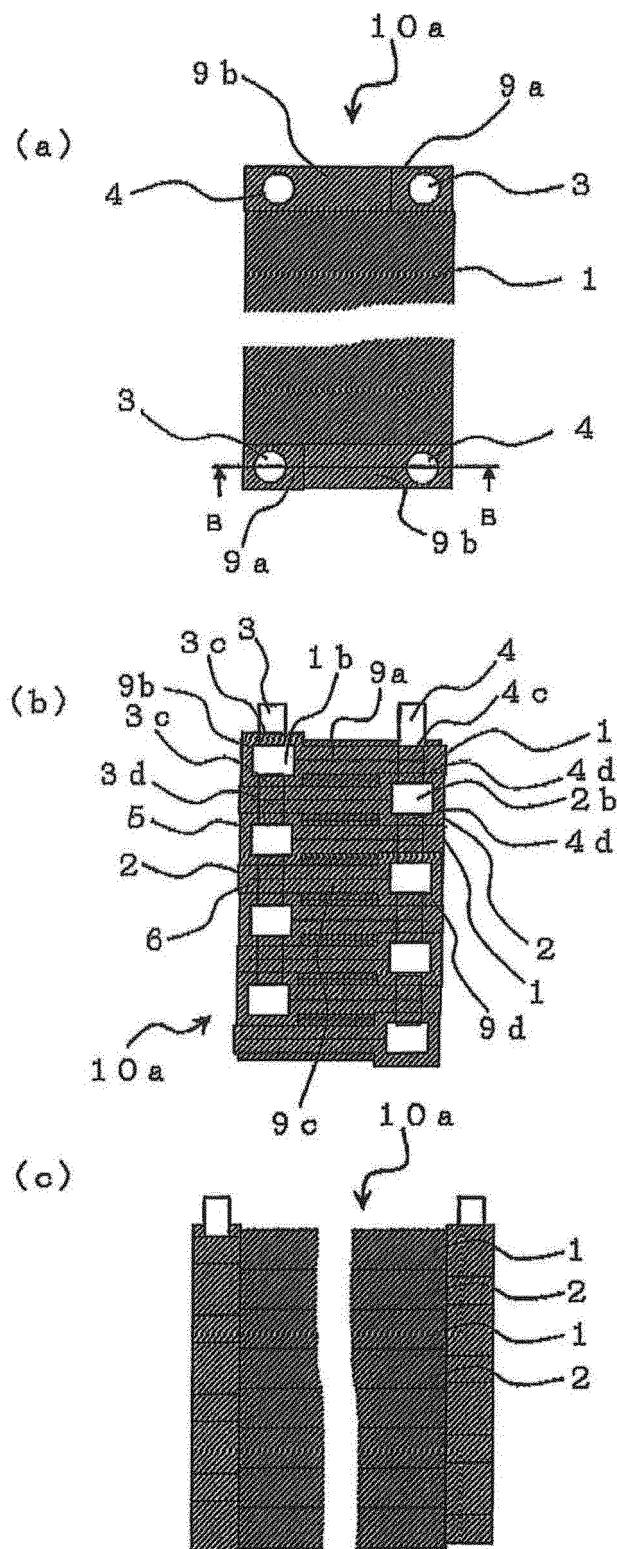


FIG. 8

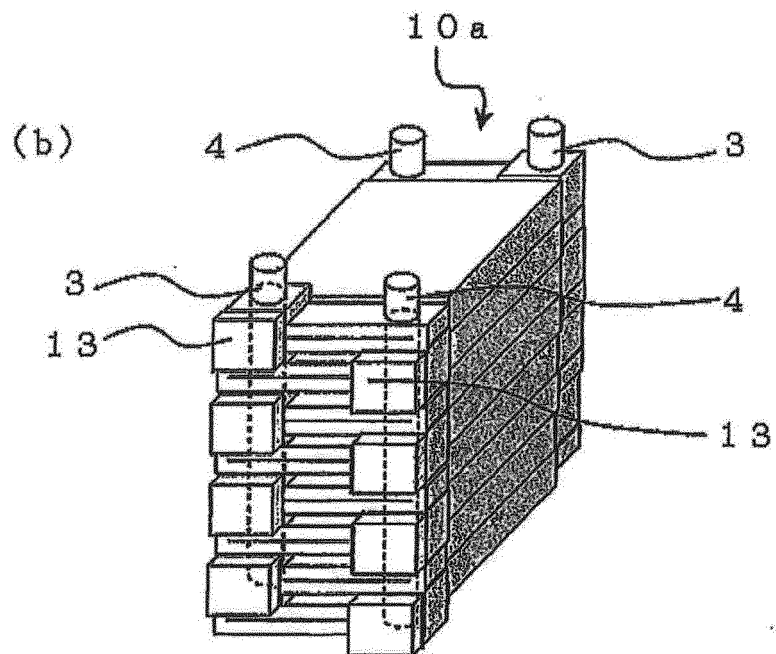
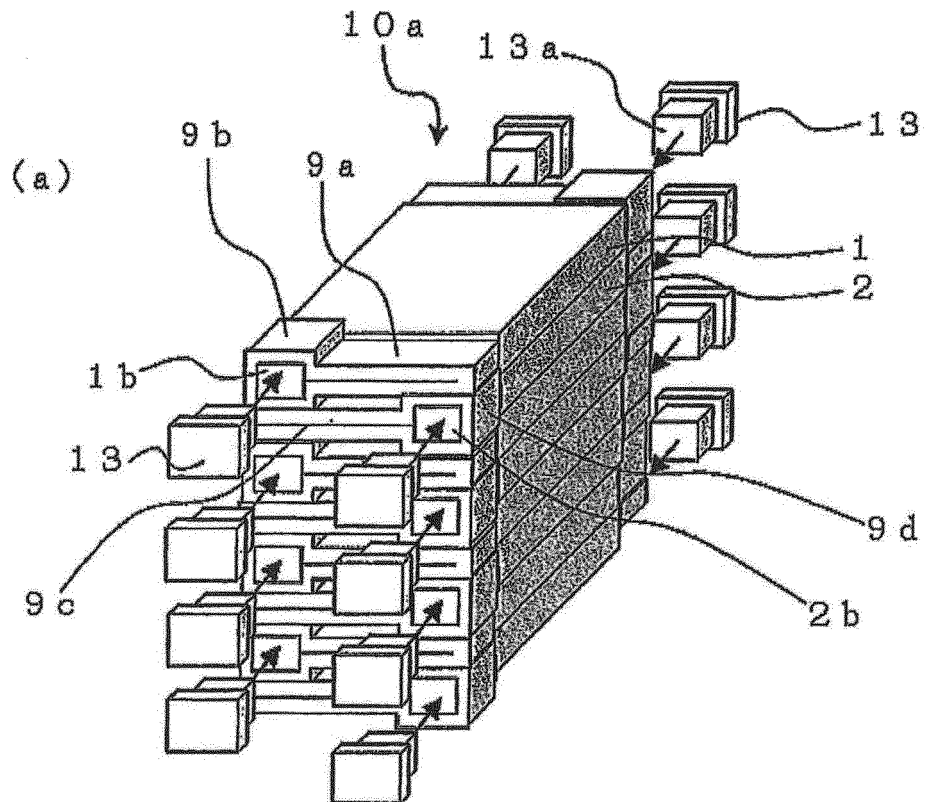


FIG. 9

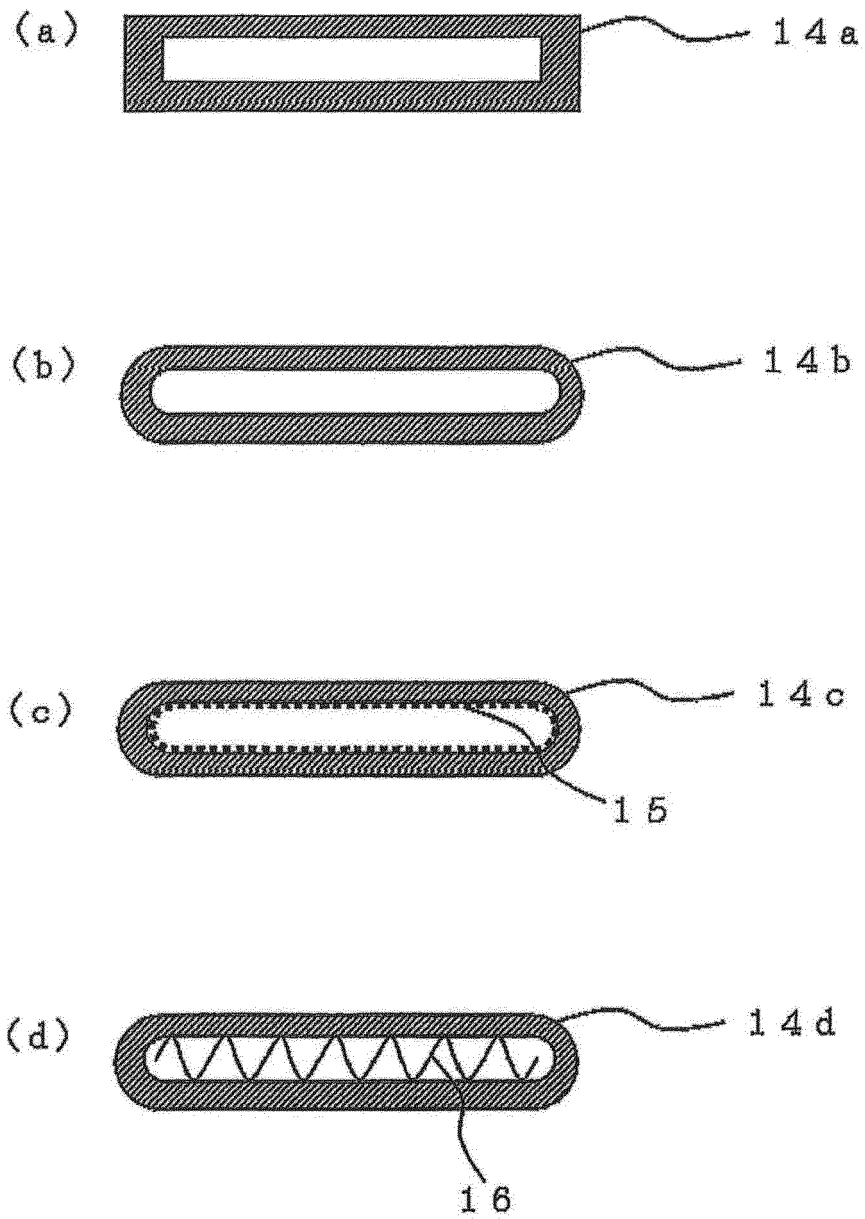


FIG. 10

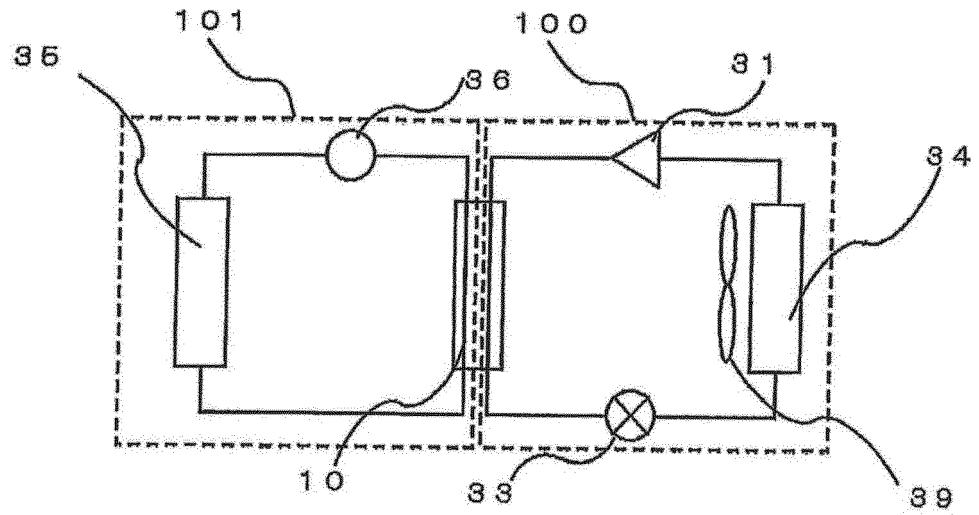


FIG. 11

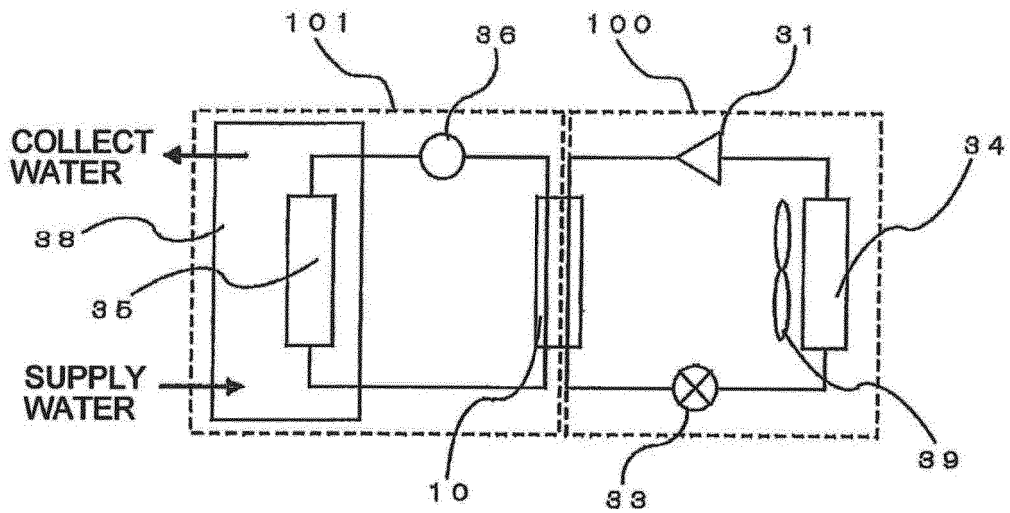


FIG. 12

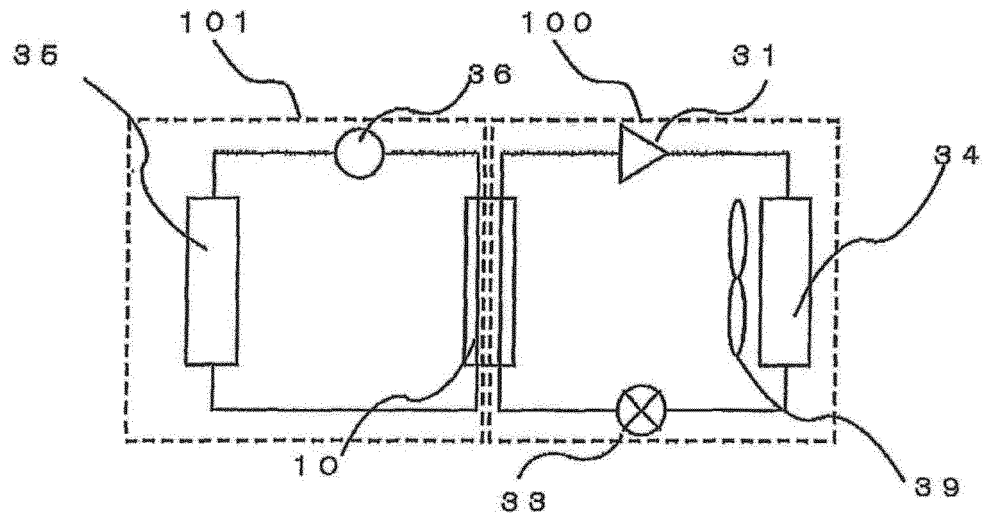
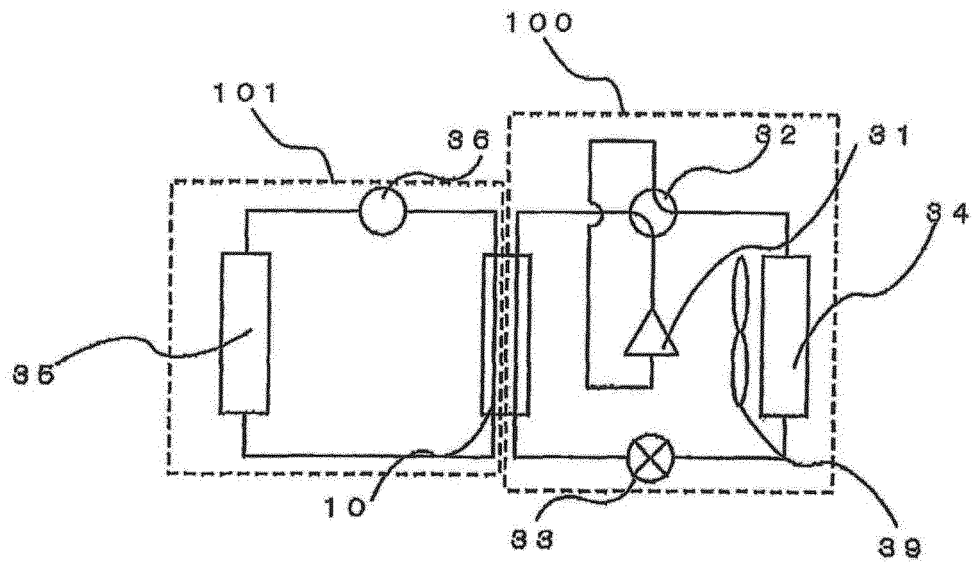


FIG. 13



REFERENCES CITED IN THE DESCRIPTION

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