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(54) WATER HEAT EXCHANGER

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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 JP 2010-117102 A, 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.

[0003] A low-cost parallel plate-type heat exchanger according to the preamble of claim 1 for recovery or dissipation of heat energy in buildings as well as for heat recovery in chemical processes, electrical power and other industries is known from US 4 744414 A, wherein a series of plastic separator plates alternating with plastic film as the heat transfer surface are stacked between a pair of end plates, and the separator plates and film are locked together to form a closed pack.

[0004] A small-sized inexpensive heat exchanger with a plurality of plates sandwiched between a pair of end plates is known from EP 1 136782 A1, wherein each of the plurality of plates has two passageways defined therein that are not in fluid communication with each other or some of the plates have one passageway, while some of the remaining plates have another passageway. Because the countercurrent flows are superior in heat transfer efficiency, it is possible to enhance the performance and reduce the size of the plate heat exchangers.

[0005] A heat exchanger capable of generating steam stably in various operation ranges as well as solving flow instabilities in flow channels is known from US 2016 0282064 A1, which includes a plate with channels having a bent or curved flow path in a primary heat transmission section and a reduced width in a flow resistance section to extend longer than a distance between an inlet and an outlet.

SUMMARY OF THE INVENTION

[0006] 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.

[0007] 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.

[0008] 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.

[0009] A water heat exchanger according to the invention comprises the features of claim 1.

[0010] 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.

[0011] Further, 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.

[0012] Further, 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

[0013]

Figs. 1-13, 15, 16 and 18 show different configurations relevant to the invention, but that do not necessarily form part of the invention as defined in claim 1 because the paths shown therein are not clearly disclosed as being merged as claim 1 requires. It is to be understood that for the configurations disclosed in these figures to be considered as forming part of the invention, at least one of the paths for the first or second fluids must be merged as claim 1 defines.

Fig. 14 shows the first flow paths of the water heat exchanger according to an embodiment of the present invention (and relates to Fig. 2).

Fig. 17 shows the second flow paths of the water heat exchanger according to an embodiment of the present invention (and relates to Fig. 3).

DESCRIPTION OF EMBODIMENTS

[0014] 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 neither defined by nor limited to those of the embodiment and the scope of protection is only defined by the wording of the claims.

(1) Configurations and Characteristics

[0015] Figs. 1 to 4 each show a water heat exchanger 1.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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

[0024] 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.

[0025] 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.

[0026] This configuration of the present modification can also provide operational effects similar to those of the above-described configuration.

(3) Modification 2

[0027] Although, in the water heat exchangers 1 of the above-described configuration 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.

[0028] 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.

[0029] This configuration of the present modification can also provide operational effects similar to those of the above-described Modification 1.

(4) Modification 3

[0030] Although, in the water heat exchangers 1 of the above-described 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.

[0031] 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.

[0032] This configuration of the present modification can also provide operational effects similar to those of the above-described Modifications 1 and 2.

(5) Modification 4

[0033] Although, in the water heat exchangers 1 of the above-described 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.

[0034] 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.

[0035] 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.

[0036] This configuration of the present modification can also provide operational effects similar to those of the above-described Modifications 1 and 2.

(6) Modification 5

[0037] In the water heat exchangers 1 of the above-described 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.

[0038] 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).

[0039] Unlike the configuration of each first flow path 11 shown in Fig. 13, the first flow paths 11 may be merged as defined in claim 1 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.

[0040] 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

[0041] 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.

[0042] 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).

[0043] 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.

[0044] Unlike the configuration of each second flow path 21 shown in Fig. 15, the second flow paths 21 may be merged as defined in claim 1 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.

[0045] 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.

[0046] 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.

[0047] 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

[0048] 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

[0049]

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

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,

characterized in that,

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,

wherein the first flow paths (11) are 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), and/or,

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,

wherein the second flow paths (21) are 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).

Patentansprüche

1. Wasserwärmetauscher (1), umfassend eine erste Schicht (10) und eine zweite Schicht (20), die übereinander gestapelt sind und Wärme zwischen einem ersten Fluid und einem zweiten Fluid austauschen, wobei die erste Schicht erste Fließwege (11) aufweist, die in einer Vielzahl von Reihen geformt sind und durch die Wasser als das erste Fluid fließt, und die zweite Schicht zweite Fließwege (21) aufweist, die in einer Vielzahl von Reihen geformt sind und durch die Wasser als das zweite Fluid fließt, wobei

wenn die erste Schicht in einer Stapelrichtung der ersten Schicht und der zweiten Schicht be-

trachtet wird, sich jeder erster Fließweg von einem Endabschnitt zu einem anderen Endabschnitt der ersten Schicht in eine Richtung erstreckt, die eine Anordnungsrichtung der ersten Fließwege schneidet,
wenn die zweite Schicht in der Stapelrichtung betrachtet wird, sich jeder zweiter Fließweg von einem Endabschnitt zu einem anderen Endabschnitt der zweiten Schicht in eine Richtung erstreckt, die eine Anordnungsrichtung erstreckt der zweiten Fließwege schneidet, und
wenn die erste Schicht in der Stapelrichtung betrachtet wird, die ersten Fließwege eine Meanderform aufweisen, und/oder
wenn die zweite Schicht in der Stapelrichtung betrachtet wird, die zweiten Fließwege eine Meanderform aufweisen,
dadurch gekennzeichnet, dass,
wenn das erste Fluid von dem zweiten Fluid erwärmt werden soll, die ersten Fließwege so geformt sind, dass eine Fließwegquerschnittsfläche einer Auslassumgebung (11a) des ersten Fluids, die in einer Nähe eines Auslasses des ersten Fluids positioniert ist, größer ist als eine Fließwegquerschnittsfläche eines stromaufwärtsseitigen Abschnitts (11b), der stromaufwärts von der Auslassumgebung des ersten Fluids angeordnet ist,
wobei die ersten Fließwege (11) so zusammengefasst sind, dass die Anzahl der Fließwege an den Auslassumgebungen (11a) des ersten Fluids geringer ist als die Anzahl von Fließwegen an den stromaufwärtsseitigen Abschnitten, die stromaufwärts von den Auslassumgebungen (11a) des ersten Fluids angeordnet sind, und/oder,
wenn das erste Fluid von dem zweiten Fluid abgekühlt werden soll, die zweiten Fließwege so geformt sind, dass eine Fließwegquerschnittsfläche einer Auslassumgebung (21a) des zweiten Fluids, die in einer Nähe eines Auslasses des zweiten Fluids positioniert ist, größer ist als eine Fließwegquerschnittsfläche eines stromaufwärtsseitigen Abschnitts (21b), der stromaufwärts von der Auslassumgebung des zweiten Fluids angeordnet ist,
wobei die zweiten Fließwege (21) so zusammengefasst sind, dass die Anzahl der Fließwege an den Auslassumgebungen (21a) des zweiten Fluids geringer ist als die Anzahl von Fließwegen an den stromaufwärtsseitigen Abschnitten, die stromaufwärts von den Auslassumgebungen (21a) des zweiten Fluids angeordnet sind.

Revendications

1. Échangeur de chaleur d'eau (1) comprenant une première couche (10) et une seconde couche (20) qui sont empilées l'une sur l'autre, et échangeant de la chaleur entre un premier fluide et un second fluide, la première couche présentant des premières voies d'écoulement (11) formées dans une pluralité de rangées et à travers lesquelles s'écoule de l'eau en tant que le premier fluide, la seconde couche présentant des secondes voies d'écoulement (21) formées dans une pluralité de rangées et à travers lesquelles s'écoule un réfrigérant en tant que le second fluide, dans lequel

    lorsque la première couche est vue dans une direction d'empilement de la première couche et de la seconde couche, chaque première voie d'écoulement s'étend depuis une portion d'extrémité jusqu'à une autre portion d'extrémité de la première couche dans une direction croisant une direction d'agencement des premières voies d'écoulement,
    lorsque la seconde couche est vue dans la direction d'empilement, chaque seconde voie d'écoulement s'étend depuis une portion d'extrémité jusqu'à une autre portion d'extrémité de la seconde couche dans une direction croisant une direction d'agencement des secondes voies d'écoulement, et
    lorsque la première couche est vue dans la direction d'empilement, les premières voies d'écoulement présentent une forme sinueuse, et/ou
    lorsque la seconde couche est vue dans la direction d'empilement, les secondes voies d'écoulement présentent une forme sinueuse,
    caractérisé en ce que
    lorsque le premier fluide doit être chauffé par le second fluide, les premières voies d'écoulement sont formées de sorte qu'une aire en coupe transversale de voie d'écoulement d'une proximité de sortie de premier fluide (11a) positionnée à une proximité d'une sortie du premier fluide soit plus grande qu'une aire en coupe transversale de voie d'écoulement d'une portion de côté en amont (11b) disposée en amont de la proximité de sortie de premier fluide,
    dans lequel les premières voies d'écoulement (11) sont fusionnées de sorte que le nombre de voies d'écoulement au niveau des proximités de sortie de premier fluide (11a) soit inférieur au nombre de voies d'écoulement au niveau des portions de côté en amont disposées en amont des proximités de sortie de premier fluide (11a), et/ou
    lorsque le premier fluide doit être refroidi par le second fluide, les secondes voies d'écoulement

sont formées de sorte qu'une aire en coupe transversale de voie d'écoulement d'une proximité de sortie de second fluide (21a) positionnée à une proximité d'une sortie du second fluide soit plus grande qu'une aire en coupe transversale de voie d'écoulement d'une portion de côté en amont (21b) disposée en amont de la proximité de sortie de second fluide,

dans lequel les secondes voies d'écoulement (21) sont fusionnées de sorte que le nombre de voies d'écoulement aux proximités de sortie de second fluide (21a) soit inférieur au nombre de voies d'écoulement aux portions de côté en amont disposées en amont des proximités de sortie de second fluide (21a).

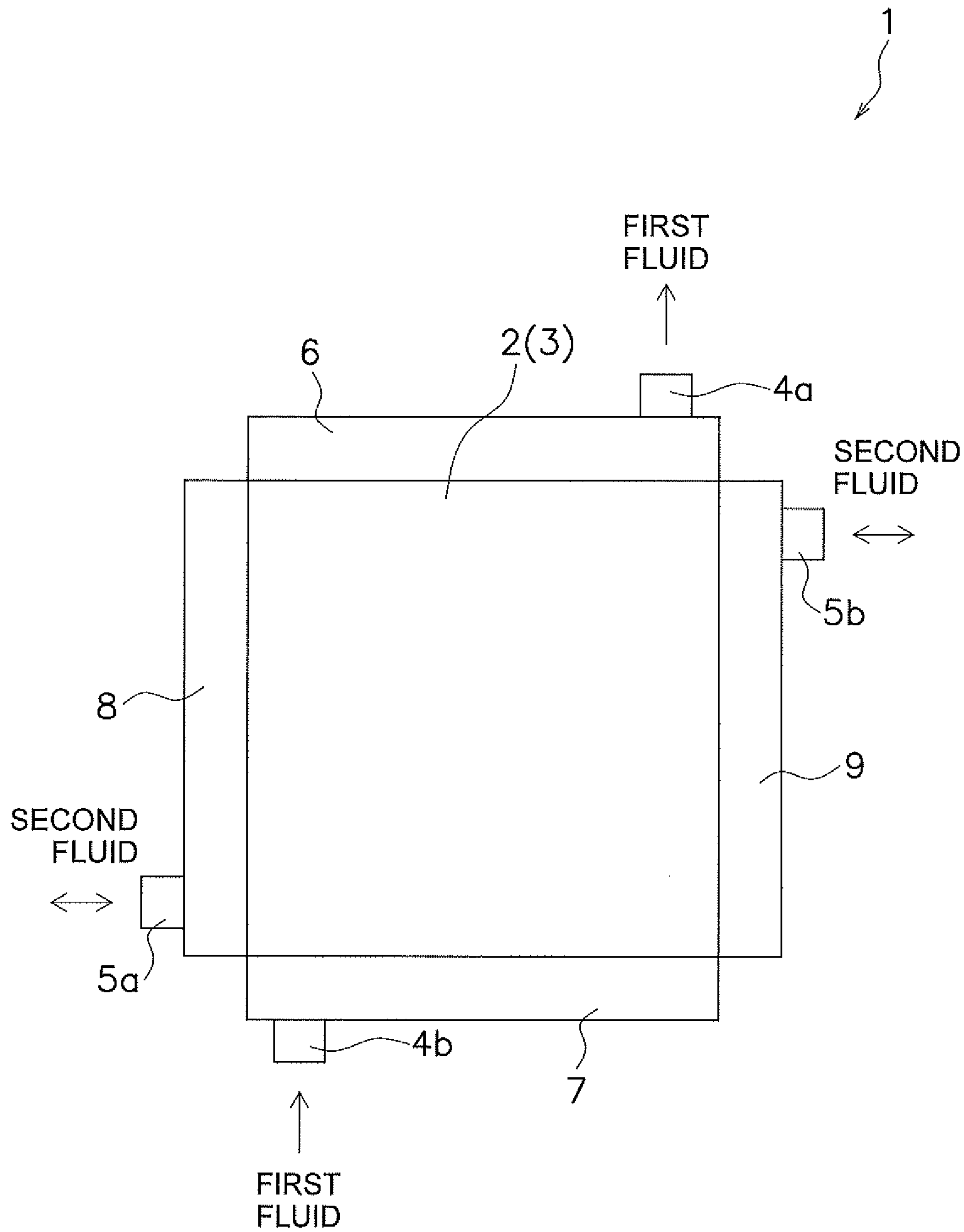

1
FIRST
FLUID
6
2(3)
4a
SECOND
FLUID
5b
8
9
SECOND
FLUID
5a
4b
7
FIRST
FLUID

FIG. 1

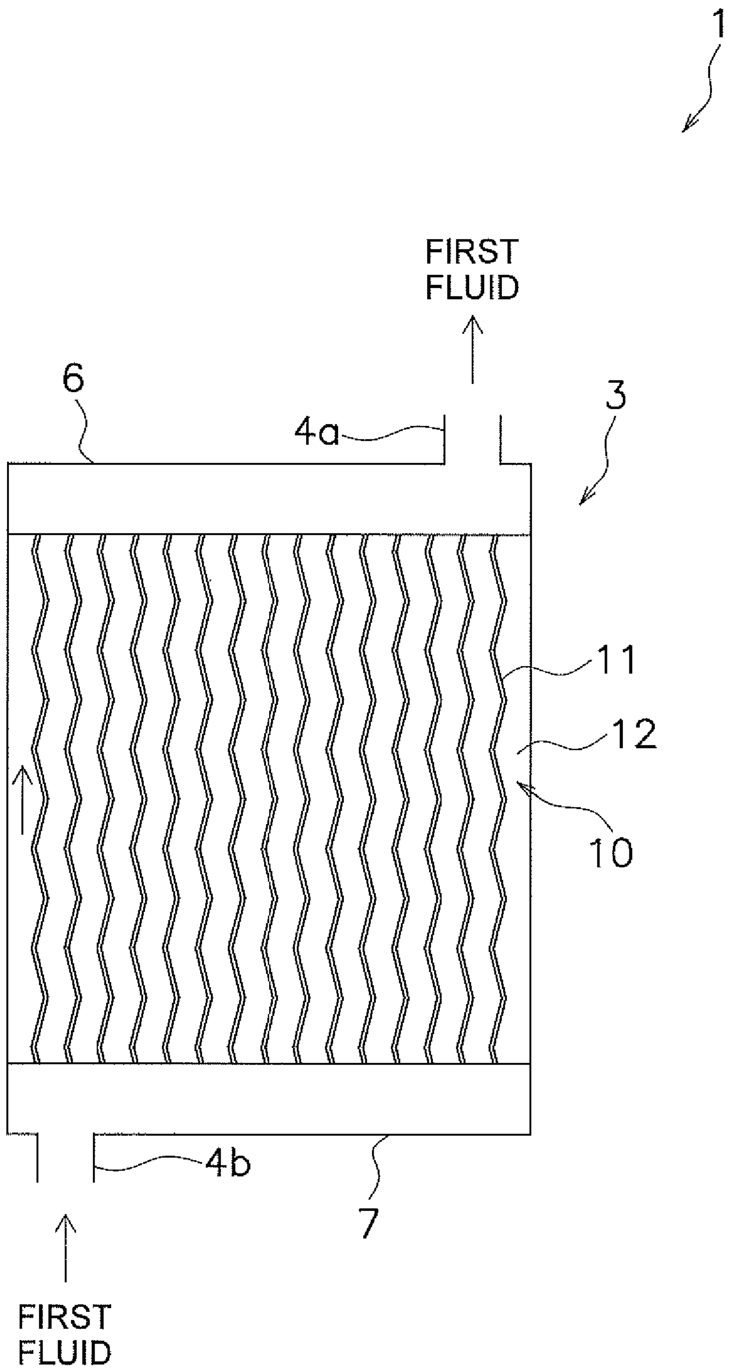


FIG. 2

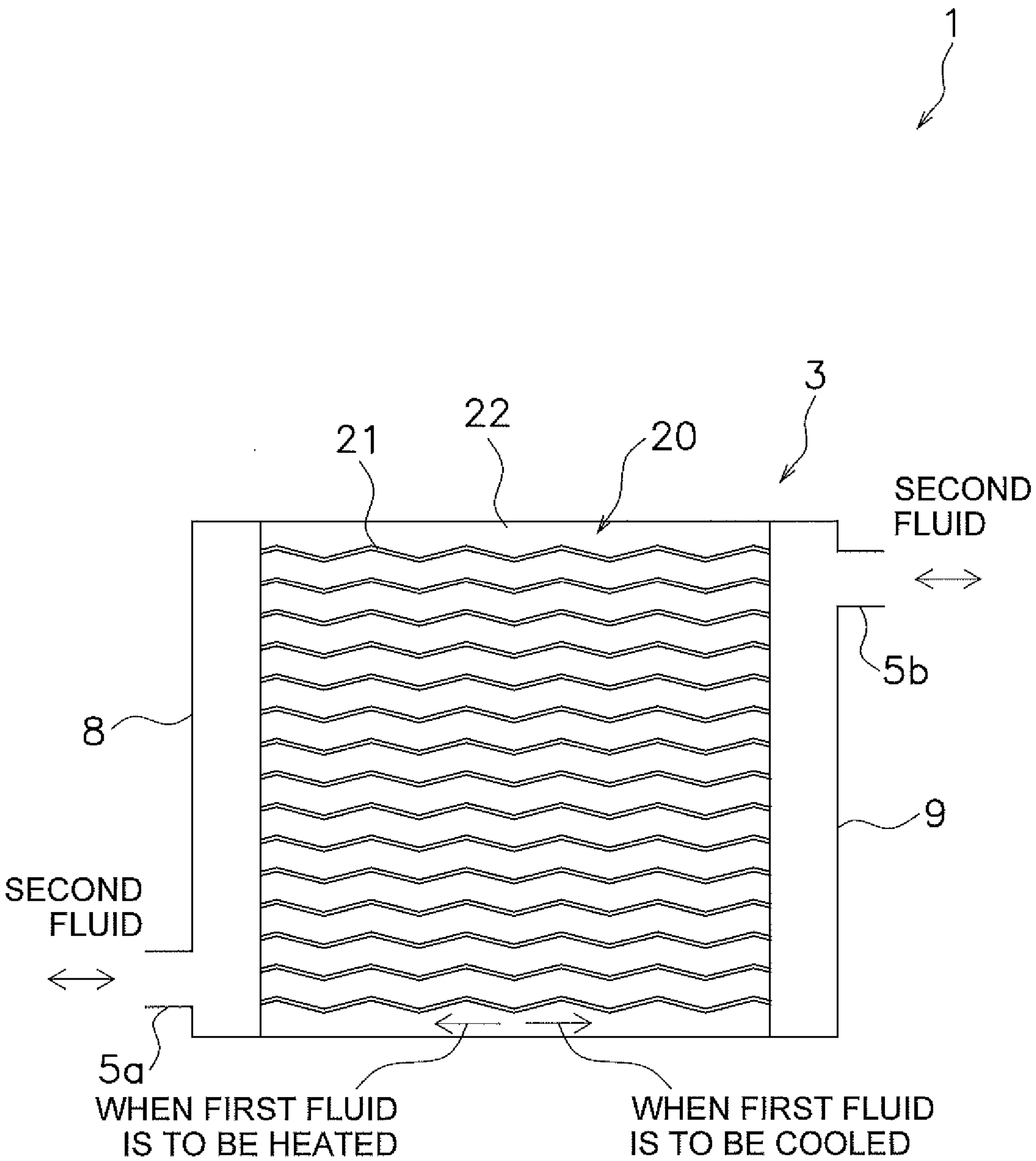

1
3
22
21
20
SECOND
FLUID
5b
8
9
SECOND
FLUID
5a
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 3

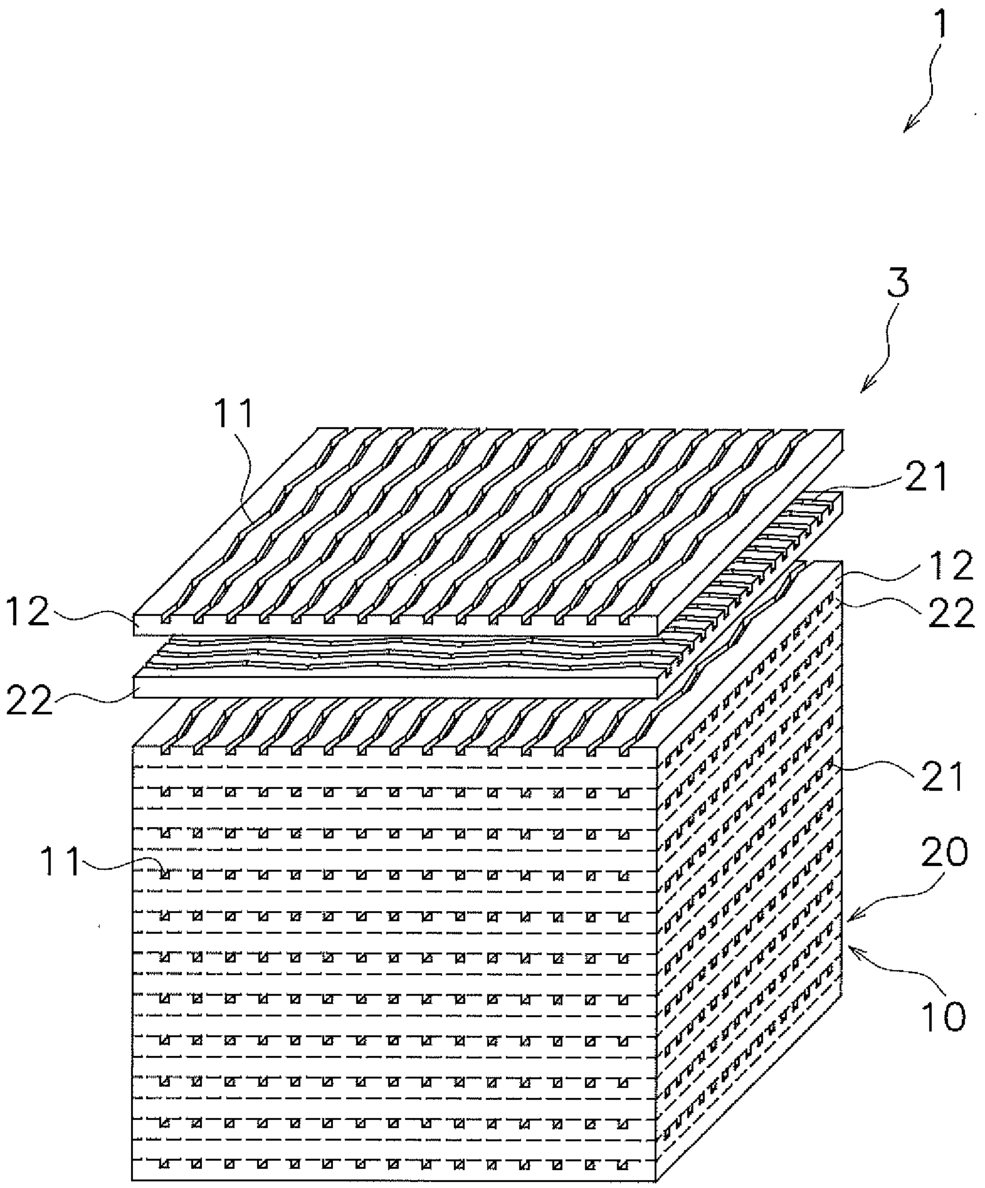


FIG. 4

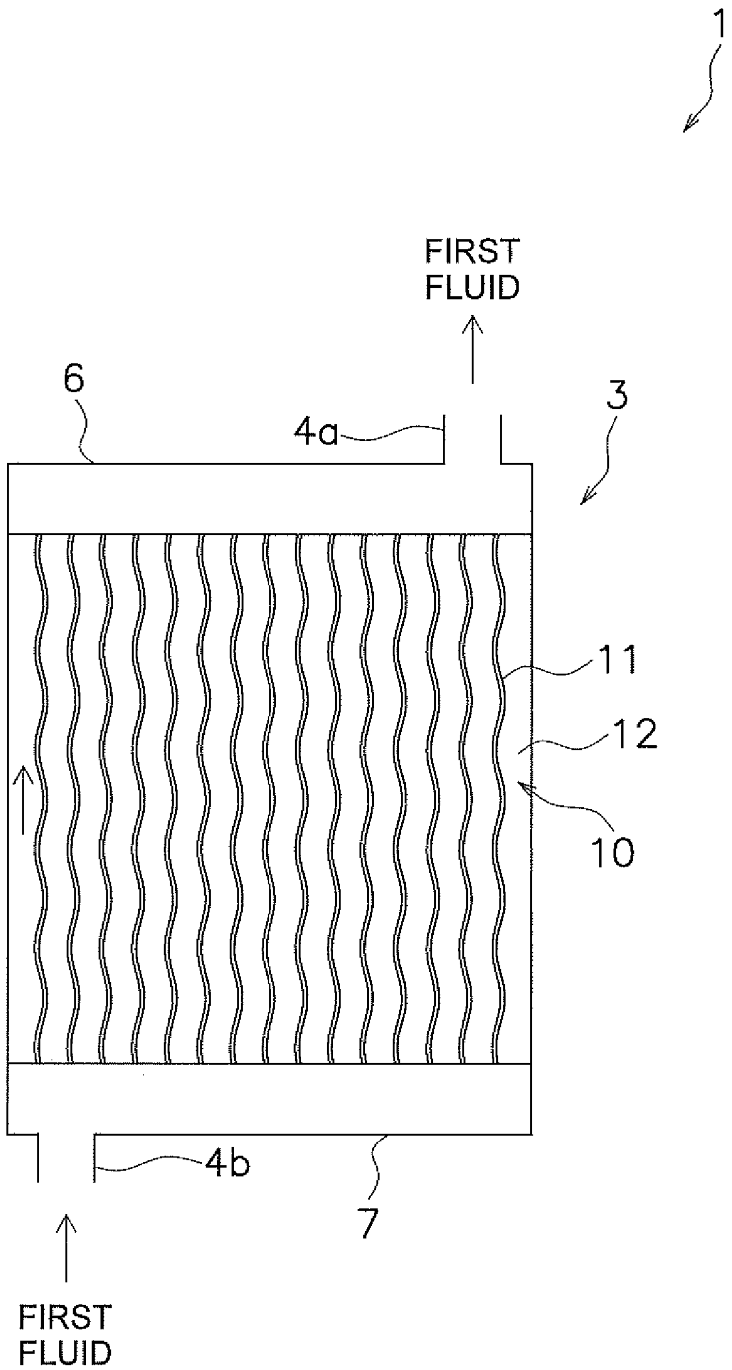


FIG. 5

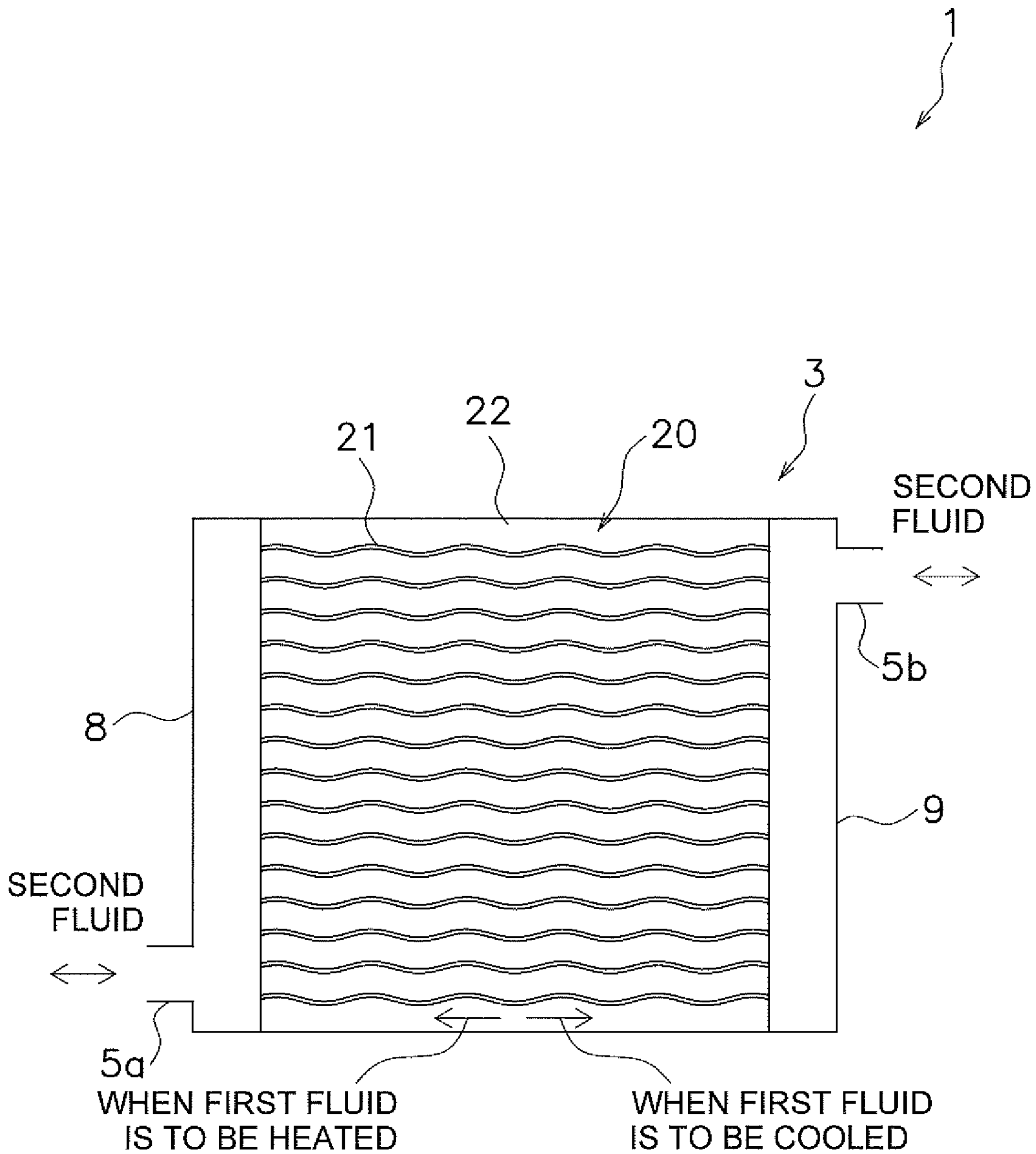

1
3
21
22
20
SECOND FLUID
5b
8
9
SECOND FLUID
5a
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 6

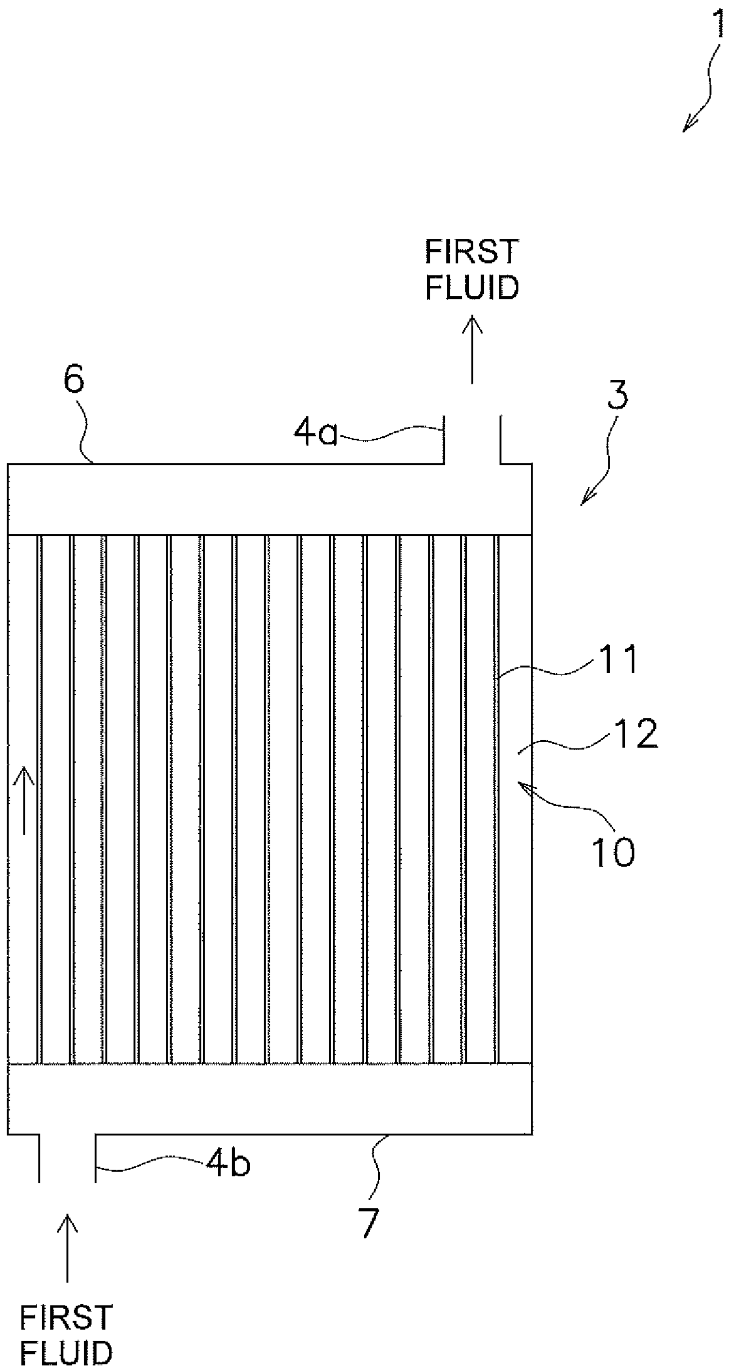


FIG. 7

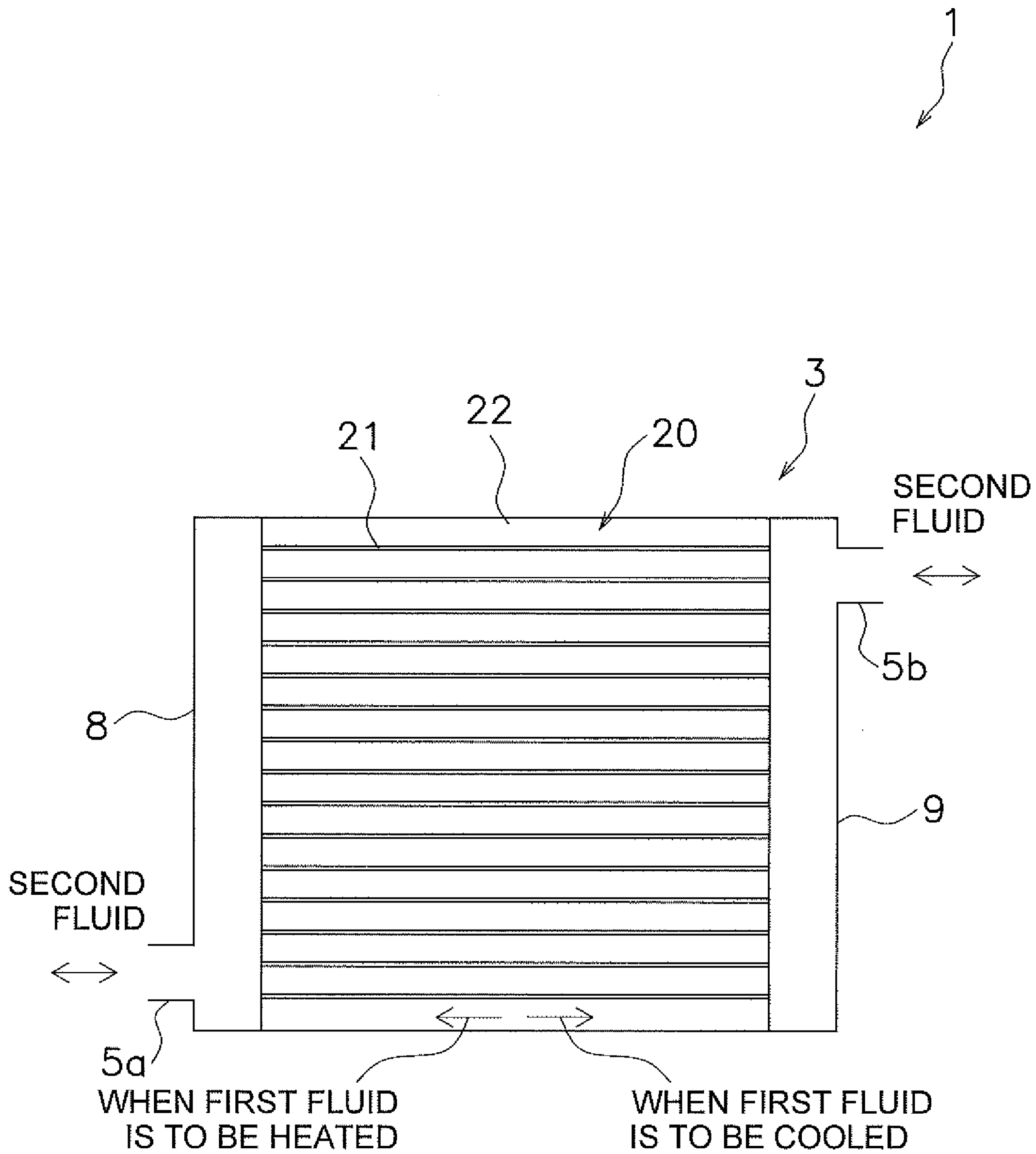

1
3
22
21
20
SECOND
FLUID
5b
8
9
SECOND
FLUID
5a
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 8

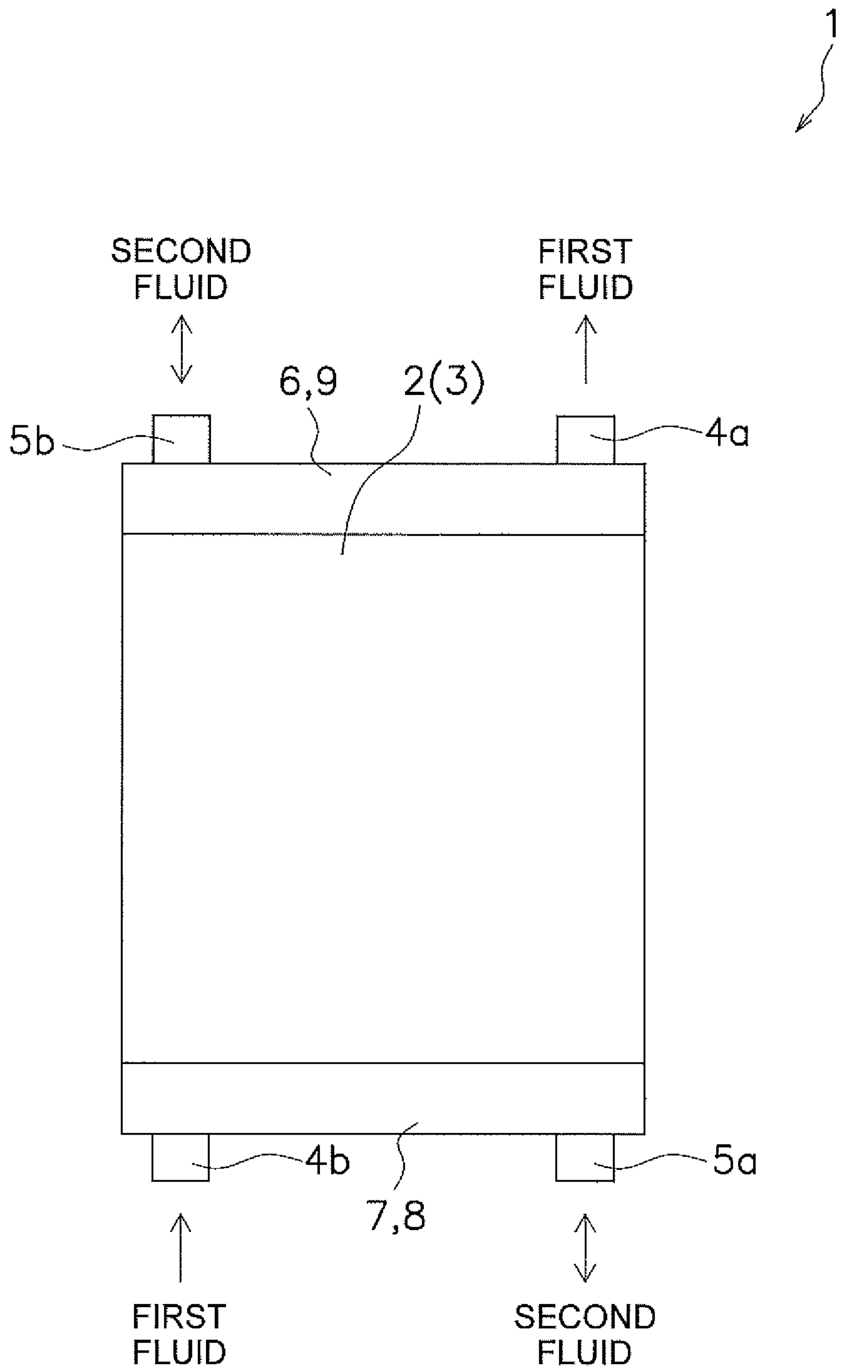

1
SECOND FLUID
FIRST FLUID
6,9
2(3)
5b
4a
4b
5a
7,8
FIRST FLUID
SECOND FLUID

FIG. 9

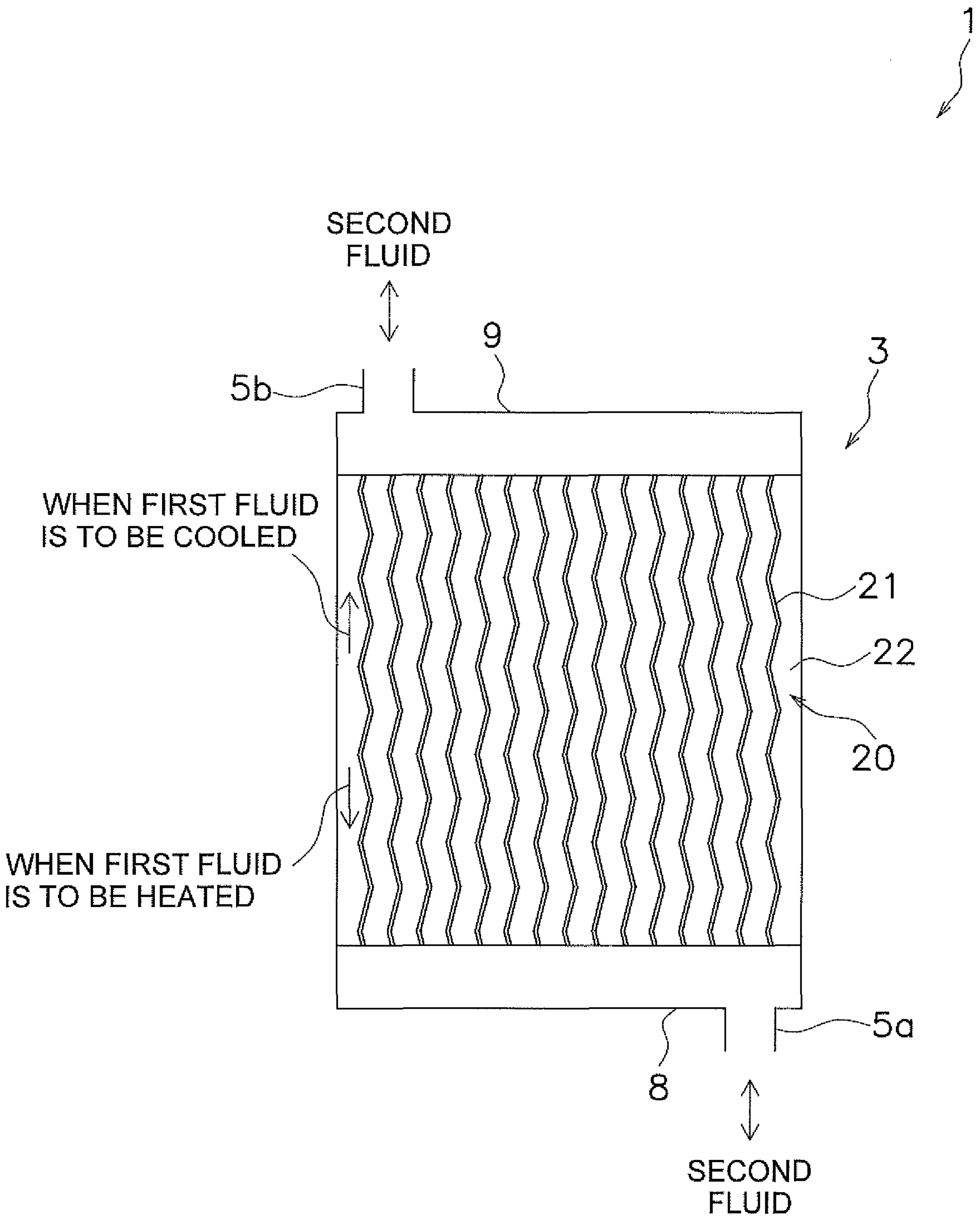

1
SECOND
FLUID
9
3
5b
WHEN FIRST FLUID
IS TO BE COOLED
21
22
20
WHEN FIRST FLUID
IS TO BE HEATED
5a
8
SECOND
FLUID

FIG. 10

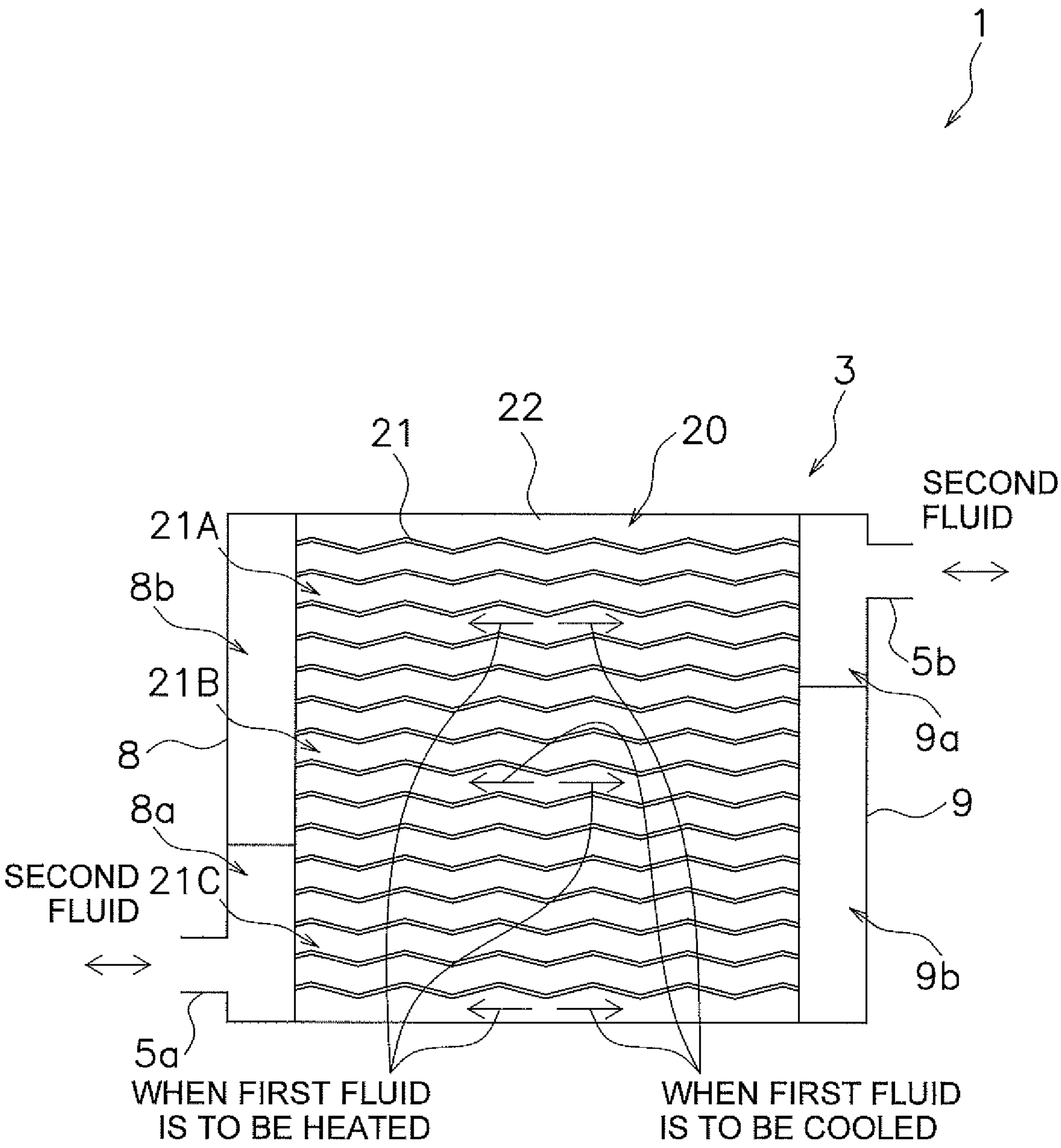

1
3
21
22
20
SECOND
FLUID
21A
8b
5b
21B
9a
8
9
8a
SECOND
FLUID
21C
9b
5a
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 11

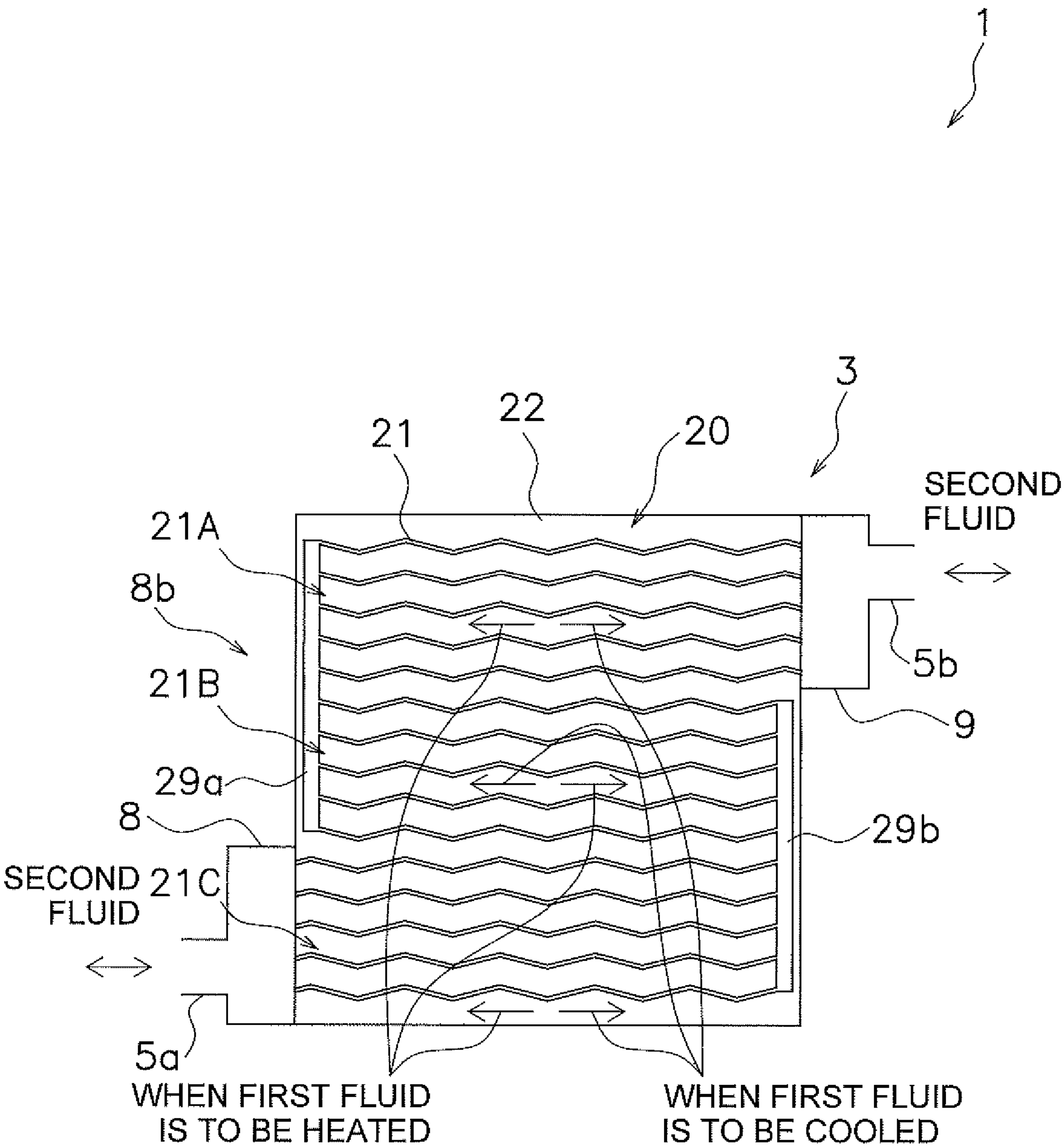

1
3
22
21
20
21A
8b
SECOND
FLUID
5b
21B
9
29a
8
29b
SECOND
FLUID
21C
5a
WHEN FIRST FLUID
IS TO BE HEATED
WHEN FIRST FLUID
IS TO BE COOLED

FIG. 12

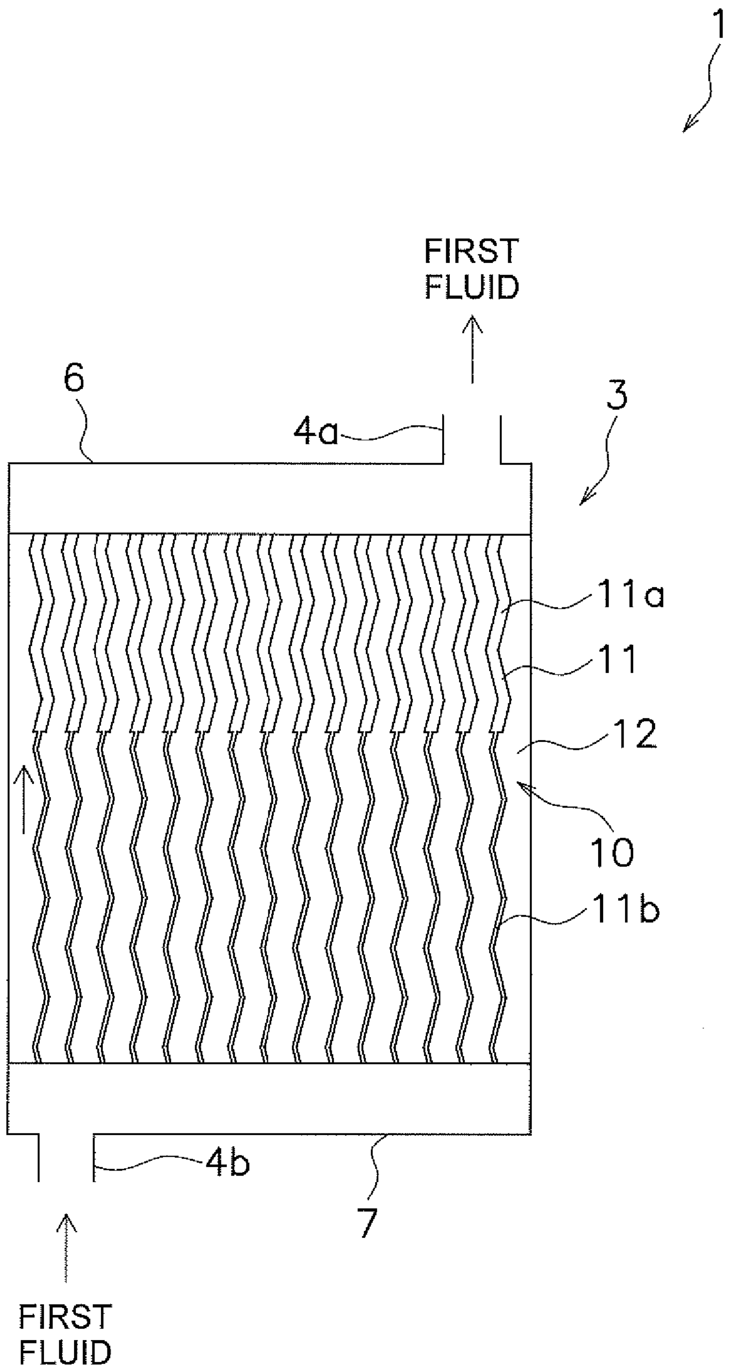


FIG. 13

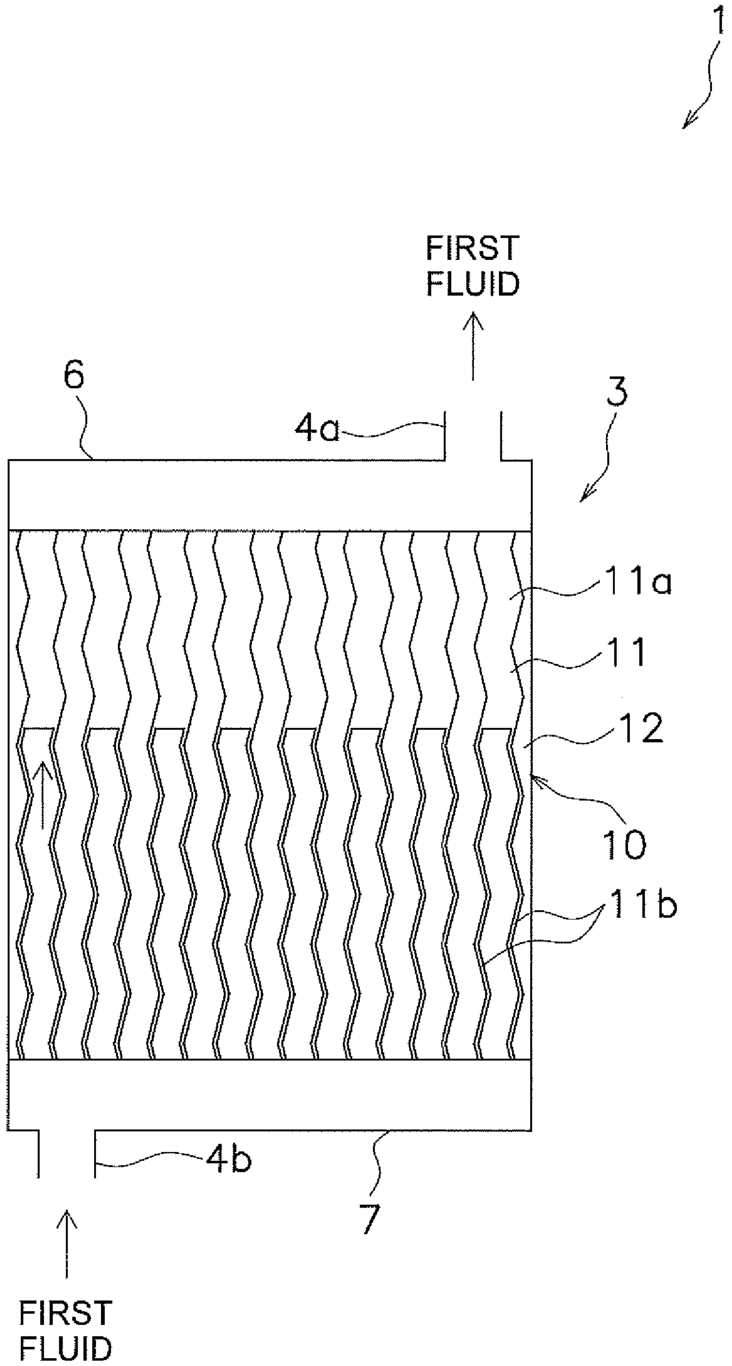
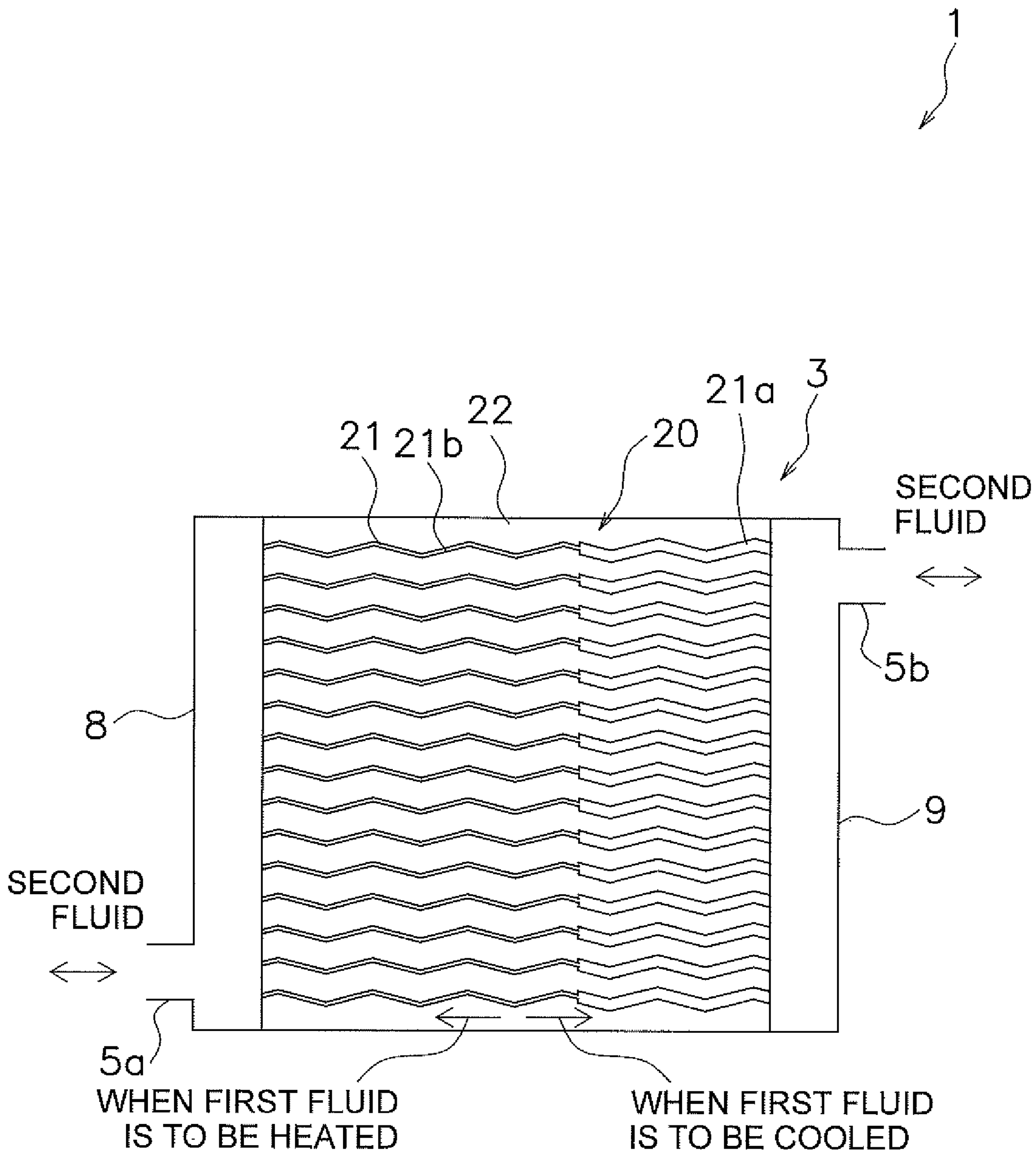


FIG. 14



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

FIG. 15

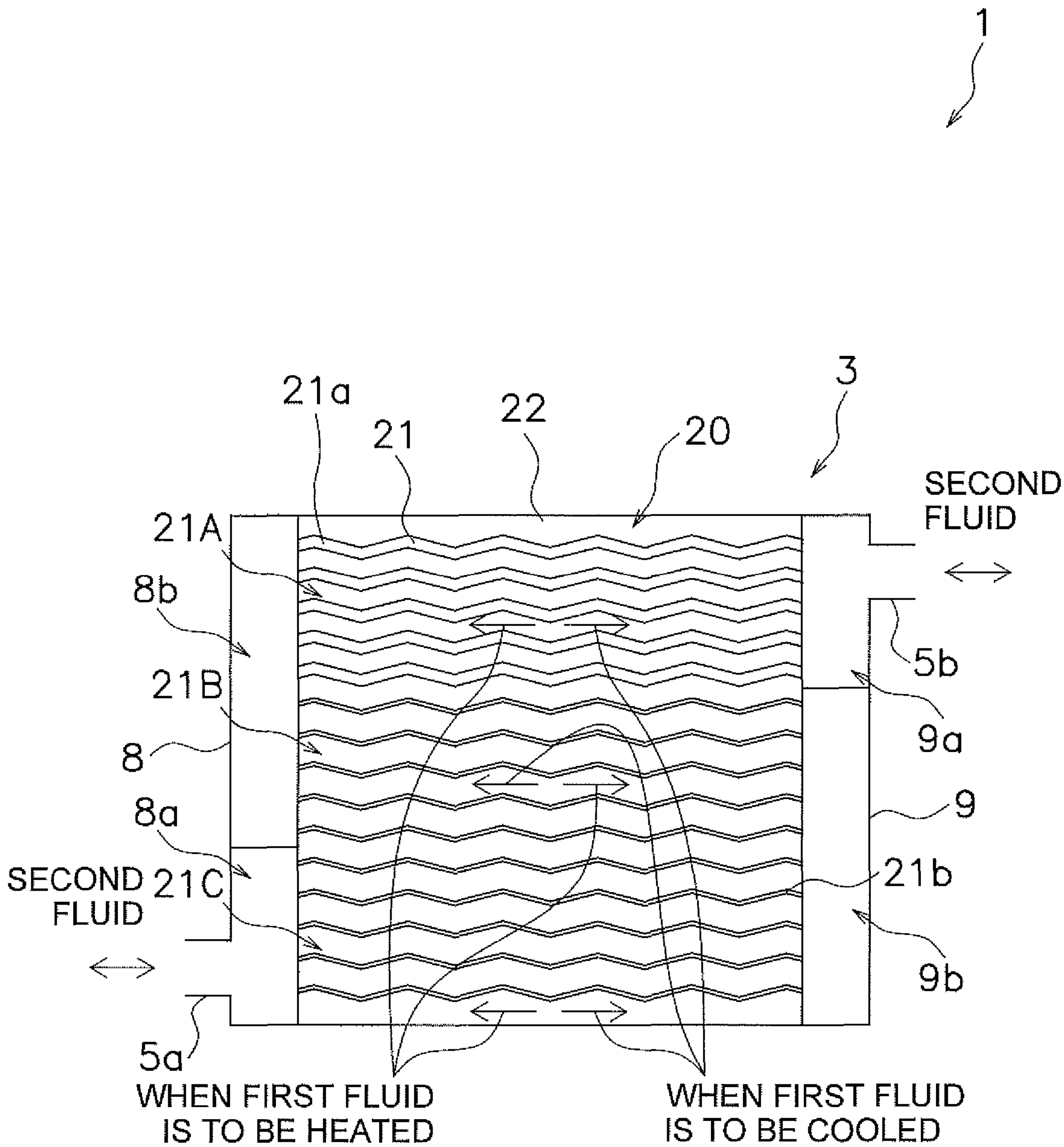

1
3
21a
22
21
20
21A
8b
21B
8
8a
SECOND FLUID
21C
5a
SECOND FLUID
5b
9a
9
21b
9b
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 16

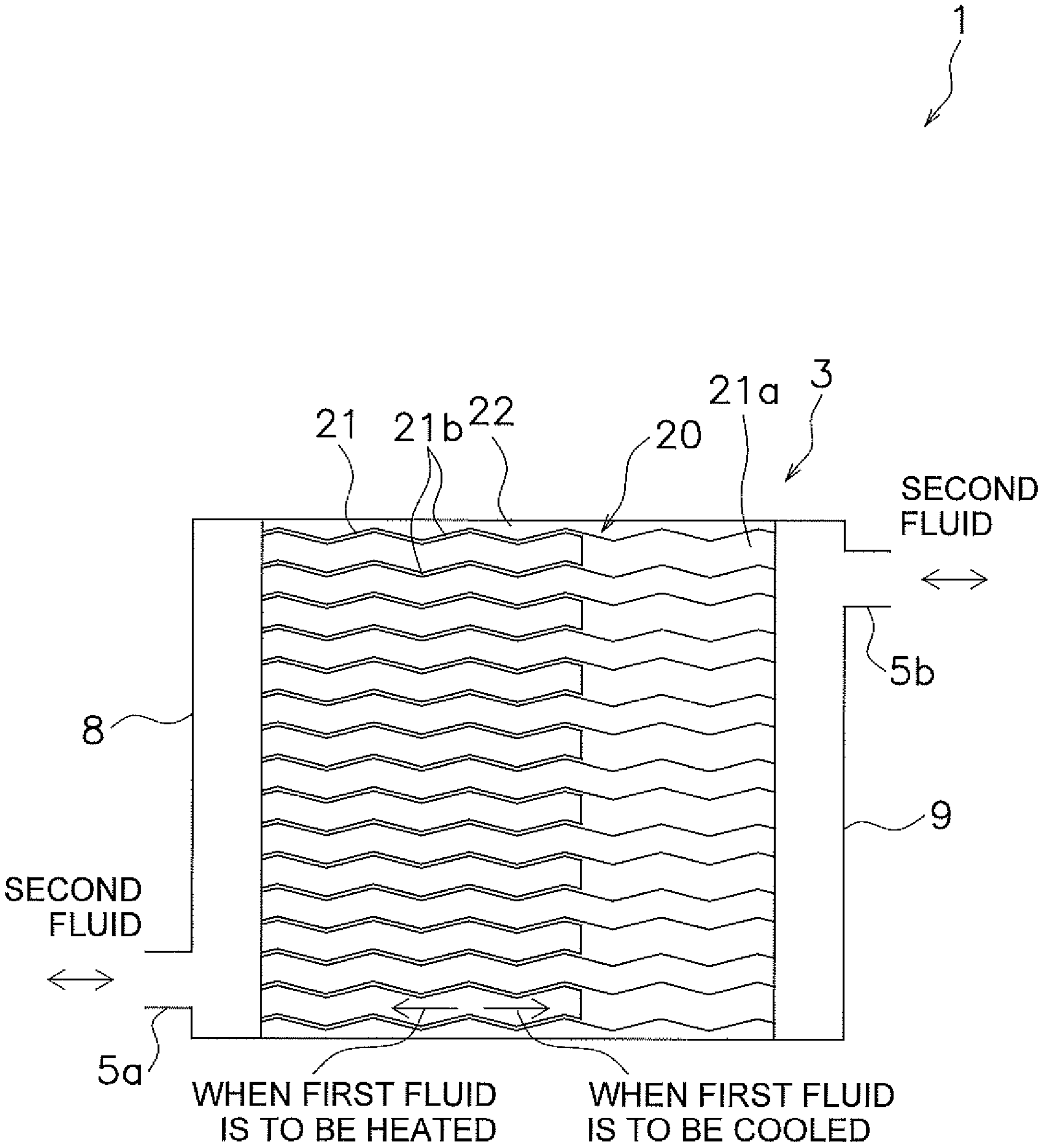

1
21
21b
22
21a
3
20
SECOND FLUID
5b
8
9
SECOND FLUID
5a
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 17

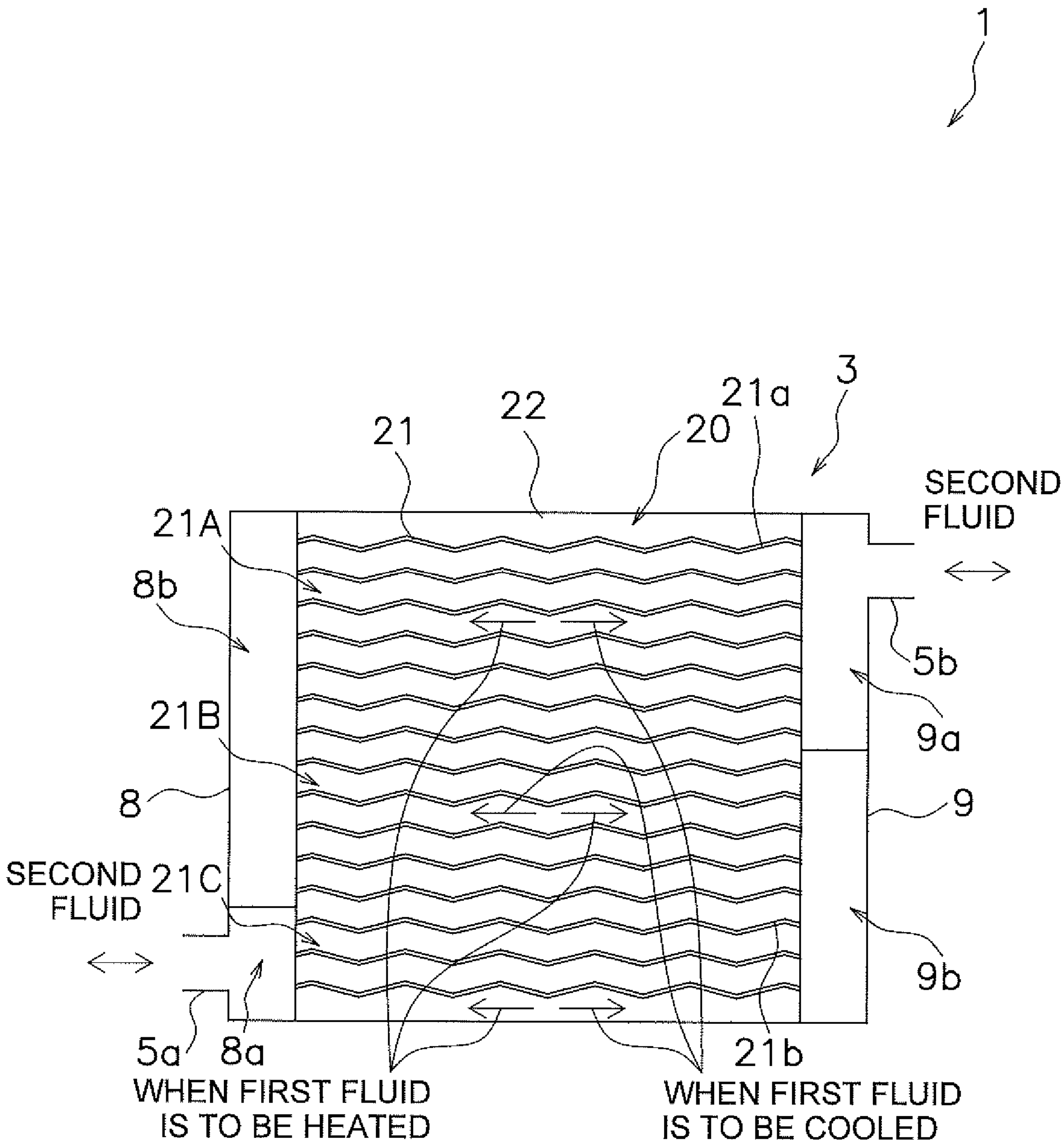

1
3
21a
20
22
21
21A
8b
21B
8
SECOND FLUID
21C
SECOND FLUID
5b
9a
9
9b
5a
8a
21b
WHEN FIRST FLUID IS TO BE HEATED
WHEN FIRST FLUID IS TO BE COOLED

FIG. 18

REFERENCES CITED IN THE DESCRIPTION

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- US 4744414 A **[0003]**
- EP 1136782 A1 **[0004]**
- US 20160282064 A1 **[0005]**