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(54) WATER HEAT EXCHANGER

(57) When a first layer (10) is viewed in a stacking direction, each first flow path (11) extends from one end portion to another end portion of the first layer (10) in a direction crossing a direction of arrangement of the first flow paths (11). When a second layer (20) is viewed in the stacking direction, each second flow path (21) extends from one end portion to another end portion of the second layer (20) in a direction crossing a direction of arrangement of the second flow paths (21). Here, when the first layer (10) is viewed in the stacking direction, the first flow paths (11) have a meandering shape, and/or when the second layer (20) is viewed in the stacking direction, the second flow paths (21) have a meandering shape.

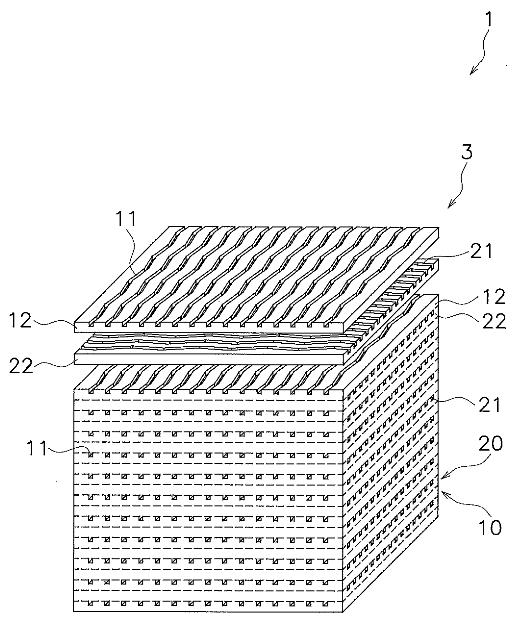

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates to a water heat exchanger, and, particularly, to a water heat exchanger including a first layer and a second layer that are stacked upon each other, and exchanging heat between a first fluid and a second fluid. The first layer has first flow paths formed in a plurality of rows and through which water as the first fluid flows. The second layer has second flow paths formed in a plurality of rows and through which a refrigerant as the second fluid flows.

BACKGROUND ART

[0002] Hitherto, water heat exchangers that exchange heat between water as the first fluid and a refrigerant (such as a chlorofluorocarbon refrigerant, a natural refrigerant, and brine) as the second fluid have been used in, for example, heat-pump cooling and heating devices and heat-pump hot water supply devices. As described in Patent Literature 1 (Japanese Unexamined Patent Application Publication No. 2010-117102), there exists a type of such water heat exchangers including first layers and second layers that are stacked upon each other. Each first layer has first flow paths formed in a plurality of rows and through which the first fluid flows. Each second layer has second flow paths formed in a plurality of rows and through which the second fluid flows.

SUMMARY OF THE INVENTION

[0003] The above-described water heat exchanger known in the art can realize higher performance and can be made compact as a result of reducing the flow-path cross-sectional area of each first flow path and the flow-path cross-sectional area of each second flow path.

[0004] However, when, for example, an increase in pressure loss and clogging of the flow paths are considered, there is a limit as to how small the flow-path cross-sectional area of each first flow path and the flow-path cross-sectional area of each second flow path can be made. Therefore, in order for the water heat exchanger to realize even higher performance and to be made more compact, it is necessary to, for example, appropriately form the shapes of the flow paths.

[0005] An object of the present invention is to provide a water heat exchanger that can realize even higher performance and can be made more compact by, for example, appropriately forming the shapes of the flow paths. The water heat exchanger includes a first layer and a second layer that are stacked upon each other, and exchanges heat between a first fluid and a second fluid. The first layer has first flow paths formed in a plurality of rows and through which water as the first fluid flows. The second layer has second flow paths formed in a plurality of rows and through which a refrigerant as the second fluid flows.

[0006] A water heat exchanger according to a first aspect includes a first layer and a second layer that are stacked upon each other, and exchanges heat between a first fluid and a second fluid, the first layer having first flow paths formed in a plurality of rows and through which water as the first fluid flows, the second layer having second flow paths formed in a plurality of rows and through which a refrigerant as the second fluid flows. When the first layer is viewed in a stacking direction of the first layer and the second layer, each first flow path extends from one end portion to another end portion of the first layer in a direction crossing a direction of arrangement of the first flow paths. When the second layer is viewed in the stacking direction, each second flow path extends from one end portion to another end portion of the second layer in a direction crossing a direction of arrangement of the second flow paths. Here, when the first layer is viewed in the stacking direction, the first flow paths have a meandering shape, and/or when the second layer is viewed in the stacking direction, the second flow paths have a meandering shape.

[0007] Here, as described above, since the first flow paths and the second flow paths have a meandering shape when the first layer and the second layer are viewed in the stacking direction, compared to when the first flow paths and the second flow paths have a straight shape, the flow path length per unit volume of the water heat exchanger can be increased. Moreover, since a heat transfer accelerating effect can be realized due to such meandering shapes of the first flow paths and the second flow paths, compared to when the first flow paths and the second flow paths each have a straight shape, the thermal conductivity of the first flow paths and the thermal conductivity of the second flow paths can be increased. In this way, here, the water heat exchanger can realize higher performance and can be made compact.

[0008] A water heat exchanger according to a second aspect is the water heat exchanger according to the first aspect, in which when the first fluid is to be heated by the second fluid, the first flow paths are formed such that a flow-path cross-sectional area of a first-fluid outlet vicinity positioned in a vicinity of an outlet for the first fluid is larger than a flow-path cross-sectional area of an upstream-side portion disposed upstream of the first-fluid outlet vicinity.

[0009] Here, as described above, since the flow-path cross-sectional area of the first-fluid outlet vicinity of the first flow paths is larger than the flow-path cross-sectional area of the upstream-side portion, disposed upstream of the first-fluid outlet vicinity, of the first flow paths, it is possible to make it less likely for scale deposited when the first fluid is heated to clog the first-fluid outlet vicinity, while a reduction in thermal conductivity caused by a reduction in the flow velocity of the first fluid in the first flow paths is limited to only the first-fluid outlet vicinity. In this way, here, clogging of the first flow paths of the water heat exchanger can be suppressed, while a reduction in thermal conductivity is minimized.

[0010] A water heat exchanger according to a third aspect is the water heat exchanger according to the first aspect or the second aspect, in which when the first fluid is to be cooled by the second fluid, the second flow paths are formed such that a flow-path cross-sectional area of a second-fluid outlet vicinity positioned in a vicinity of an outlet for the second fluid is larger than a flow-path cross-sectional area of an upstream-side portion disposed upstream of the second-fluid outlet vicinity.

[0011] Here, as described above, since the flow-path cross-sectional area of the second-fluid outlet vicinity of the second flow paths is larger than the flow-path cross-sectional area of the upstream-side portion, disposed upstream of the second-fluid outlet vicinity, of the second flow paths, the second fluid containing a large amount of gas component that increases due to evaporation can smoothly flow in the second-fluid outlet vicinity, while a reduction in thermal conductivity caused by a reduction in the flow velocity of the second fluid in the second flow paths is limited to only the second-fluid outlet vicinity. In this way, here, an increase in pressure loss in the second flow paths of the water heat exchanger can be suppressed, while a reduction in thermal conductivity is minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is an external view of a water heat exchanger according to an embodiment of the present invention.

Fig. 2 shows first flow paths of the water heat exchanger according to the embodiment of the present invention.

Fig. 3 shows second flow paths of the water heat exchanger according to the embodiment of the present invention.

Fig. 4 is a perspective view of a state in which the first flow paths and the second flow paths of the water heat exchanger according to the embodiment of the present invention are stacked upon each other.

Fig. 5 shows first flow paths of a water heat exchanger according to Modification 1 of the present invention (and corresponds to Fig. 2).

Fig. 6 shows second flow paths of the water heat exchanger according to Modification 1 of the present invention (and corresponds to Fig. 3).

Fig. 7 shows first flow paths of a water heat exchanger according to Modification 2 of the present invention (and corresponds to Fig. 2).

Fig. 8 shows second flow paths of the water heat exchanger according to Modification 2 of the present invention (and corresponds to Fig. 3).

Fig. 9 is an external view of a water heat exchanger according to Modification 3 of the present invention.

Fig. 10 shows second flow paths of the water heat exchanger according to Modification 3 of the present invention (and corresponds to Fig. 3).

Fig. 11 shows second flow paths of a water heat exchanger according to Modification 4 of the present invention (and corresponds to Fig. 3).

Fig. 12 shows the second flow paths of the water heat exchanger according to Modification 4 of the present invention (and corresponds to Fig. 3).

Fig. 13 shows first flow paths of a water heat exchanger according to Modification 5 of the present invention (and corresponds to Fig. 2).

Fig. 14 shows the first flow paths of the water heat exchanger according to Modification 5 of the present invention (and corresponds to Fig. 2).

Fig. 15 shows second flow paths of a water heat exchanger according to Modification 6 of the present invention (and corresponds to Fig. 3).

Fig. 16 shows the second flow paths of the water heat exchanger according to Modification 6 of the present invention (and corresponds to Fig. 3).

Fig. 17 shows the second flow paths of the water heat exchanger according to Modification 6 of the present invention (and corresponds to Fig. 3).

Fig. 18 shows the second flow paths of the water heat exchanger according to Modification 6 of the present invention (and corresponds to Fig. 3).

DESCRIPTION OF EMBODIMENTS

[0013] An embodiment and modifications thereof of a water heat exchanger according to the present invention are described below on the basis of the drawings. Specific configurations of the water heat exchanger according to the present invention are not limited to those of the embodiment and the modifications thereof below and are changeable within a scope that does not depart from the spirit of the invention.

(1) Configurations and Characteristics

[0014] Figs. 1 to 4 each show a water heat exchanger 1 according to the embodiment of the present invention.

[0015] The water heat exchanger 1 is a heat exchanger that exchanges heat between water as a first fluid and a refrigerant as a second fluid in, for example, an air-conditioning and heating device and a heat-pump hot water supply device. In the description below, with reference to a near-side surface in a sheet plane of the water heat exchanger 1 shown in Figs. 1 to 3, expressions indicating directions, such as "up", "down", "left", "right", "vertical", and "horizontal" are used. However, these expressions are used for convenience of description, and do not indicate the actual arrangement of the water heat exchanger 1 and structural portions thereof.

[0016] The water heat exchanger 1 primarily includes a casing 2 in which a heat exchanging unit 3 that exchanges heat between the first fluid and the second fluid is provided, a first pipe 4a and a first pipe 4b that are each an inlet and an outlet for the first fluid, and a second pipe 5a and a second pipe 5b that are each an inlet and an outlet for the second fluid.

[0017] The heat exchanging unit 3 includes first layers 10 and second layers 20 that are stacked upon each other. Each first layer 10 has first flow paths 11 formed in a plurality of rows and through which the first fluid flows. Each second layer 20 has second flow paths 21 formed in a plurality of rows and through which the second fluid flows. Here, the direction in which the first layers 10 and the second layers 20 are stacked upon each other (here, a direction from the near side in the sheet plane to a far side in the sheet plane of Figs. 1 to 3) is defined as a stacking direction. The direction in which the plurality of first flow paths 11 are arranged side by side (here, a left-right direction in the sheet plane of Fig. 2) is defined as a direction of arrangement of the first flow paths 11, and the direction in which the plurality of second flow paths 21 are arranged side by side (here, an up-down direction in the sheet plane of Fig. 3) is defined as a direction of arrangement of the second flow paths 21. When the first layers 10 are viewed in the stacking direction of the first layers 10 and the second layers 20, each first flow path 11 extends from one end portion of the first layer 10 (an upper end portion of the first layer 10 in Fig. 2) to another end portion of the first layer 10 (a lower end portion of the first layer 10 in Fig. 2) in a direction crossing the direction of arrangement of the first flow paths 11 (here, the up-down direction or a vertical direction in the sheet plane of Fig. 2). When the second layers 20 are viewed in the stacking direction of the first layers 10 and the second layers 20, each second flow path 21 extends from one end portion of the second layer 20 (a left end portion of the second layer 20 in Fig. 3) to another end portion of the second layer 20 (a right end portion of the second layer 20 in Fig. 3) in a direction crossing the direction of arrangement of the second flow paths 21 (here, the left-right direction or a horizontal direction in the sheet plane of Fig. 3). In this way, here, the first flow paths 11 and the second flow paths 21 are arranged so as to allow cross-flows.

[0018] Here, when the first layers 10 are viewed in the stacking direction, the first flow paths 11 have a meandering shape. Specifically, each first flow path 11 extends in the direction crossing the direction of arrangement of the first flow paths 11 (here, the vertical direction) while each first flow path 11 linearly (that is, angularly) meanders in the direction of arrangement of the first flow paths 11 (here, the left-right direction in the sheet plane of Fig. 2). It is desirable that each first flow path 11 meander three or more times from the one end portion to the other end portion of the first layer 10. When the second layers 20 are viewed in the stacking direction, the second flow paths 21 have a meandering shape. Specifically, each second flow path 21 extends in the direction crossing the direction of arrangement of the second flow paths 21 (here, the horizontal direction) while each second flow path 21 linearly (that is, angularly) meanders in the direction of arrangement of the second flow paths 21 (here, the up-down direction in the sheet plane of Fig. 3). It is desirable that each second flow path 21 meander three or more times from the one end portion to the other end portion of the second layer 20.

[0019] Here, the heat exchanging unit 3 including the first layers 10 and the second layers 20 that are stacked upon each other includes first plates 12 and second plates 22 that are alternately stacked upon each other. Grooves that form the first flow paths are formed in one surface of each first plate 12. Grooves that form the second flow paths 21 are formed in one surface of each second plate 22. Each first plate 12 and each second plate 22 are made of a metallic material. The grooves that form the first flow paths 11 and the grooves that form the second flow paths 21 are formed by, for example, machining or etching the first plates 12 and the second plates 22, respectively. After stacking predetermined numbers of the first plates 12 and the second plates 22, each being grooved thus, for example, the first plates 12 and the second plates 22 are joined to each other by a joining process, such as diffusion joining, to form the heat exchanging unit 3 including the first layers 10 and the second layers 20 that are stacked upon each other. Here, although the grooves that form the flow paths 11 are formed in one surface of each first plate 12 and the grooves that form the flow paths 21 are formed in one surface of each second plate 22, the configurations are not limited thereto. Each first plate 12 may have grooves that form the flow paths 11, 21 in both surfaces thereof, and/or each second plate 22 may have grooves that form the flow paths 11, 21 in both surfaces thereof.

[0020] Here, the first pipe 4a is disposed at an upper portion of the casing 2, and the first pipe 4b is disposed at a lower portion of the casing 2. The casing 2 includes a first header 6 disposed at the upper portion of the casing 2 and having a space that allows upper end portions of the first flow paths 11 to merge, and a first header 7 disposed at the lower portion of the casing 2 and having a space that allows lower end portions of the first flow paths 11 to merge. The first pipe 4a communicates with the upper end portions of the first flow paths 11 via the first header 6, and the first pipe 4b communicates with the lower end portions of the first flow paths 11 via the first header 7. Here, the second pipe 5a is disposed on a left portion of the casing 2, and the second pipe 5b is disposed on a right portion of the casing 2. The casing 2 includes a second header 8 disposed at the left portion of the casing 2 and having a space that allows left end portions of the second flow paths 21 to merge, and a second header 9 disposed at the right portion of the casing 2 and having a space that allows right end portions of the second flow paths 21 to merge. The second pipe 5a communicates with the left end portions of the second flow paths 21 via the second header 8, and the second pipe 5b communicates with the right end portions of the second flow paths 21 via the second header 9.

[0021] In the water heat exchanger 1 having such a configuration, for example, when the first fluid is to be heated by the second fluid, the first pipe 4b can be the inlet for the first fluid, the first pipe 4a can be the outlet for the first fluid, the second pipe 5b can be the inlet for the second fluid, and the second pipe 5a can be the outlet for the second fluid. In this case, the water heat exchanger 1 functions as a heat exchanger in which the first fluid flows through the first flow paths 11 from bottom to top and is heated and in which the second fluid flows through the second flow paths 21 from right to left and is cooled. In the water heat exchanger 1, for example, when the first fluid is to be cooled by the second fluid, the first pipe 4b can be the inlet for the first fluid, the first pipe 4a can be the outlet for the first fluid, the second pipe 5a can be the inlet for the second fluid, and the second pipe 5b can be the outlet for the second fluid. In this case, the water heat exchanger 1 functions as a heat exchanger in which the first fluid flows through the first flow paths 11 from the bottom to the top and is cooled and in which the second fluid flows through the second flow paths 21 from the left to the right and is heated.

[0022] In such a water heat exchanger 1, as described above, since the first flow paths 11 and the second flow paths 21 have a meandering shape when the first layers 10 and the second layers 20 are viewed in the stacking direction, compared to when the first flow paths 11 and the second flow paths 21 each have a straight shape, the flow path length per unit volume of the water heat exchanger 1 can be increased. Moreover, since a heat transfer accelerating effect can be realized due to such meandering shapes of the first flow paths 11 and the second flow paths 21, compared to when the first flow paths 11 and the second flow paths 21 each have a straight shape, the thermal conductivity of the first flow paths 11 and the thermal conductivity of the second flow paths 21 can be increased. In this way, here, the water heat exchanger 1 can realize higher performance and can be made compact.

(2) Modification 1

[0023] Although, in the water heat exchanger 1 of the above-described embodiment, as shown in Figs. 2 and 3, the first flow paths 11 and the second flow paths 21 have a linearly (that is, angularly) meandering shape, the shape is not limited thereto.

[0024] For example, as shown in Figs. 5 and 6, the first flow paths 11 and the second flow paths 21 may have a curvedly (that is, a roundedly instead of an angularly) meandering shape.

[0025] This configuration of the present modification can also provide operational effects similar to those of the above-described embodiment.

(3) Modification 2

[0026] Although, in the water heat exchangers 1 of the above-described embodiment and Modification 1, the first flow paths 11 and the second flow paths 21 both have a meandering shape, only the first flow paths 11 or only the second flow paths 21 may have a meandering shape.

[0027] For example, the second flow paths 21 may have a meandering shape such as that shown in Fig. 3 or Fig. 6, and the first flow paths 11 may each have a straight shape such as that shown in Fig. 7. In contrast, the first flow paths 11 may have a meandering shape such as that shown in Fig. 2 or Fig. 5, and the second flow paths 21 may each have a straight shape such as that shown in Fig. 8.

[0028] This configuration of the present modification can also provide operational effects similar to those of the above-described embodiment and Modification 1.

(4) Modification 3

[0029] Although, in the water heat exchangers 1 of the above-described embodiment and Modifications 1 and 2, the first flow paths 11 and the second flow paths 21 are arranged so as to allow cross-flows, the structures are not limited thereto.

[0030] For example, as shown in Figs. 9 and 10, each second flow path 21 extending from the one end portion of the second layer 20 (the left end portion of the second layer 20 in Fig. 3) to the other end portion of the second layer 20 (the right end portion of the second layer 20 in Fig. 3) in the horizontal direction may be caused to extend from one end portion of the second layer 20 (a lower end portion of the second layer 20 in Fig. 10) to another end portion of the second layer 20 (an upper end portion of the second layer 20 in Fig. 10) in the vertical direction, to arrange the first flow paths 11 and the second flow paths 21 so as to allow counter-flows (or parallel flows). In this case, the second pipe 5a and the second header 8 are disposed at the lower portion of the casing 2, and the second pipe 5b and the second header 9 are disposed at the upper portion of the casing 2. This configuration functions as a heat exchanger in which, when the first fluid is to be heated by the second fluid, the first fluid flows through the first flow paths 11 from the bottom to the top and is heated, and the second fluid flows through the second flow paths 21 from the top to the bottom and is cooled. This configuration also functions as a heat exchanger in which, when the first fluid is to be cooled by the second fluid, the first fluid flows through the first flow paths 11 from the bottom to the top and is cooled, and the second fluid flows through the second flow paths 21 from the bottom to the top and is heated.

[0031] This configuration of the present modification can also provide operational effects similar to those of the above-described embodiment and Modifications 1 and 2.

(5) Modification 4

[0032] Although, in the water heat exchangers 1 of the above-described embodiment and Modifications 1 and 2, the first flow paths 11 and the second flow paths 21 are arranged so as to allow cross-flows, the structures are not limited thereto.

[0033] For example, the second flow paths 21 may be divided into a plurality of flow path groups and these flow path groups may be connected in series, to arrange the first flow paths 11 and the second flow paths 21 so as to allow orthogonal counter-flows (or orthogonal parallel flows). Specifically, in the configuration shown in Fig. 11, the second flow paths 21 are divided into three flow path groups 21A, 21B, and 21C in the direction of arrangement of the second flow paths 21 (here, in the up-down direction in the sheet plane of Fig. 11). For example, a partitioning member in the second header 9 partitions the space in the second header 9 into a space 9a that communicates with the second pipe 5b and the right end portions of the second flow paths 21 of the flow path group 21A and into a space 9b that communicates with the right end portions of the second flow paths 21 of the flow path groups 21B and 21C. For example, a partitioning member in the second header 8 partitions the space in the second header 8 into a space 8a that communicates with the second pipe 5a and the left end portions of the second flow paths 21 of the flow path group 21C and into a space 8b that communicates with the left end portions of the second flow paths 21 of the flow path groups 21A and 21B. Therefore, the flow path groups 21A, 21B, and 21C of the second flow paths 21 are connected in series by the second headers 8 and 9 and are arranged such that the first flow paths 11 and the second flow paths 21 allow orthogonal counter-flows (or orthogonal parallel flows). This configuration functions as a heat exchanger in which, when the first fluid is to be heated by the second fluid, the first fluid flows through the first flow paths 11 from the bottom to the top and is heated, and the second fluid flows through the second flow paths 21 from the flow path groups 21A to 21B and to 21C in that order from the top to the bottom while the second fluid makes turns leftwards and rightwards, and is cooled. This configuration functions as a heat exchanger in which, when the first fluid is to be cooled by the second fluid, the first fluid flows through the first flow paths 11 from the bottom to the top and is cooled, and the second fluid flows through the second flow paths 21 from the flow path groups 21C to 21B and to 21A in that order from the bottom to the top while the second fluid makes turns leftwards and rightwards, and is heated.

[0034] Although, in the configuration shown in Fig. 11, the space in the second header 8 is partitioned into the spaces 8a and 8b such that the flow path groups 21A, 21B, and 21C are connected in series and the space in the second header 9 is partitioned into the spaces 9a and 9b such that the flow path groups 21A, 21B, and 21C are connected in series, the structure is not limited thereto. For example, as shown in Fig. 12, a connecting flow path 29a having the same function as the space 8b may be disposed on the left end portions of the second flow paths 21, and a connecting flow path 29b having the same function as the space 9b may be disposed on the right end portions of the second flow paths 21. That is, the connecting flow path 29a that causes the left end portions of the second flow paths 21 of the flow path groups 21A and 21B to communicate with each other and the connecting flow path 29b that causes the right end portions of the second flow paths 21 of the flow path groups 21B and 21C to communicate with each other are formed in the second layer 20. Here, grooves that form the connecting flow paths 29a and 29b can be formed in the second plate 22. In this case, the second header 8 can have only a space corresponding to the space 8a in Fig. 11, and the second header 9 can have only a space corresponding to the space 9a in Fig. 11.

[0035] This configuration of the present modification can also provide operational effects similar to those of the above-described embodiment and Modifications 1 and 2.

(6) Modification 5

[0036] In the water heat exchangers 1 of the above-described embodiment and Modifications 1 to 4, when water as the first fluid is to be heated by the second fluid, the first flow paths 11 may become clogged by scale deposited in the first flow paths 11.

[0037] Therefore, here, in order to suppress such clogging of portions of the first flow paths 11 in the vicinity of the outlet caused by the deposited scale, for example, as shown in Fig. 13, each first flow path 11 is formed such that a flow-path cross-sectional area S11a of a first-fluid outlet vicinity 11a positioned in the vicinity of the outlet for the first fluid is larger than a flow-path cross-sectional area S11b of an upstream-side portion 11b disposed upstream of the first-fluid outlet vicinity 11a. Here, by making a flow-path width W11a of the first-fluid outlet vicinity 11a of each first flow path 11 larger than a flow-path width W11b of each upstream-side portion 11b disposed upstream of the first-fluid outlet vicinity 11a, each flow-path cross-sectional area S11a is made larger than its corresponding flow-path cross-sectional area S11b. The first-fluid outlet vicinity 11a refers to a portion that is disposed closer to the outlet and that has a flow-path length which is 20% to 50% of the flow-path length from an inlet side of the first flow path 11 (here, an end portion on a side of the first pipe 4b) to an outlet side of the first flow path 11 (here, an end portion on a side of the first pipe 4a).

[0038] Unlike the configuration of each first flow path 11 shown in Fig. 13, the first flow paths 11 may be merged such that the number of flow paths at the first-fluid outlet vicinities 11a is less than the number of flow paths at the upstream-side portions disposed upstream of the first-fluid outlet vicinities 11a. For example, as shown in Fig. 14, by merging at the first-fluid outlet vicinities 11a two first flow paths 11 adjacent to each other in the direction of arrangement of the first flow paths 11 and forming the two first flow paths 11 into one first flow path 11, the flow-path width W11a of the first-fluid outlet vicinity 11a after the first flow paths 11 have been merged may be made larger than the total of the flow-path widths W11b of the upstream-side portions 11b disposed upstream of the first-fluid outlet vicinities 11a before the first flow paths 11 have been merged. Therefore, the flow-path cross-sectional area S11a of the first-fluid outlet vicinity 11a after the first flow paths 11 have been merged can be made larger than the total of the flow-path cross-sectional areas S11b of the upstream-side portions 11b disposed upstream of the first-fluid outlet vicinities 11a before the first flow paths 11 have been merged.

[0039] In such a water heat exchanger 1, as described above, since the flow-path cross-sectional area S11a of the first-fluid outlet vicinity 11a of each first flow path 11 is larger than the flow-path cross-sectional area of each upstream-side portion 11b disposed upstream of the first-fluid outlet vicinity 11a, it is possible to make it less likely for scale deposited when the first fluid is heated to clog the first-fluid outlet vicinities 11a, while a reduction in thermal conductivity caused by a reduction in the flow velocity of the first fluid in the first flow paths 11 is limited to only the first-fluid outlet vicinities 11a. In this way, here, not only can operational effects similar to those of the above-described embodiment and Modifications 1 to 4 be provided, but also clogging of the first flow paths 11 of the water heat exchanger 1 can be suppressed, while a reduction in thermal conductivity is minimized.

(7) Modification 6

[0040] In the water heat exchangers 1 of the above-described embodiment and Modifications 1 to 5, when the first fluid is to be cooled by a refrigerant as the second fluid, the amount of gas component that flows through the second flow paths 21 is increased due to evaporation of the second fluid, as a result of which pressure loss in the second flow paths 21 may increase.

[0041] Therefore, here, in order to suppress such an increase in pressure loss in the second flow paths 21 caused by evaporation of the second fluid, for example, as shown in Fig. 15, each second flow path 21 is formed such that a flow-path cross-sectional area S21a of a second-fluid outlet vicinity 21a positioned in the vicinity of the outlet for the second fluid is larger than a flow-path cross-sectional area S21b of an upstream-side portion 21b disposed upstream of the second-fluid outlet vicinity 21a. Here, by making a flow-path width W21a of the second-fluid outlet vicinity 21a of each second flow path 21 larger than a flow-path width W21b of each upstream-side portion 21b disposed upstream of the second-fluid outlet vicinity 21a, each flow-path cross-sectional area S21a is made larger than its corresponding flow-path cross-sectional area S21b. The second-fluid outlet vicinity 21a refers to a portion that is disposed closer to the outlet and that has a flow-path length which is 20% to 50% of the flow-path length from an inlet side of the second flow path 21 (here, an end portion on a side of the second pipe 5a) to an outlet side of the second flow path 21 (here, an end portion on a side of the second pipe 5b). The first flow paths 11 and the second flow paths 21 may be arranged so as to allow orthogonal counter-flows (or orthogonal parallel flows).

[0042] Even the configuration, such as that of Modification 4 above, in which the second flow paths 21 are divided into the plurality of flow path groups 21A, 21B, and 21C and in which these flow path groups 21A, 21B, and 21C are connected in series may use the configuration in which the flow-path widths W21a of the second-fluid outlet vicinities 21a of the second flow paths 21 are made large similarly to the configuration shown in Fig. 15. In this case, for example, as shown in Fig. 16, the flow path group 21A positioned in the vicinity of the outlet for the second fluid may be defined as second-fluid outlet vicinities 21a, the flow path groups 21B and 21C may be defined as upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a, and the flow-path width W21a of each second flow path 21 of the flow path group 21A may be made larger than the flow-path width W21b of each second flow path 21 of the flow path groups 21B and 21C.

[0043] Unlike the configuration of each second flow path 21 shown in Fig. 15, the second flow paths 21 may be merged such that the number of flow paths at the second-fluid outlet vicinities 21a is less than the number of flow paths at the upstream-side portions disposed upstream of the second-fluid outlet vicinities 21a. For example, as shown in Fig. 17, by merging at the second-fluid outlet vicinities 21a two second flow paths 21 adjacent to each other in the direction of arrangement of the second flow paths 21 and forming the two second flow paths 21 into one second flow path 21, the flow-path width W21a of the second-fluid outlet vicinity 21a after the second flow paths 21 have been merged may be made larger than the total of the flow-path widths W21b of the upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a before the second flow paths 21 have been merged. Therefore, the flow-path cross-sectional area S21a of the second-fluid outlet vicinity 21a after the second flow paths 21 have been merged can be made larger than the total of the flow-path cross-sectional areas S21b of the upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a before the second flow paths 21 have been merged.

[0044] In contrast to the configuration shown in Fig. 17 in which the flow-path cross-sectional area S21a is made larger than the total of the flow-path cross-sectional areas S21b by merging the second flow paths 21 at the second-fluid outlet vicinities 21a, the total of the flow-path cross-sectional areas S21a may be made larger than the total of the flow-path cross-sectional areas S21b by branching the second flow paths 21 such that the number of flow paths at the second-fluid outlet vicinities 21a is larger than the number of flow paths at the upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a. For example, in the configuration, such as that of Modification 4 above, in which the second flow paths 21 are divided into the plurality of flow path groups 21A, 21B, and 21C and in which these flow path groups 21A, 21B, and 21C are connected in series, as shown in Fig. 18, the flow path group 21A positioned in the vicinity of the outlet for the second fluid may be defined as second-fluid outlet vicinities 21a, the flow path groups 21B and 21C may be defined as upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a, and the number N21a of the second flow paths 21 of the flow path group 21A may be larger than the number N21b of the flow paths of the flow path groups 21B and 21C. Here, the flow-path widths W21a and W21b (the flow-path cross-sectional areas S21a and S21b) of the second flow paths 21 are equal to each other, and the flow-path cross-sectional area S21a of the flow path group 21A and the total of the flow-path cross-sectional areas S21b of the flow path groups 21B and 21C are changed by changing the number of flow paths.

[0045] As described above, since the flow-path cross-sectional area S21a of the second-fluid outlet vicinity 21a of each second flow path 21 is larger than that of the upstream-side portion 21b disposed upstream of the second-fluid outlet vicinity 21a, such a water heat exchanger 1 allows the second fluid containing a large amount of gas component that increases due to evaporation to smoothly flow in each second-fluid outlet vicinity 21a, while a reduction in thermal conductivity caused by a reduction in the flow velocity of the second fluid in the second flow paths 21 is limited to only the second-fluid outlet vicinities 21a. In this way, here, not only can operational effects similar to those of the above-described embodiment and Modifications 1 to 5 be provided, but also an increase in pressure loss in the second flow paths 21 of the water heat exchanger 1 can be suppressed, while a reduction in thermal conductivity is minimized.

[0046] As with the configuration shown in Fig. 18, the configuration in which the number N21a of flow paths at the second-fluid outlet vicinities 21a is larger than the number of flow paths at the upstream-side portions 21b disposed upstream of the second-fluid outlet vicinities 21a not only suppresses an increase in pressure loss in the second flow paths 21 of the water heat exchanger 1, but also can properly maintain the distribution performance in the second flow paths 21 for the second fluid by reducing the number of flow paths at the inlet for the second fluid. In particular, the configuration shown in Fig. 18 effectively contributes to the distribution performance in each second flow path 21 for the second fluid because, not only is the number N21a of flow paths of the flow path group 21A larger than the number N21b of flow paths of the flow path groups 21B and 21C disposed upstream of the flow path group 21A, but also the number of flow paths from largest to smallest is the number of flow paths of the flow path group 21A, the number of flow paths of the flow path group 21B, and the number of flow paths of the flow path group 21C in this order, that is, the number of flow paths decreases with decreasing distance from the inlet for the second fluid.

INDUSTRIAL APPLICABILITY

[0047] The present invention provides a configuration that includes a first layer and a second layer that are stacked upon each other, with the first layer having first flow paths formed in a plurality of rows and through which water as a first fluid flows and the second layer having second flow paths formed in a plurality of rows and through which a refrigerant as a second fluid flows; and can be widely applied to water heat exchangers that exchange heat between the first fluid and the second fluid.

REFERENCE SIGNS LIST

[0048]

1	water heat exchanger
10	first layer
11	first flow path
11a	first-fluid outlet vicinity
11b	upstream-side portion disposed upstream of first-fluid outlet vicinity
20	second layer
21	second flow path
21a	second-fluid outlet vicinity
21b	upstream-side portion disposed upstream of second-fluid outlet vicinity

CITATION LIST

PATENT LITERATURE

Patent Literature 1

[0049] Japanese Unexamined Patent Application Publication No. 2010-117102

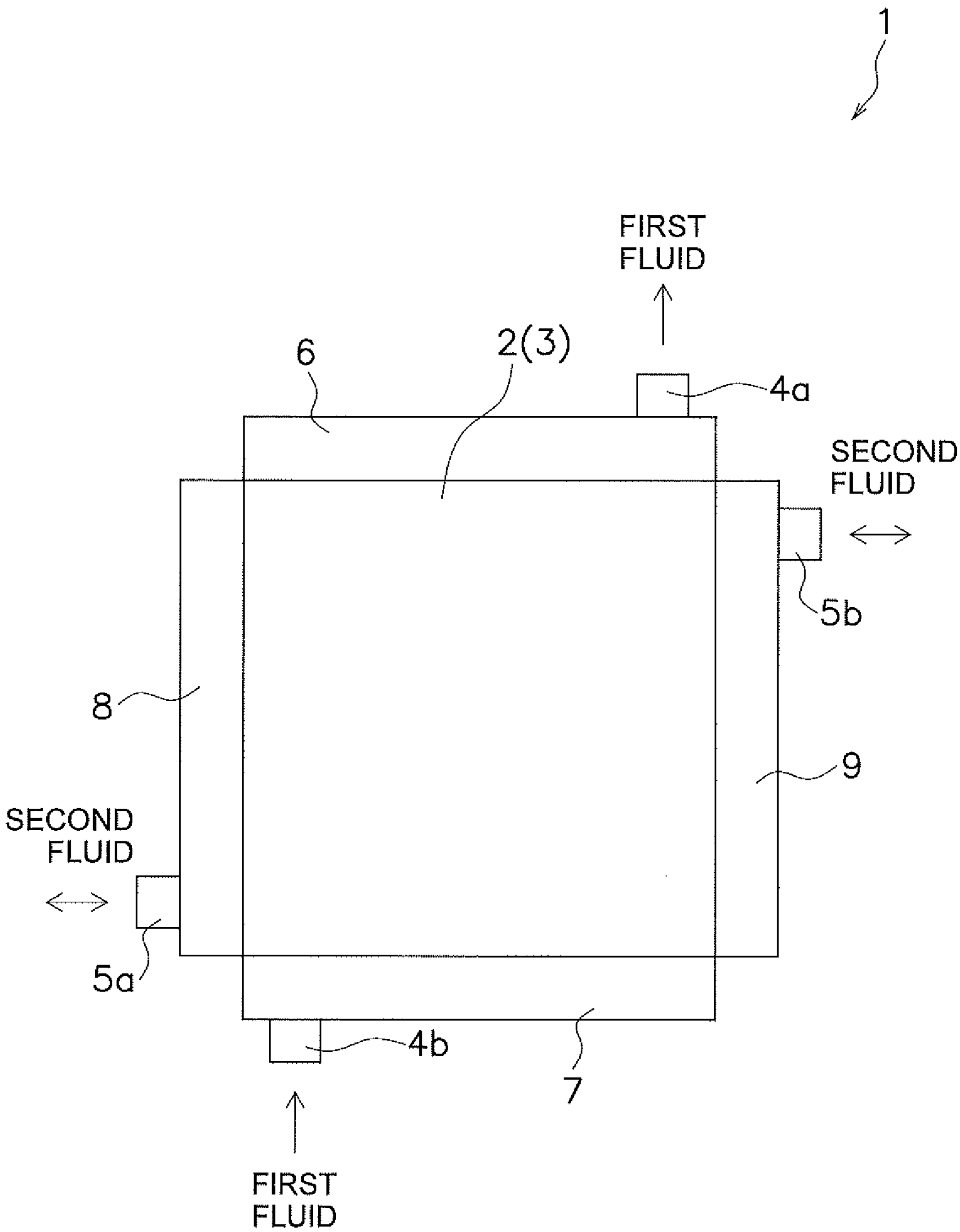
Claims

1. A water heat exchanger (1) comprising a first layer (10) and a second layer (20) that are stacked upon each other, and exchanging heat between a first fluid and a second fluid, the first layer having first flow paths (11) formed in a plurality of rows and through which water as the first fluid flows, the second layer having second flow paths (21) formed in a plurality of rows and through which a refrigerant as the second fluid flows, wherein
 when the first layer is viewed in a stacking direction of the first layer and the second layer, each first flow path extends from one end portion to another end portion of the first layer in a direction crossing a direction of arrangement of the first flow paths,

when the second layer is viewed in the stacking direction, each second flow path extends from one end portion to another end portion of the second layer in a direction crossing a direction of arrangement of the second flow paths, and
when the first layer is viewed in the stacking direction, the first flow paths have a meandering shape, and/or when the second layer is viewed in the stacking direction, the second flow paths have a meandering shape.

2. The water heat exchanger according to claim 1, wherein
when the first fluid is to be heated by the second fluid, the first flow paths are formed such that a flow-path cross-sectional area of a first-fluid outlet vicinity (11a) positioned in a vicinity of an outlet for the first fluid is larger than a flow-path cross-sectional area of an upstream-side portion (11b) disposed upstream of the first-fluid outlet vicinity.

3. The water heat exchanger according to claim 1 or claim 2, wherein
when the first fluid is to be cooled by the second fluid, the second flow paths are formed such that a flow-path cross-sectional area of a second-fluid outlet vicinity (21a) positioned in a vicinity of an outlet for the second fluid is larger than a flow-path cross-sectional area of an upstream-side portion (21b) disposed upstream of the second-fluid outlet vicinity.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FIRST
FLUID
6
2(3)
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FLUID
5b
8
9
SECOND
FLUID
5a
4b
7
FIRST
FLUID

FIG. 1

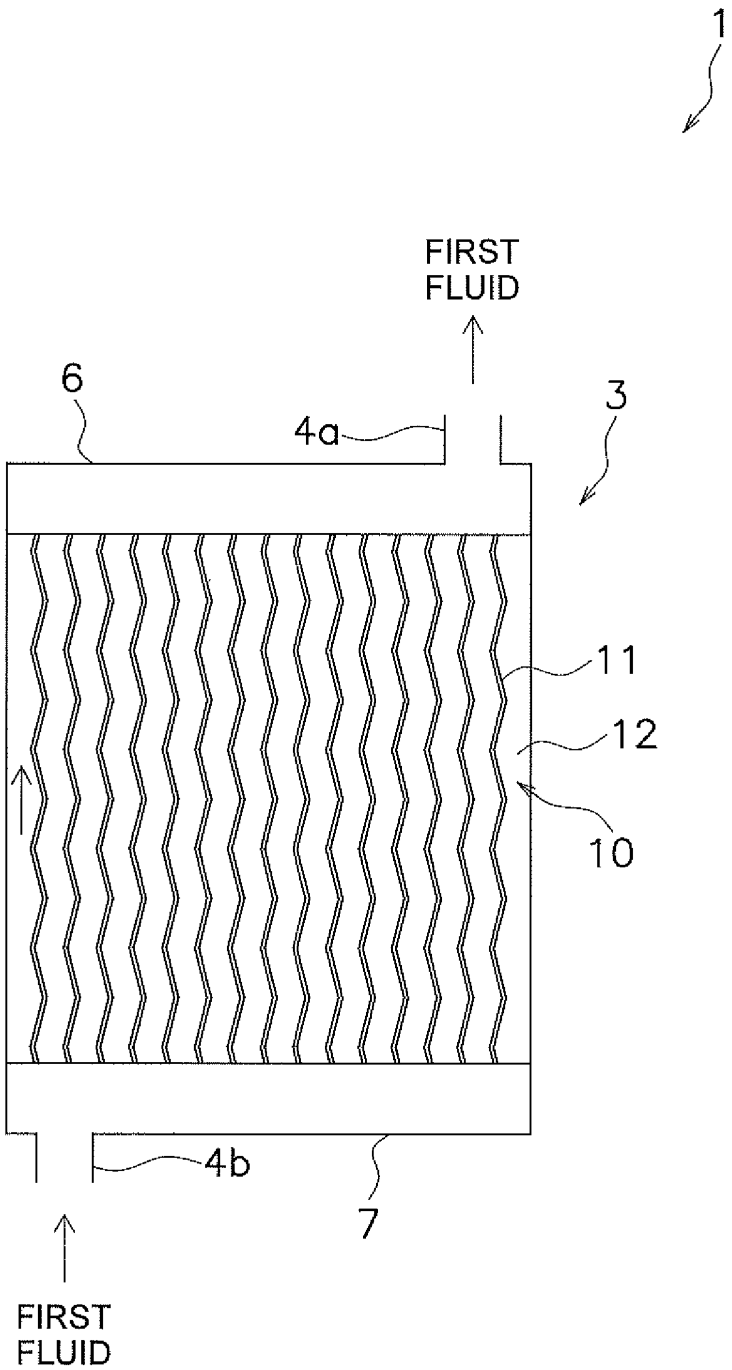
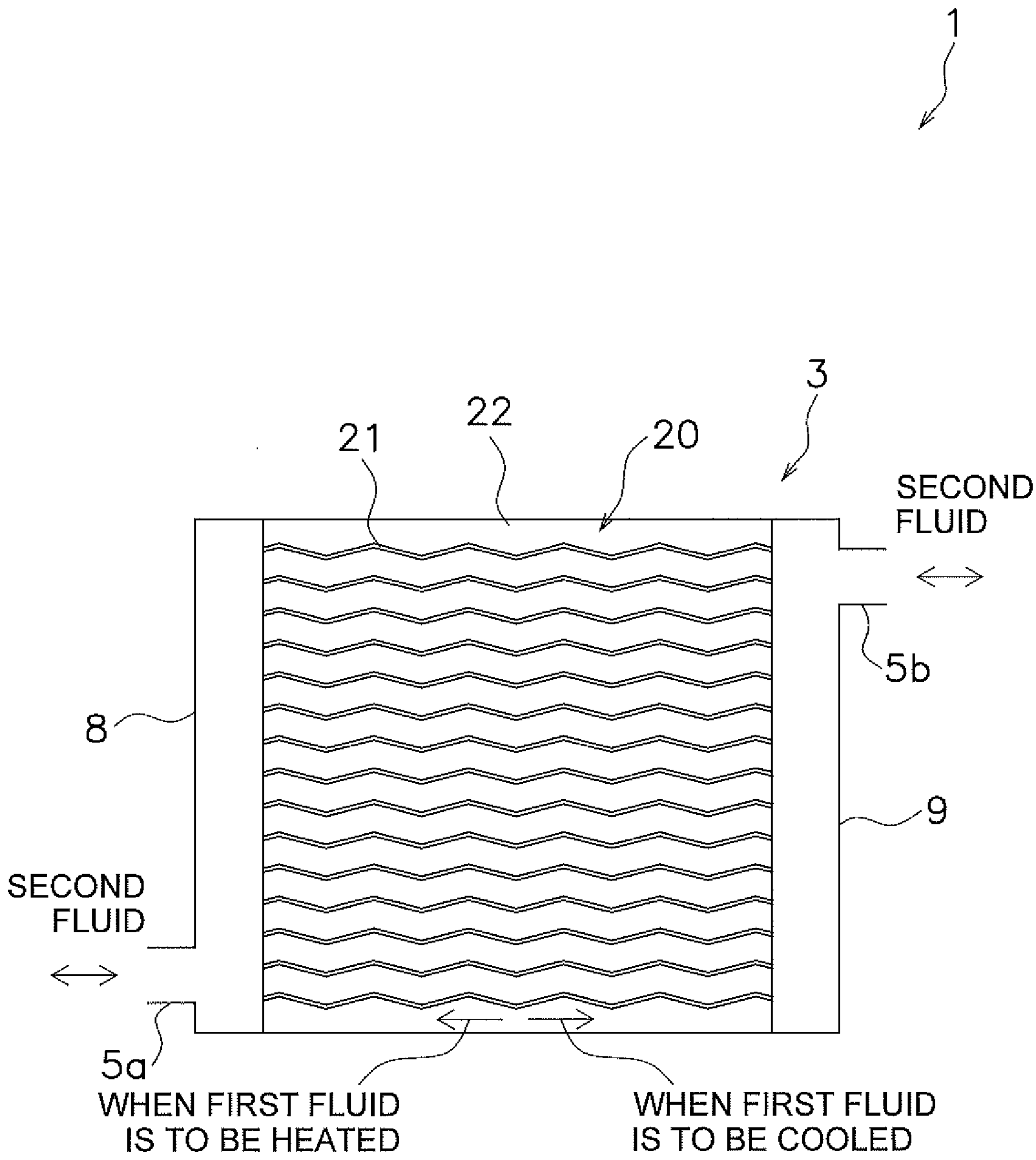


FIG. 2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3
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21
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WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 3

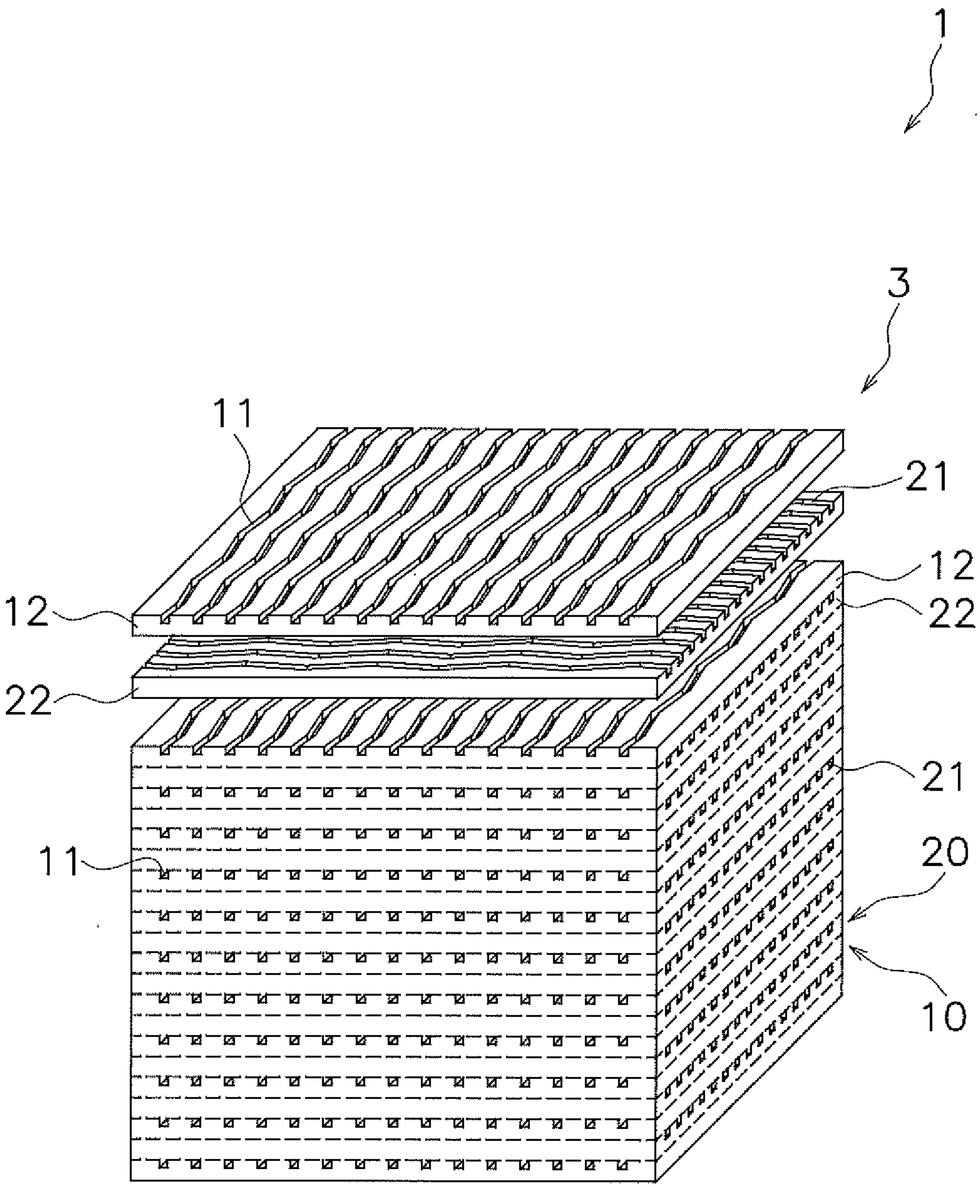


FIG. 4

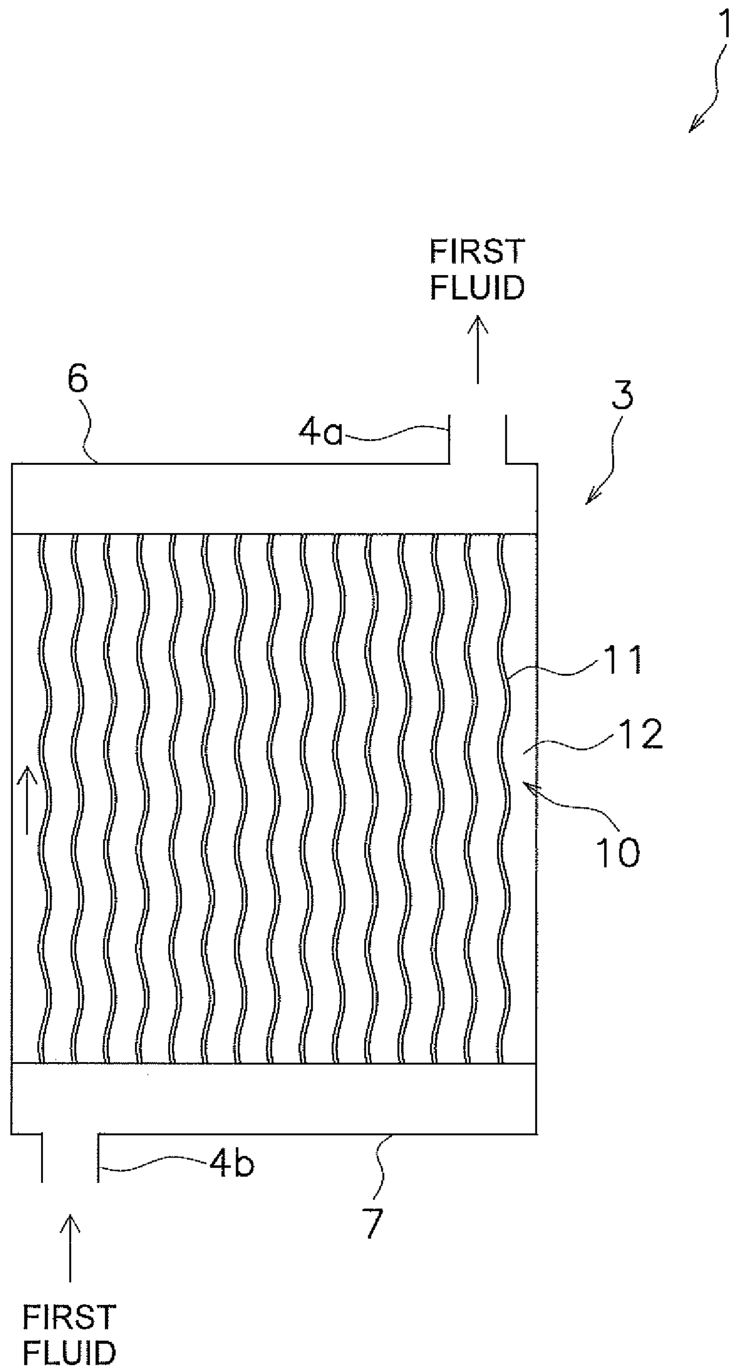
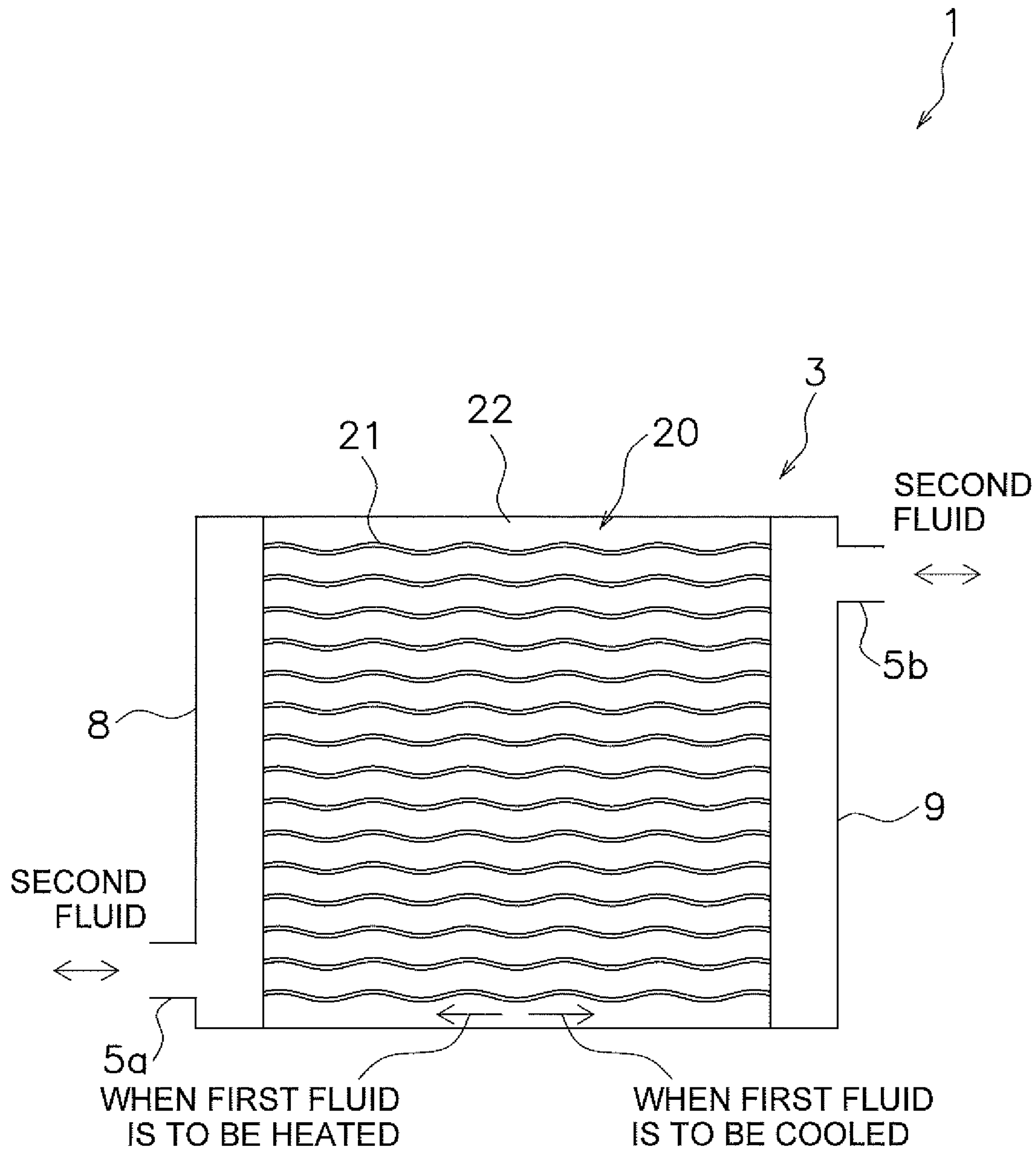


FIG. 5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5a
WHEN FIRST FLUID
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WHEN FIRST FLUID
IS TO BE COOLED

FIG. 6

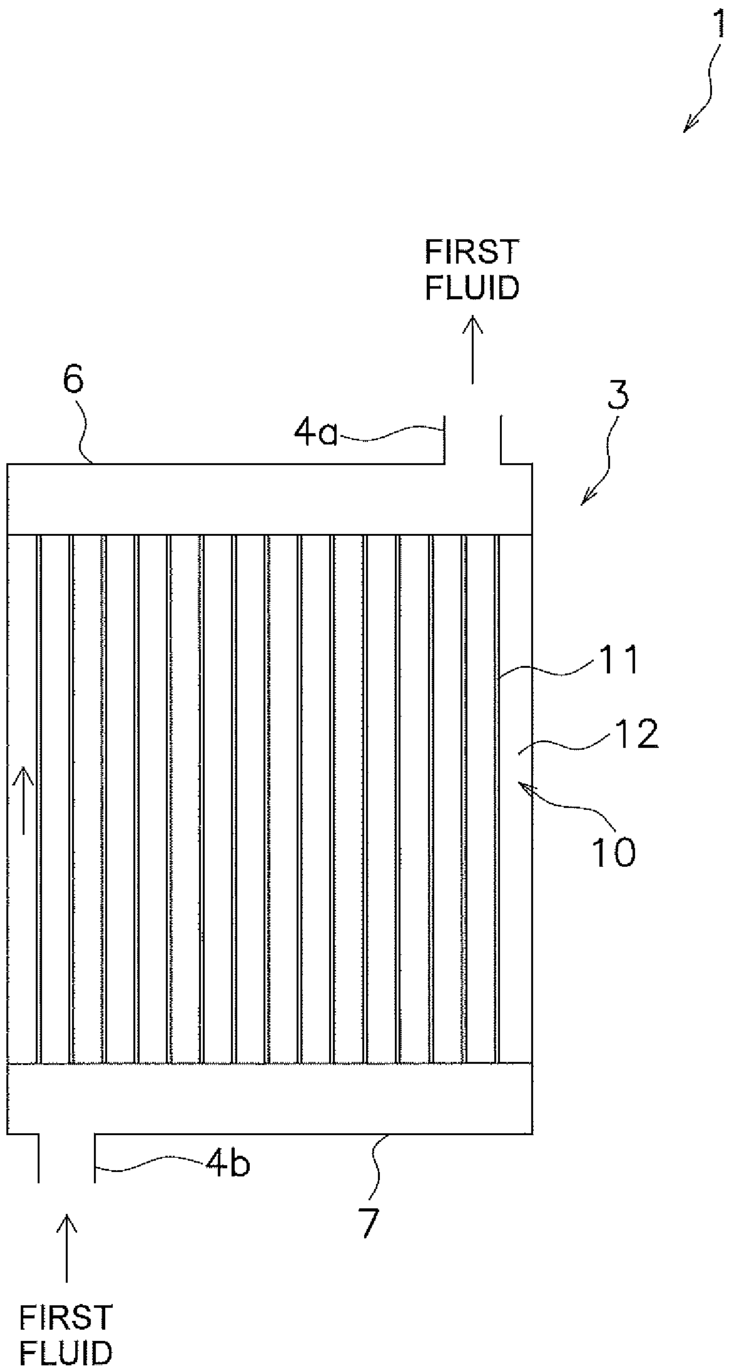
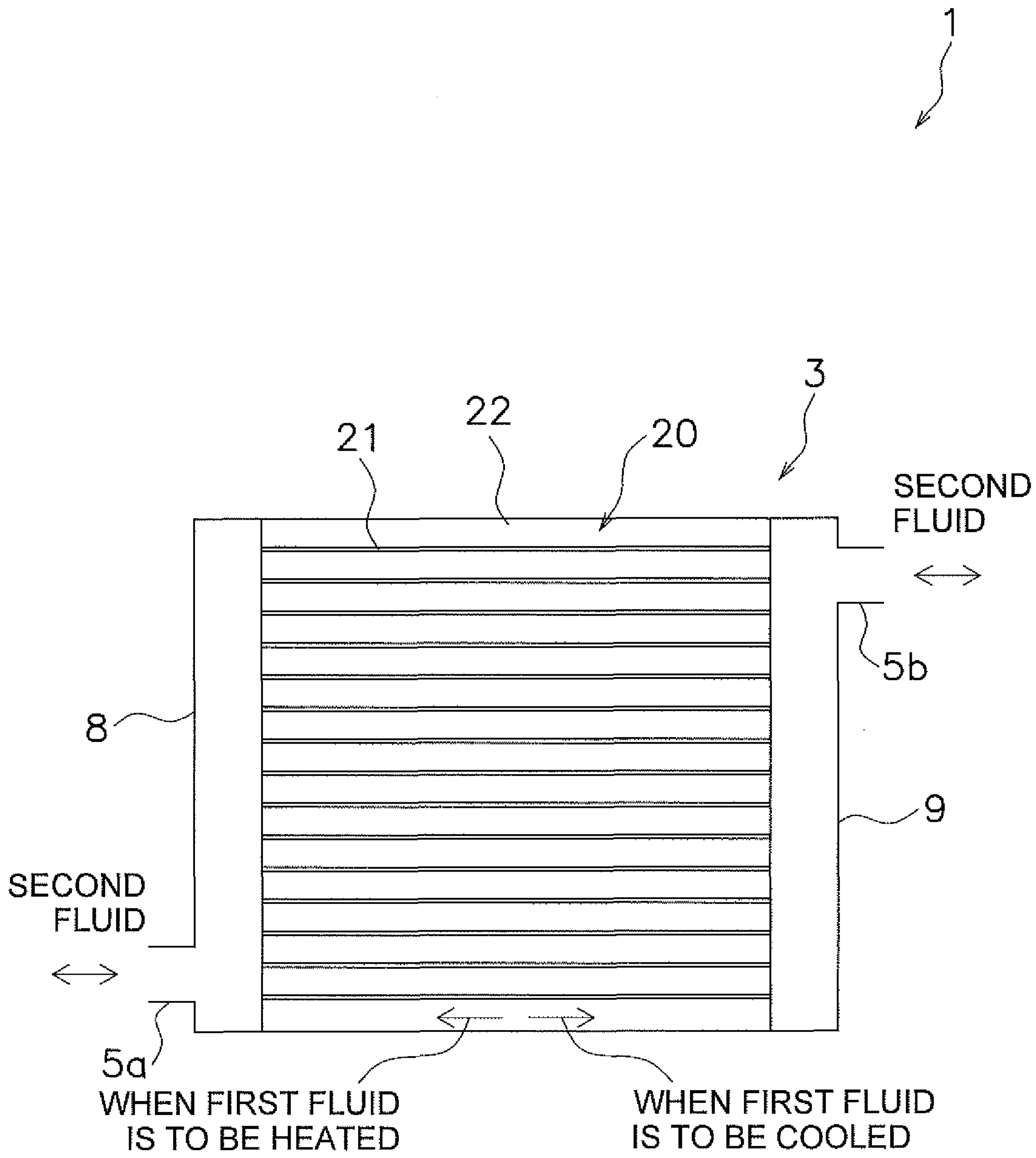


FIG. 7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20
SECOND
FLUID
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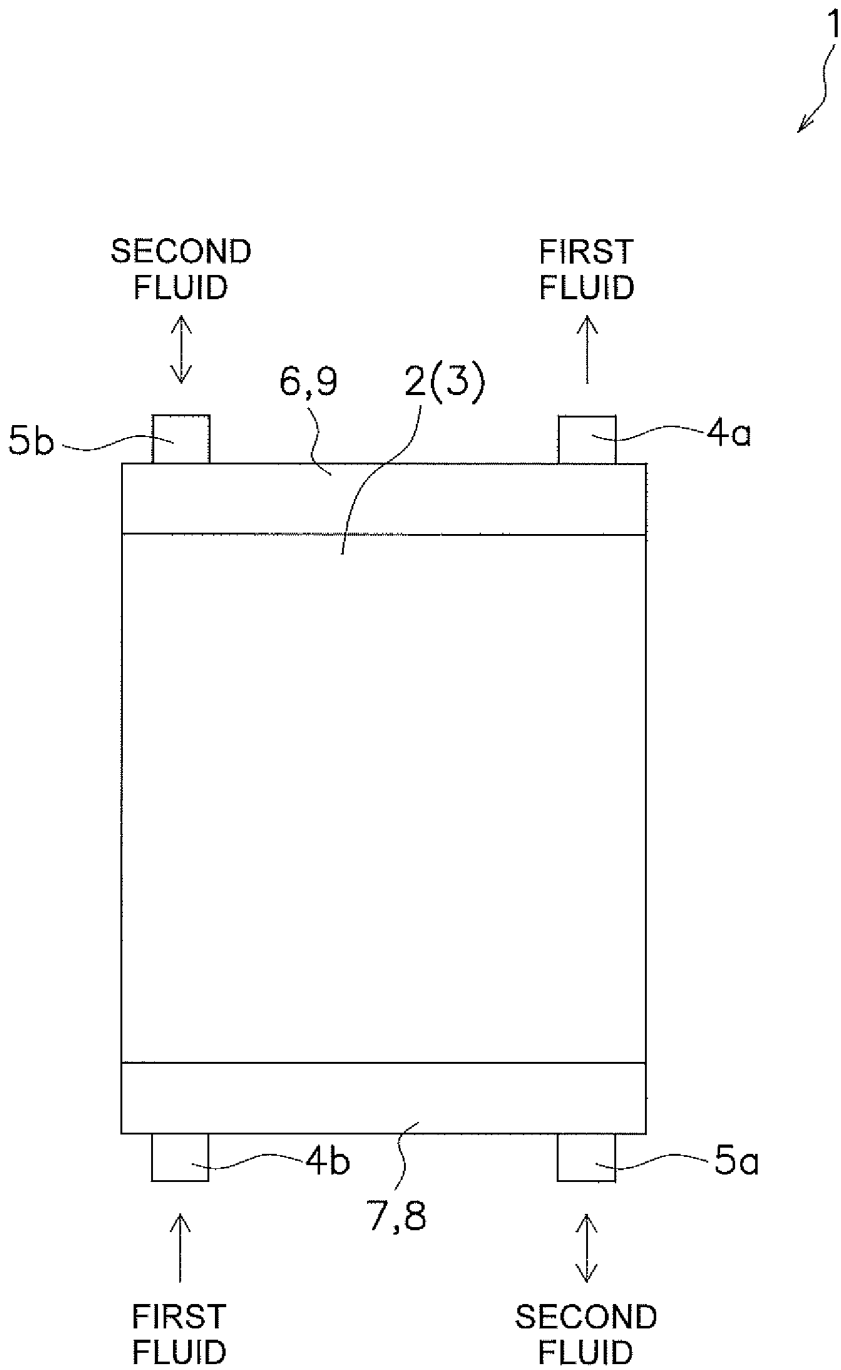
9
SECOND
FLUID
5a
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 8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6,9
2(3)
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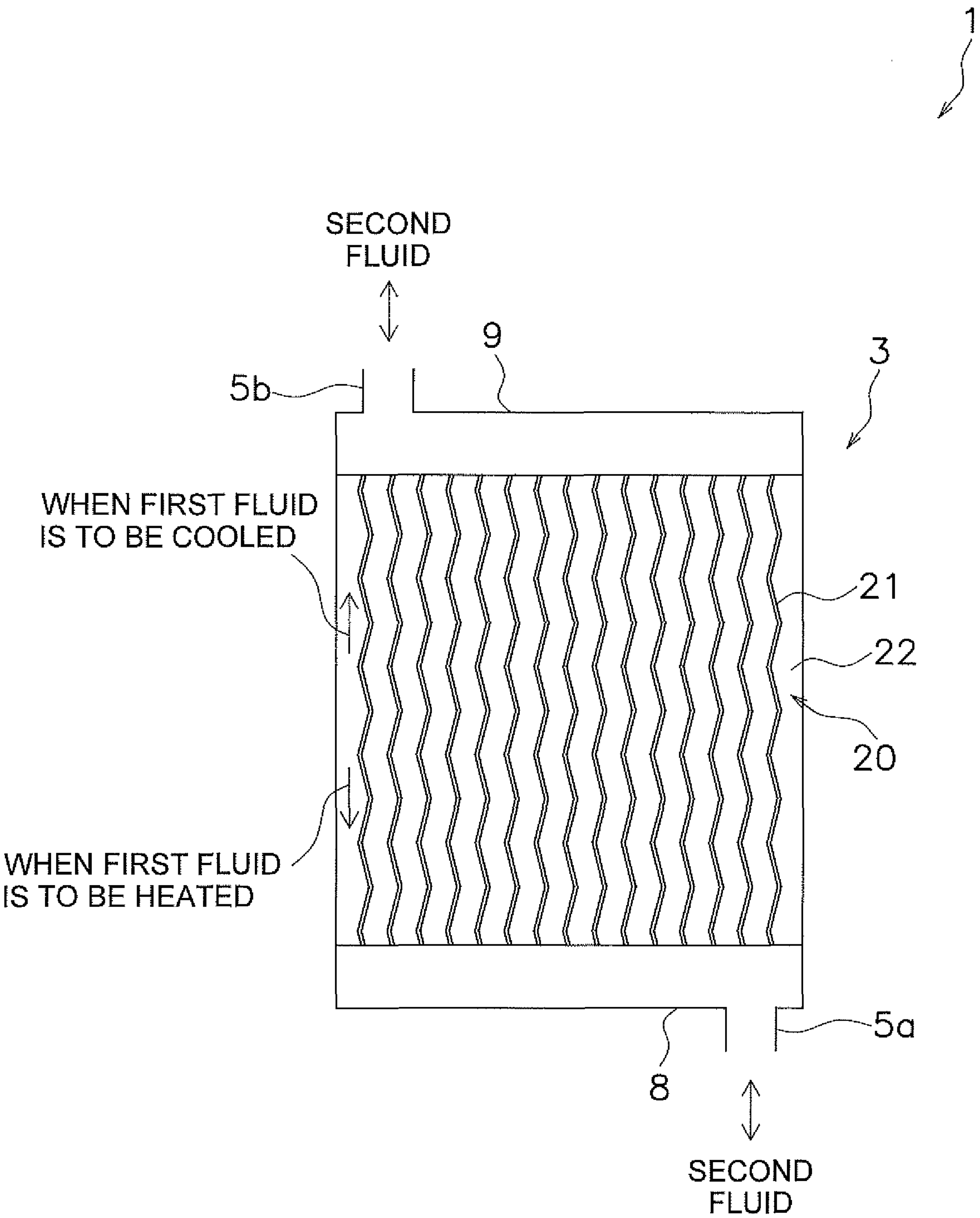
4a
4b
5a
7,8
FIRST FLUID
SECOND FLUID

FIG. 9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5b
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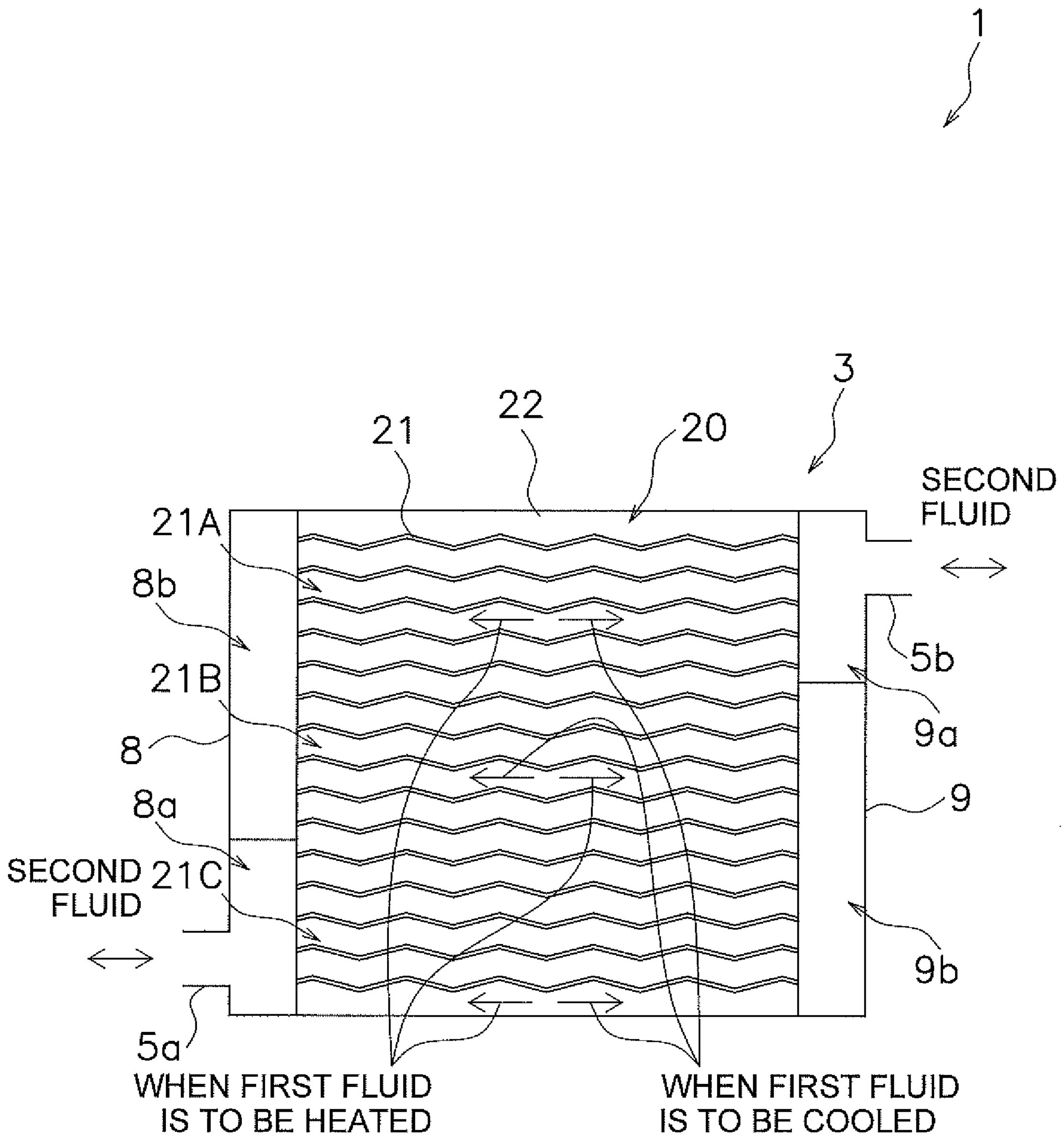
21
22
20
WHEN FIRST FLUID IS TO BE HEATED
5a
8
SECOND FLUID

FIG. 10


1
3
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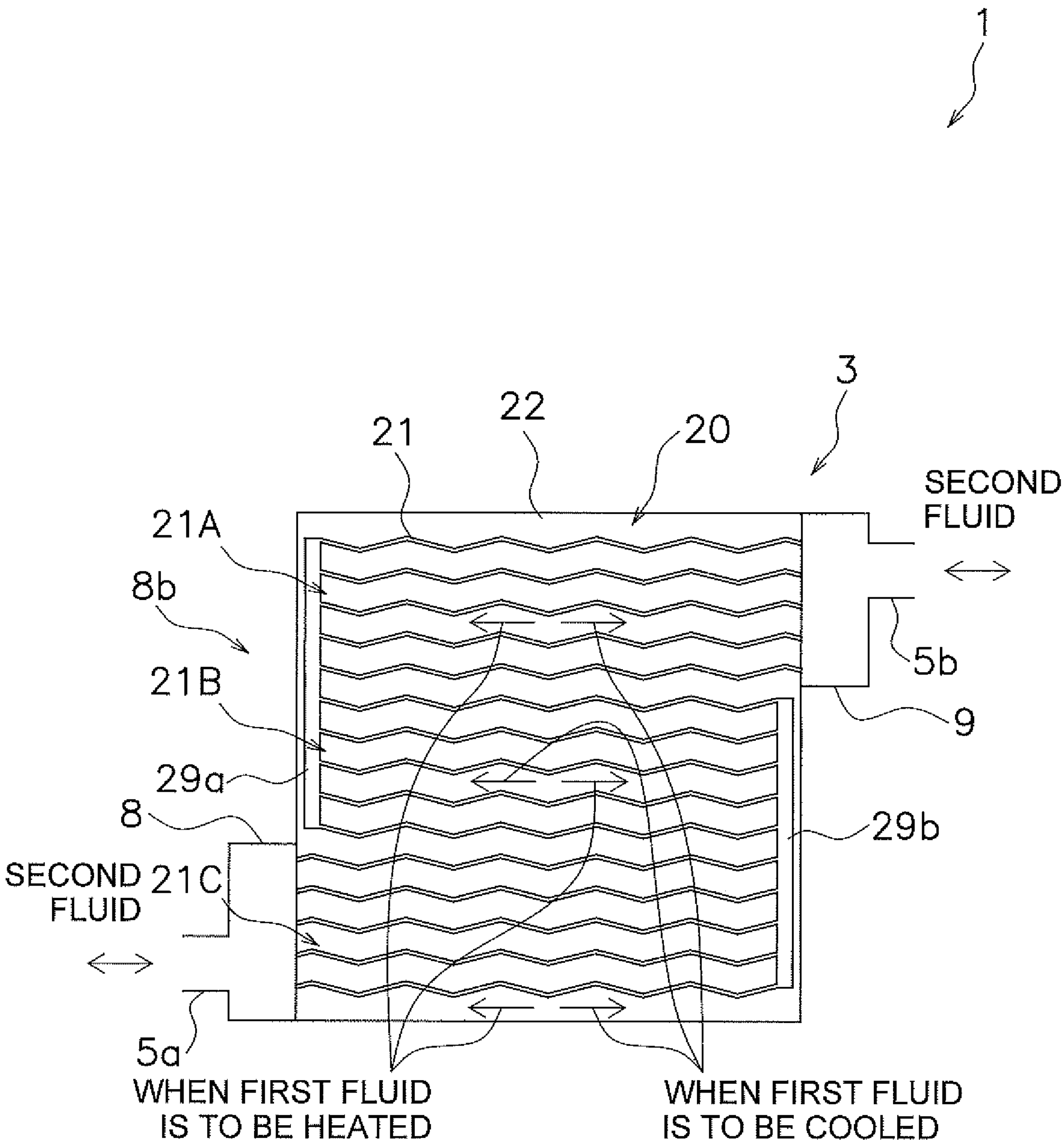
21
20
21A
8b
21B
8
8a
SECOND FLUID
21C
5a
SECOND FLUID
5b
9a
9
9b
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 11



1
3
22
21
20
21A
8b
21B
29a
8
SECOND FLUID
21C
SECOND FLUID
5b
9
29b
5a
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 12

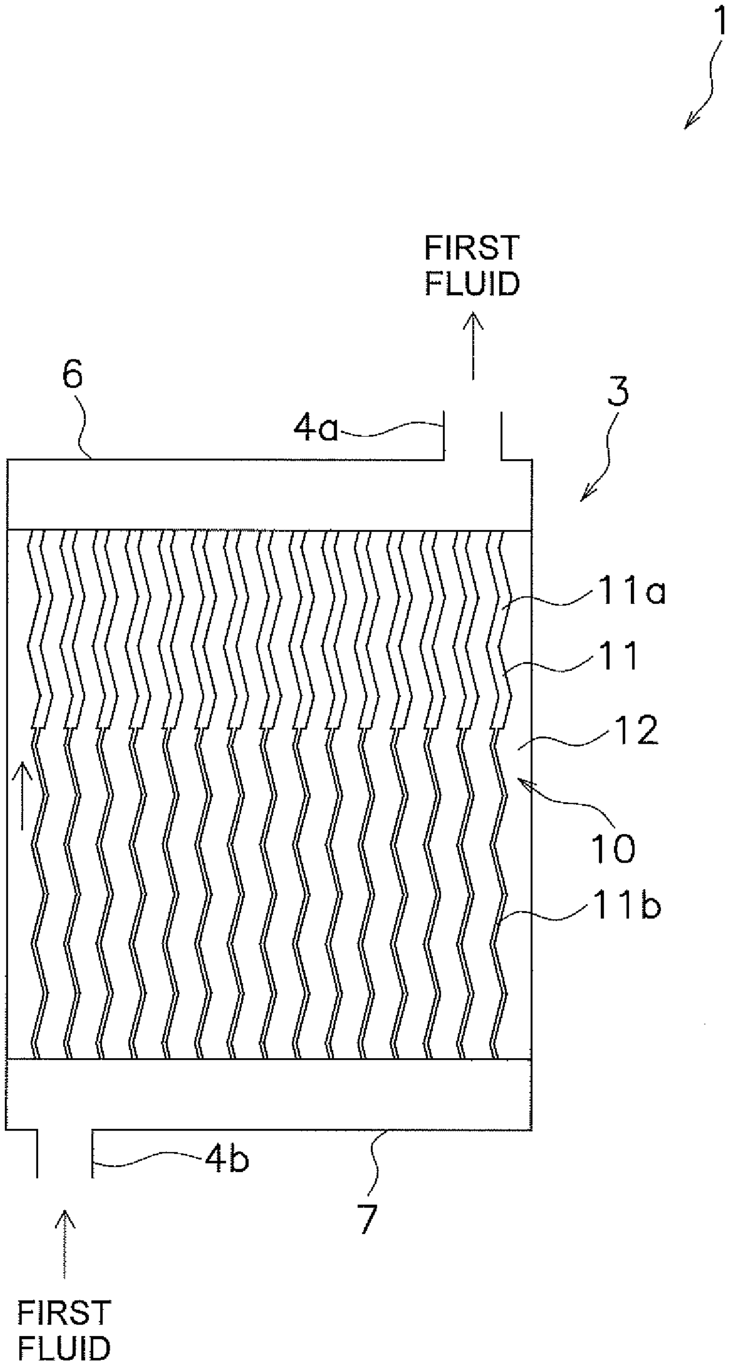


FIG. 13

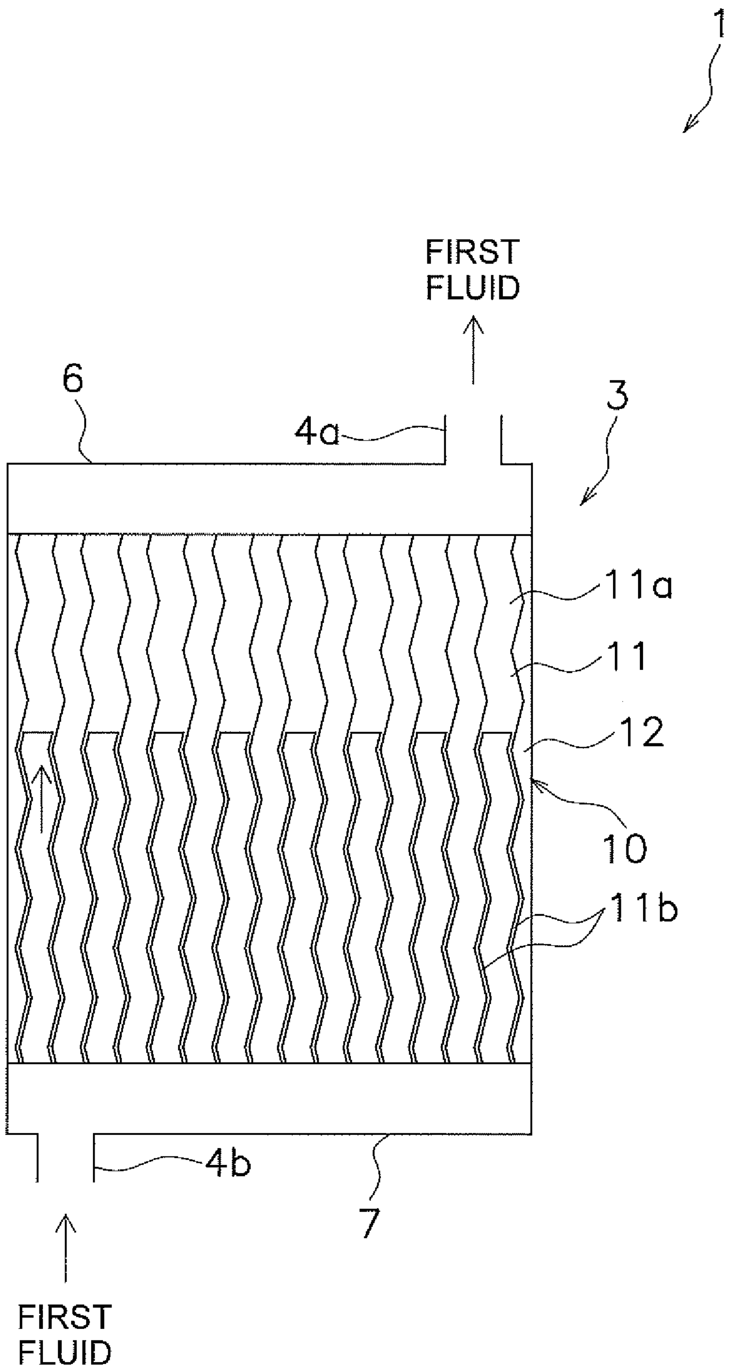
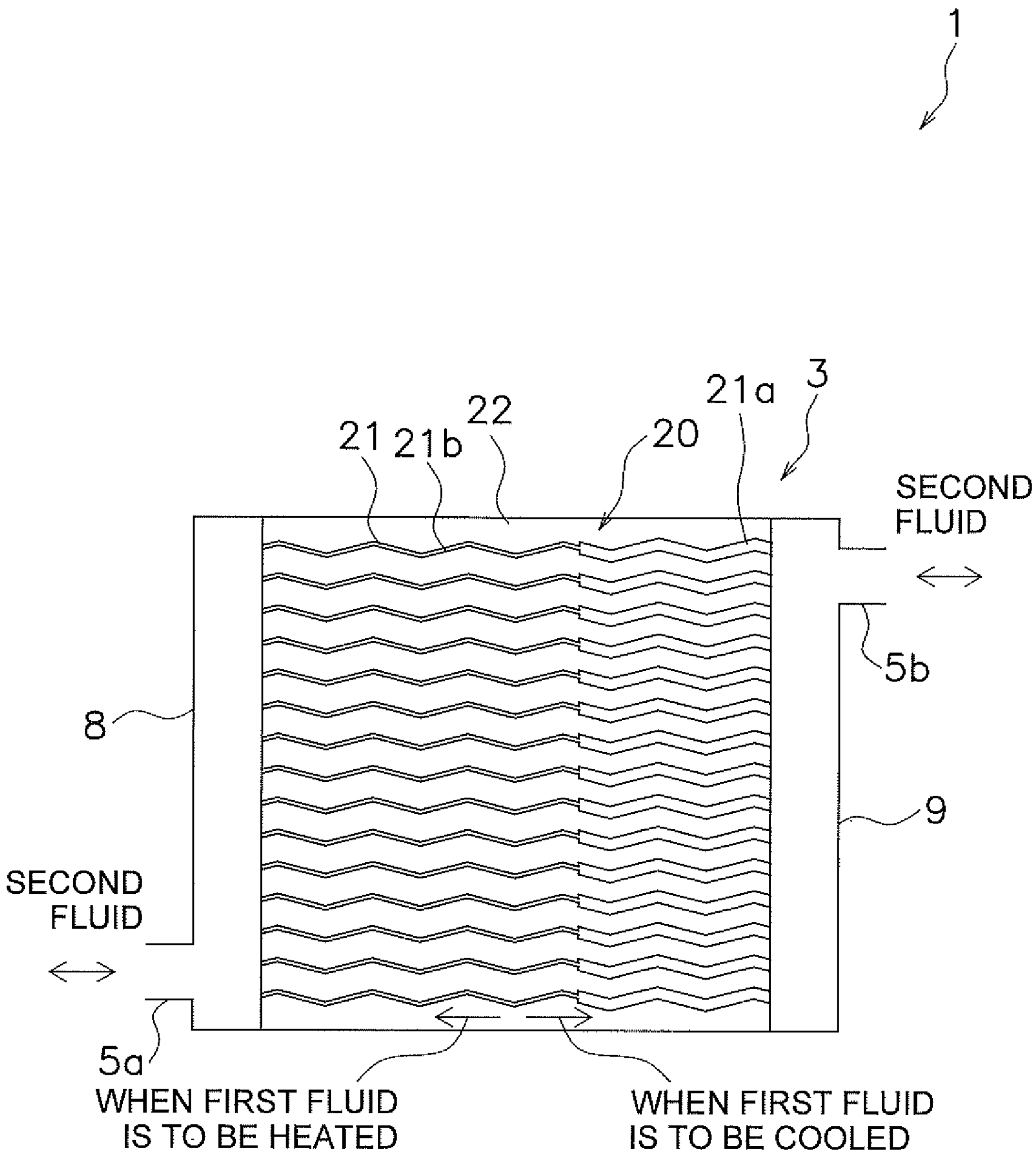


FIG. 14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21b
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20
21a
3
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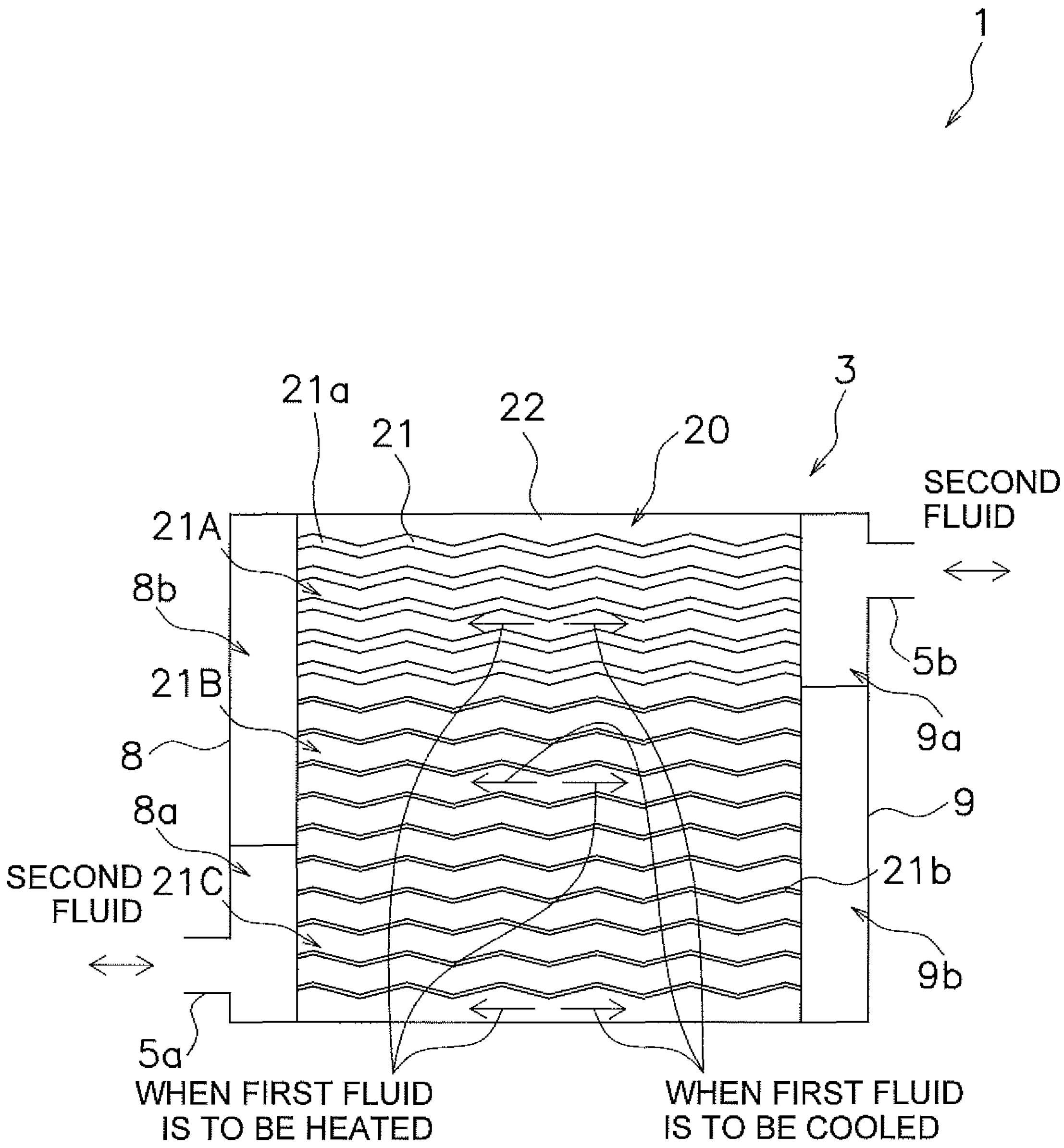
9
SECOND FLUID
5a
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 15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9a
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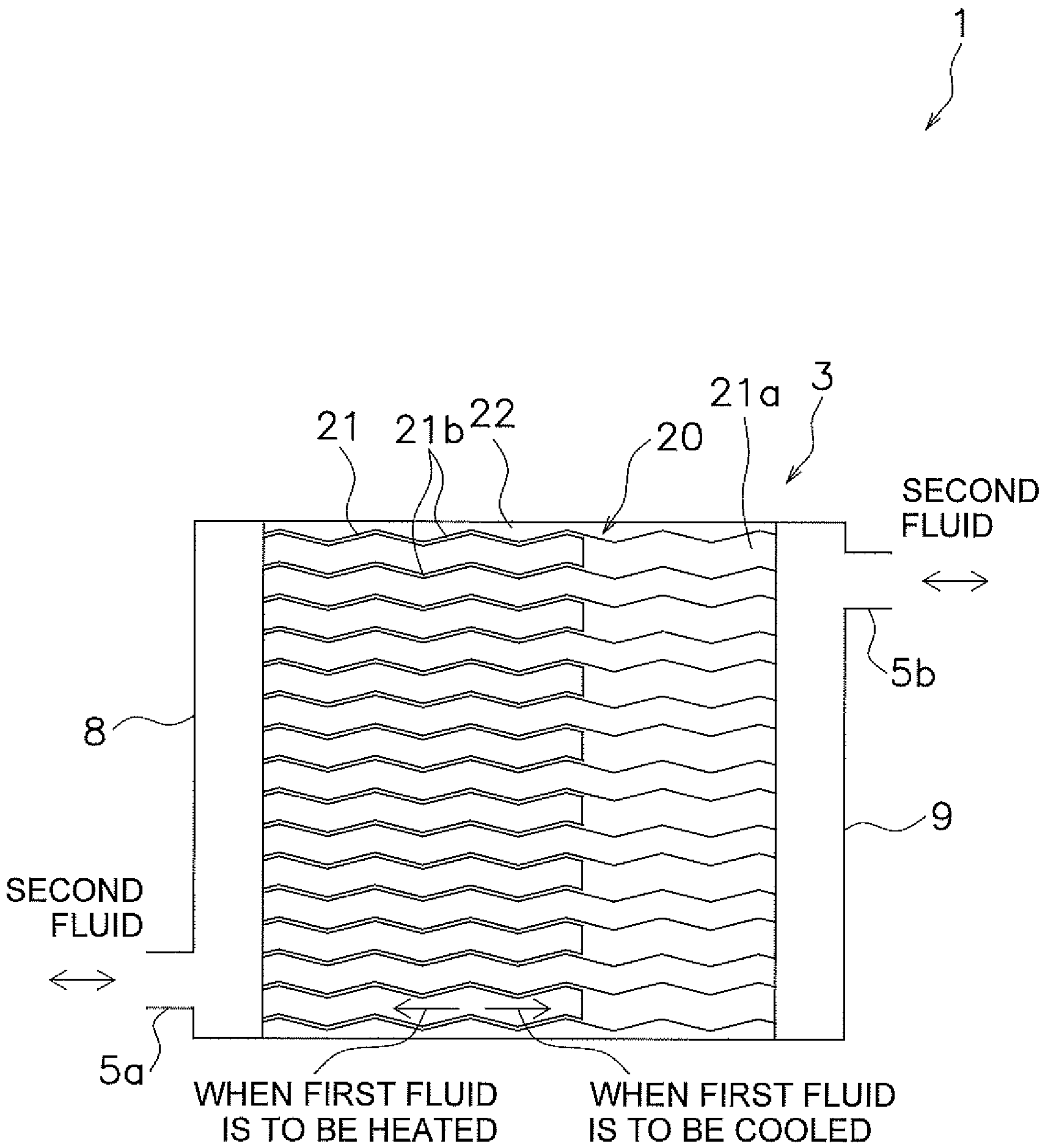
21b
9b
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 16


1
3
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21b
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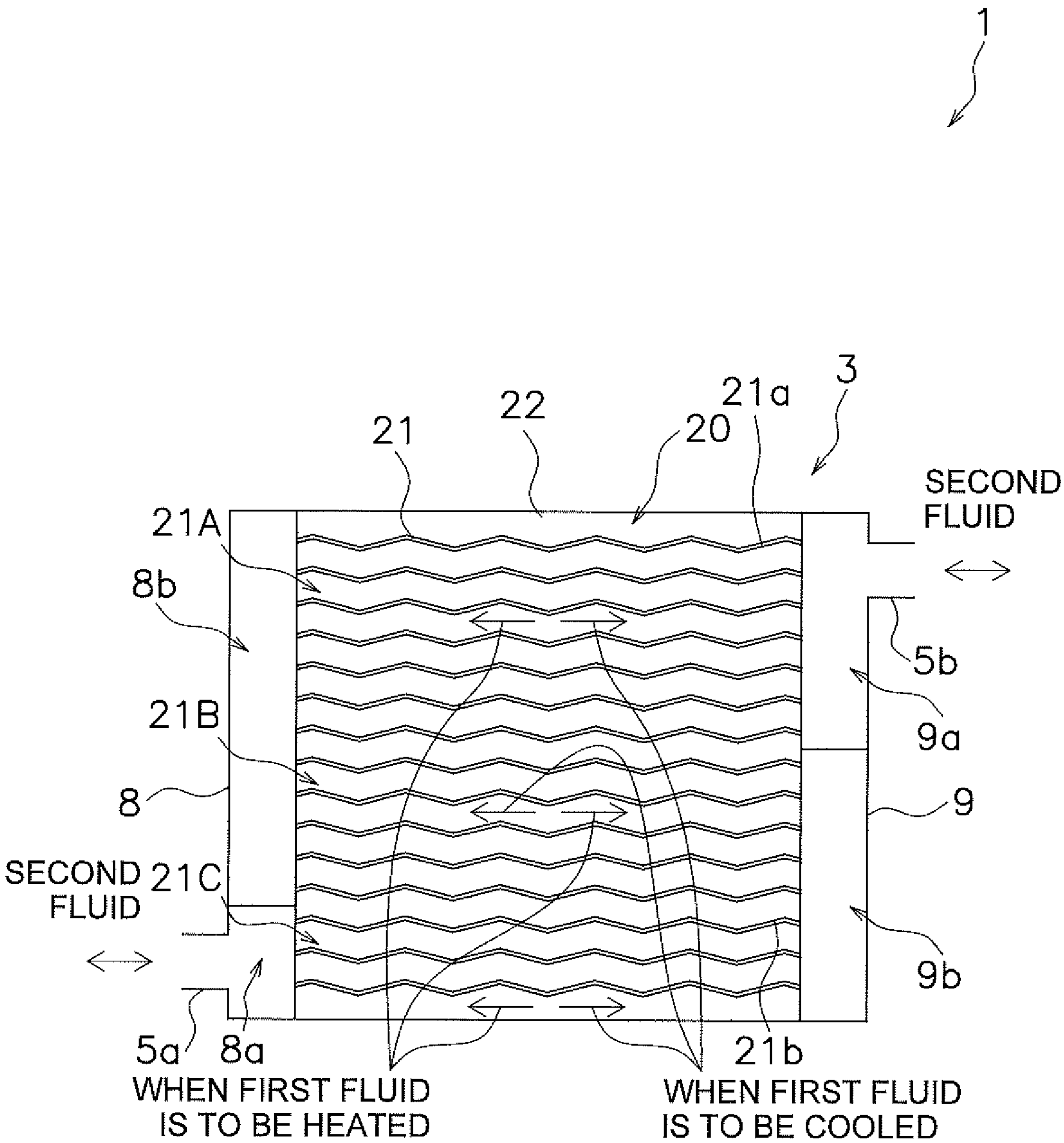
FIG. 17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21b
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/000309

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F28F3/04(2006.01)i, F28D9/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F28F3/04, F28D9/00-9/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 62-37687 A (HEATRIC PTY LTD.) 18 February 1987, page 4, lower left column, line 3 to lower right column, line 15, fig. 1-3 & EP 212878 A1, page 8, line 20 to page 9, line 24, fig. 1-3	1 2-3
X Y	JP 2008-128574 A (TOSHIBA CORP.) 05 June 2008, paragraphs [0048]-[0052], fig. 1-5 & US 2010/0051248 A1 paragraphs [0106]-[0110], fig. 1-5 & WO 2008/062802 A1 & EP 2110635 A1	1 2-3
X Y	JP 2010-286229 A (AGENCY FOR DEFENSE DEVELOPMENT, ADD) 24 December 2010, paragraphs [0010]-[0015], fig. 1-4 & US 2010/0314088 A1 paragraphs [0028]-[0037], fig. 1-4 & KR 10-0938802 B1	1 2-3
Y	JP 2004-116943 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 15 April 2004, paragraphs [0041]-[0044], fig. 3 (Family: none)	2-3
Y	JP 53-129701 A (TOKYO SHIBAURA ELECTRIC CO., LTD.) 13 November 1978, page 1, lower left column, line 10 to page 2, upper left column, line 11, fig. 1 (Family: none)	3

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

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 March 2018 (09.03.2018)	20 March 2018 (20.03.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2010117102 A **[0002] [0049]**