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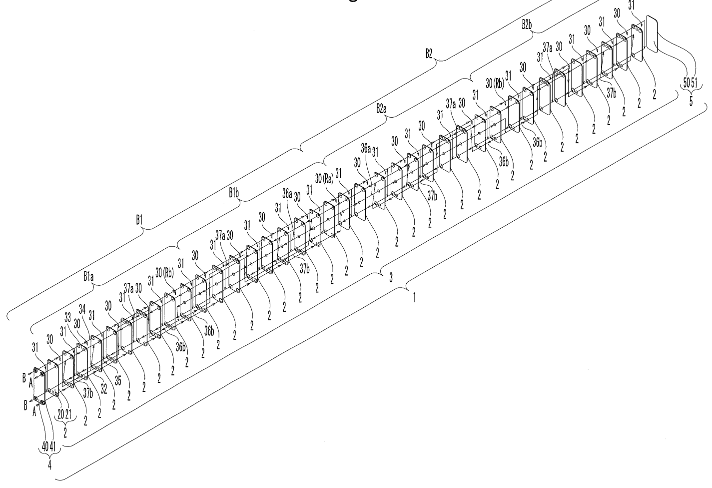
(54) PLATE-TYPE HEAT EXCHANGER

(57) Provided is a plate heat exchanger, in which first flow channels and second flow channels are formed alternately with heat transfer plates therebetween. A pair of communication flow channels are provided to allow a first fluid medium to flow into and out of the first flow channels through communication of the first flow channels with each other. A flow channel of the first fluid medium is formed from the one first communication flow channel to the other first communication flow channel. At least one of the first flow channels is a reference flow channel serving as a starting point of the flow channel of the first fluid medium. One of the first communication flow channels communicates only with the reference flow channel, and the other of the first communication flow channels communicates only with a plurality of the first flow channels, the number of which is greater than the number of the reference flow channel and which serve as a terminal end of the flow channel of the first fluid medium.

Fig. 2



EP 2 980 519 A1

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2013-74894, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a plate heat exchanger that is used as an evaporator and a condenser.

BACKGROUND ART

[0003] There are hitherto many cases, in which a plate heat exchanger is used as an evaporator that evaporates a first fluid medium along with heat exchange between the first fluid medium and a second fluid medium, and as a condenser that condenses a first fluid medium along with heat exchange between the first fluid medium and a second fluid medium (see Patent Literature 1, for example).

[0004] As shown in Fig. 5, a plate heat exchanger generally includes a body portion 3 that includes a plurality of heat transfer plates 2. The body portion 3 includes first flow channels 30, second flow channels 31, a pair of first communication flow channels 32 and 33, and a pair of second communication flow channels 34 and 35. The first flow channel 30 circulates a first fluid medium A. The second flow channel 31 circulates a second fluid medium B. The pair of first communication flow channels 32 and 33 communicate with the first flow channels 30 to allow the first fluid medium A to flow into and out of the first flow channels 30. The pair of second communication flow channels communicate with the second flow channels 31 to allow the second fluid medium B to flow into and out of the second flow channels 31.

[0005] More specific description is given herein. The plurality of the heat transfer plates 2 each include at least four openings (no reference numeral is allocated). The plurality of the heat transfer plates 2 are stacked on each other in the body portion 3. With this configuration, the first flow channels 30 for circulation of the first fluid medium A and the second flow channels 31 for the circulation of the second fluid medium B are alternately formed with the plurality of the heat transfer plates 2 respectively interposed therebetween. With the plurality of the heat transfer plates stacked on each other, each opening of each of the plurality of the heat transfer plates 2 forms a continuous opening extending in the stacked direction of the plurality of the heat transfer plates 2. Whereby, the one first communication flow channel 32 for flowing the first fluid medium A into the first flow channels 30, the other first communication flow channel 33 for flowing the first fluid medium A out of the first flow channels 30, the one second communication flow channel 34 for flowing the second fluid medium B into the second flow channels 31, and the other second communication flow channel 35 for flowing the second fluid medium B out of the second flow channels 31 extend through the plurality of the heat transfer plates 2 in the stacked direction of the plurality of the heat transfer plates 2 (see Patent Literature 1, for example).

[0006] In a plate heat exchanger 1 of this type, the first fluid medium A supplied into the one first communication flow channel 32 flows out to the other first communication flow channel 33 through the first flow channels 30. The second fluid medium B supplied into the one second communication flow channel 34 flows out to the other second communication flow channel 35 through the second flow channels 31. As described above, in the plate heat exchanger 1, the first fluid medium A circulates in the first flow channels 30, and the second fluid medium B circulates in the second flow channels 31. Whereby, the plate heat exchanger 1 enables the heat exchange between the first fluid medium A and the second fluid medium B through a large heat transfer surface of each heat transfer plate 2 separating the first flow channel 30 and the second flow channel 31.

[0007] Meanwhile, in the plate heat exchanger 1 of this type, as the number of the heat transfer plates 2 increases, the heat transfer surface contributing to the heat exchange increases and thereby it is assumed that the heat exchange performance becomes high.

[0008] However, as the number of the heat transfer plates 2 increases, the first communication flow channels 32 and 33 and the second communication flow channels 34 and 35 which extend in the stacked direction of the plurality of the heat transfer plates 2 increase in length according to the number of the stacked heat transfer plates 2.

[0009] That is, the pair of first communication flow channels 32 and 33 and the pair of second communication flow channels 34 and 35 each are formed by the alignment of the corresponding openings of the heat transfer plates 2, so that the flow channel length of each of the pair of first communication flow channels 32 and 33 and the pair of second communication flow channels 34 and 35 increases according to the number of the stacked heat transfer plates 2 when the number thereof increases.

[0010] As a result, the distribution resistance of the first fluid medium A in the first communication flow channel for flowing the first fluid medium A into the first flow channels 30 (the one first communication flow channel) 32 increases and thus the first fluid medium A is not easy to circulate. Therefore, in the plate heat exchanger 1 of this type, the inflow of the first fluid medium A into the first flow channels 30 at the inlet side of the one first communication flow channel 32 and the inflow of the first fluid medium A into the first flow channels 30 at the far side of the one first communication flow channel 32 become uneven. That is, in the plate heat exchanger 1 of this type, distribution unevenness of the first fluid medium

A is caused in the plurality of the first flow channels 30 aligning in the stacked direction of the heat transfer plates 2. As a result, in the plate heat exchanger 1 of this type, even if the number of the heat transfer plates 2 is increased or the number of the first flow channel 30 is increased, there is a limit in improving the heat exchange performance (evaporation performance).

CITATION LIST

Patent Literature

[0011] PATENT LITERATURE 1 JP-1999-287572 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0012] In view of the above, an object of the present invention is to provide a plate heat exchanger that is capable of evenly supplying a first fluid medium into a plurality of first flow channels for circulation of the first fluid medium, while suppressing increase in pressure loss in the plurality of the first flow channels.

[0013] According to the present invention, there is provided a plate heat exchanger including a body portion that includes a plurality of heat transfer plates stacked on each other, the body portion further including a plurality of first flow channels that circulate a first fluid medium, a plurality of second flow channels that circulate a second fluid medium, a pair of first communication flow channels that communicate with the plurality of the first flow channels and allow the first fluid medium to flow into and out of the plurality of the first flow channels, a pair of second communication flow channels that communicate with the plurality of the second flow channels and allow the second fluid medium to flow into and out of the plurality of the second flow channels, the plurality of the first flow channels and the plurality of the second flow channels being alternately formed with the plurality of the heat transfer plates being respectively interposed therebetween, and the pair of first communication flow channels and the pair of second communication flow channels extending in the stacked direction of the plurality of the heat transfer plates through the plurality of the heat transfer plates. The plurality of the first flow channels communicate with each other to form a flow channel of the first fluid medium from one of the pair of first communication flow channels to the other of the pair of first communication flow channels. At least one of the plurality of the first flow channels is a reference flow channel that serves as a starting point of the flow channel of the first fluid medium. The one of the pair of first communication flow channels communicates only with the reference flow channel. The other of the pair of first flow channels communicates only with a plurality of the first flow channels, the number of the plurality of the first flow channels being greater than the number of the reference flow channel, and the plurality of the first flow channels serving as a terminal end of the flow channel of the first fluid medium.

[0014] According to one aspect of the present invention, it may be configured such that at least one the plurality of the first flow channels located at an intermediate position in the stacked direction of the plurality of the heat transfer plates is a reference flow channel which serves as a starting point of the flow channel of the first fluid medium. In this configuration, the body portion includes at least one pair of primary branch flow channels that provide communication between the reference flow channel and at least one first flow channel located on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates. The other of the pair of first communication flow channels communicates only with a plurality of first flow channels which serve as a terminal end of the flow channel of the first fluid medium on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates, the number of the plurality of first flow channels being greater than the number of the reference flow channel.

[0015] In this case, the plate heat exchanger may be configured such that: a plurality of the first flow channels are provided on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates. In this configuration, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates, the first flow channel of the plurality of first flow channels located at an intermediate position in the stacked direction of the plurality of the heat transfer plates is an intermediate reference flow channel that serves as a branching position of the flow channel of the first fluid medium. The body portion includes a pair of secondary branch flow channels that provide communication between the corresponding intermediate reference flow channel and at least one first flow channel located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates. The pair of primary branch flow channels respectively communicate with the corresponding intermediate reference flow channels located respectively on the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates.

[0016] According to a specific aspect of the present invention, it may be configured such that: a plurality of the first flow channels are provided on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates. In this configuration, each of the pair of secondary branch flow channels communicates with one first flow channel located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates.

The body portion includes at least one connection flow channel that connects the first flow channels with each other on one side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, and at least one connection flow channel that connects the first flow channels with each other on the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates. The other of the pair of first communication flow channels communicates only with a plurality of first flow channels which communicate with each other via one connection flow channel on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, the number of the plurality of first flow channels being greater than the number of the reference flow channel.

[0017] In this case, the plate heat exchanger may be configured such that: the body portion includes, as connection flow channels, a first connection flow channel that communicates the first flow channel communicating with the secondary branch flow channel and another first flow channel, and a second connection flow channel that communicates a plurality of first flow channels including the other first flow channel with each other. In this configuration, the first connection flow channel and the second connection flow channel are arranged with a distance from each other in a direction orthogonal to the stacked direction of the plurality of the heat transfer plates. The other of the pair of first communication flow channels communicates with the first flow channels other than the other first flow channel, of the plurality of the first flow channels being connected to the second connection flow channel.

[0018] According to still another specific aspect of the present invention, the plate heat exchanger may be configured such that: a plurality of the first flow channels are provided on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates. In this configuration, each of the pair of secondary branch flow channels communicates with a plurality of the first flow channels located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates. The body portion includes, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates, a connection flow channel that connects the plurality of the first flow channels communicating with one of the pair of the secondary branch flow channels and a plurality of the other first flow channels, the number of the plurality of the other first flow channels being greater than the number of the plurality of the first communication flow channels communicating with the one of the pair of the secondary branch flow channels on one side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates, and a connection flow channel that connects the plurality of the first flow channels communicating with the other of the pair of the secondary branch flow channels and a plurality of the other first flow channels, the number of the plurality of the other first flow channels being greater than the number of the plurality of the first communication flow channels communicating with the other of the pair of the secondary branch flow channels on the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates. The other of the first communication flow channels communicates only with the plurality of the other first flow channels located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a schematic overall perspective view of a plate heat exchanger according to one embodiment of the present invention.

Fig. 2 is a schematic exploded perspective view of the plate heat exchanger according to the embodiment of the present invention.

Fig. 3 is a schematic view for explaining a flow channel of a first fluid medium and a flow channel of a second fluid medium in the plate heat exchanger according to the embodiment of the present invention.

Fig. 4 is a schematic view for explaining a flow channel of a first fluid medium and a flow channel of a second fluid medium in a plate heat exchanger according to another embodiment of the present invention.

Fig. 5 is a schematic view for explaining a flow channel of a first fluid medium and a flow channel of a second fluid medium in a conventional plate heat exchanger.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] A description is given for a plate heat exchanger according to one embodiment of the present invention with reference to the attached drawings.

[0021] As shown in Fig. 1, the plate heat exchanger includes a body portion 3 that includes a plurality of heat transfer plates 2 stacked on each other.

[0022] As shown in Fig. 2 and Fig. 3, the body portion 3 includes first flow channels 30, second flow channels 31, a pair of first communication flow channels 32 and 33, and a pair of second communication flow channels

34 and 35. The first flow channels 30 circulate a first fluid medium A. The second flow channels 31 circulate a second fluid medium B. The pair of first communication flow channels 32 and 33 communicate with the first flow channels 30 to allow the first fluid medium A to flow into and out of the first flow channels 30. The pair of second communication flow channels 34 and 35 communicate with the second flow channels 31 to allow the second fluid medium B to flow into and out of the second flow channels 31. In the following description, one flow channel 32 of the pair of first communication flow channels 32 and 33 is referred to as the "first inflow communication flow channel," and the other flow channel 33 of the pair of first communication flow channels 32 and 33 is referred to as the "first outflow communication flow channel." Also, one flow channel 34 of the pair of second communication flow channels 34 and 35 is referred to as the "second inflow communication flow channel," and the other flow channel 35 of the pair of second communication flow channels 34 and 35 is referred to as the "second outflow communication flow channel."

[0023] The first flow channels 30 and the second flow channels 31 are alternately formed with the heat transfer plates 2 respectively interposed therebetween. On the other hand, the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35 each extend through the heat transfer plates 2 in the stacked direction of the plurality of the heat transfer plates 2 (hereinafter referred to as the "first direction").

[0024] A more specific description is given herein. A plate heat exchanger 1 according to this embodiment includes the body portion 3 that includes the plurality of the heat transfer plates 2 stacked on each other, and a pair of end plates 4 and 5 that sandwich the body portion 3.

[0025] The plurality of the heat transfer plates 2 each are provided by press forming a metal plate. As shown in Fig. 2, the plurality of the heat transfer plates 2 each include a heat transfer portion 20 that defines the first flow channel 30 and the second flow channel 31, and an annular fitting portion 21 that extends from the outer circumference of the heat transfer portion 20 in a direction orthogonal to the plane of the heat transfer portion 20.

[0026] Each of the heat transfer plates 2 includes a front side and a back side on which a plurality of ridges and valleys (not shown) are alternately formed. The heat transfer portion 20 of each heat transfer plate 2 includes openings (no reference number is allocated) for forming the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35. That is, openings are provided at at least four places of the heat transfer portion 20 of each heat transfer plate 2. These openings are to form flow channels extending in the first direction.

[0027] The plate heat exchanger 1 according to the present embodiment is provided with different kinds of the heat transfer plates 2. The plate heat exchanger 1 according to the present embodiment includes the heat transfer plates 2 each having openings for forming primary branch flow channels 36a or secondary branch flow channels 36b, as well as the heat transfer plates 2 each having the openings for forming the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35. In the present embodiment, detailed description is given for the flow channels such as the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, the second outflow communication flow channel 35, the primary branch flow channels 36a, and the secondary branch flow channels 36b, and the like. The number, arrangement and dimensions of the openings for forming them are appropriately determined according to, for example, the intended use of the plate heat exchanger 1, the kind and flow rate of each of the first fluid medium A and the second fluid medium B, in the same manner as a conventional plate heat exchanger.

[0028] The pair of end plates 4 and 5 each are provided by press-forming a metal plate and has substantially the same shape as that of the heat transfer plates 2. Specifically, the end plates 4 and 5 include sealing portions 40 and 50, and annular fitting portions 41 and 51. The sealing portions 40 and 50 have substantially the same shape as that of the heat transfer portion 20. The annular fitting portions 41 and 51 extend from the entire outer circumferences of the sealing portions 40 and 50 in a direction orthogonal to the plane of the sealing portions 40 and 50.

[0029] One end plate (hereinafter referred to as the "first end plate") 4 includes openings (no reference numeral is allocated) that correspond to the openings formed in the adjacent heat transfer plates 2 and are configured to form the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35. That is, the openings are provided at four places of the sealing portion 40 of the first end plate 4. Along with this configuration, tubular nozzles (no reference numeral is allocated) for connection of conduits are connected to the outer surface of the sealing portion 40 of the first end plate 4 in an arrangement corresponding to the respective openings.

[0030] On the other hand, the sealing portion 50 of the other end plate (hereinafter referred to as the "second end plate") 5 is not provided with openings. That is, the second end plate 5 is provided with the sealing portion 50 that can seal the flow channels formed by the openings of the stacked heat transfer plates 2.

[0031] The plurality of the heat transfer plates 2 are stacked on each other. In this state, the ridges of each adjacent heat transfer plates 2 abut each other at their crossing points, and the annular fitting portions 21 of each adjacent heat transfer plates 2 fit each other. Accordingly, the tight contact portions of each adjacent heat transfer plates 2 are sealed by brazing to thereby form the body portion 3.

[0032] The plurality of the heat transfer plates 2 are stacked on each other with the first end plate 4 and the second end plate 5 sandwiching the stacked heat transfer plates 2 (the body portion 3). In this state, the annular fitting portions 21 of the first end plate 4 and the second end plate 5 respectively fit the fitting portions 21 of the adjacent heat transfer plates 2. Accordingly, the tight contact portions of the adjacent heat transfer plates 2 (the body portion 3) with the first end plate 4 and the second end plate 5 are sealed by brazing.

[0033] With the above configuration, as shown in Fig. 2 and Fig. 3, the first flow channels 30 and the second flow channels 31 are alternately formed with the heat transfer plates 2 respectively therebetween. In the present embodiment, the first flow channels 30 circulate the first fluid medium A such as chlorofluorocarbon or ammonia whose phase changes. The second flow channels 31 circulate the second fluid medium B in liquid form such as water or brine.

[0034] The openings of the plurality of the heat transfer plates 2 are connected to each other, thereby forming the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35, which extend in the first direction.

[0035] A more specific description is given herein. In the present embodiment, the heat transfer portion 20 of each heat transfer plate 2 has a rectangular shape in plan view (as viewed in the direction of the normal line of the heat transfer portion 20).

[0036] The first inflow communication flow channel 32 and the second outflow communication flow channel 35 are provided on one side of the heat transfer plates 2 in the longitudinal direction of the heat transfer portion 20 (a direction orthogonal to the first direction: hereinafter referred to as the "second direction"). The first outflow communication flow channel 33 and the second inflow communication flow channel 34 are provided on the other side of the heat transfer plates 2 in the second direction.

[0037] Fig. 3 is a schematic view, and therefore the first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34, and the second outflow communication flow channel 35 align in the second direction (arranged in parallel). However, according to the actual arrangement, the first inflow communication flow channel 32 and the second outflow communication flow channel 35 align in the short side direction of the heat transfer portion 20 (the direction orthogonal to the first direction and the second direction, hereinafter referred to as the "third direction"). The second inflow communication flow channel 34 and the first outflow communication flow channel 33 also align in the short side direction of the heat transfer portion 20 (the third direction).

[0038] With the above configuration, in the plate heat exchanger 1, the first fluid medium A is circulated within the first flow channels 30 in the second direction orthogonal to the first direction. The second fluid medium B is circulated within the second flow channels 31 in the second direction. That is, in the plate heat exchanger 1 of the present embodiment, the first fluid medium A is circulated within the first flow channels 30 in the longitudinal direction of the heat transfer portion 20, and the second fluid medium B is circulated within the second flow channels 31 in the longitudinal direction of the heat transfer portion 20.

[0039] In the plate heat exchanger 1 of the present embodiment, at least one first flow channel 30 (one first flow channel in an example of the present embodiment) located at an intermediate position in the first direction is a reference flow channel Ra which serves as a starting point of the flow channel of the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33. The first inflow communication flow channel 32 communicates only with the reference flow channel Ra. On the other hand, the first outflow communication flow channel 33 communicates only with a plurality of first flow channels 30, the number of which is greater than the number of the reference flow channel Ra and which serve as a terminal end of the flow channel of the first fluid medium A formed with the reference flow channel Ra as a starting point. The intermediate position in the present embodiment is an arbitrary position excluding the first flow channels 30 on both ends in the first direction.

[0040] Now, a specific description is given for a flow channel (distribution line) for the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33.

[0041] In the plate heat exchanger 1 of the present embodiment, one first flow channel 30 located at a center position in the first direction is a reference flow channel Ra. The body portion 3 includes one pair of primary branch flow channels 36a. The pair of primary branch flow channels 36a provide communication between the reference flow channel Ra and at least one first flow channel 30 located on one side of the reference flow channel Ra in the first direction, and provide communication between the reference flow channel Ra and at least one first flow channel 30 located on the other side of the reference flow channel Ra in the first direction. That is, the body portion 3 includes the primary branch flow channel 36a that provides communication (connection) between the reference flow channel Ra and at least one first flow channel 30 located on the one side of the reference flow channel Ra in the first direction, and the primary branch flow channel 36a that provides communication (connection) between the reference flow channel Ra and at least one first flow channel 30 located on the other side of the reference flow channel Ra. The primary branch flow channels 36a of the present embodiment extend through a center portion in the second direction of the heat transfer portion 20.

[0042] In the present embodiment, the body portion 3 includes a plurality of the first flow channels 30 located on each of the one side and the other side of the reference flow channel Ra in the first direction.

[0043] The plurality of the first flow channels 30 of the body portion 3 are grouped into two or more blocks B1 and B2. In the body portion 3 of the present embodiment, the entire portion on the one side in the first direction with the reference flow channel Ra as a boundary is grouped as a single block (hereinafter referred to as the "first large block B1"). In the body portion 3, the entire portion on the other side in the first direction with the reference flow channel Ra as a boundary is grouped as a single block (hereinafter referred to as the "second large block B2").

[0044] The plurality of the first flow channels 30 located in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction) are further grouped into a set of blocks B1a, B2a, B1b and B2b. The blocks B1a, B2a, B1b and B2b each include three or more first flow channels 30.

[0045] In the present embodiment, the first flow channel 30 located at an intermediate position (a center position in the present embodiment) in the first direction of each of the first large block B1 and the second large block B2 is an intermediate reference flow channel Rb at which the flow channel of the first fluid medium A is branched off. That is, the first large block B1 and the second large block B2 each are sectioned into a single block that includes all of the first flow channels 30 (the plurality of the first flow channels 30) located on the one side in the first direction with each corresponding intermediate reference flow channel Rb as a boundary (this block is hereinafter referred to as the "first small block") B1a or B2a, and a single block that includes all of the first flow channels 30 (the plurality of the first flow channels 30) located on the other side in the first direction with each corresponding intermediate reference flow channel Rb as a boundasry (this block is hereinafter referred to as the "second small block") B1b or B2b.

[0046] The pair of primary branch flow channels 36a respectively communicate with the intermediate reference flow channels Rb. Specifically, the one of the pair of primary branch flow channels 36a extends through the second small block B1b of the first large block B1 and communicates with the intermediate reference flow channel Rb of the first large block B1. The other of the pair of primary branch flow channels 36a extends through the first small block B2a of the second large block B2 and communicates with the intermediate reference flow channel Rb of the second large block B2.

[0047] As described above, the first large block B1 and the second large block B2 of the body portion 3 of the present embodiment are each sectioned into the blocks with the corresponding intermediate reference flow channel Rb. With this configuration, the body portion 3 includes at least the pair of secondary branch flow channels 36b. This pair of secondary branch flow channels 36b each provide communication (connection) between the corresponding intermediate reference flow channel Rb and at least one first flow channel 30 located on the one side of the corresponding intermediate reference flow channel Rb, or between the corresponding intermediate reference flow channel Rb and at least one first flow channel 30 located on the other side of the corresponding intermediate reference flow channel Rb in the first direction. That is, the body portion 3 of the present embodiment includes the secondary branch flow channel 36b that provides communication (connection) between the corresponding intermediate reference flow channel Rb and at least one first flow channel 30 of the first small blocks B1a and B2a, and between the corresponding intermediate reference flow channel Rb and at least one first flow channel 30 of the second small blocks B1b and B2b.

[0048] In the present embodiment, the first small blocks B1a and B2a, and the second small blocks B1b and B2b each include the plurality of the first flow channels 30.

[0049] In association with the above configuration, the body portion 3 includes connection flow channels 37a and 37b that provide communication between the adjacent first flow channels 30 in each of the first small blocks B1a and B2a, and the second small blocks B1b and B2b.

[0050] A more specific description is given herein. In the present embodiment, the pair of secondary branch flow channels 36b each provide communication between the corresponding intermediate reference flow channel Rb and the first flow channel 30 adjacent to the corresponding intermediate reference flow channel Rb. That is, one of the pair of secondary branch flow channels 36b communicates with the first flow channel 30 adjacent to the intermediate reference flow channel Rb in each of the first small blocks B1a and B2a. Also, the other of the pair of secondary branch flow channels 36b communicates with the first flow channel 30 adjacent to the intermediate reference flow channel Rb in each of the second small blocks B1b and B2b.

[0051] As described above, the pair of first small blocks B1a and B2a and the pair of second small blocks B1b and B2b each include a plurality of first flow channels 30. Along with this, the body portion 3 includes at least one connection flow channel 37a, 37b that provides connection between the first flow channels 30 in each of the first small blocks B1a and B2a (blocks on the one side of the intermediate reference flow channel Rb in the first direction), and at least one connection flow channel 37a, 37b that provides connection between the first flow channels 30 in each of the second small blocks B1b and B2b (blocks on the other side of the intermediate reference flow channel Rb in the first direction) in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). That is, the body portion 3 includes the connection flow channels 37a and 37b that provide communication between the adjacent first flow channels 30 in each of the first small blocks B1a and B2a, and the second small blocks B1b and B2b.

[0052] In the present embodiment, each of the first small blocks B1a and B2a and the second small blocks B1b and B2b includes four first flow channels 30. The body portion 3 of the present embodiment includes two connection flow channels 37a and 37b that each provide communication between the adjacent first flow channels 30 in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b.

[0053] One of the connection flow channels (hereinafter referred to as the "first connection flow channel") 37a provides communication between the one first flow channel 30 communicating with the secondary branch flow channel 36b and the one first flow channel (hereinafter referred to as the "primary side first flow channel") 30, which is adjacent to the intermediate reference flow channel Rb on the side opposite to the aforesaid first flow channel 30. On the other hand, the other of the connection flow channels (hereinafter referred to as the "second connection flow channel ") 37b provides communication between the primary side first flow channel 30 communicating with the first connection flow channel 37a and a plurality of the first flow channels (hereinafter referred to as the "outermost first flow channels) 30, the number of which is greater than the number of the reference flow channel Ra and which are located on the opposite side of the intermediate reference flow channel Rb to the primary side first flow channel 30. In the present embodiment, there are three first flow channels 30 communicating with the second connection flow channel 37b. The two first flow channels 30 except the primary side first flow channel 30, which is one among them, communicate with the first outflow communication flow channel 33.

[0054] The first connection flow channels 37a and the secondary branch flow channels 37b are arranged with a distance from each other in the second direction. In the present embodiment, the first connection flow channel 37a extends through the other end portion of the heat transfer plates 2 (heat transfer portion 20) in the second direction. The second connection flow channel 37b extends through the one end portion of the heat transfer plates 2 (heat transfer portion 20) in the second direction. With this configuration, in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b, the flow channel for the first fluid medium A from the intermediate reference flow channel Rb to the first outflow communication flow channel 33 forms a serpentine flow channel, in which the first fluid medium A changes its circulation direction in the second direction every time the first fluid medium A transfers to each adjacent first flow channel 30.

[0055] In the present embodiment, the first inflow communication flow channel 32 extends from the one end in the first direction to the reference flow channel Ra located at the intermediate position in the first direction, and communicates only with the reference flow channel Ra.

[0056] Contrary to the above, the first outflow communication flow channel 33 extends from one end to the other end in the first direction and communicates only with each of the outermost first flow channels 30 of the first small blocks B1a and B2a and the second small blocks B1b and B2b. That is, in the present embodiment, the terminal ends of the flow channels of the first fluid medium A in the first large block B1 and the second large block B2 are a plurality of first flow channels 30 located in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b.

[0057] Along with this, the plurality of first flow channels 30 that are located in each of the first large block B1 and the second large block B2, and that communicate only with the second connection flow channel 37b in between the intermediate reference flow channel Rb and the first outflow communication flow channel 33.

[0058] Contrary to the above, the second inflow communication flow channel 34 and the second outflow communication flow channel 35 each extend from one end to the other end in the first direction of the body portion 3. The plurality of the second flow channels 31 aligned in the first direction each communicate with the second inflow communication flow channel 34 and the second outflow communication flow channel 35.

[0059] Accordingly, in the plate heat exchanger 1 of the present embodiment, the flow channel of the first fluid medium A is arranged in serpentine manner between the first inflow communication flow channel 32 and the first outflow communication flow channel 33. On the other hand, the flow channel of the second fluid medium B is arranged to be straight between the second inflow communication flow channel 34 and the second outflow communication flow channel 35.

[0060] The plate heat exchanger 1 of the present embodiment includes the body portion 3 that includes the plurality of the stacked heat transfer plates 2, as described above. The body portion 3 includes the first flow channels 30 for circulating the first fluid medium A, the second flow channels 31 for circulating the second fluid medium B, the first inflow communication flow channel 32 and the first outflow communication flow channel 33 (a pair of first communication flow channels 32 and 33) that respectively communicate with the first flow channels 30 and allow the first fluid medium A to flow into and out of the first flow channels 30, and the second inflow communication flow channel 34 and the second outflow communication flow channel 35 (a pair of second communication flow channels 34 and 35) that respectively communicate with the second flow channels 31 and allow the second fluid medium B to flow into and out of the second flow channels 31. The first flow channels 30 and the second flow channels 31 are alternately formed with the heat transfer plates 2 respectively therebetween. The first inflow communication flow channel 32, the first outflow communication flow channel 33, the second inflow communication flow channel 34 and the second outflow communication flow channel 35 respectively extend through the heat transfer plates 2 in the first direction. The first flow channels 30 communicate with each other so that the flow channel for the first fluid medium A extending from the first inflow communication flow channel 32 to the first outflow communication flow channel 33 is formed. At least one of the plurality of first flow channels 30 is a reference flow channel Ra serving as a starting point of the flow channel for the first fluid medium A. The first inflow communication flow channel 32 communicates only with the reference flow channel Ra. The first outflow communication flow channel 33 communicates only with the plurality of first flow channels 30, the number of which is greater than the number of the reference flow channel Ra and which serve as terminal ends of the flow channels of the first fluid medium A.

[0061] Thus, according to the plate heat exchanger 1 of the present embodiment, the number of the plurality of first flow channels 30 communicating with the first outflow communication flow channel 33 is greater than the number of the reference flow channels Ra. Therefore, the cross sectional area of the flow channel for the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33 gradually increases toward the downstream side. Whereby, the plate heat exchanger 1 having the above configuration makes it possible to suppress increase in pressure loss in the entire flow channel of the fist fluid medium A, and hence achieve high heat exchange performance.

[0062] In the present embodiment, at least one first flow channel 30 located at an intermediate position in the first direction is the reference flow channel Ra serving as a starting point of the flow channel for the first fluid medium A. The body portion 3 includes a pair of primary branch flow channels 36a that each provide communication between the reference flow channel Ra and at least one first flow channel 30 located in each of the first large block B1 and the second large block B2 (blocks on one side and the other side of the reference flow channel Ra in the first direction). The first outflow communication flow channel 33 communicates only with the plurality of first flow channels 30, the number of which is greater than the number of the reference flow channels Ra and which serve as terminal ends of the flow channels of the first fluid medium A in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction).

[0063] Thus, according to the plate heat exchanger 1 of the present embodiment, the first inflow communication flow channel 32 communicates only with the reference flow channel Ra (first flow channel 30) located at an intermediate position in the first direction. Thus, the first inflow communication flow channel 32 is formed to extend up to only the intermediate position in the first direction. Whereby, it is possible to suppress increase in pressure loss of the first fluid medium A in the first inflow communication flow channel 32.

[0064] The pair of primary branch flow channels 36a provide communication between the reference flow channel Ra and at least one first flow channel 30 located in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). Consequently , two systems are formed as flow channels of the first fluid medium A within the body portion 3, one including the one primary branch flow channel 36a communicating with the reference flow channel Ra, and the other including the other primary branch flow channel 36a communicating with the reference flow channel Ra.

[0065] Accordingly, the length of the flow channel (the length of the flow channel per one system) of the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33 is shortened. Whereby, the plate heat exchanger 1 having the above configuration makes it possible to suppress increase in pressure loss in the entire flow channel of the first fluid medium A, and hence achieve high heat exchange performance.

[0066] In the present embodiment, a plurality of the first flow channels 30 are provided in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). In each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction), the first flow channel 30 located at an intermediate position in the first direction among the plurality of the first flow channels 30 is the intermediate reference flow channel Rb, at which the flow channel of the first fluid medium A is branched off. The body portion 3 includes at least one pair of secondary branch flow channels 36b that provide communication between the corresponding intermediate reference flow channel Rb and at least one first flow channel 30 located in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). The primary branch flow channels 36a communicate respectively with the intermediate reference flow channels Rb located in the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction).

[0067] Accordingly, the primary branch flow channels 36a each communicate only with the intermediate reference flow channel Rb located at an intermediate position in the first direction in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). Thus, the primary branch flow channels 36a each are formed to extend up only to the intermediate position in the first direction in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). Therefore, it is possible to suppress increase in pressure loss of the first fluid medium A in the primary branch flow channels 36a.

[0068] In each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction) of the body portion 3, two systems are formed as flow channels of the first fluid medium A, one including the one secondary branch flow channel 36b communicating with the intermediate reference flow channel Rb, and the other including the other secondary branch flow channel 36b communicating with the intermediate reference flow channel Rb.

[0069] Accordingly, in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction) of the body portion 3, the length of the flow channel of the first fluid medium A from the primary branch flow channel 36a to the first outflow communication flow channel 33 (the flow channel length per one system) is shortened. Whereby, the plate heat exchanger 1 having the above configuration makes it possible to further suppress increase in pressure loss in the entire flow channel of the first fluid medium A, and hence achieve high heat exchange performance.

[0070] A plurality of the first flow channels 30 are provided in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b in the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). A pair of the secondary branch flow channels 36b each communicate with the one first flow channel 30 located in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b (blocks on the one side and the other side of the intermediate reference flow channel Rb in the first direction). The body portion 3 includes at least one connection flow channel 37a and at least one connection flow channel 37b that each provide connection between the first flow channels 30 in each of the first small blocks B1a and B2a (blocks on the one side of the intermediate reference flow channel Rb in the first direction) and at least one connection flow channel 37a and at least one connection flow channel 37b that each provide connection between the first flow channels 30 in each of the second small blocks B1b and B2b (blocks on the other side of the intermediate reference flow channel Rb in the first direction), in the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). The first outflow communication flow channel 33 communicates only with the plurality of first flow channels 30, the number of which is greater than the number of the reference flow channels Ra, and which communicate with each other through the one second connection flow channel 37b (connection flow channel) in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b (blocks on the one side and the other side of the intermediate reference flow channel Rb). Whereby, the heat transmission area can be increased without increase in length of the flow channel of the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33.

[0071] In particular, the body portion 3 includes the first connection flow channels 37a each providing communication between the first flow channel 30 communicated with the corresponding secondary branch flow channel 36b and the other first flow channel 30, and the second connection flow channels 37b each providing communication between the plurality of the first flow channels 30 including the aforesaid other first flow channel 30, as the connection flow channels 37a and 37b. The first connection flow channels 37a and the second connection flow channels 37b are arranged with a distance from each other in the second direction (the direction orthogonal to the first direction). The first inflow communication flow channel 32 communicates with the first flow channels 30 other than the aforesaid other first flow channel 30, of the plurality of the first flow channels 30 connected to the second connection flow channel 37b. With this, the flow channel for the first fluid medium A from the reference flow channel Ra to the second connection flow channel 37b forms a serpentine flow channel. The first fluid medium A which circulates the first flow channels 30 forming such a serpentine flow channel and the second fluid medium B which circulates the second flow channels 31 adjacent to the respective first flow channels 30 are different from each other in heat exchanging timing. Accordingly, as the first fluid medium A flows from the upstream side to the downstream side, the first fluid medium A and the second fluid medium B securely perform heat exchange therebetween.

[0072] It is a matter of course that the plate heat exchanger according to the present invention is not necessarily limited to the above embodiment, and can be appropriately modified without departing from the gist of the present invention.

[0073] In the plate heat exchanger 1 of the above embodiment, the flow channel of the first fluid medium A in the first large block B1 and the flow channel of the first fluid medium A in the second large block B2 are symmetrically formed with reference to the reference flow channel Ra, but the present invention is not necessarily limited to this arrangement. The flow channel of the first fluid medium A in the first large block B1 and the flow channel of the first fluid medium A in the second large block B2 may be formed unsymmetrically with reference to the reference flow channel Ra. That is, the number of the first flow channels 30, the arrangement of the intermediate reference flow channels Rb, the arrangement of the secondary branch flow channels 36b or the like may be different from each other between the first large block B1 and the second large block B2.

[0074] In the above embodiment, the first large block B1 and the second large block B2 each are sectioned into two small blocks (the first small block and the second small block) B1a, B2a, B1b and B2b with reference to the intermediate reference flow channel Rb, but there is no limitation thereto. For example, in each of the first large block B1 and the second large block B2 located on both sides of the reference flow channel Ra, all of the first flow channels 30 may directly communicate with the first outflow communication flow channel 33. Even in this configuration, the first outflow communication flow channel 33 communicates only with the first flow channels 30, the number of which is greater than the number of the reference flow channel Ra and which serve as a terminal end of the flow channel of the first fluid medium A. Therefore, the cross sectional area of the flow channel of the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33 becomes greater as it advances toward the downstream side. Accordingly, the plate heat exchanger having such a configuration makes it possible to suppress increase in pressure loss in the entire flow channel of the first fluid medium A, and thus achieve high heat exchange performance.

[0075] In each of the first small blocks B1a and B2a and the second small blocks B1b and B2b of the above embodiment, the one first flow channel 30 adjacent to the intermediate reference flow channel Rb communicates with the first flow channel 30 adjacent to this first flow channel 30 via the first connection flow channel 37a. However, the present invention is not necessarily limited to this configuration. For example, as shown in Fig. 4, it may be configured such that the secondary branch flow channel 36b communicates with the first flow channel 30 adjacent to the intermediate reference flow channel Rb, and the first connection flow channel 37a provides communication between the first flow channel 30 communicating with the secondary branch flow channel 36b and a first group formed by a plurality of the first flow channels 30 including a first flow channel 30 adjacent to the aforesaid first flow channel 30, the number of the plurality of the first flow channels 30 being greater than the number of the reference flow channel Ra. And, it may be configured such that the second connection flow channel 37b provides communication between the first group and a second group adjacent to the first group, which is formed by a plurality of the first flow channels 30, the number of which is greater than the number of the first flow channels 30 of the first group, and the first outflow communication flow channel 33 communicates with the plurality of the first flow channels 30 of the second group.

[0076] Further, it may be configured such that, on the premise that the pair of secondary branch flow channels 36b each communicate with the plurality of the first flow channels 30 in the first small blocks B1a and B2a and the second small blocks B1b and B2b (blocks on the one side and the other side of the intermediate reference flow channel in the first direction), the body portion 3 has the configuration mentioned below.

[0077] The body portion 3 includes: the connection flow channel (first connection flow channel) 37a that provides communication between the first flow channels 30 communicating with one secondary branch flow channels 36b in the first small blocks B1a and B2a (blocks on the one side of the intermediate reference flow channel Rb in the first direction) and a plurality of the other first flow channels 30, the number of which is greater than the first flow channels 30 communicating with the one secondary branch flow channel 36b; and a connection flow channel (second connection flow channel) 37b that provides communication between the first flow channels 30 communicating with the other secondary branch flow channel 36b in the second small blocks B1b and B2b (blocks on the other side of the intermediate reference flow channel Rb in the first direction) and a plurality of the other first flow channels 30, the number of which is greater than the first flow channels 30 communicating with the other secondary branch flow channel 36b, in each of the first large block B1 and the second large block B2 (blocks on the one side and the other side of the reference flow channel Ra in the first direction). The first outflow communication flow channel 33 communicates only with a plurality of the other first flow channels (a plurality of the first flow channels communicating with only with the second connection flow channel 37b) 30 in each of the first small blocks B1a and B2a and the second small blocks B1b and B2b.

[0078] With the above configuration, a flow channel communicating between the groups (blocks) of the first flow channels 30 communicating with each other respectively via the connection flow channels 37a and 37b is formed. In this configuration, the number of the first flow channels 30 forming the second group (the group of the first flow channels 30) on the downstream side is greater than the number of the first flow channels 30 forming the first group (the group of the first flow channels 30) on the upstream side in the circulation direction of the first fluid medium A. Whereby, the cross sectional area of the flow channel of the first fluid medium A from the first inflow communication flow channel 32 to the first outflow communication flow channel 33 is stepwisely increased, with the result that the cross sectional area of the flow channel of the first fluid medium A is not sharply increased. Accordingly, even with increase in the heat transfer plates 2 and increase in the first flow channels 30 (even with increase in the heat transfer area contributing to the heat exchange in the entire body portion 3), it is possible to secure smooth circulation of the first fluid medium A, while suppressing increase in pressure loss in the flow channel of the first fluid medium A.

[0079] In the above embodiment, the first large block B1 and the second large block B2 are each sectioned into the first small blocks B1a and B2a and the second small blocks B1b and B2b, only, but there is no limitation thereto. For example, the first small blocks B1a and B2a and the second small blocks B1b and B2b may be further sectioned into smaller blocks. However, even in this case, the first outflow communication flow channel 33 communicates only with a plurality of the first flow channels 30, the number of which is greater than the number of the reference flow channel Ra, and which serve as a terminal end of the flow channel of the first fluid medium A within each sectioned block.

[0080] In the above embodiment, in the first small blocks B1a and B2a and the second small blocks B1b and B2b, these first flow channels 30 sequentially communicate with each other to allow the flow channel of the first fluid medium A to be formed in serpentine manner, but there is no limitation thereto. For example, it may be configured such that the first small blocks B1a and B2a and the second small blocks B1b and B2b each encompass a plurality of first flow channels 30, and all of the plurality of the first flow channels 30 communicate with the secondary branch flow channels 36b and the first outflow communication flow channel 33. In this way, the first fluid medium A flows from the secondary branch flow channels 36b into the plurality of the first flow channels 30, then circulates in the plurality of the first flow channels 30, and then flows out of the first outflow communication flow channel 33. In such a way in which the first fluid medium A is circulated in the plurality of the first flow channels 30, a large heat transfer area can be secured without extending the length of the flow channel of the first fluid medium A, and thereby a high heat exchange can be achieved.

[0081] The body portion 3 of the above embodiment includes a pair of primary branch flow channels 36a, but there is no limitation thereto. The body portion 3 may include two or more pairs of primary branch flow channels 36a. That is, the body portion 3 may include at least a pair of primary branch flow channels 36a.

[0082] In this case, the second pair of primary branch flow channels 36a each communicate only with the first flow channel 30 located in an area (second area) outside, with reference to the reference flow channel Ra, of the area (first area) in which the flow channel of the first fluid medium A with the first pair of primary branch flow channels 36a serving as a starting point is located. A plurality of the first flow channels 30, which serve as a terminal end of the flow channel of the first fluid medium A with the primary branch flow channel 36a (one of the second pair of the primary branch flow channels 36a) serving as a starting point on the one side of the reference flow channel Ra in the first direction, and a plurality of the first flow channels 30, which serve as a terminal end of the flow channel of the first fluid medium A with the primary branch flow channel 36a (the other of the second pair of the primary branch flow channels 36a) serving as a starting point on the other side of the reference flow channel Ra in the first direction communicate with the first outflow communication flow channel 33. In this case, the flow channel of the first fluid medium A that is located on the one side of the reference flow channel Ra in the first direction and has the primary branch flow channel 36a (one of the second pair of primary branch flow channels 36a) serving as a starting point, and the flow channel of the first fluid medium A that is located on the other side of the reference flow channel Ra in the first direction and has the primary branch flow channel 36a (the other of the second pair of primary branch flow channels 36a) are both arranged in the second area. In the flow channel of the first fluid medium A with the second pair of the primary branch flow channels 36a serving as a starting point, the number of the plurality of the first flow channels 30 which serve as a terminal end of this flow channel is greater than the number of the reference flow channel Ra.

[0083] That is, it may be configured such that the nth pair of primary branch flow channels 36a communicate only with the first flow channels 30 located in an area (the nth area) outside of the nth - 1 area of the body portion 3, and the flow channel of the first fluid medium A with the nth pair of primary branch flow channels 36a serving as a starting point is located in the nth area, in which n is natural number.

[0084] In the above embodiment, the plurality of the second flow channels 31 each communicate with the second inflow communication flow channel 34 and the second outflow communication flow channel 35, and the flow channel of the second fluid medium B that connects the second inflow communication flow channel 34 and the second outflow communication flow channel 35 is formed to be straight, but there is no limitation thereto. For example, the flow channel of the second fluid medium B that connects the second inflow communication flow channel 34 and the second outflow communication flow channel 35 may be formed in serpentine manner in the same manner as the flow channel of the first fluid medium A. That is, the flow channel of the second fluid medium B may be branched off at least at one place on each of the one side and the other side of the body portion 3 in the first direction, in the same manner as the flow channel of the first fluid medium A, and the second outflow communication flow channel 35 may communicate only with the second flow channel 31 that is located on each of the one side and the other side in the first direction in the body portion 3, and that is a terminal end of the flow channel through which the second fluid medium B circulates. Also, in this case, it may be configured such that a flow channel which serves as a branching position of the flow channel of the second fluid medium B is provided, and the body portion 3 is sectioned into small blocks with reference to this flow channel so that the circulation route of the second fluid medium B may be branched off at least at two places.

REFERENCE SIGNS LIST

[0085]

1	Plate Heat Exchanger
2	Heat Transfer Plate
3	Body Portion
4	First End Plate (End Plate)
5	Second End Plate (End Plate)
20	Heat Transfer Portion

21	Fitting Portion
30	First Flow Channel
31	Second Flow Channel
32	First Inflow Communication Flow Channel (One First Communication Flow Channel)
33	First Outflow Communication Flow Channel (Another First Communication Flow Channel)
34	Second Inflow Communication Flow Channel (One Second Communication Flow Channel)
35	Second Outflow Communication Flow Channel (Another Second Communication Flow Channel)
36a	Primary Branch Flow Channel
36b	Secondary Branch Flow Channel
36c	Tertiary Branch Flow Channel
37a	First Connection Flow Channel (Connection Flow Channel)
37b	Second Connection Flow Channel (Connection Flow Channel)
40, 50	Sealing Portion
41, 51	Fitting Portion
A	First Fluid Medium
B	Second Fluid Medium
B1	First Large Block (Block)
B2	Second Large Block (Block)
B1a, B2a	First Small Block (Block)
B1b, B2b	Second Small Block (Block)
B1a, B2a	First Small Block (Block)
Ra	Reference Flow Channel
Rb	Intermediate Reference Flow Channel

Claims

1. A plate heat exchanger comprising a body portion that includes a plurality of heat transfer plates stacked on each other, the body portion further including a plurality of first flow channels that circulate a first fluid medium, a plurality of second flow channels that circulate a second fluid medium, a pair of first communication flow channels that communicate with the plurality of the first flow channels and allow the first fluid medium to flow into and out of the plurality of the first flow channels, a pair of second communication flow channels that communicate with the plurality of the second flow channels and allow the second fluid medium to flow into and out of the plurality of the second flow channels, the plurality of the first flow channels and the plurality of the second flow channels being alternately formed with the plurality of the heat transfer plates being respectively interposed therebetween, and the pair of first communication flow channels and the pair of second communication flow channels extending in the stacked direction of the plurality of the heat transfer plates through the plurality of the heat transfer plates,
wherein the plurality of the first flow channels communicate with each other to form a flow channel of the first fluid medium from one of the pair of first communication flow channels to the other of the pair of first communication flow channels,
wherein at least one of the plurality of the first flow channels is a reference flow channel that serves as a starting point of the flow channel of the first fluid medium,
wherein the one of the pair of first communication flow channels communicates only with the reference flow channel, and
wherein the other of the pair of first flow channels communicates only with a plurality of the first flow channels, the number of the plurality of the first flow channels being greater than the number of the reference flow channel, and the plurality of the first flow channels serving as a terminal end of the flow channel of the first fluid medium.

2. The plate heat exchanger according to claim 1, wherein at least one the plurality of the first flow channels located at an intermediate position in the stacked direction of the plurality of the heat transfer plates is a reference flow channel which serves as a starting point of the flow channel of the first fluid medium,
wherein the body portion includes at least one pair of primary branch flow channels that provide communication between the reference flow channel and at least one first flow channel located on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates, and
wherein the other of the pair of first communication flow channels communicates only with a plurality of first flow channels which serve as a terminal end of the flow channel of the first fluid medium on each of the one end and the other end of the reference flow channel in the stacked direction of the plurality of the heat transfer plates, the number of the plurality of first flow channels being greater than the number of the reference flow channel.

3. The plate heat exchanger according to claim 2, wherein a plurality of the first flow channels are provided on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates,
wherein, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates, the first flow channel of the plurality of the first flow channels located at an intermediate position in the stacked direction of the plurality of the heat transfer plates is an intermediate reference flow channel that serves as a branching position of the flow channel of the first fluid medium,

wherein the body portion includes a pair of secondary branch flow channels that provide communication between the corresponding intermediate reference flow channel and at least one first flow channel located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates, and
wherein the pair of primary branch flow channels respectively communicate with the corresponding intermediate reference flow channels located respectively on the one side and the other side of the reference flow channel in the stacked direction of the plurality of the heat transfer plates.

4. The plate heat exchanger according to claim 3, wherein a plurality of the first flow channels are provided on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates,
wherein each of the pair of secondary branch flow channels communicates with one first flow channel located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates,
wherein the body portion includes at least one connection flow channel that connects the first flow channels with each other on one side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, and at least one connection flow channel that connects the first flow channels with each other on the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates, and
wherein the other of the pair of first communication flow channels communicates only with a plurality of first flow channels which communicate with each other via one connection flow channel on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, the number of the plurality of first flow channels being greater than the number of the reference flow channel.

5. The plate heat exchanger according to claim 4, wherein the body portion includes, as connection flow channels, a first connection flow channel that provides communication between the first flow channel communicating with the secondary branch flow channel and another first flow channel, and a second connection flow channel that communicates a plurality of the first flow channels including the other first flow channel with each other,
wherein the first connection flow channel and the second connection flow channel are arranged with a distance from each other in a direction orthogonal to the stacked direction of the plurality of the heat transfer plates, and
wherein the other of the pair of first communication flow channels communicates with the first flow channels other than the other first flow channel, of the plurality of the first flow channels being connected to the second connection flow channel.

6. The plate heat exchanger according to claim 3, wherein a plurality of the first flow channels are provided on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates,
wherein each of the pair of secondary branch flow channels communicates with a plurality of the first flow channels located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates;
wherein the body portion includes, on each of the one side and the other side of the reference flow channel in the stacked direction of the plurality of heat transfer plates, a connection flow channel that connects the plurality of the first flow channels communicating with one of the pair of the secondary branch flow channels and a plurality of the other first flow channels, the number of the plurality of the other first flow channels being greater than the number of the plurality of the first communication flow channels communicating with the one of the pair of the secondary branch flow channels on one side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates, and a connection flow channel that connects the plurality of the first flow channels communicating with the other of the pair of the secondary branch flow channels and a plurality of the other first flow channels, the number of the plurality of the other first flow channels being greater than the number of the plurality of the first communication flow channels communicating with the other of the pair of the secondary branch flow channels on the other side of the intermediate reference flow channel in the stacked direction of the plurality of the heat transfer plates, and
wherein the other of the first communication flow channels communicates only with the plurality of the other first flow channels located on each of the one side and the other side of the intermediate reference flow channel in the stacked direction of the plurality of heat transfer plates.

Fig. 1

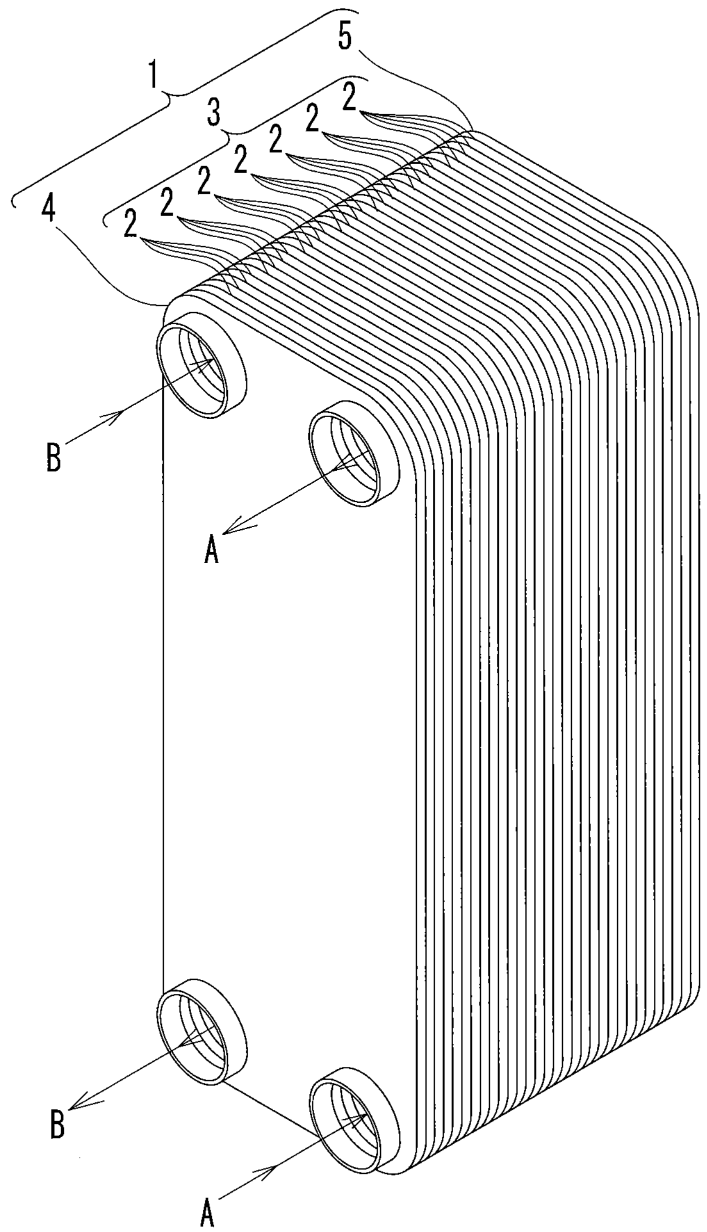


Fig. 2

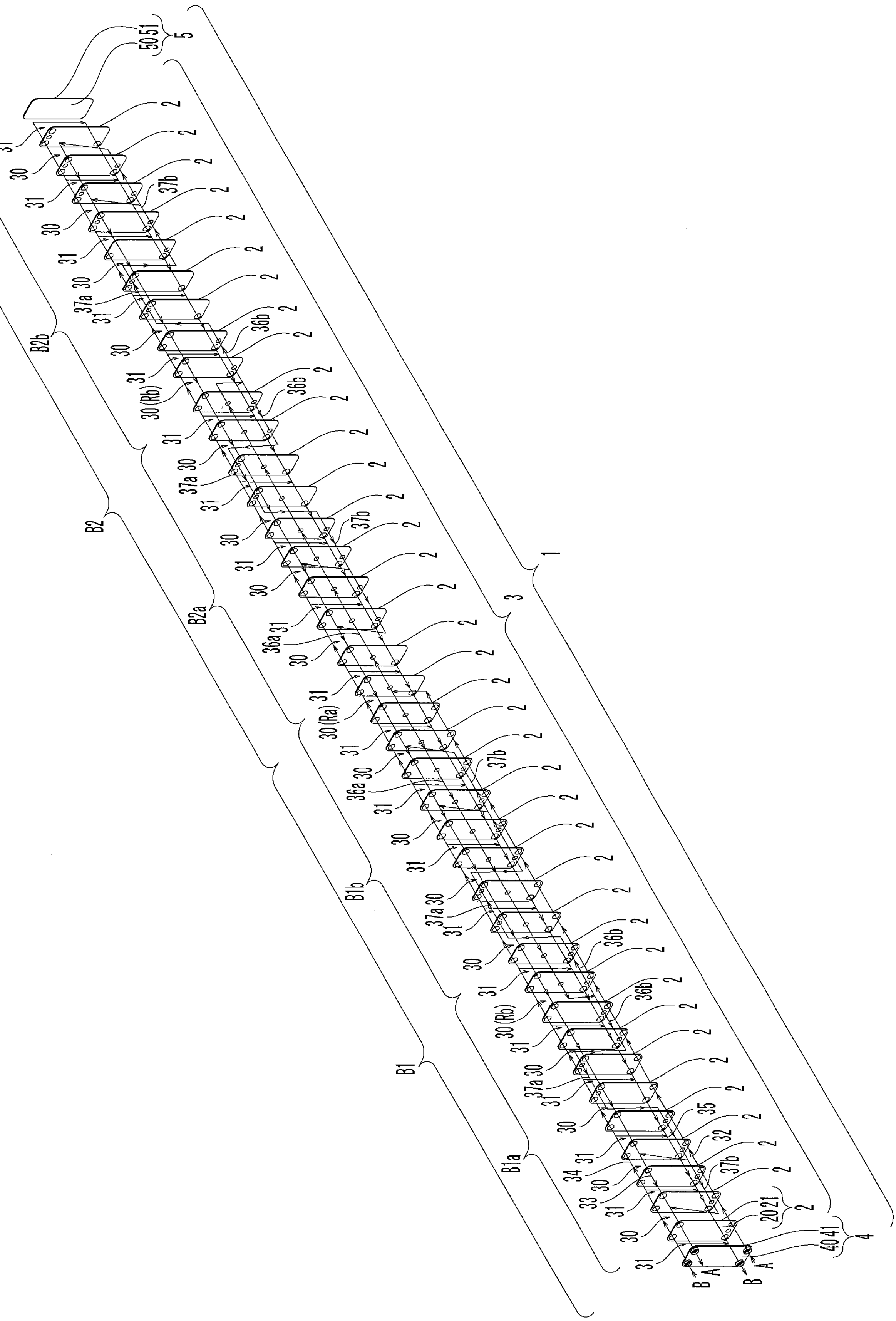
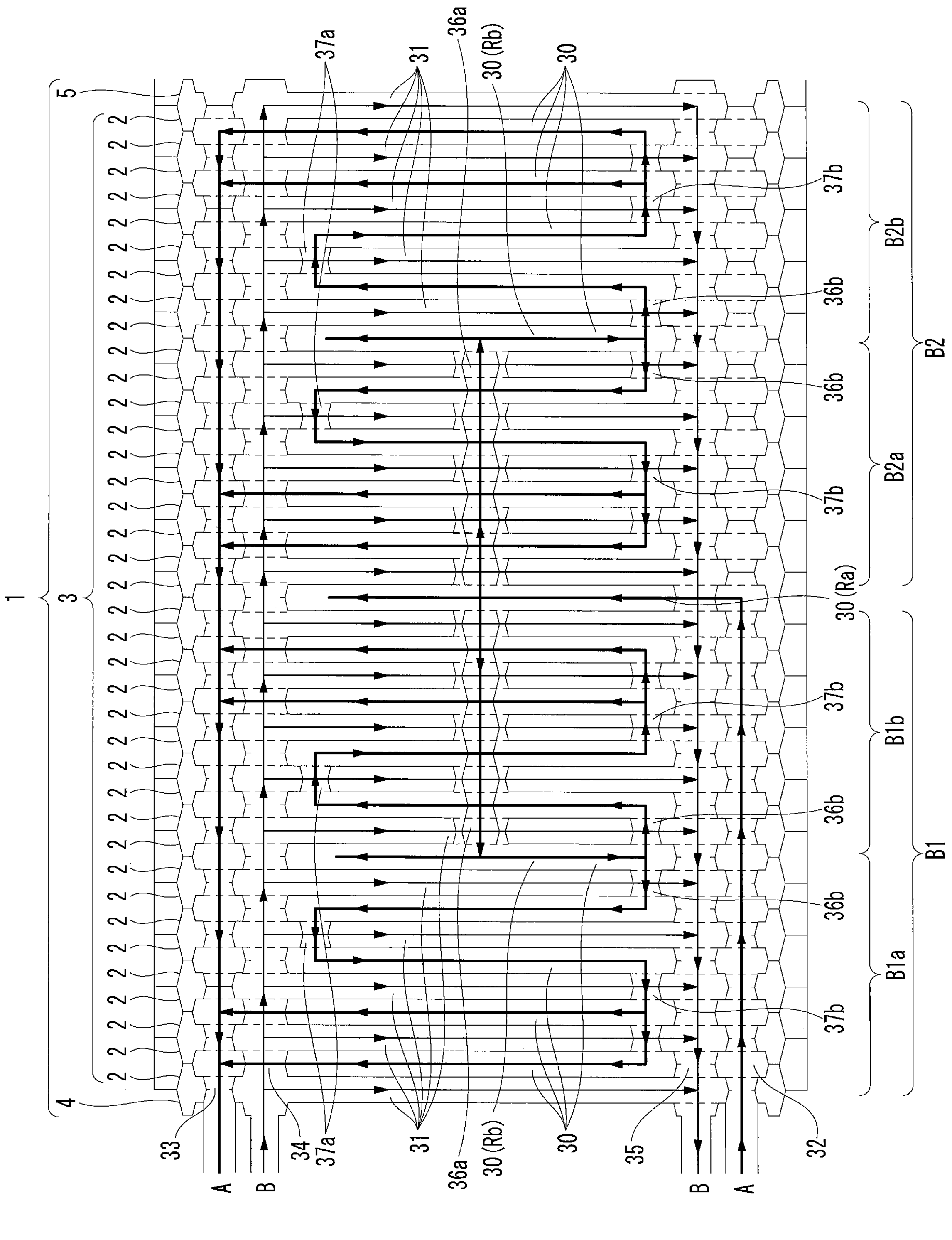


Fig. 3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30 (Rb)
31
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33
34
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36b
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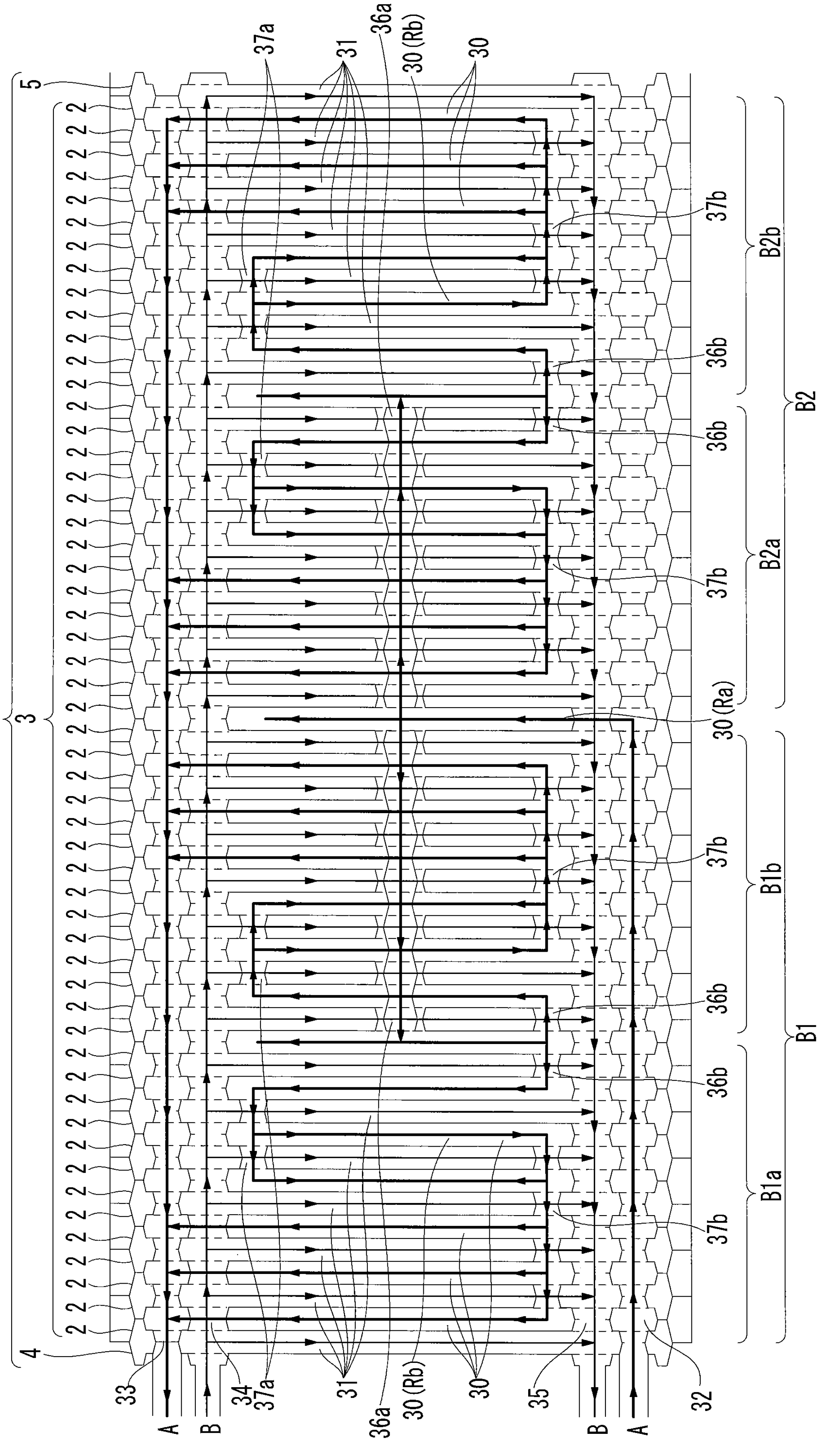
37b
A
B
B1
B1a
B1b
B2
B2a
B2b

Fig. 4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30 (Rb)
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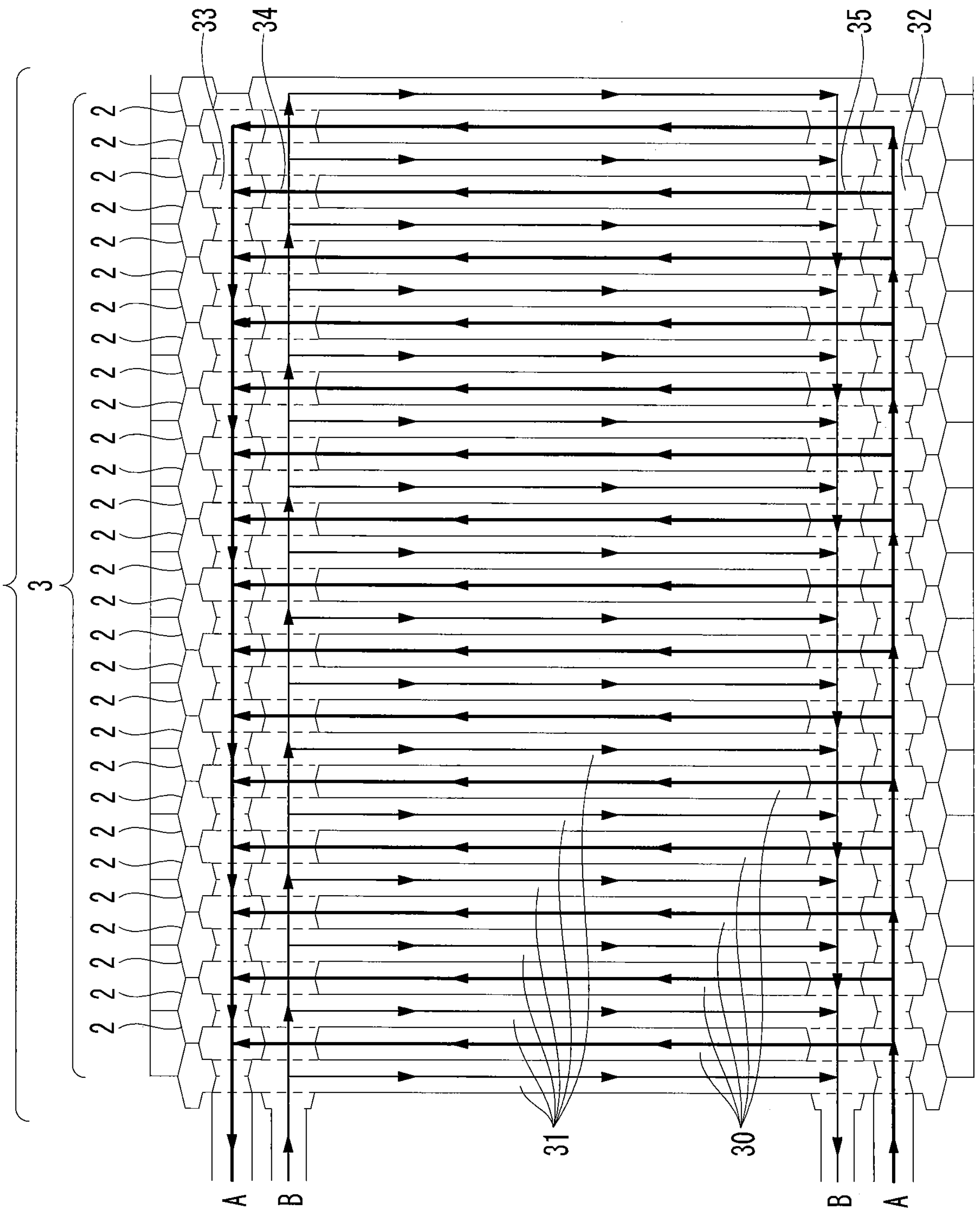
B1a
B1b
B2
B2a
B2b

Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/082582

A. CLASSIFICATION OF SUBJECT MATTER
F28F3/08(2006.01)i, *F28D9/02*(2006.01)i, *F28F9/22*(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)
F28F3/08, F28D9/02, F28F9/22

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2007/003193 A1 (ANMELDER), 11 January 2007 (11.01.2007), fig. 3; entire text; all drawings & EP 1902268 A & DE 102005031026 B & CN 101258377 A & AT 429624 T & DK 1902268 T & RU 2363904 C	1 2-6
A	JP 2012-229880 A (Hisaka Works, Ltd.), 22 November 2012 (22.11.2012), entire text; all drawings (Family: none)	1-6
A	JP 2005-509514 A (Cellular Process Chemistry Inc.), 14 April 2005 (14.04.2005), paragraphs [0186] to [0187] & US 2002/0106311 A1 & WO 2003/043730 A1	1-6

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

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Date of the actual completion of the international search 25 February, 2014 (25.02.14)	Date of mailing of the international search report 04 March, 2014 (04.03.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/082582

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 2002-267289 A (Sanyo Electric Co., Ltd.), 18 September 2002 (18.09.2002), entire text; all drawings (Family: none)	1-6
A	JP 10-288480 A (Daikin Industries, Ltd.), 27 October 1998 (27.10.1998), entire text; all drawings (Family: none)	1-6
A	JP 46-29951 B1 (Hisaka Works, Ltd.), 31 August 1971 (31.08.1971), entire text; all drawings (Family: none)	1-6
A	EP 608195 A1 (H.S.TARM A/S), 27 July 1994 (27.07.1994), entire text; all drawings & DE 69400757 C & DK 9300044 U	1-6
A	US 3106243 A (PETER SKJODE KNUDSEN), 08 October 1963 (08.10.1963), entire text; all drawings (Family: none)	1-6

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- JP 11287572 A **[0011]**