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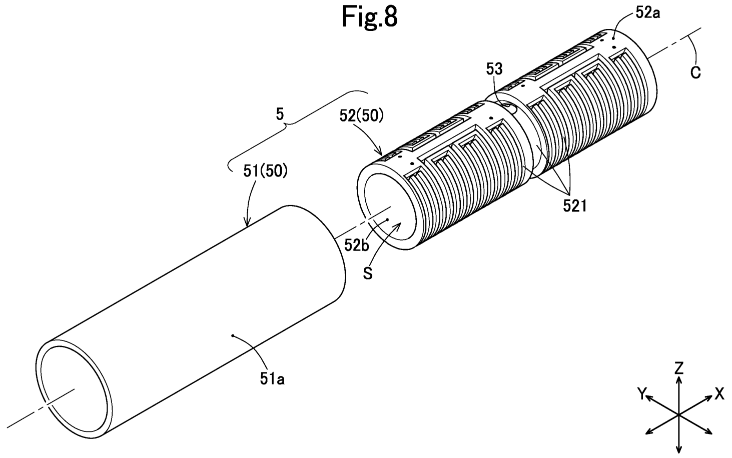
(54) PLATE HEAT EXCHANGER AND DISTRIBUTOR FOR PLATE HEAT EXCHANGER

(57) The present invention includes: a heat exchanger body including a plurality of heat transfer plates stacked on each other in a certain direction to form a plurality of first flow channels; and a distributor to allow a first fluid medium to be distributed. The plurality of heat transfer plates respectively have through holes at positions corresponding to each other. The through holes are lined up to form a communicating space communicating with the plurality of first flow channels. The distributor has a tubular wall defining a hollow portion and including a plurality of tubular portions overlapped with each other in their thickness direction. The tubular wall has a distributing flow channel in two or more of the plurality of tubular portions. The distributing flow channel includes: a distributing portion allowing the first fluid medium that has flown through the hollow portion to be distributed to one side and an other side in the certain direction; and a plurality of outflow portions each communicating with the one side and the other side of the distributing portion and communicating with the communicating space or the plurality of first flow channels.

Fig.8



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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2019-105205, the disclosure of which is incorporated herein by reference in its entirety.

FIELD

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

BACKGROUND

[0003] Conventionally known is a plate heat exchanger used as an evaporator for causing a fluid medium to evaporate or as a condenser for condensing a fluid medium (see Patent Literature 1). As shown in Fig. 26 to Fig. 28, this plate heat exchanger includes a plurality of heat transfer plates 101. The plurality of heat transfer platers 101 are stacked on each other in a thickness direction of each heat transfer plate 101 to thereby form first flow channels Fa through which a first fluid medium A, which is to evaporate or to be condensed, is circulated, and second flow channels Fb through which a second fluid medium B for causing the first fluid medium A to evaporate or condense is circulated. The second fluid medium B serves as a fluid medium to exchange heat with the first fluid medium A. Further, the plurality of heat transfer plates 101 are stacked on each other to thereby form a first fluid medium supply channel Fa1 that communicates with the first flow channels Fa and allows the first fluid medium A to flow into the first flow channels Fa, a first fluid medium discharge channel Fa2 that communicates with the first flow channels Fa and allows the first fluid medium A to flow out of the first flow channels Fa, a second fluid medium supply channel Fb1 that communicates with the second flow channels Fb and allows the second fluid medium B to flow into the second flow channels Fb, and a second fluid medium discharge channel Fb2 that communicates with the second flow channels Fb and allows the second fluid medium B to flow out of the second flow channels Fb.

[0004] Each of the plurality of heat transfer plates 101 is a plate having a rectangular shape, and has a plurality of valleys and ridges on both surfaces thereof. When the plurality of heat transfer plates 101 are stacked on each other, the ridges of the adjacent heat transfer plates 101 cross and abut against each other to thereby form the first flow channels Fa or the second flow channels Fb between the adjacent heat transfer plates 101. In this plate heat exchanger 100, the first flow channels Fa and the second flow channels Fb are formed alternately with the heat transfer plates 101 respectively interposed therebetween.

[0005] Each of the plurality of heat transfer plates 101 has through holes at corners. These through holes at the corners include a first through hole 102, a second through hole 103, a third through hole 104, and a fourth through hole 105. Thus, when the plurality of heat transfer plates 101 are stacked on each other, the first through holes 102 are lined up in an X-axis direction to form a first fluid medium supply channel Fa1. The second through holes 103 are lined up in the X-axis direction to form a first fluid medium discharge channel Fa2. The third through holes 104 are lined up in the X-axis direction to form a second fluid medium supply channel Fb1. The fourth through holes 105 are lined up in the X-axis direction to form a second fluid medium discharge channel Fb2.

[0006] In the plate heat exchanger 100 configured as above, the first fluid medium A supplied to the first fluid medium supply channel Fa1 flows into the first flow channels Fa for circulating therethrough, followed by flowing out to the first fluid medium discharge channel Fa2. The second fluid medium B supplied to the second fluid medium supply channel Fb1 flows into the second flow channels Fb for circulating therethrough, followed by flowing out to the second fluid medium discharge channel Fb2. At this time, the first fluid medium A flowing through the first flow channels Fa and the second fluid medium B flowing through the second flow channels Fb exchange heat with each other via the heat transfer plates 101 to thereby cause the first fluid medium A to evaporate or condense.

[0007] Generally, in the plate heat exchanger 100, the larger the number of the heat transfer plates 101 to be stacked on each other, the larger the total heat transfer area contributing to heat exchange, consequently being considered to increase heat exchange performance.

[0008] However, in the aforementioned plate heat exchanger 100, as the number of the heat transfer plates 101 increases, the length of the first fluid medium supply channel Fa1 increases and the circulating resistance of the first fluid medium A circulating through the first fluid medium supply channel Fa1 increases, thereby causing uneven distribution of the first fluid medium A to the plurality of first flow channels Fa. Consequently, heat exchange performance is degraded.

[0009] Specifically, as the length of the first fluid medium supply channel Fa1 increases in the direction in which the heat transfer plates 101 are stacked on each other, the circulating resistance of the first fluid medium A circulating through the first fluid medium supply channel Fa1 increases. Thus, as the number of the heat transfer plates 101 stacked on each other in the plate heat exchanger 100 increases, the circulating resistance causes unevenness between the amount of the first fluid medium A flowing into the first flow channels Fa on the inlet side of the first fluid medium supply channel Fa1 and the amount of the first fluid medium A flowing into the first flow channels Fa on the innermost side of the first fluid medium supply channel Fa1. That is, in the plate heat exchanger 100, uneven distribution of the first fluid medium A results from the circulating resistance as the number of the heat transfer plates 100 stacked on each other increases. This uneven distribution degrades heat exchange performance of the plate heat exchanger 100 as compared with the case where no uneven distribution occurs.

[0010] As described above, the plate heat exchanger 100 has limitations to increase heat exchange performance (i.e., evaporating performance or condensing performance) by increasing the number of the heat transfer plates 101 stacked on each other.

CITATION LIST

Patent Literature

[0011] Patent Literature 1: JP H11-287572 A

SUMMARY

Technical Problem

[0012] It is therefore an object of the present invention to provide a plate heat exchanger capable of suppressing uneven distribution of a first fluid medium to a plurality of first flow channels, and a distributor for the plate heat exchanger.

Solution to Problem

[0013] A plate heat exchanger according to the present invention includes: a heat exchanger body including a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween; and a distributor to allow the first fluid medium to be distributed to the plurality of first flow channels, in which two or more heat transfer plates continuously lined up out of the plurality of heat transfer plates each have a through hole at a mutually overlapping position as seen from the certain direction, the two or more heat transfer plates continuously lined up each have the through hole lined up in the certain direction to form a communicating space communicating with the plurality of first flow channels, the distributor has a tubular wall defining a hollow portion that extends in the certain direction in the communicating space and through which the first fluid medium supplied from outside the heat exchanger body is circulated, the tubular wall including a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall, the tubular wall has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped in the thickness direction out of the plurality of tubular portions, the distributing flow channel includes: a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion including a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to communicate with the communicating space or the plurality of first flow channels, and the plurality of outflow portions are arranged at intervals from each other in the certain direction.

[0014] In the plate heat exchanger, the configuration can be such that the distributing flow channel has: an opening portion communicating with the hollow portion; and a connecting flow channel extending along a peripheral direction of the tubular wall and connecting the opening portion and the distributing portion to each other.

[0015] In the plate heat exchanger, the configuration can be such that the distributing portion includes a distributing portion inlet that communicates with the hollow portion and through which the first fluid medium flows into the distributing portion from the hollow portion, the distributor includes a direction changing member arranged at a position corresponding to the distributing portion inlet in the hollow portion of the tubular wall, and the direction changing member has an internal space that allows the hollow portion and the distributing portion inlet to communicate with each other and through which the first fluid medium can be circulated, and causes the first fluid medium to pass through the internal space to allow a flow direction of the first fluid medium to be directed along the thickness direction of the tubular wall at a position of the distributing portion inlet.

[0016] In the plate heat exchanger, the configuration can be such that the heat exchanger body has, at a boundary position between the communicating space and each of the plurality of first flow channels, an opening portion through which the first fluid medium passes when flowing into the each of the plurality of first flow channels from the communicating space, and the opening portion causes differential pressure between the communicating space and the each of the plurality of first flow channels when the first fluid medium is circulated in the heat exchanger body.

[0017] A distributor for a plate heat exchanger according to the present invention is configured such that in the plate heat exchanger including a heat exchanger body including a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween, the distributor is arranged in a communicating space formed by through holes respectively of two or more heat transfer plates continuously lined up out of the plurality of heat transfer plates, the through holes line up in the certain direction, the communicating space communicating with the plurality of first flow channels, to allow the first fluid medium to be distributed to the plurality of first flow channels, the distributor includes a tubular wall defining a hollow portion that extends in the certain direction and through which the first fluid medium supplied from outside the plate heat exchanger is circulated when the distributor is arranged in the communicating space, the tubular wall includes a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall, and has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped in the thickness direction out of the plurality of tubular portions, the distributing flow channel includes: a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion including a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to be capable of communicating with the communicating space or the plurality of first flow channels, and the plurality of outflow portions are arranged at intervals from each other in the certain direction.

BRIEF DESCRIPTION OF DRAWINGS

[0018]

Fig. 1 is a perspective view of a plate heat exchanger according to an embodiment.
Fig. 2 is a front view of the plate heat exchanger.
Fig. 3 is an exploded perspective view of the plate heat exchanger with some configurations omitted.
Fig. 4 is a schematic cross-sectional view taken along line IV-IV in Fig. 2.
Fig. 5 is the same view as Fig. 4 but has a distributor removed.
Fig. 6 is a schematic cross-sectional view taken along line VI-VI in Fig. 2.
Fig. 7 is a schematic view of the distributor.
Fig. 8 is an exploded schematic view of the distributor.
Fig. 9 is a view of the distributor as viewed from an opening direction of an inflow opening.
Fig. 10 is a cross-sectional view taken along line X-X in Fig. 9.
Fig. 11 is a cross-sectional view taken along line XI-XI in Fig. 9.
Fig. 12 is a perspective view of an outer tubular portion of the distributor.
Fig. 13 is a view for describing a distributing flow channel of the distributor.
Fig. 14 is a partially enlarged view of Fig. 13.
Fig. 15 is a view for describing the distributing flow channel.
Fig. 16A is a schematic view showing a path of a first fluid medium flowing out of the distributor into first flow channels.
Fig. 16B is a conceptual view for describing a sectional area of a flow channel of the first fluid medium used for setting an opening area of an upstream end opening portion.
Fig. 17 is a view of a distributor according to another embodiment, as viewed from an opening direction of an inflow opening thereof.
Fig. 18 is a cross-sectional view taken along line XVIII-XVIII in Fig. 17.
Fig. 19 is a view for describing a distributing flow channel of the distributor.
Fig. 20 is a perspective view of a direction changing member.
Fig. 21 is a perspective view of a direction changing member.
Fig. 22 is a cross-sectional view for describing a state where the direction changing member is arranged.
Fig. 23 is a view for describing a state where a plurality of distributors are installed.
Fig. 24 is a partially enlarged cross-sectional view for describing a configuration of a distributing flow channel according to another embodiment.
Fig. 25 is a partially enlarged cross-sectional view for describing an opening direction of an inflow opening of a distributing flow channel according to another embodiment.
Fig. 26 is a front view of a conventional plate heat exchanger.
Fig. 27 is a schematic cross-sectional view taken along line XXVII-XXVII in Fig. 26.
Fig. 28 is a schematic cross-sectional view taken along line XXVIII-XXVIII in Fig. 26.

DESCRIPTION OF EMBODIMENTS

[0019] Hereinafter, one embodiment of the present invention will be described with reference to Fig. 1 to Fig. 16.

[0020] A plate heat exchanger according to this embodiment (hereinafter referred to also simply as "heat exchanger") causes a first fluid medium to evaporate or condense by exchanging heat with a second fluid medium. As shown in Fig. 1 to Fig. 6, this heat exchanger includes: a heat exchanger body 2 that includes a plurality of heat transfer plates 21 each having a surface extending in a direction orthogonal to a certain direction; and a distributor 5 arranged inside the heat exchanger body 2 and configured to distribute a first fluid medium A. In Fig. 3 to Fig. 6, the plurality of heat transfer plates 21 are schematically illustrated with projections and recesses omitted for ease of understanding of the configuration.

[0021] The heat exchanger body 2 includes: the plurality (four or more in this embodiment) of heat transfer plates 21 stacked on each other in the certain direction; a plurality of gaskets 22 arranged respectively between the plurality of heat transfer plates 21 stacked on each other; and a pair of end plates 23, 24 that sandwich the plurality of heat transfer plates 21 stacked on each other (i.e., a heat transfer plate group 21A) from both sides thereof in the certain direction. In this heat exchanger body 2, a first flow channel Ra through which the first fluid medium A is circulated or a second flow channel Rb through which a second fluid medium B is circulated is formed between each adjacent heat transfer plates 21 out of the plurality of heat transfer plates 21 stacked on each other in the certain direction. The heat transfer plates 21 of this embodiment each have a rectangular shape.

[0022] In the description below, a direction in which the heat transfer plates 21 are stacked on each other (the certain direction) is represented as an X-axis direction in the orthogonal coordinate system, a direction in which a short side of each of the plurality of heat transfer plates 21 extends is represented as a Y-axis direction of the orthogonal coordinate system, and a direction in which a long side of the heat transfer plate 21 extends is represented as a Z-axis direction of the orthogonal coordinate system.

[0023] Two or more heat transfer plates 21 continuously lined up in the X-axis direction out of the plurality of heat transfer plates 21 each have a through hole (first hole 211) at a position overlapping each other as seen from the X-axis direction. These two or more heat transfer plates 21 continuously lined up have their first holes 211 lined up in the X-axis direction to thereby form a communicating space Ra1 communicating with the first flow channel Ra (see Fig. 5). In the heat exchanger body 2 of this embodiment, each heat transfer plate 21 has the first hole 211, and the communicating space Ra1 extends from one end to the other end in the X-axis direction of the heat transfer plate group 21A.

[0024] Specifically, each heat transfer plate 21 is a metal plate, and has a rectangular shape elongated in the Z-axis direction. The heat transfer plate 21 has both surfaces in the X-axis direction each having a number of projections and recesses formed thereon. The projections of this embodiment extend along a Y-Z surface (i.e., surface including the Y-axis direction and the Z-axis direction) to thereby form ridges. Further, the recesses extend along the Y-Z surface to form valleys.

[0025] The heat transfer plate 21 is formed by pressing a flat metal plate. Thus, a ridge (projection) on one surface in the X-axis direction of the heat transfer plate 21 and a valley (recess) on the other surface thereof are formed at the same portion of the heat transfer plate 21. That is, at the portion of the heat transfer plate 21, when the one surface forms the ridge (projection) 211, the other surface forms the valley (recess) 212, and when the one surface forms the valley (recess), the other surface forms the ridge (projection).

[0026] Each heat transfer plate 21 has through holes (first hole 211, second hole 212, third hole 213, and fourth hole 214) at corners (see Fig. 3). Each of the through holes 211, 212, 213, 214 is a circular hole. Further, the first hole 211, the second hole 212, the third hole 213, and the fourth hole 214 share the same diameter (hole diameter).

[0027] The gaskets 22 are sandwiched respectively between the heat transfer plates 21 and brought into tight contact with the heat transfer plates 21 to define flow channels or the like through which the first fluid medium A or the second fluid medium B flows between the adjacent heat transfer plates 21, and secure liquid tightness of the flow channels or the like. Each of the gaskets 22 has at least one endless annular portion.

[0028] Each of the pair of end plates 23, 24 is a plate-shaped member having a shape corresponding to the heat transfer plates 21. The pair of end plates 23, 24 are provided to firmly sandwich the heat transfer plate group 21A, that is, the plurality of (200 in an example of this embodiment) heat transfer plates 21 stacked on each other, and are thus members each having a thick plate shape with sufficient strength. One end plate 23 out of the pair of end plates 23, 24 has through holes 231, 232, 233, 234 at positions corresponding to the respective through holes (i.e., the first hole 211, the second hole 212, the third hole 213, and the fourth hole 214) of each heat transfer plate 21. Each of the pair of end plates 23, 24 of this embodiment has a rectangular plate shape. Further, the one end plate 23 has the through holes 231, 232, 233, 234 at corners.

[0029] In the heat exchanger body 2 including the configurations 21, 22, 23, 24 as described above, the plurality of heat transfer plates 21 are stacked on each other so as to have the gaskets 22 respectively sandwiched between the respective adjacent heat transfer plates 21 to form the heat transfer plate group 21A. Further, in the heat exchanger body 2, the pair of end plates 23, 24 sandwiching the heat transfer plates group 21A from the outside in the X-axis direction are fastened with long bolts 25. In the heat exchanger body 2, this configuration allows the ridges of each adjacent heat transfer plates 21 to cross and abut against each other, and allows the gaskets 22 sandwiched by the respective heat transfer plates 21 to be in tight contact therewith. Consequently, a space with liquid tightness is formed between, for example, each adjacent heat transfer plates 21. The space with liquid tightness is a space through which the first fluid medium A or the second fluid medium B flows, such as the first flow channel Ra, the second flow channel Rb, the communicating space Ra1, or the like. Details of the space will be described below.

[0030] As shown in Fig. 4 to Fig. 6, the heat exchanger body 2 has the first flow channel Ra or the second flow channel Rb formed between each adjacent heat transfer plates 21. The first flow channel Ra and the second flow channel Rb are alternately arranged in the X-axis direction with the heat transfer plates 21 respectively interposed therebetween. That is, the heat exchanger body 2 has a plurality of first flow channels Ra and at least one second flow channel Rb. In the heat exchanger body 2 of this embodiment, the first fluid medium A flows through the first flow channels Ra to one side in the Z-axis direction (i.e., the upper side in Fig. 4), and the second fluid medium B flows through the second flow channels Rb to the other side in the Z-axis direction (i.e., the lower side in Fig. 6).

[0031] In the heat exchanger body 2, the first holes 211 are lined up in the X-axis direction to form the communicating space Ra1 that communicates with the first flow channels Ra and through which the distributor 5 is arranged. The communicating space Ra1 extends from one end to the other end in the X-axis direction of the heat transfer plate group 21A. One end (i.e., the left side in Fig. 5) in the X-axis direction of the communicating space Ra1 communicates with an external space through the through hole 231 of the one end plate 23, and the other end (i.e., the right side in Fig. 5) in the X-axis direction thereof is in contact with the other end plate 24 or the heat transfer plate immediately before the end plate 24 (i.e., the heat transfer plate having no through holes 211, 212, 213, 214).

[0032] In the heat exchanger body 2, the second holes 212 are lined up in the X-axis direction to form a first fluid medium discharge channel Ra2 that communicates with the first flow channels Ra and allows streams of the first fluid medium A flowing out of the first flow channels Ra to join together and be guided to one end in the X-axis direction of the heat transfer plate group 21A. The first fluid medium discharge channel Ra2 extends from the one end to the other end in the X-axis direction of the heat transfer plate group 21A. One end in the X-axis direction of the first fluid medium discharge channel Ra2 communicates with the external space through the through hole 232 of the one end plate 23, and the other end in the X-axis direction thereof is in contact with the other end plate 24 or the heat transfer plate immediately before the end plate 24.

[0033] In the heat exchanger body 2, as shown in Fig. 6, the third holes 213 are lined up in the X-axis direction to form a second fluid medium supply channel Rb1 that communicates with the second flow channels Rb and through which the second fluid medium B externally supplied flows into the second flow channels Rb. The second fluid medium supply channel Rb1 extends from the one end to the other end in the X-axis direction of the heat transfer plate group 21A. One end in the X-axis direction of the second fluid medium supply channel Rb1 communicates with the external space through the through hole 233 of the one end plate 23, and the other end in the X-axis direction thereof is in contact with the other end plate 24 or the heat transfer plate immediately before the end plate 24.

[0034] In the heat exchanger body 2, the fourth holes 214 are lined up in the X-axis direction to form a second fluid medium discharge channel Rb2 that communicates with the second flow channels Rb and allows streams of the second fluid medium B flowing out of the second flow channels Rb to join together and be guided to the one end in the X-axis direction of the heat transfer plate group 21A. The second fluid medium discharge channel Rb2 extends from the one end to the other end in the X-axis direction of the heat transfer plate group 21A. One end in the X-axis direction of the second fluid medium discharge channel Rb2 communicates with the external space through the through hole 234 of the one end plate 23, and the other end in the X-axis direction thereof is in contact with the other end plate 24 or the heat transfer plate immediately before the end plate 24.

[0035] The distributor 5 is configured to distribute the first fluid medium A supplied from outside the heat exchanger body 2 to each of the plurality of first flow channels Ra. As shown in Fig. 3, Fig. 4, and Fig. 7 to Fig. 12, the distributor 5 has a wall having a tubular shape (tubular wall) defining a hollow portion S that extends in the X-axis direction in the communicating space Ra1 and through which the first fluid medium A supplied from outside the heat exchanger body 2 is circulated. The tubular wall of this embodiment has a cylindrical shape, and the distributor 5 is formed only of the tubular wall. That is, the distributor (tubular wall) 5 of this embodiment has a cylindrical shape.

[0036] The distributor 5 has a plurality of tubular portions 50 overlapped with each other in a radial direction (i.e., a thickness direction of the tubular wall). This distributor 5 has a distributing flow channel 6 through which the first fluid medium A can be circulated, between at least two tubular portions 50 continuously overlapped in the radiation direction out of the plurality of tubular portions 50 (see Fig. 10 and Fig. 11).

[0037] The distributor 5 of this embodiment extends from one end to the other end in the X-axis direction of the communicating space Ra1. That is, one end in the X-axis direction of the distributor 5 is located at the through hole 231 of the one end plate 23, and the other end in the X-axis direction of the distributor 5 is in contact with the other end plate 24 or the heat transfer plate immediately before the end plate 24. The hollow portion S of the distributor 5 communicates with the external space of the heat exchanger body 2 through the through hole 231 of the one end plate 23. The distributor 5 of this embodiment has the two tubular portions 50 (i.e., an outer tubular portion 51 and an inner tubular portion 52) overlapped with each other in the radial direction. The distributing flow channel 6 is formed between the two tubular portions 51, 52 overlapped with each other in the radial direction.

[0038] The outer tubular portion 51 is a member having a cylindrical shape. The outer tubular portion 51 has an outer diameter smaller than the diameter of the first hole 211 of each heat transfer plate 21. With this configuration, a gap G is formed between an outer peripheral surface 51a of the outer tubular portion 51 and opening edge portions respectively of the first holes 211 of the heat transfer plates 21 in the state where the distributor 5 is arranged through the communicating space Ra1 (see Fig. 4). In the heat exchanger 1 of this embodiment, the gap G is maintained, for example, by arranging a flange at an end in the X-axis direction of the distributor 5 and fixing the flange to an opening edge portion of the through hole 231 of the one end plate 23.

[0039] The outer tubular portion 51 has a plurality of through holes 511. Each of the plurality of through holes 511 is a hole through which the first fluid medium A that has flown through the distributing flow channel 6 flows out of the distributor 5.

[0040] The plurality of through holes 511 are provided at locations corresponding to the respective downstream ends (i.e., outflow portions 616: see Fig. 14) of the distributing flow channel 6. The plurality of through holes 511 are arranged at intervals in the X-axis direction from each other. The portion on the other side in the Z-axis direction of the outer tubular portion 51 (i.e., the lower portion in Fig. 12) of this embodiment has a row of the through holes 511 formed to extend through the entire region in the X-axis direction. In the outer tubular portion 51, a plurality of (two in the example shown in Fig. 12) rows of the through holes 511 each including the plurality of (16 in the example shown in Fig. 12) through holes 511 lined up in the X-axis direction at intervals from each other are arranged away from each other in a peripheral direction of the outer tubular portion 51.

[0041] The inner tubular portion 52 is a member having a cylindrical shape and arranged inside the outer tubular portion 51, and has an outer diameter corresponding to the inner diameter of the outer tubular portion 51. The inner tubular portion 52 has an outer peripheral surface 52a on which a groove 521 having a shape corresponding to the distributing flow channel 6 is formed. The inner tubular portion 52 has an inner peripheral surface 52b defining (surrounding) the hollow portion S. Further, the inner tubular portion 52 has an inflow opening 53 allowing the hollow portion S and the inside of the groove 521 to communicate with each other.

[0042] The inner tubular portion 52 described as above is arranged inside the outer tubular portion 51, that is, the outer tubular portion 51 and the inner tubular portion 52 are overlapped with each other in the radial direction to thereby allow a radially outward opening of the groove 521 of the inner tubular portion 52 to be covered with the inner peripheral surface 51b of the outer tubular portion 51. A space (region) surrounded by the groove 521 and the inner peripheral surface 51b functions as the distributing flow channel 6.

[0043] The distributing flow channel 6 allows the first fluid medium A that has flown in from the hollow portion S to be distributed to one side and the other side in the X-axis direction at least once, and to flow out of the distributor 5 at positions corresponding to the respective ones of the plurality of first flow channels Ra lined up in the X-axis direction.

[0044] As shown also in Fig. 13 to Fig. 15, the distributing flow channel 6 includes a first distributing portion (distributing portion) 603 and the plurality of the outflow portions 616. Further, the distributing flow channel 6 includes an inflow opening portion (opening portion) 601 and a first connecting flow channel (connecting flow channel) 602. The first distributing portion 603 allows the first fluid medium A that has flown into the distributing flow channel 6 to be distributed to the one side and the other side in the X-axis direction. The plurality of outflow portions 616 each are directly or indirectly connected to the first distributing portion 603 and penetrate though the outer tubular portion 51 to thereby communicate with the communicating space Ra1 or the corresponding ones of the first flow channels Ra. The inflow opening portion 601 communicates with the hollow portion S of the distributor 5. The first connecting flow channel 602 extends along the peripheral direction of the distributor 5, and connects the inflow opening portion 601 and the first distributing portion 603 to each other.

[0045] Fig. 13 shows a pattern of a path of the distributing flow channel 6 in the state where the distributor 5 is cut for development along the X-axis direction (a direction of a center axis C of the distributor 5: see Fig. 7) so as to pass through an opposite position in the peripheral direction to a center of the inflow opening 53. Fig. 14 is a partial enlarged view of Fig. 13. Fig. 15 shows the pattern of the path of the distributing flow channel 6 in the state where the distributor 5 is cut for development along the X-axis direction so as to pass through the center of the inflow opening 53 of the inner tubular portion 52.

[0046] The distributing flow channel 6 of this embodiment includes, sequentially from its upstream end toward its downstream end, the inflow opening portion 601, the first connecting flow channel 602, the first distributing portion 603, a first distributing flow channel 604, a peripheral distributing portion 605, a peripheral distributing flow channel 606, a second distributing portion 607, a second distributing flow channel 608, a second connecting flow channel 609, a third distributing portion 610, a third distributing flow channel 611, a third connecting flow channel 612, a fourth distributing portion 613, a fourth distributing flow channel 614, a fourth connecting flow channel 615, and the outflow portions 616.

[0047] In Fig. 13, the distributing flow channel 6 is substantially linearly symmetrical with a virtual line C1 that passes through the center of the inflow opening 53 (inflow opening portion 601) and extends in the peripheral direction. Further, the distributing flow channel 6 is substantially linearly symmetrical with a virtual line C2 that passes through the center and extends in the X-axis direction. A detailed description will be hereinafter given on a circulating path of the first fluid medium A from the inflow opening portion 601 to one of the outflow portions 616, with reference to Fig. 13 to Fig. 15.

[0048] The inflow opening portion 601 is the upstream end of the distributing flow channel 6, and communicates with the hollow portion S to thereby allow the first fluid medium A flowing through the hollow portion S to flow into the distributing flow channel 6. The inflow opening portion 601 is formed by the inflow opening 53 of the inner tubular portion 52. The inflow opening portion 601 of this embodiment is arranged at a central position in the X-axis direction of the distributor 5.

[0049] The first connecting flow channel 602 extends along the peripheral direction to thereby connect the inflow opening portion 601 and the first distributing portion 603 to each other. The first connecting flow channel 602 of this embodiment includes a channel segment extending to one side (i.e., the right side in Fig. 13) and a channel segment extending to the other side (i.e., the left side in Fig. 13), in the peripheral direction from the inflow opening portion 601. That is, two first connecting flow channels 602 are arranged.

[0050] The first distributing portion 603 allows the first fluid medium A that has flown into the first distributing portion 603 to be distributed to one side (i.e., the upper side in Fig. 13) and the other side (i.e., the lower side in Fig. 13) in the X-axis direction. Specifically, the first distributing portion 603 includes: a first distributing portion inlet (distributing portion inlet) 6031 that is arranged on an opposite side in the peripheral direction to the inflow opening portion 601 and through which the first fluid medium A flows in; a one side outlet (one side distributing portion outlet) 6032 through which the first fluid medium A flows out to the one side in the X-axis direction; and an other side outlet (other side distributing portion outlet) 6033 through which the first fluid medium A flows out to the other side in the X-axis direction.

[0051] The first distributing portion 603 of this embodiment includes: a first distributing portion inlet 6031a that communicates with the first connecting flow channel 602 extending to the one side in the peripheral direction from the inflow opening portion 601; and a first distributing portion inlet 6031b that communicates with the first connecting flow channel 602 extending to the other side in the peripheral direction from the inflow opening portion 601. That is, the first distributing portion 603 includes the two first distributing portion inlets 6031a and 6031b.

[0052] The first distributing flow channel 604 includes a channel segment extending to the one side and a channel segment extending to the other side in the X-axis direction from the first distributing portion 603. That is, a pair of first distributing flow channels 604 are arranged to extend from the single first distributing portion 603. Specifically, one first distributing flow channel 604a out of the pair of first distributing flow channels 604 extends to one side in the X-axis direction from the one side outlet 6032 of the first distributing portion 603. The other first distributing flow channel 604b out of the pair of first distributing flow channels 604 extends to the other side in the X-axis direction from the other side outlet 6033 of the first distributing portion 603. The one first distributing flow channel 604a and the other first distributing flow channel 604b share the same length.

[0053] The peripheral distributing portion 605 communicates with the corresponding one of the pair of first distributing flow channels 604, and allows the first fluid medium A flowing in through the first distributing flow channel 604 to be distributed to the one side and the other side in the peripheral direction. Specifically, the peripheral distributing portion 605 is arranged at an interval in the X-axis direction from the first distributing portion 603, and includes: a peripheral distributing portion inlet 6051 through which the first fluid medium A flows in; a one side outlet 6052 through which the first fluid medium A flows out to the one side in the peripheral direction; and an other side outlet 6053 through which the first fluid medium A flows out to the other side in the peripheral direction.

[0054] The peripheral distributing flow channel 606 includes a channel segment extending to one side and a channel segment extending to the other side in the peripheral direction from the peripheral distributing portion 605. That is, a pair of peripheral distributing flow channels 606 are arranged to extend from the single peripheral distributing portion 605. Specifically, one peripheral distributing flow channel 606a out of the pair of peripheral distributing flow channels 606 extends to one side in the peripheral direction from the one side outlet 6052 of the peripheral distributing portion 605. The other peripheral distributing flow channel 606b out of the pair of peripheral distributing flow channels 606 extends to the other side in the peripheral direction from the other side outlet 6053 of the peripheral distributing portion 605. The one peripheral distributing flow channel 606a and the other peripheral distributing flow channel 606b share the same length.

[0055] The second distributing portion 607 communicates with the corresponding one of the pair of peripheral distributing flow channels 606, and allows the first fluid medium A flowing in through the peripheral distributing flow channel 606 to be distributed to the one side and the other side in the X-axis direction. Specifically, the second distributing portion 607 is arranged at an interval in the peripheral direction from the peripheral distributing portion 605, and includes: a second distributing portion inlet 6071 through which the first fluid medium A flows in; a one side outlet 6072 through which the first fluid medium A flows out to the one side in the X-axis direction; and an other side outlet 6073 through which the first fluid medium A flows out to the other side in the X-axis direction.

[0056] The second distributing flow channel 608 includes a channel segment extending to one side and a channel segment extending to the other side in the X-axis direction from the second distributing portion 607. That is, a pair of second distributing flow channels 608 are arranged to extend from the single second distributing portion 607. Specifically, one second distributing flow channel 608a out of the pair of second distributing flow channels 608 extends to one side in the X-axis direction from the one side outlet 6072 of the second distributing portion 607. The other second distributing flow channel 608b out of the pair of second distributing flow channels 608 extends to the other side in the X-axis direction from the other side outlet 6073 of the second distributing portion 607. The one second distributing flow channel 608a and the other second distributing flow channel 608b share the same length.

[0057] The second connecting flow channel 609 extends in the peripheral direction to thereby connect the corresponding one of the pair of second distributing flow channels 608 and the third distributing portion 610 to each other. The second connecting flow channel 609 of this embodiment extends from the downstream end of the second distributing flow channel 608 to the other side in the peripheral direction.

[0058] The third distributing portion 610 communicates with the second connecting flow channel 609, and allows the first fluid medium A flowing in through the second connecting flow channel 609 to be distributed to the one side and the other side in the X-axis direction. Specifically, the third distributing portion 610 is arranged at an interval in the peripheral direction from the downstream end of the second distributing flow channel 608, and includes: a third distributing portion inlet 6101 through which the first fluid medium A flows in; a one side outlet 6102 through which the first fluid medium A flows out to the one side in the X-axis direction; and an other side outlet 6103 through which the first fluid medium A flows out to the other side in the X-axis direction.

[0059] The third distributing flow channel 611 includes a channel segment extending to one side and a channel segment extending to the other side in the X-axis direction from the third distributing portion 610. That is, a pair of third distributing flow channels 611 are arranged to extend from the single third distributing portion 610. Specifically, one third distributing flow channel 611a out of the pair of third distributing flow channels 610 extends to one side in the X-axis direction from the one side outlet 6102 of the third distributing portion 610. The other third distributing flow channel 611b out of the pair of third distributing flow channels 611 extends to the other side in the X-axis direction from the other side outlet 6103 of the third distributing portion 610. The one third distributing flow channel 611a and the other third distributing flow channel 611b share the same length.

[0060] The third connecting flow channel 612 extends in the peripheral direction to thereby connect the corresponding one of the pair of third distributing flow channels 611 and the fourth distributing portion 613 to each other. The third connecting flow channel 612 of this embodiment extends from the downstream end of the third distributing flow channel 611 to the one side in the peripheral direction.

[0061] The fourth distributing portion 613 communicates with the third connecting flow channel 612, and allows the first fluid medium A flowing in through the third connecting flow channel 612 to be distributed to the one side and the other side in the X-axis direction. Specifically, the fourth distributing portion 613 is arranged at an interval in the peripheral direction from the downstream end of the third distributing flow channel 611, and includes: a fourth distributing portion inlet 6131 through which the first fluid medium A flows in; a one side outlet 6132 through which the first fluid medium A flows out to the one side in the X-axis direction; and an other side outlet 6133 through which the first fluid medium A flows out to the other side in the X-axis direction.

[0062] The fourth distributing flow channel 614 includes a channel segment extending to one side and a channel segment extending to the other side in the X-axis direction from the fourth distributing portion 613. That is, a pair of fourth distributing flow channels 614 are arranged to extend from the single fourth distributing portion 613. Specifically, one fourth distributing flow channel 614a out of the pair of fourth distributing flow channels 614 extends to one side in the X-axis direction from the one side outlet 6132 of the fourth distributing portion 613. The other fourth distributing flow channel 614b out of the pair of fourth distributing flow channels 614 extends to the other side in the X-axis direction from the other side outlet 6133 of the fourth distributing portion 613. The one fourth distributing flow channel 614a and the other fourth distributing flow channel 614b share the same length.

[0063] The fourth connecting flow channel 615 extends in the peripheral direction to thereby connect the corresponding one of the pair of fourth distributing flow channels 614 and the corresponding one of the outflow portions 616 to each other. The fourth connecting flow channel 615 of this embodiment extends from the downstream end of the fourth distributing flow channel 614 to the other side in the peripheral direction.

[0064] The outflow portion 616 is the downstream end of the distributing flow channel 6, and communicates with the communicating space Ra1 or the first flow channels Ra to thereby allow the first fluid medium A that has flown through the distributing flow channel 6 to flow out to the communicating space Ra1 or the first flow channels Ra. The outflow portion 616 is formed by the corresponding one of the through holes 511 of the outer tubular portion 51.

[0065] The distributing flow channel 6 of this embodiment includes the circulating paths each from the inflow opening portion 601 to the outflow portion 616 configured as above, and the number of such circulating paths is the same as the number of (32 in this embodiment) outflow portions 616. Further, in the distributing flow channel 6, the circulating paths in the number equal to the number of the outflow portions 515 share the same distance.

[0066] In the heat exchanger 1 configured as above, when the first fluid medium A is supplied from, for example, a pipe connected to the through hole 231 of the one end plate 23 to the hollow portion S of the distributor 5 through the through hole 231, the first fluid medium A flows through the hollow portion S to the other side in the X-axis direction. When the first fluid medium A reaches the inflow opening 53 (inflow opening portion 601) provided at an intermediate portion in the X-axis direction of the hollow portion S, the first fluid medium A flows into the distributing flow channel 6 through the inflow opening 53 (inflow opening portion 601).

[0067] The first fluid medium A that has flown in the distributing flow channel 6 flows through the pair of first connecting flow channels 602 each extending in the peripheral direction from the inflow opening portion 601 to flow into the first distributing portion 603 and to be distributed to the one side and the other side in the X-axis direction by the first distributing portion 603.

[0068] The first fluid medium A that has been distributed by the first distributing portion 603 flows through the pair of first distributing flow channels 604 each extending from the first distributing portion 603 to flow into the peripheral distributing portion 605 arranged at an interval on the one side in the X-axis direction from the first distributing portion 603 and into the peripheral distributing portion 605 arranged at an interval on the other side in the X-axis direction from the first distributing portion 603, and to be distributed to the one side and the other side in the peripheral direction by the respective peripheral distributing portions 605.

[0069] The first fluid medium A that has been distributed by each of the peripheral distributing portions 605 flows through the corresponding one of the peripheral distributing flow channels 606 to flow into the corresponding one of the second distributing portions 607 to which the peripheral distributing flow channel 606 is connected, and to be distributed to the one side and the other side in the X-axis direction by the second distributing portion 607.

[0070] The first fluid medium A that has been distributed by each of the second distributing portions 607 sequentially flows through the corresponding one of the second distributing flow channels 608 and the corresponding one of the second connecting flow channels 609 extending in the peripheral direction from the second distributing flow channel 608 to flow into the third distributing portion 610 arranged at an interval on the one side in the X-axis direction from the second distributing portion 607 and into the third distributing portion 610 arranged at an interval on the other side in the X-axis direction from the second distributing portion 607, and to be distributed to the one side and the other side in the X-axis direction by the respective third distributing portions 610.

[0071] Subsequently, the first fluid medium A that has been distributed by each of the third distributing portions 610 sequentially flows through the corresponding one of the third distributing flow channels 611 and the corresponding one of the third connecting flow channels 612 extending in the peripheral direction from the third distributing flow channel 611 to flow into the fourth distributing portion 613 arranged at an interval on the one side in the X-axis direction from the third distributing portion 610 and into the fourth distributing portion 613 arranged at an interval on the other side in the X-axis direction from the third distributing portion 610, and to be distributed to the one side and the other side in the X-axis direction by the respective fourth distributing portions 613.

[0072] Further, the first fluid medium A that has been distributed by each of the fourth distributing portions 613 sequentially flows through the corresponding one of the fourth distributing flow channels 614 and the corresponding one of the fourth connecting flow channels 615 extending in the peripheral direction from the fourth distributing flow channel 614 to reach the outflow portion 616 arranged at an interval on the one side in the X-axis direction from the fourth distributing portion 613 and the outflow portion 616 arranged at an interval on the other side in the X-axis direction from the fourth distributing portion 613.

[0073] The first fluid medium A that has reached the plurality of outflow portions 616 that serve as the downstream ends of the distributing channel 6 flows out of the distributor 5 (flows out to the communicating space Ra1) through the through holes 511 of the outer tubular portion 51 serving as the respective outflow portions 616.

[0074] As described above, the first fluid medium A that has flown into the distributing flow channel 6 through the inflow opening 53 (inflow opening portion 601) provided at the intermediate portion in the X-axis direction of the hollow portion S is distributed to the one side and the other side in the X-axis direction by the first distributing portion 603, the respective second distributing portions 607, the respective third distributing portions 610, and the respective fourth distributing portions 613, which are respectively arranged at different positions in the X-axis direction, to be thereby supplied to the entire region in the X-axis direction of the communicating space Ra1 while uneven distribution thereof is suppressed.

[0075] As shown in Fig. 16A, the first fluid medium A that has flown out to the communicating space Ra1 flows along the outer peripheral surface (outer peripheral surface of the outer tubular portion 51) 51a of the distributor 5 in the gap around the periphery of the distributor 5 (i.e., the gap formed between the periphery of the distributor 5 and the members defining the communicating space Ra1), and flows into the first flow channels Ra located close in the X-axis direction to the through hole 511 through which the first fluid medium A has flown out.

[0076] An opening at an upstream end of each of the first flow channels Ra in the heat exchanger body 2 of this embodiment, specifically, the opening located at a boundary position between the first flow channel Ra and the communicating space Ra1 is an opening portion (upstream end opening portion) RaO through which the first fluid medium A having flown through the distributing flow channel 6 and flown out from the distributor 5 to the communicating space Ra1 flows into the first flow channel Ra. The opening portion RaO is set to have such a size (opening area) as to cause differential pressure between the communicating space Ra1 and the first flow channel Ra when the first fluid medium A is being circulated within the heat exchanger body 2. Specifically, the opening portion RaO has an opening area smaller than the sectional area of an assumed flow channel (flow channel region) of the first fluid medium A that flows out of the corresponding one of the through holes 511 to flow toward the opening portion RaO along the outer peripheral surface 51a of the distributor 5 (i.e., the outer peripheral surface of the outer tubular portion). More specifically, as shown in Fig. 16B, the opening area of the opening portion RaO is smaller than the value that is obtained by obtaining the dimension by subtracting an outer diameter α of the distributor 5 from an inner diameter β of the first hole 211 of each heat transfer plate 21, and then multiplying the dimension by a dimension γ between two heat transfer plates 21 defining the first flow channel Ra (i.e., a sectional area of the flow channel: the area of the dotted regions in Fig. 16B). In the opening portion RaO of this embodiment, the opening width in the X-axis direction is made smaller than the dimension γ between two heat transfer plates 21 defining the first flow channel Ra (preferably, made smaller than a half of the dimension γ between two heat transfer plates 21 defining the first flow channel Ra (that is, smaller than $\gamma/2$)) to have the opening area of the opening portion RaO smaller than the sectional area of the flow channel, thereby causing the differential pressure. The differential pressure means the state where the pressure in the communicating space Ra1 is higher than the pressure in the first flow channel Ra.

[0077] With this configuration, the first fluid medium A that has flown out through the distributor 5 is accumulated in the gap around the periphery of the distributor 5, and flows into the first flow channels Ra while the upstream end opening portions RaO of the first flow channels Ra are subjected to substantially constant pressure. Thus, variation (unevenness) in the amount of the first fluid medium A flowing into the fist flow channels Ra is suppressed.

[0078] The first fluid medium A that has flown into the first flow channels Ra flows through the respective first flow channels Ra to one side in the Z-axis direction, and then flows out to the first fluid medium discharge channel Ra2. The first fluid medium A that has flown out from the first flow channels Ra flows through the first fluid medium discharge channel Ra1 while streams thereof join together in the first fluid medium discharge channel Ra2, and is discharged out of the heat exchanger body 2.

[0079] In contrast, when the second fluid medium B is supplied from, for example, a pipe connected to the through hole 233 of the one end plate 23 to the second fluid medium supply channel Rb1, the second fluid medium B flows through the second fluid medium supply channel Rb1 to flow into the plurality of second flow channels Rb. The second fluid medium B flows to the other side in the Z-axis direction through each of the plurality of second flow channels Rb, and then flows out into the second fluid medium discharge channel Rb2. Subsequently, the second fluid medium B that has flown out from these second flow channels Rb flows through the second fluid medium discharge channel Rb2 while streams thereof join together in the second fluid medium discharge channel Rb2, and is discharged to the outside.

[0080] In the heat exchanger 1, the first fluid medium A is circulated through the first flow channels Ra and the second fluid medium B is circulated through the second flow channels Rb, as described above, so that the first fluid medium A and the second fluid medium B exchange heat through the heat transfer plates 21 respectively defining the first flow channels Ra and the second flow channels Rb to cause the first fluid medium A to evaporate or condense.

[0081] The heat exchanger 1 as described above is configured such that the first fluid medium A is distributed to the one side and the other side in the X-axis direction by the distributing portions 603, 607, 610, and 613 of the distributing flow channel 6 before the first fluid medium A that has been supplied to the hollow portion S of the distributor 5 from the outside of the heat exchanger body 2 flows out through the plurality of outflow portions 616 to reach the first flow channels Ra. This configuration suppresses a difference in the distances of the circulating paths of the first fluid medium A from the inlet of the hollow portion S to the respective first flow channels Ra, as compared with the conventional plate heat exchanger (see Fig. 27) in which first flow channels arranged further away from the inlet for the first fluid medium result in longer circulating paths. This configuration suppresses uneven distribution of the first fluid medium A to the first flow channels Ra (that is, uneven distribution of the first fluid medium A to the plurality of first flow channels Ra) that results from the difference in the distances (i.e., circulating resistances) of the circulating paths of the first fluid medium A from the inlet of the heat exchanger body 2.

[0082] In the heat exchanger 1 of this embodiment, the distributing flow channel 6 includes the inflow opening portion 601 communicating with the hollow portion S, and the first connecting flow channels 602 each extending along the peripheral direction of the distributor 5 and connecting the inflow opening portion 601 and the first distributing portion 603 to each other. Thus, even when the first fluid medium A flowing in the X-axis direction through the hollow portion S flows into the distributing flow channel 6 through the inflow opening portion 601 while having a flow component (velocity component) of this circulating direction, the first fluid medium A flows through the first connecting flow channels 602 each extending in the peripheral direction, followed by flowing into the first distributing portion 603, so that the flow component of the X-axis direction is lost (or made small) in the flow of the first fluid medium A flowing into the first distributing portion

603. This configuration suppresses (or eliminates) the difference between the amount of the first fluid medium A flowing out through the one side outlet 6032 and the amount of the first fluid medium A flowing out through the other side outlet 6033 when the first distributing portion 603 distributes the first fluid medium A flowing in therethrough to the one side and the other side in the X-axis direction. Consequently, the uneven distribution of the first fluid medium A to the first flow channels Ra is more effectively suppressed.

[0083] In the heat exchanger 1 of this embodiment, the upstream end opening portion RaO of each of the first flow channels Ra has differential pressure caused between the communicating space Ra1 and the corresponding first flow channel Ra when the first fluid medium A is circulated through the heat exchanger body 2.

[0084] Thus, as in the case where the number of the first flow channels Ra is greater than the number of the outflow portions 616, the differential pressure is caused when the first fluid medium A that has flown through one outflow portion 616 flows into a plurality of first flow channels Ra located at the corresponding position to the outflow portion 616, despite a difference in the distances between the one outflow portion 616 and the respective upstream end opening portions RaO located at the corresponding position. Accordingly, the first fluid medium A accumulated in the communicating space Ra1 passes through each upstream end opening portion RaO under the same pressure to flow into the plurality of first flow channels Ra corresponding thereto. Thus, the difference in the amounts of the first fluid medium A flowing into the first flow channels Ra can be suppressed even in the configuration that the number of the first flow channels Ra is greater than the number of the outflow portions 616. As a result, the uneven distribution of the first fluid medium A into the plurality of first flow channels Ra is suitably suppressed.

[0085] It is a matter of course that the plate heat exchanger and the distributor of the present invention are not limited to the aforementioned embodiment, but various modifications can be made without departing from the gist of the present invention. For example, a configuration of an embodiment can be added to a configuration of another embodiment, and part of a configuration of an embodiment can be replaced by a configuration of another embodiment. Further, part of a configuration of an embodiment can be deleted.

[0086] The specific configuration of the distributing flow channel 6 is not limited. For example, the aforementioned embodiment has been described by taking, for example, the case where the distributing flow channel 6 has a linearly symmetrical configuration with the virtual line C1 extending in the peripheral direction and the virtual line C2 extending in the X-axis direction (see Fig. 13), without limitation thereto. The distributing flow channel 6 can have non-symmetrical patterns of the paths. Any configuration can be employed, provided that the distributing flow channel 6 has no difference in distances between the circulating routes from the inflow opening portion 601 to the respective outflow portions 616, or can have a smaller difference in such distances than that of the conventional plate heat exchanger (see Fig. 26 to Fig. 28).

[0087] The aforementioned embodiment has been described by taking, for example, the case where the distributing flow channel 6 has the circulating paths with the same distance from the inflow opening portion 601 to the respective outflow portions 616, without limitation thereto. In the distributing flow channel 6, the distances of the circulating paths from the inflow opening portion 601 to the respective outflow portions 616 can be different from each other. For example, all the circulating paths can have different distances, or some of the circulating paths among the plurality of circulating paths can have different distances. In this configuration too, any configuration can be employed, provided that there is no difference in distances between the circulating paths from the inflow opening portion 601 to the respective outflow portions 616, or there is a smaller difference in such distances than that of the conventional plate heat exchanger (see Fig. 26 to Fig. 28).

[0088] The aforementioned embodiment has been described by taking, for example, the case where the distributing flow channel 6 includes the plurality of distributing portions (in the example of the aforementioned embodiment, one first distributing portion 603, four second distributing portions 607, eight third distributing portions 610, and sixteen fourth distributing portions 613), without limitation thereto. Any configuration can be employed, provided that the distributing flow channel 6 has at least one distributing portion.

[0089] Such a configuration also allows the first fluid medium A to be distributed to the one side and the other side in the X-axis direction, to be thereby capable of suppressing the difference in the distances between the circulating paths of the first fluid medium A from the through hole 231 of the one end plate 23 to the respective first flow channels Ra. That is, the difference in the lengths (path lengths) between the shortest circulating path and the longest circulating path among the circulating paths from the through hole 231 of the one end plate to the respective first flow channels Ra can be made smaller than that of the conventional plate heat exchanger 100 in which, as shown in Fig. 26 to Fig. 28, the distances of the circulating paths of the first fluid medium A from an inlet to respective first flow channels Fa become longer as the first flow channels Fa are located further away in a certain direction (i.e., a direction in which heat transfer plates 101 are stacked on each other) from the inlet. This configuration can suppress uneven distribution of the first fluid medium A to the plurality of first flow channels Ra resulting from, for example, circulating resistances.

[0090] The aforementioned embodiment has been described by taking, for example, the case where the distributing flow channel 6 includes the peripheral distributing portions 605 each allowing the first fluid medium A to be distributed to the one side and the other side in the peripheral direction of the distributor 5, without limitation thereto. The distributing flow channel 6 can be configured without the peripheral distributing portions 605.

[0091] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has flow channels (first connecting flow channels 602) extending along the peripheral direction that are arranged upstream of the first distributing portion (first distributing portion) of the distributing flow channel 6, without limitation thereto. For example, as shown in Fig. 17 to Fig. 19, the configuration can be such that the distributing portion (first distributing portion 603) is arranged at the upstream end of the distributing flow channel 6. That is, the distributing flow channel 6 can be configured such that the first distributing portion 603 is arranged at the upstream end of the distributing flow channel 6 and the first distributing portion inlet 6031 of the first distributing portion 603 communicates with the hollow portion S. In this case, the inflow opening 53 of the inner tubular portion 52 forms the first distributing portion inlet 6031 of the first distributing portion 603.

[0092] In the case of this configuration, it is preferable that the distributor 5 have a direction changing member 7, as shown in Fig. 20 to Fig. 22, arranged at a position corresponding to the inflow opening 53 (first distributing portion inlet 6031) in the hollow portion S. This direction changing member 7 has an internal space S 1 allowing the hollow portion S and the inflow opening 53 (first distributing portion inlet 6031) to communicate with each other and allowing the first fluid medium A to be circulated therethrough, and is configured to cause the first fluid medium A to pass through the internal space S 1 to change the flowing direction of the first fluid medium A to a direction along the radial direction of the distributor 5 (i.e., thickness direction of the distributor (tubular wall) 5 at the position of the inflow opening 53).

[0093] Specifically, the direction changing member 7 has: a body 70 defining the internal space S1 through which the first fluid medium A can be circulated; a first opening 71 allowing the external space of the body 70 and the internal space S1 to communicate with each other; and a second opening 72 arranged at a different position from the first opening 71 and allowing the external space of the body 70 and the internal space S1 to communicate with each other.

[0094] The body 70 has a shape corresponding to the hollow portion S at a position corresponding to the inflow opening 53. That is, the body 70 has such a shape as to be internally fitted to the inner tubular portion 52.

[0095] In the body 70, the first opening 71 is arranged at a position where the first fluid medium A flowing in the hollow portion S can flow into the internal space S 1 when the direction changing member 7 is arranged in the hollow portion S of the distributor 5. The first opening 71 is arranged at a position away from the second opening 72 in order to secure a flowing distance in the hollow portion S of the first fluid medium A that has flown through the first opening 71. For example, in the direction changing member 7 shown in Fig. 20 and Fig. 22, the first opening 71 is arranged at a position further away from the second opening 72 opposed to the inflow opening 53 than a central axis C of the distributor 5 (i.e., a position lower than the central axis C in Fig. 22). In the internal space S1 of this direction changing member 7, the first fluid medium A when it is flowing into the inflow opening 53 makes small or loses its the flow component (velocity component) of the direction of the central axis C as the distance over which the first fluid medium A flows along the radial direction (specifically, the thickness direction of the distributor 5 at the position of the inflow opening 53) toward the inflow opening 53 (second opening 72) becomes longer. Specifically, the distance over which the first fluid medium A flows through the internal space S1 is preferably 10 or more times as long as the diameter of the inflow opening 53.

[0096] In the body 70, the second opening 72 is arranged at a position opposed to or directly communicating with the inflow opening 53 when the direction changing member 7 is arranged in the hollow portion S of the distributor 5.

[0097] Since there are some cases where a plurality of the distributors 5 are arranged in a row in the communicating space Ra1 of the heat exchanger 1 (see Fig. 23), the direction changing member 7 is preferably configured to enable the first fluid medium A in the hollow portion S to pass through the position of the direction changing member 7 in the direction of the central axis C. For example, in the direction changing member 7 shown in Fig. 20, two first openings 71 are arranged respectively at positions opposed to each other in the direction of the central axis C when the direction changing member 7 is arranged in the hollow portion S of the distributor 5. Further, in the direction changing member 7 shown in Fig. 21, the body 70 has such a shape as to form a gap between the body 70 and the inner peripheral surface 52b of the inner tubular portion 52 at a position opposite to the inflow opening 53 with the central axis C therebetween, when the direction changing member 7 is arranged in the hollow portion S of the distributor 5.

[0098] According to the direction changing member 7 as described above, even when the configuration is such that the first fluid medium A flowing through the hollow portion S directly flows into the first distributing portion 603 of the distributing flow channel 6, as in the configuration shown in Fig. 17 to Fig. 19, the direction changing member 7 is arranged immediately before the first distributing portion inlet 6031 (i.e., the position corresponding to the first distributing portion inlet 6031) in the hollow portion S to thereby allow the first fluid medium A flowing along the radial direction of the distributor 5 to flow into the first distributing portion 603 (first distributing portion inlet 6031). That is, the first fluid medium A having no flow component (velocity component) or a small flow component (velocity component) of the direction of the central axis C (i.e., the direction corresponding to the X-axis direction when the distributor 5 is arranged in the communicating space Ra1) flows into the first distributing portion 603. This configuration suppresses (or eliminates) the difference between the amount of the first fluid medium A flowing out through the one side outlet 6032 and the amount of the first fluid medium A flowing out through the other side outlet 6033 when the first fluid medium A is distributed to the one side and the other side in the X-axis direction by the first distributing portion 603, consequently effectively suppressing uneven distribution of the first fluid medium A to the first flow channels Ra.

[0099] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has the inlet opening 53 arranged at the center in the direction of the central axis C, without limitation thereto. The inflow opening 53 can be arranged at any position in the X-axis direction. In this case, any configuration can be employed, provided that the distributing flow channel 6 has such a pattern as to have the circulating paths from the inflow opening portion 601 to the respective outflow portions 616, of which the distances are smaller than those of the conventional plate heat exchanger.

[0100] The aforementioned embodiment has been described by taking, for example, the case where the heat exchanger 1 includes one distributor 5, without limitation thereto. In the case where the heat exchanger 1 includes a large number of heat transfer plates 21 and has a large dimension in the X-axis direction, that is, the communicating space Ra1 has a large lengthwise dimension in the X-axis direction, the plurality of (two in the example shown in Fig. 23) distributors 5 can be arranged in a row in the direction of the central axis C in the communicating space Ra1. That is, the heat exchanger 1 can include the plurality of distributors 5.

[0101] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has a tubular shape with openings at both ends in the direction of the central axis C, without limitation thereto. The distributor 5 can have a so-called bottomed tubular shape with one end closed in the direction of the central axis C.

[0102] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has a cylindrical shape, without limitation thereto. The distributor 5 can have, for example, a polygonal tubular shape that is polygonal in cross section, or a tubular shape that is oval in cross section. That is, the configuration can be such that the distributor 5 has the hollow portion S, enables the first fluid medium A to be supplied from the outside to the hollow portion S, and enables the first fluid medium A to be circulated through the hollow portion S.

[0103] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has the distributing flow channel 6 formed (defined) by the groove 521 formed on the outer peripheral surface 52a of the inner tubular portion 52 and the inner peripheral surface 51b of the outer tubular portion 51, without limitation thereto. For example, the distributing flow channel 6 can be formed by a groove formed on the inner peripheral surface 51b of the outer tubular portion 51 and the outer peripheral surface 52a of the inner tubular portion 52. Further, the distributing flow channel 6 can be formed by a groove formed on the inner peripheral surface 51b of the outer tubular portion 51 and a groove formed on the outer peripheral surface 52a of the inner tubular portion 52.

[0104] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 has the two tubular portions 50 (i.e., the outer tubular portion 51 and the inner tubular portion 52), without limitation thereto. The distributor 5 can have three or more tubular portions 50 overlapped with each other in the thickness direction of their tubular walls (i.e., the radial direction in the example of the aforementioned embodiment).

[0105] In this case, the distributing flow channel 6 can be formed in the three or more tubular portions 50 continuously overlapped with each other in the radial direction, that is, formed by the three or more tubular portions 50 continuously overlapped with each other in the radial direction. For example, the distributing flow channel 6 can be formed such that, when the distributing flow channel 6 has three tubular portions (i.e., the outer tubular portion 51, an intermediate tubular portion 55, and the inner tubular portion 52) overlapped with each other in the radial direction, as shown in Fig. 24, the intermediate tubular portion 55 has a slit (corresponding to the groove 521 of the aforementioned embodiment penetrating therethrough in the thickness direction) 521a having the same shape as the pattern of the path (see Fig. 13) of the aforementioned embodiment, and the radially outside of the slit 521a is closed by the inner peripheral surface 51b of the outer tubular portion 51 while the radially inside of the slit is closed by the outer peripheral surface 52a of the inner tubular portion 52.

[0106] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 allows the first fluid medium A to flow into the distributing flow channel 6 through the inflow opening 53 opening in the radial direction (i.e., the thickness direction of the tubular wall), without limitation thereto. For example, as shown in Fig. 25, the configuration can be such that the first fluid medium A flows into the distributing flow channel 6 through the inflow opening 53 opening in the direction of the central axis C of the distributor 5.

[0107] The aforementioned embodiment has been described by taking, for example, the case where, in the distributor 5, the number of the through holes 511 (outflow portions 616) lined up in the X-axis direction on the outer tubular portion 51 is smaller than the number of the first flow channels Ra, without limitation thereto. The number of the through holes 511 lined up in the X-axis direction of the outer tubular portion 51 can be equal to the number of the first flow channels Ra, or greater than the number of the first flow channels Ra.

[0108] The aforementioned embodiment has been described by taking, for example, the case where, in the heat exchanger 1, the gap is formed between, for example, the distributor 5 and the members defining the communicating space Ra1, without limitation thereto. There can be no gap between the distributor 5 and the members defining the communicating space Ra1. In this case, the first fluid medium A that has flown out through the outflow portions 616 of the distributing flow channel 6 directly flows into the first flow channels Ra.

[0109] Further, the aforementioned embodiment has been described by taking, for example, the case where, in the heat exchanger 1, the pair of end plates 23, 24 are placed away from each other by unfastening the long bolts 25 to undo the sandwiching in the X-axis direction of the heat transfer plate group 21A, so that the heat transfer plates 21, the gaskets 22, the distributor 5, or the like can be replaced. However, the aforementioned embodiment is not limited to this configuration. The heat exchanger 1 can be configured such that the flow channels (e.g., the first flow channels Ra, the second flow channels Rb) are closed in a liquid tight manner by brazing the peripheral portion of the heat transfer plate group 21A.

[0110] The aforementioned embodiment has been described by taking, for example, the case where the distributor 5 is one of the members forming the heat exchanger 1, without limitation thereto. The configuration can be such that the distributor 5 is additionally arranged to a first fluid medium supply channel (a flow channel through which the first fluid medium A is supplied to the first flow channels Ra: corresponding to the communicating space Ra1 of the aforementioned embodiment) of the conventional plate heat exchanger (i.e., the plate heat exchanger formed only by the heat exchanger body 2 of the aforementioned embodiment).

[0111] As described above, the present invention can provide a plate heat exchanger capable of suppressing uneven distribution of a first fluid medium to a plurality of first flow channels, and can provide a distributor for the plate heat exchanger.

[0112] A plate heat exchanger according to the present invention includes: a heat exchanger body including a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween; and a distributor to allow the first fluid medium to be distributed to the plurality of first flow channels, in which two or more heat transfer plates continuously lined up (i.e., arranged adjacent to each other) out of the plurality of heat transfer plates each have a through hole at a mutually overlapping position as seen from the certain direction, the two or more heat transfer plates continuously lined up each have the through hole lined up in the certain direction to form a communicating space communicating with the plurality of first flow channels, the distributor has a tubular wall defining a hollow portion that extends in the certain direction in the communicating space and through which the first fluid medium supplied from outside the heat exchanger body is circulated, the tubular wall including a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall, the tubular wall has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped (i.e., arranged adjacent to each other) in the thickness direction out of the plurality of tubular portions, the distributing flow channel includes: a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion including a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to communicate with the communicating space or the plurality of first flow channels, and the plurality of outflow portions are arranged at intervals from each other in the certain direction.

[0113] As described above, the plate heat exchanger is configured to allow the first fluid medium to be distributed to the one side and the other side in the certain direction (i.e., the direction in which the plurality of heat transfer plates are stacked on each other) before the first fluid medium that has been supplied to the hollow portion of the distributor from the outside of the heat exchanger body flows out through the plurality of outflow portions to reach the plurality of first flow channels. Accordingly, a difference in the distances of the circulating paths of the first fluid medium from the inlet of the hollow portion to the respective first flow channels can be suppressed as compared with the conventional plate heat exchanger (see Fig. 27) in which first flow channels arranged further away from the inlet of the first fluid medium result in longer circulating paths. This configuration can suppress uneven distribution of the first fluid medium to the respective first flow channels (that is, uneven distribution of the first fluid medium to the plurality of first flow channels) that results from the difference in the distances (i.e., circulating resistances) of the circulating paths of the first fluid medium from the inlet of the heat exchanger body.

[0114] In the plate heat exchanger, the configuration can be such that the distributing flow channel has: an opening portion communicating with the hollow portion;

and a connecting flow channel extending along a peripheral direction of the tubular wall and connecting the opening portion and the distributing portion to each other.

[0115] According to such a configuration, even when the first fluid medium circulating in the certain direction through the hollow portion flows into the distributing flow channel through the opening portion while having a flow component (velocity component) of this circulating direction, the first fluid medium flows through the connecting flow channel extending along the peripheral direction, followed by flowing into the distributing portion, so that the flow component of the certain direction is lost (or made small) in the flow of the first fluid medium flowing into the distributing portion. This configuration suppresses (or eliminates) the difference between the amount of the first fluid medium flowing out through the one side distributing portion outlet and the amount of the first fluid medium flowing out through the other side distributing portion outlet when the distributing portion distributes the first fluid medium flowing in therethrough to the one side and the other side in the certain direction. Consequently, the uneven distribution of the first fluid medium to the first flow channels is more effectively suppressed.

[0116] In the plate heat exchanger, the configuration can be such that the distributing portion includes a distributing portion inlet that communicates with the hollow portion and through which the first fluid medium flows into the distributing portion from the hollow portion, the distributor includes a direction changing member arranged at a position corresponding to the distributing portion inlet in the hollow portion of the tubular wall, and the direction changing member has an internal space that allows the hollow portion and the distributing portion inlet to communicate with each other and through which the first fluid medium can be circulated, and causes the first fluid medium to pass through the internal space to allow a flow direction of the first fluid medium to be directed along the thickness direction of the tubular wall at a position of the distributing portion inlet.

[0117] In the configuration that the first fluid medium circulating through the hollow portion in the tubular wall directly flows into the distributing portion as described above, the direction changing member arranged immediately before the distributing portion inlet (i.e., the position corresponding to the distributing portion inlet) in the hollow portion allows the first fluid medium flowing along the thickness direction of the tubular wall to flow into the distributing portion (distributing portion inlet), that is, allows the first fluid medium having no (or a small) flow component of the certain direction to flow into the distributing portion (distributing portion inlet). This suppresses (or eliminates) the difference between the amount of the first fluid medium flowing out through the one side distributing portion outlet and the amount of the first fluid medium flowing out through the other side distributing portion outlet when the first distributing portion distributes the flowing first fluid medium. Consequently, the uneven distribution of the first fluid medium to the first flow channels is more effectively suppressed.

[0118] In the plate heat exchanger, the configuration can be such that the heat exchanger body has, at a boundary position between the communicating space and each of the plurality of first flow channels, an opening portion through which the first fluid medium passes when flowing into the each of the plurality of first flow channels from the communicating space, and the opening portion causes differential pressure between the communicating space and the each of the plurality of first flow channels when the first fluid medium is circulated in the heat exchanger body.

[0119] According to such a configuration, as in the case where the number of the first flow channels is greater than the number of the outflow portions, the differential pressure is caused when the first fluid medium that has flown through one outflow portion flows into a plurality of first flow channels located at the corresponding position to the outflow portion, despite a difference in the distances between the one outflow portion and the respective opening portions located at the corresponding position. Accordingly, the first fluid medium accumulated in the communicating space passes through the respective opening portions under the same pressure to flow into the plurality of first flow channels Ra corresponding thereto. Thus, the difference in the amounts of the first fluid medium flowing into the first flow channels can be suppressed even in the configuration that the number of the first flow channels is greater than the number of the outflow portions. As a result, the uneven distribution of the first fluid medium into the plurality of first flow channels is suitably suppressed.

[0120] A distributor for a plate heat exchanger according to the present invention is configured such that in the plate heat exchanger including a heat exchanger body including a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween, the distributor is arranged in a communicating space formed by through holes respectively of two or more heat transfer plates continuously lined up (arranged adjacent to each other) out of the plurality of heat transfer plates, the through holes line up in the certain direction, the communicating space communicating with the plurality of first flow channels, to allow the first fluid medium to be distributed to the plurality of first flow channels, the distributor includes a tubular wall defining a hollow portion that extends in the certain direction and through which the first fluid medium supplied from outside the plate heat exchanger is circulated when the distributor is arranged in the communicating space, the tubular wall includes a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall, and has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped (adjacent to each other) in the thickness direction out of the plurality of tubular portions, the distributing flow channel includes: a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion including a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to be capable of communicating with the communicating space or the plurality of first flow channels, and the plurality of outflow portions are arranged at intervals from each other in the certain direction.

[0121] According to such a configuration, the distributor arranged in the communicating space of the plate heat exchanger allows the first fluid medium to be distributed to the one side and the other side in the certain direction (i.e., the direction in which the plurality of heat transfer plates are stacked on each other) by the distributing portion of the distributing flow channel before the first fluid medium that has been supplied to the hollow portion of the distributor from the outside of the heat exchanger body flows out through the plurality of outflow portions to reach the plurality of first flow channels. Accordingly, a difference in the distances of the circulating paths of the first fluid medium from the inlet of the hollow portion to the respective first flow channels can be suppressed as compared with the conventional plate heat exchanger (see Fig. 27) in which first flow channels arranged further away from the inlet of the first fluid medium result in longer circulating paths. This configuration can suppress uneven distribution of the first fluid medium to the first flow channels (that is, uneven distribution of the first fluid medium to the plurality of first flow channels) that results from the difference in the distances (i.e., circulating resistances) of the circulating paths of the first fluid medium from the inlet of the heat exchanger body.

[0122] The present invention has been appropriately and sufficiently described above through the embodiment with reference to the drawings in order to express the present invention, but it shall be understood that those skilled in the art can easily modify and/or improve the aforementioned embodiment. Accordingly, it shall be interpreted that any modified embodiment or any improved embodiment achieved by those skilled in the art are within the scope of the claims unless such a modified embodiment or such an improved embodiment departs from the scope of the claims.

REFERENCE SIGNS LIST

[0123]

1: Heat exchanger
2: Heat exchanger body
5: Distributor
50: Tubular portion
51: Outer tubular portion (tubular portion)
51a: Outer peripheral surface of outer tubular portion
51b: Inner peripheral surface of outer tubular portion
511: Through hole of outer tubular portion
52: Inner tubular portion
52a: Outer peripheral surface of inner tubular portion
52b: Inner peripheral surface of inner tubular portion
521: Groove
53: Inflow opening
55: Intermediate tubular portion
6: Distributing flow channel
601: Inflow opening portion (opening portion)
602: First connecting flow channel
603: First distributing portion (distributing portion)
6031: First distributing portion inlet (distributing portion inlet)
6031a, 6031b: First distributing portion inlet
6032: One side outlet (one side distributing portion outlet)
6033: Other side outlet (other side distributing portion outlet)
604: First distributing flow channel
604a: One first distributing flow channel
604b: Other first distributing flow channel
605: Peripheral distributing portion
6051: Peripheral distributing portion inlet
6052: One side outlet
6053: Other side outlet
606: Peripheral distributing flow channel
606a: One peripheral distributing flow channel
606b: Other peripheral distributing flow channel
607: Second distributing portion
6071: Second distributing portion inlet
6072: One side outlet
6073: Other side outlet
608: Second distributing flow channel
608a: One second distributing flow channel
608b: Other second distributing flow channel
609: Second connecting flow channel
610: Third distributing portion
6101: Third distributing portion inlet
6102: One side outlet
6103: Other side outlet
611: Third distributing flow channel
611a: One third distributing flow channel
611b: Other third distributing flow channel
612: Third connecting flow channel
613: Fourth distributing portion
6131: Fourth distributing portion inlet
6132: One side outlet

6133: Other side outlet
614: Fourth distributing flow channel
614a: One fourth distributing flow channel
614b: Other fourth distributing flow channel
615: Fourth connecting flow channel
616: Outflow portion
7: Direction changing member
70: Body
71: First opening
72: Second opening
21: Heat transfer plate
21A: Heat transfer plate group
211: First hole (through hole)
212: Second hole
213: Third hole
214: Fourth hole
22: Gasket
23: One end plate
231, 232, 233, 234: Through hole of one end plate
24: Other end plate
25: Long bolt
100: Plate heat exchanger
101: Heat transfer plate
102: First through hole
103: Second through hole
104: Third through hole
105: Fourth through hole
A: First fluid medium
B: Second fluid medium
C: Central axis
C1, C2: Virtual line
Fa: First flow channel
Fa1: First fluid medium supply channel
Fa2: First fluid medium discharge channel
Fb: Second flow channel
Fb1: Second fluid medium supply channel
Fb2: Second fluid medium discharge channel
G: Gap
Ra: First flow channel
Ra1: Communicating space
Ra2: First fluid medium discharge channel
RaO: Upstream end opening portion (opening portion)
Rb: Second flow channel
Rb1: Second fluid medium supply channel
Rb2: Second fluid medium discharge channel
S: Hollow portion
S1: Internal space
α: Outer diameter of distributor
β: Inner diameter of first hole
γ: Dimension between two heat transfer plates defining a first flow channel

Claims

1. A plate heat exchanger comprising:

a heat exchanger body comprising a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween; and

a distributor to allow the first fluid medium to be distributed to the plurality of first flow channels, wherein

two or more heat transfer plates continuously lined up out of the plurality of heat transfer plates each have a through hole at a mutually overlapping position as seen from the certain direction,

the two or more heat transfer plates continuously lined up each have the through hole lined up in the certain direction to form a communicating space communicating with the plurality of first flow channels,

the distributor has a tubular wall defining a hollow portion that extends in the certain direction in the communicating space and through which the first fluid medium supplied from outside the heat exchanger body is circulated, the tubular wall comprising a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall,

the tubular wall has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped in the thickness direction out of the plurality of tubular portions,

the distributing flow channel comprises:

a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion comprising a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and

a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to communicate with the communicating space or the plurality of first flow channels, and the plurality of outflow portions are arranged at intervals from each other in the certain direction.

2. The plate heat exchanger according to claim 1, wherein the distributing flow channel has: an opening portion communicating with the hollow portion; and a connecting flow channel extending along a peripheral direction of the tubular wall and connecting the opening portion and the distributing portion to each other.

3. The plate heat exchanger according to claim 1, wherein

the distributing portion comprises a distributing portion inlet that communicates with the hollow portion and through which the first fluid medium flows into the distributing portion from the hollow portion,
the distributor comprises a direction changing member arranged at a position corresponding to the distributing portion inlet in the hollow portion of the tubular wall, and
the direction changing member has an internal space that allows the hollow portion and the distributing portion inlet to communicate with each other and through which the first fluid medium can be circulated, and causes the first fluid medium to pass through the internal space to allow a flow direction of the first fluid medium to be directed along the thickness direction of the tubular wall at a position of the distributing portion inlet.

4. The plate heat exchanger according to any one of claims 1 to 3, wherein

the heat exchanger body has, at a boundary position between the communicating space and each of the plurality of first flow channels, an opening portion through which the first fluid medium passes when flowing into the each of the plurality of first flow channels from the communicating space, and
the opening portion causes differential pressure between the communicating space and the each of the plurality of first flow channels when the first fluid medium is circulated in the heat exchanger body.

5. A distributor for a plate heat exchanger, the plate heat exchanger comprising a heat exchanger body comprising a plurality of heat transfer plates each having a surface extending in a direction orthogonal to a certain direction, the plurality of heat transfer plates being stacked on each other in the certain direction to form a plurality of first flow channels through which a first fluid medium is circulated and at least one second flow channel through which a second fluid medium is circulated so as to be alternately arranged with the plurality of heat transfer plates respectively interposed therebetween, in which the distributor is arranged in a communicating space formed by through holes respectively of two or more heat transfer plates continuously lined up out of the plurality of heat transfer plates, the through holes lined up in the certain direction, the communicating space communicating with the plurality of first flow channels, to allow the first fluid medium to be distributed to the plurality of first flow channels,

the distributor comprising a tubular wall defining a hollow portion that extends in the certain direction and through which the first fluid medium supplied from outside the plate heat exchanger is circulated when the distributor is arranged in the communicating space, wherein
the tubular wall comprises a plurality of tubular portions overlapped with each other in a thickness direction of the tubular wall, and has a distributing flow channel through which the first fluid medium can be circulated in two or more tubular portions continuously overlapped in the thickness direction out of the plurality of tubular portions,
the distributing flow channel comprises:

a distributing portion to allow the first fluid medium that has flown into the distributing flow channel through the hollow portion to be distributed to one side and an other side in the certain direction, the distributing portion comprising a one side distributing portion outlet through which the first fluid medium flows out to the one side and an other side distributing portion outlet through which the first fluid medium flows out to the other side; and
a plurality of outflow portions each directly or indirectly communicating with the one side distributing portion outlet or the other side distributing portion outlet and penetrating through at least an outermost tubular portion in the thickness direction to be capable of communicating with the communicating space or the plurality of first flow channels, and
the plurality of outflow portions are arranged at intervals from each other in the certain direction.

Fig.1

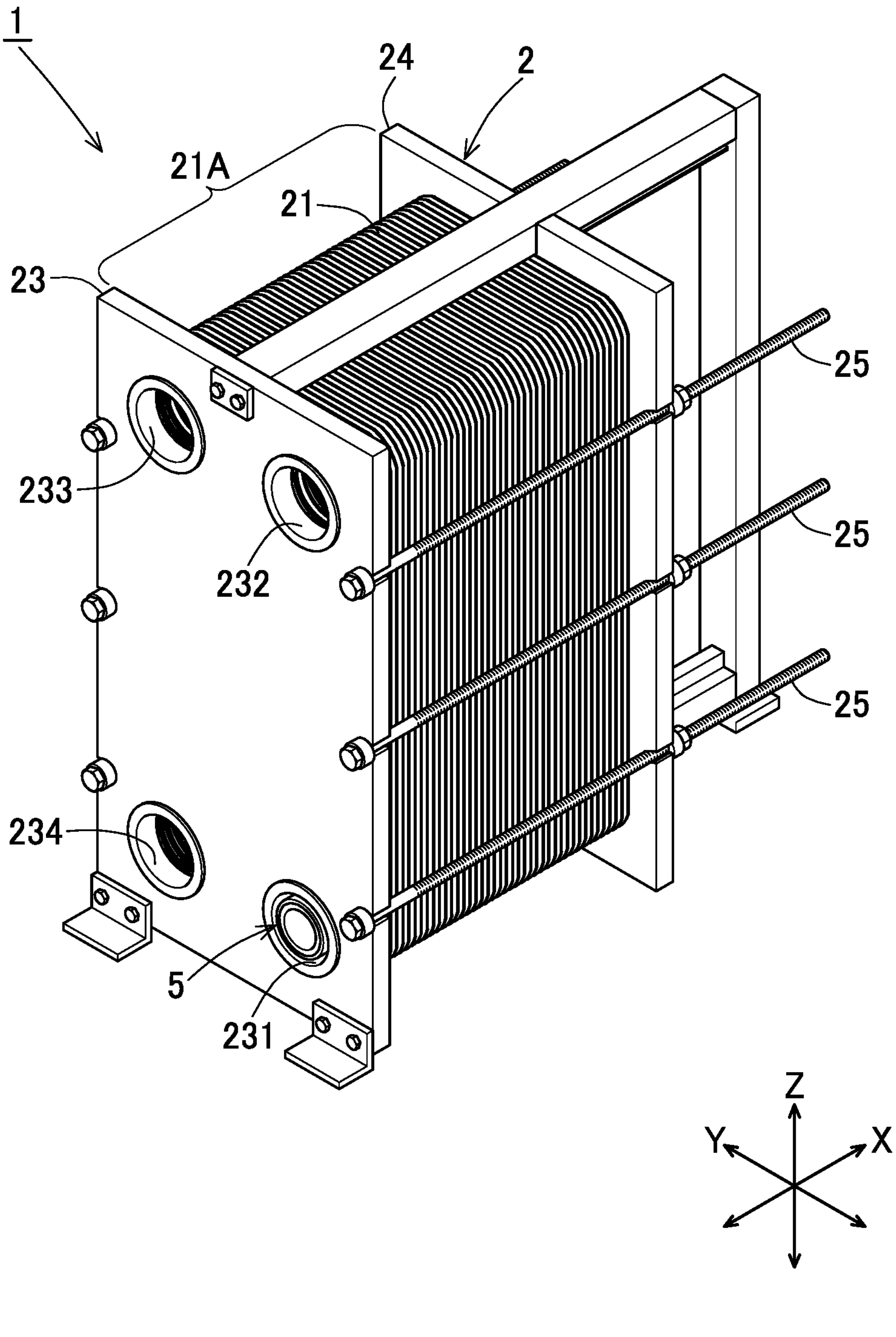


Fig.2

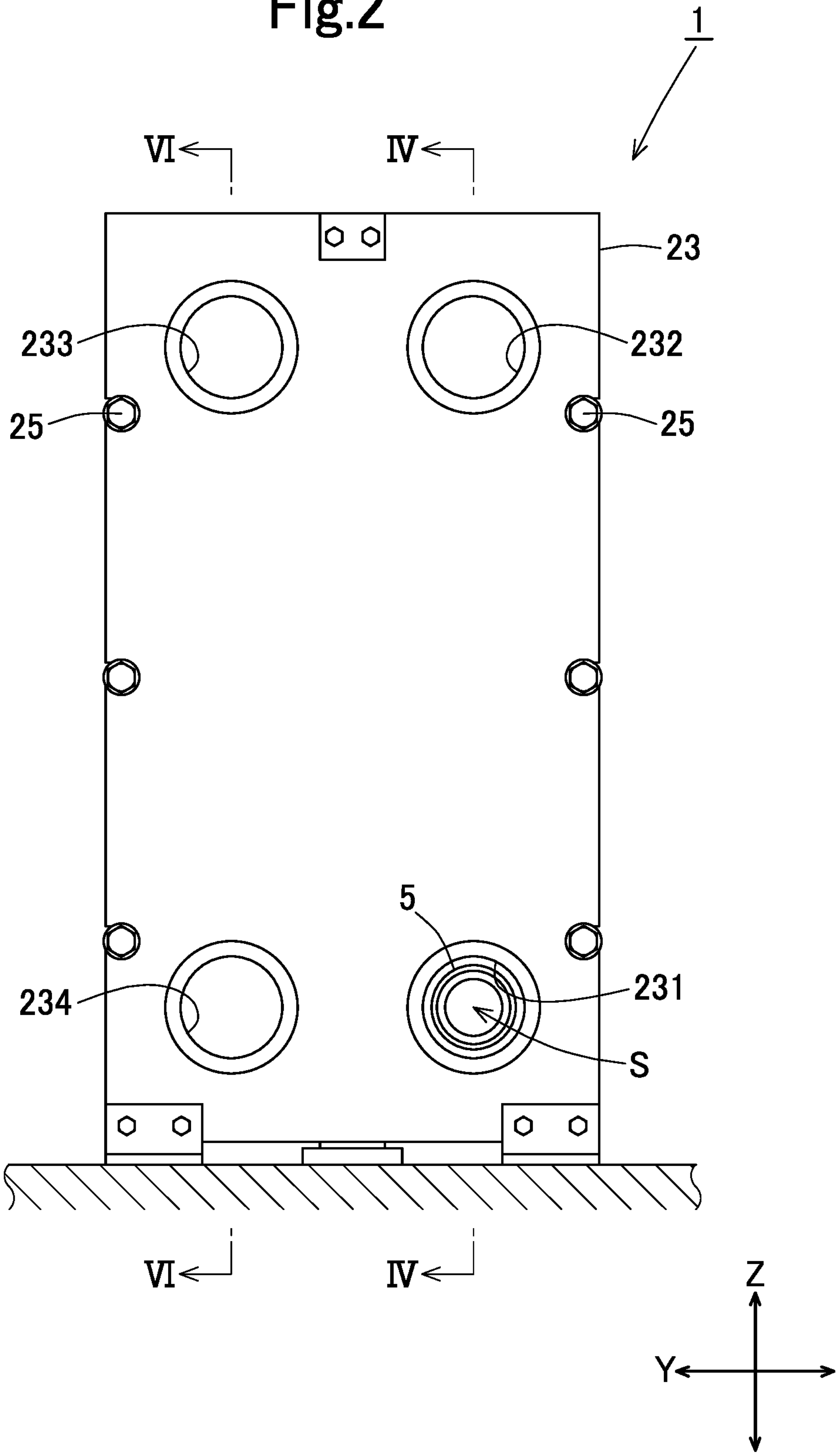
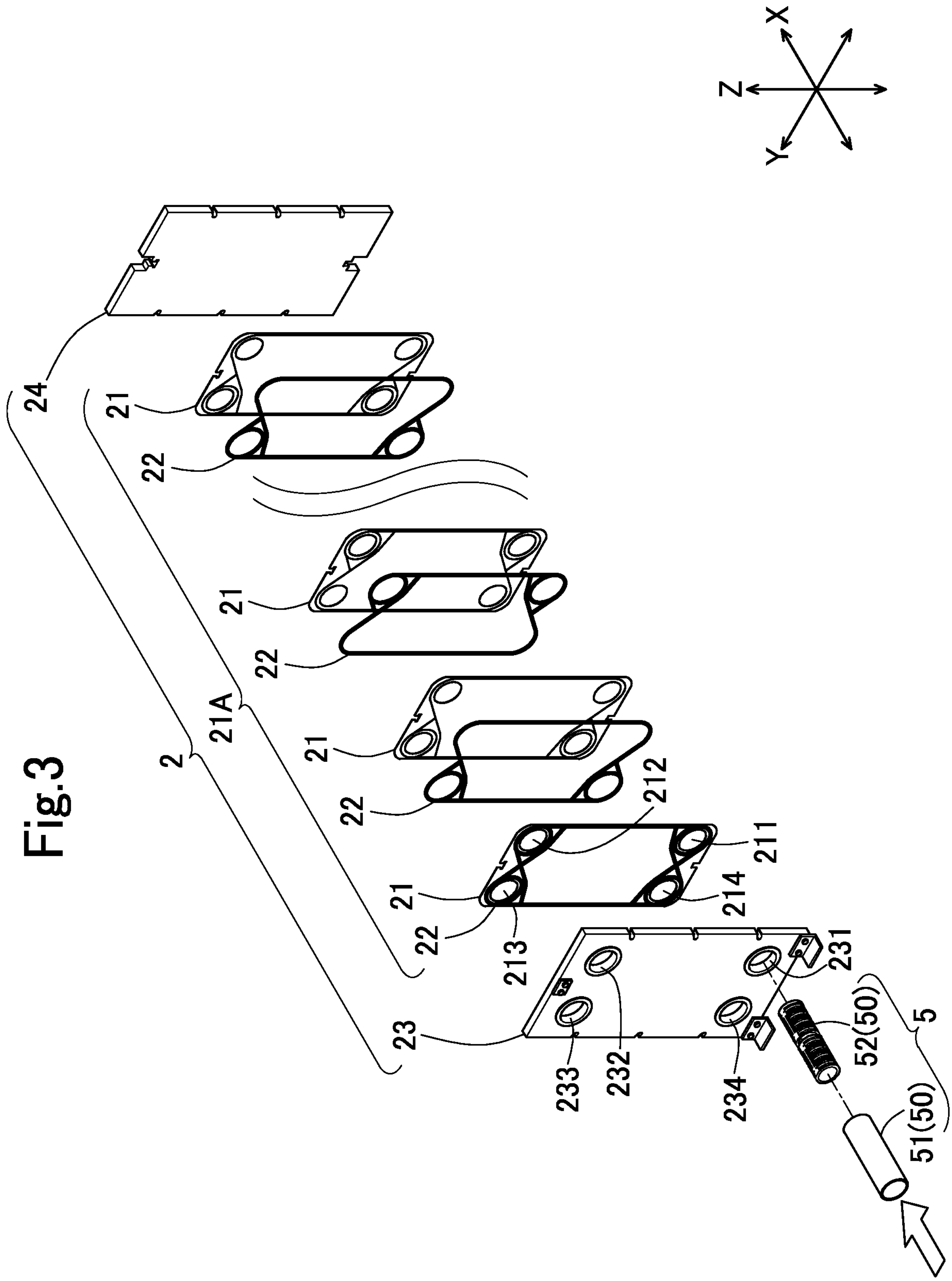


Fig.3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21
22
21A
2
21
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212
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52(50)
233
232
234
51(50)

Fig.4

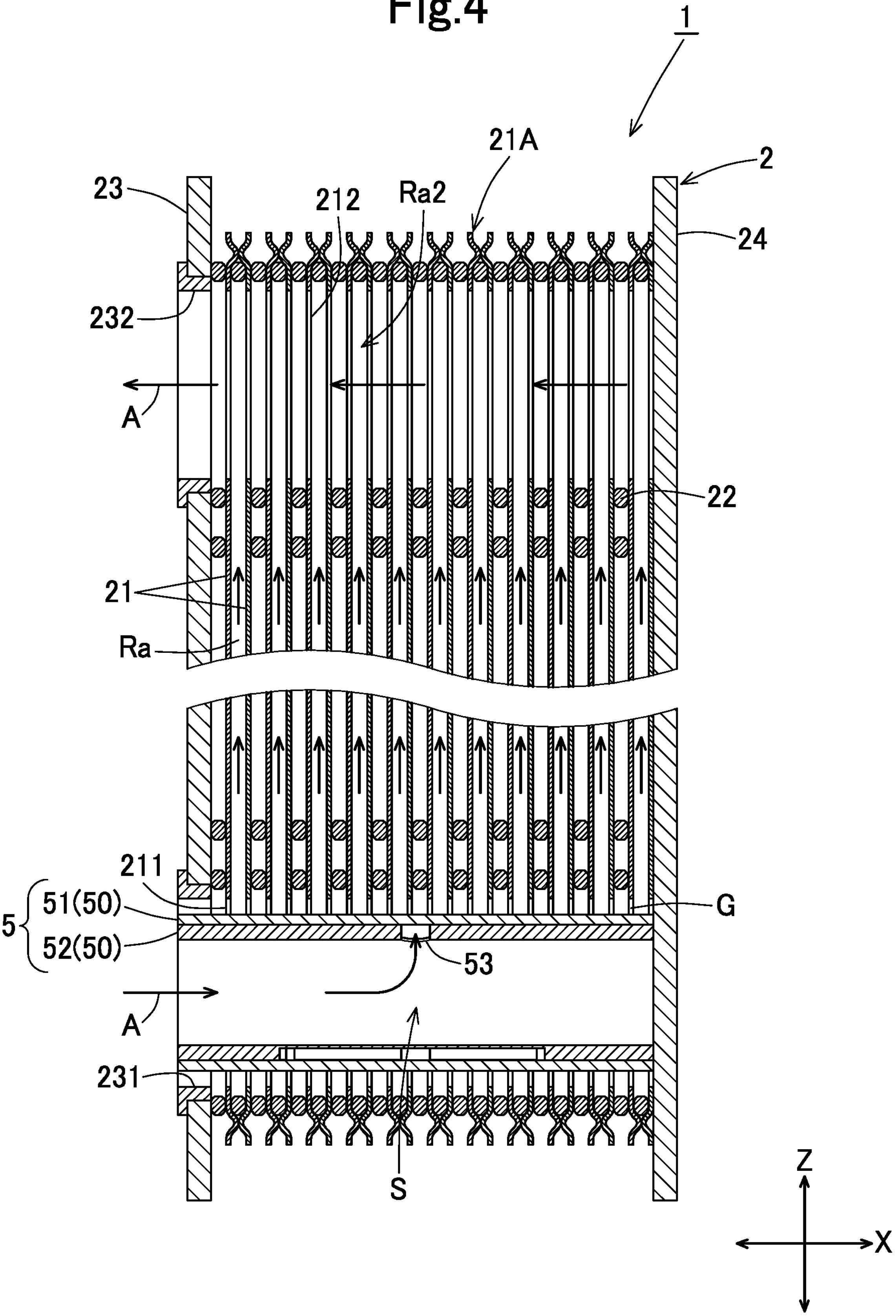


Fig.5

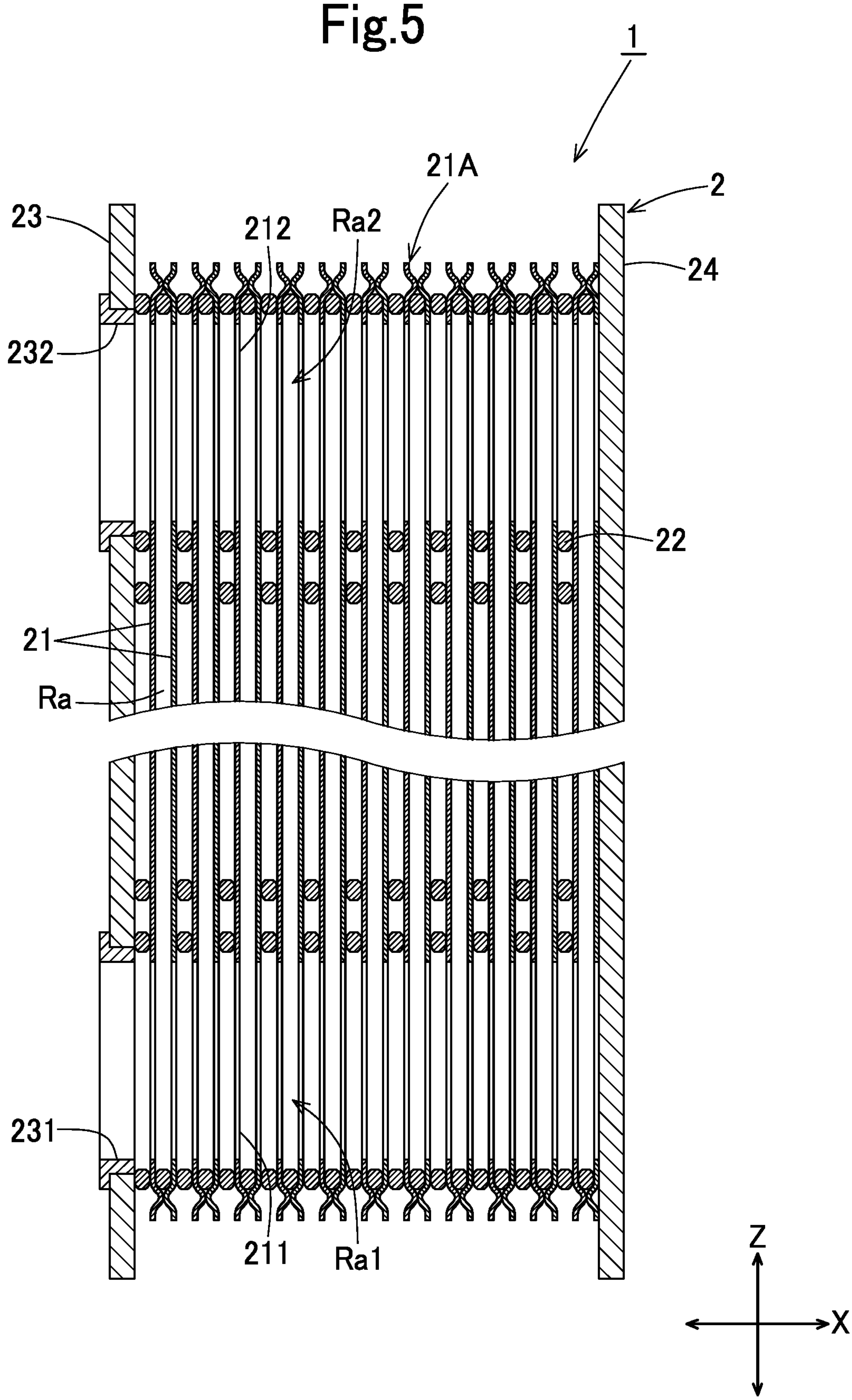


Fig.6

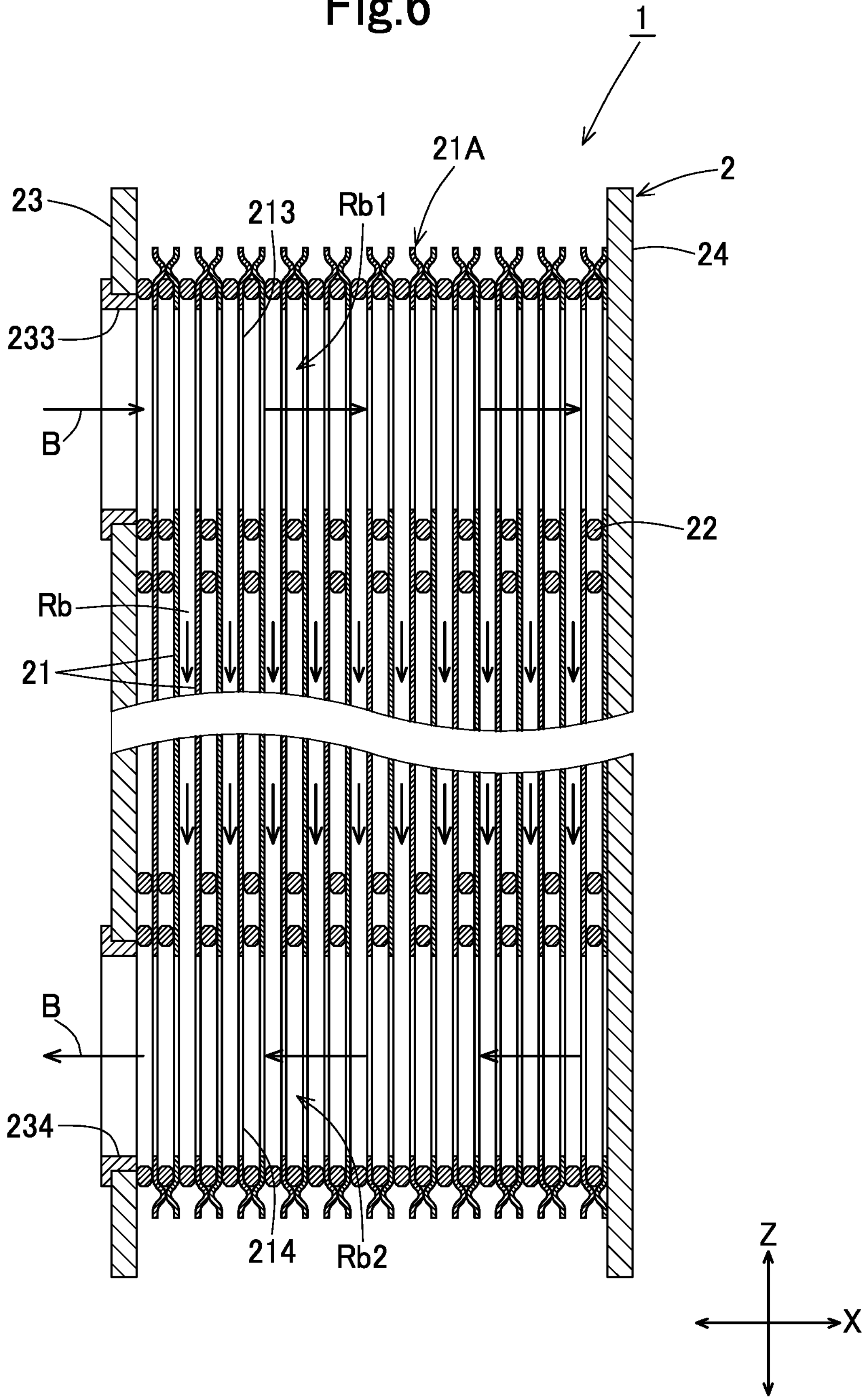


Fig.7

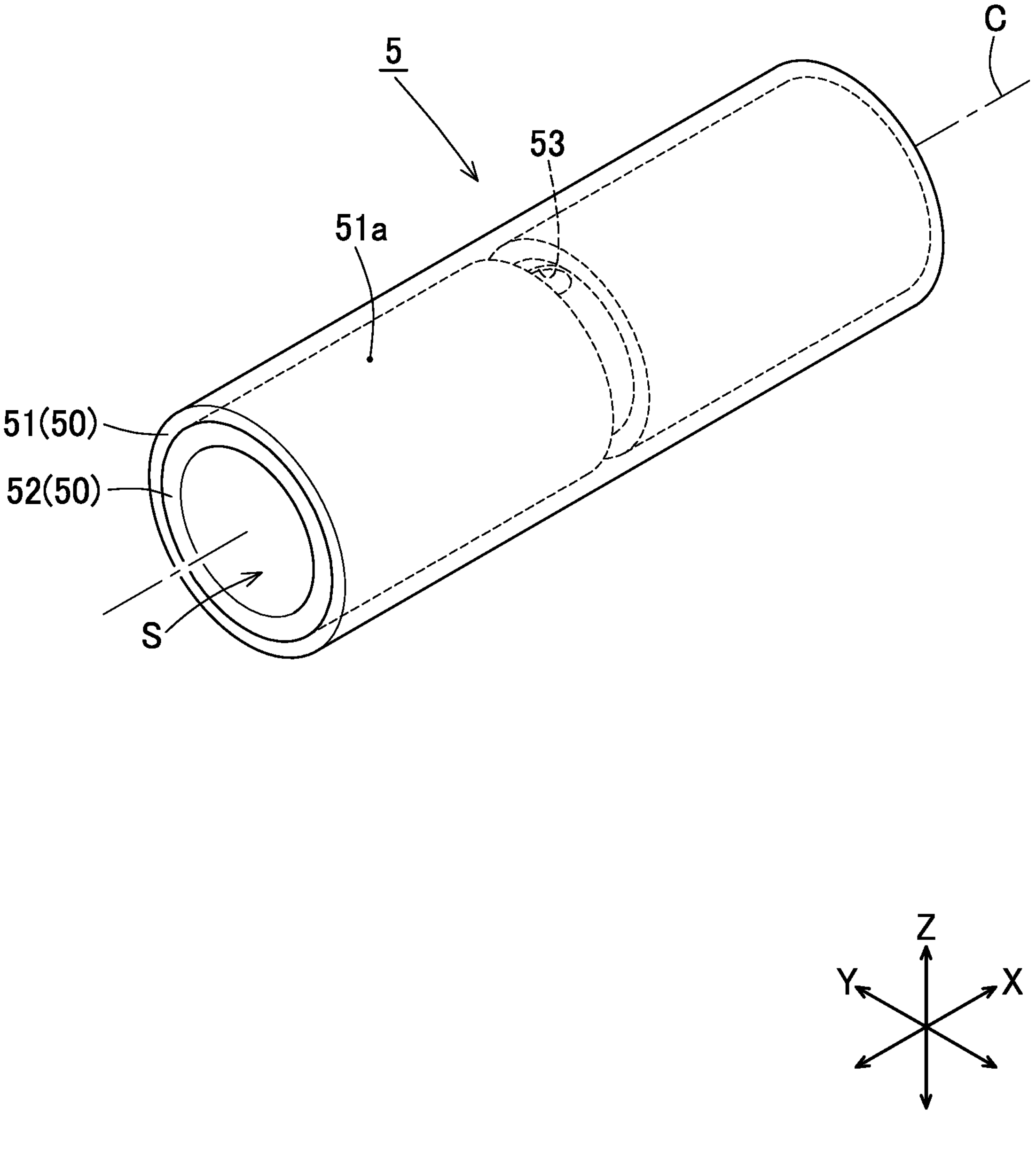


Fig.8

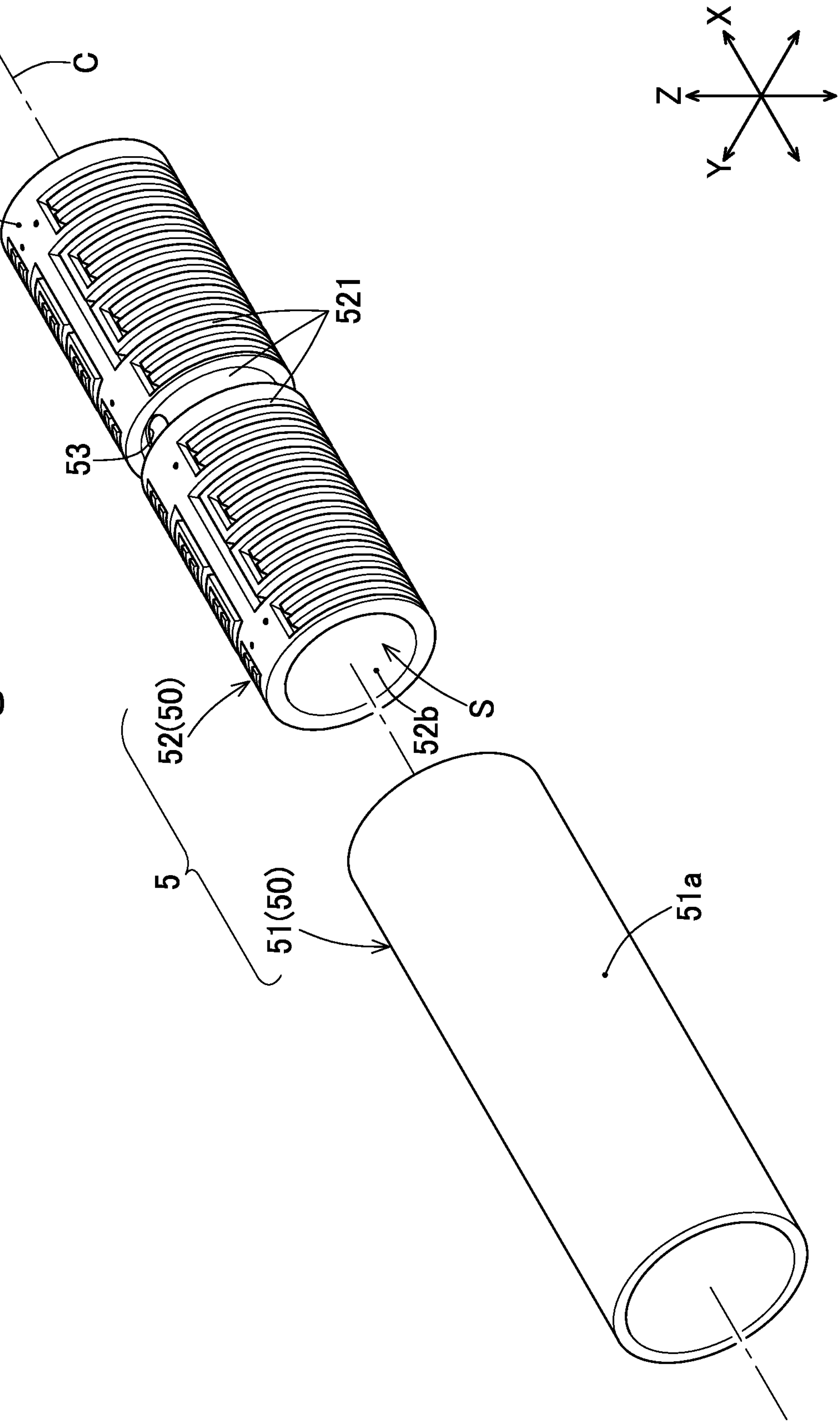


Fig.9

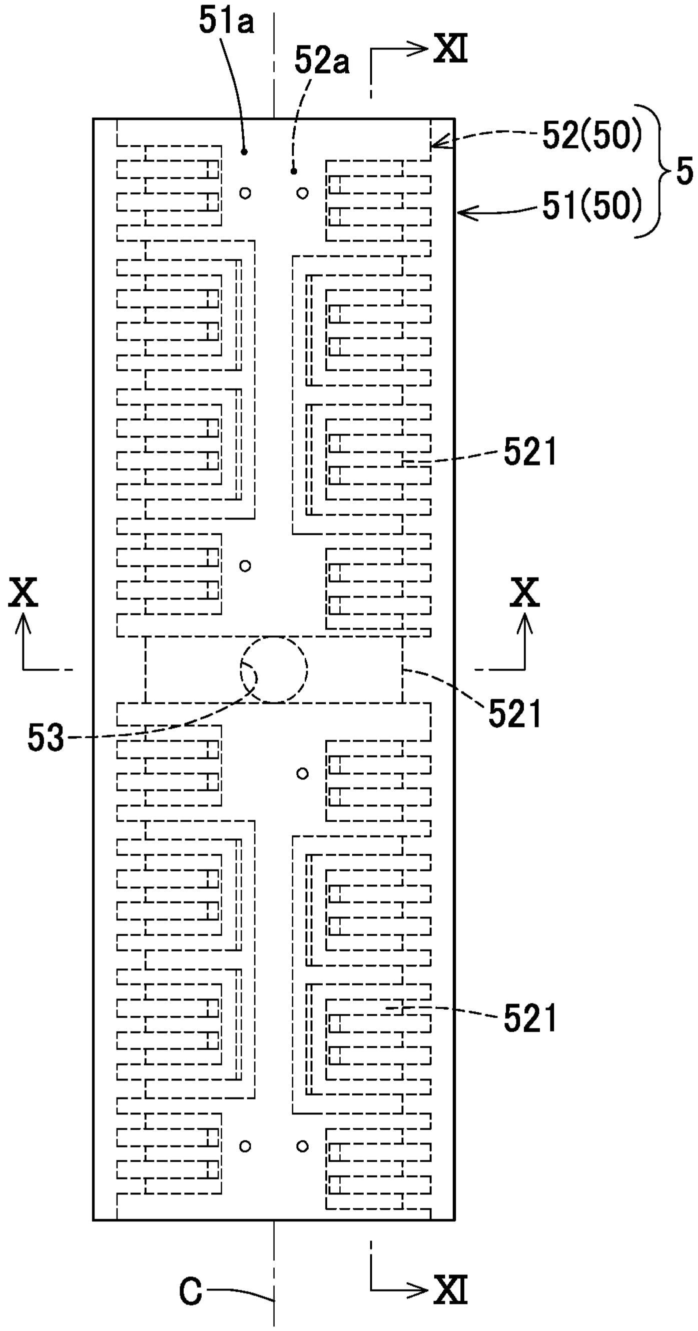


Fig.10

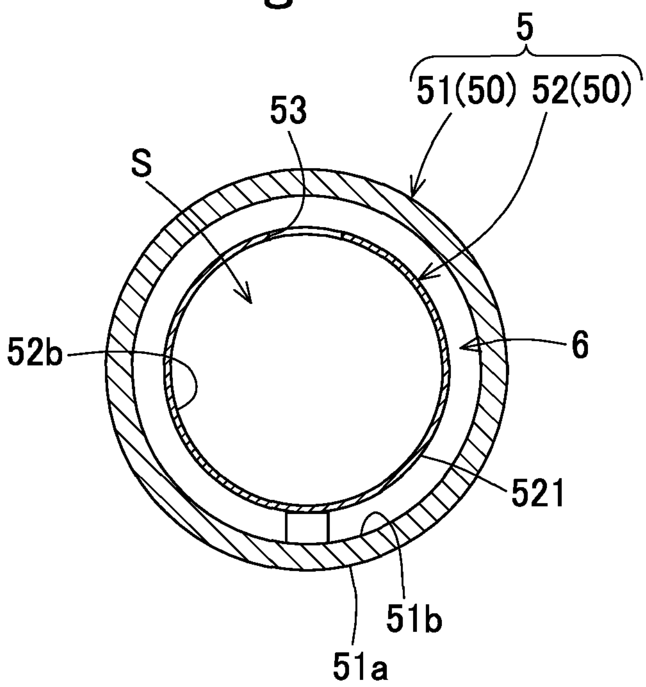


Fig.11

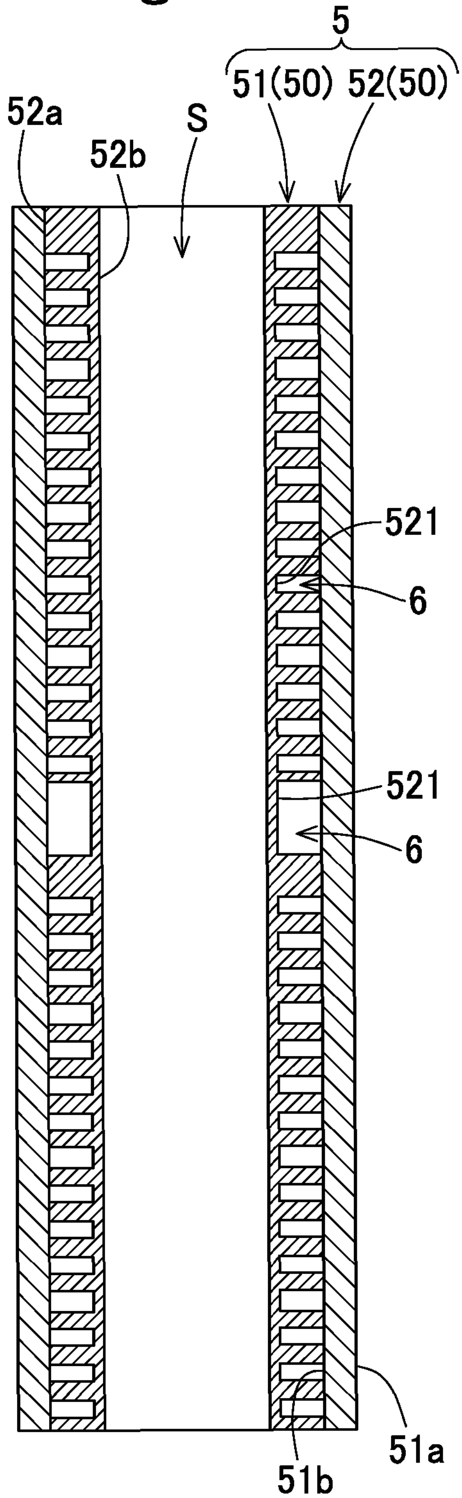
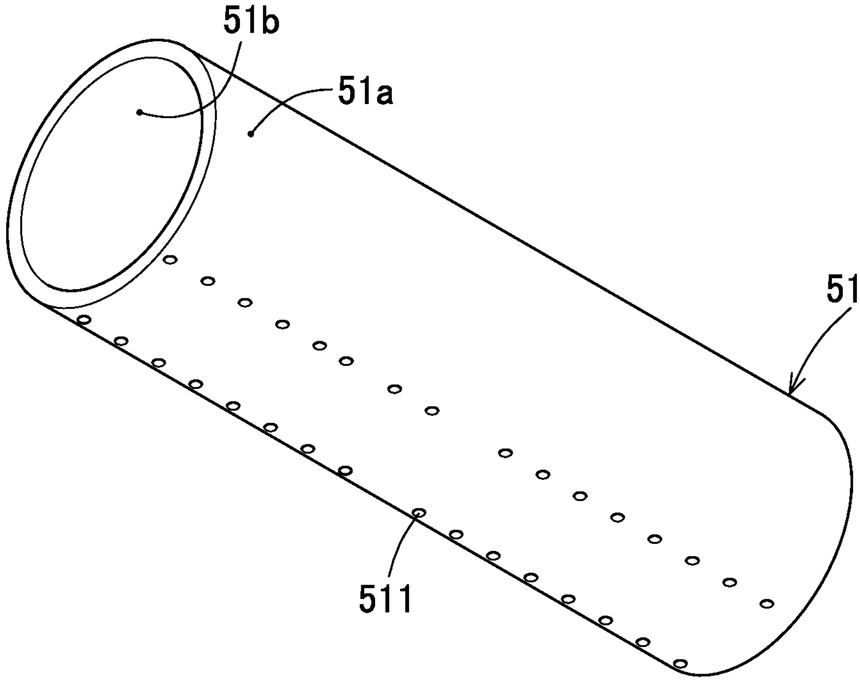


Fig.12



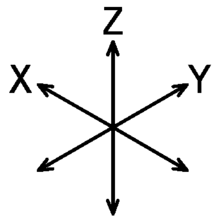
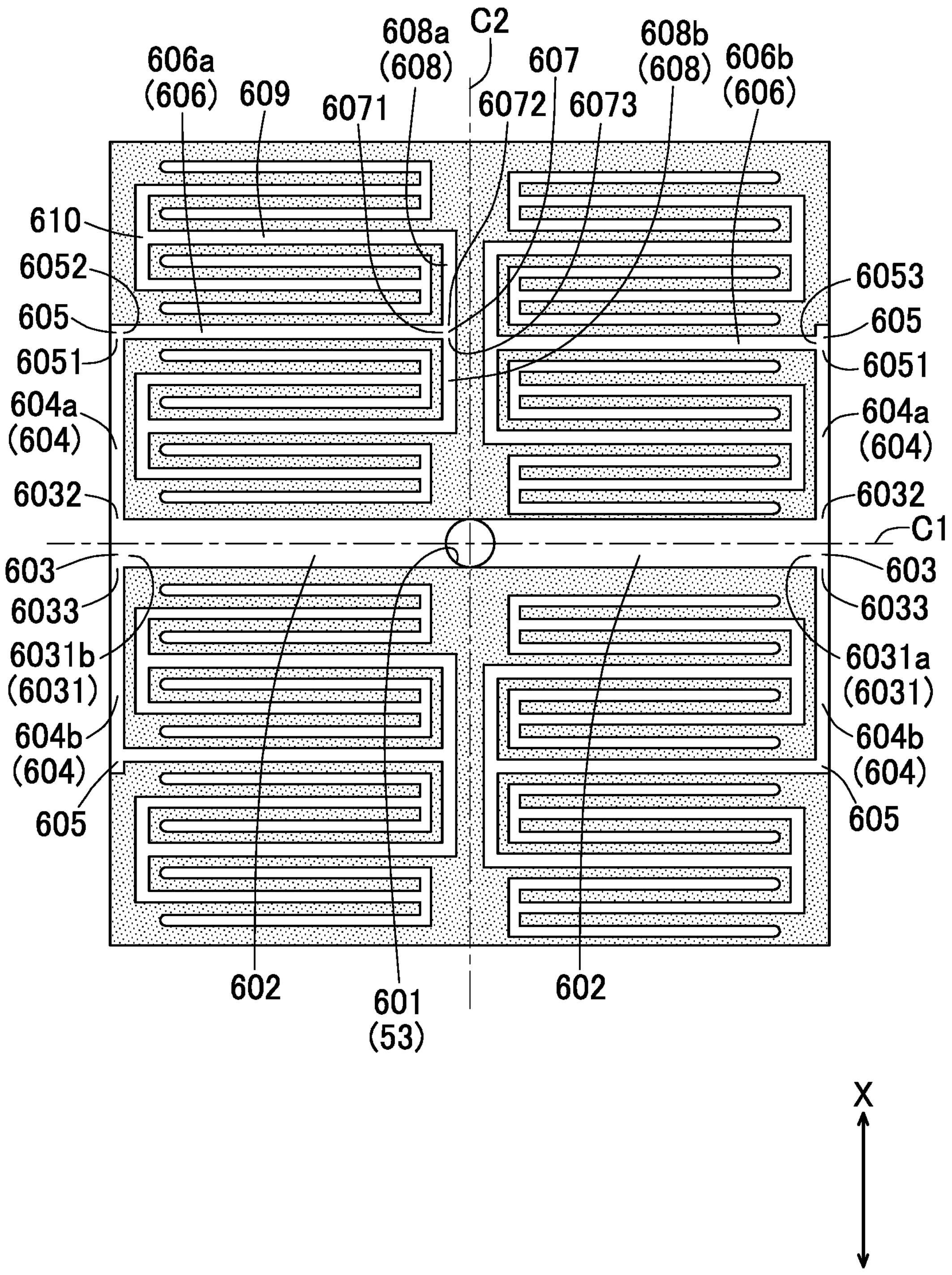


Fig.13



C2
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(606)
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6073
608b
(608)
606b
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605
6051
604a
(604)
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(6031)
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(604)
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6051
604a
(604)
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(53)
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X

Fig.14

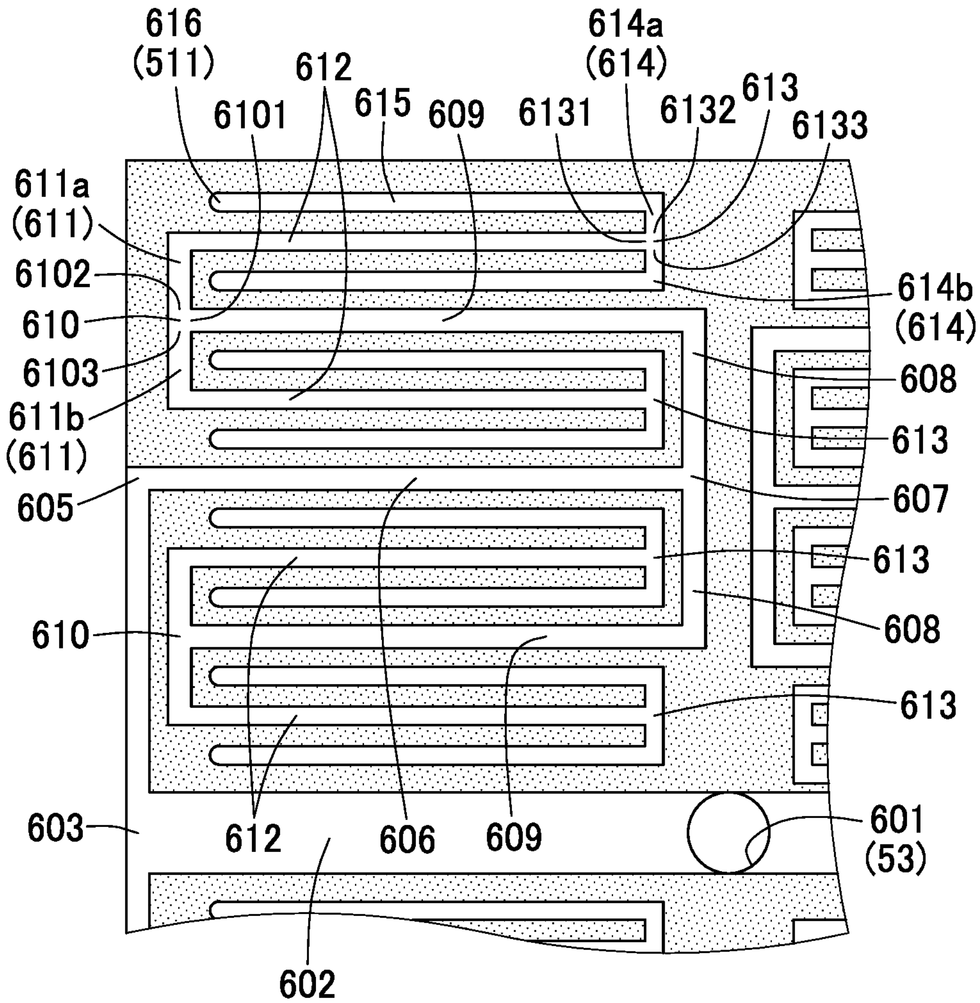

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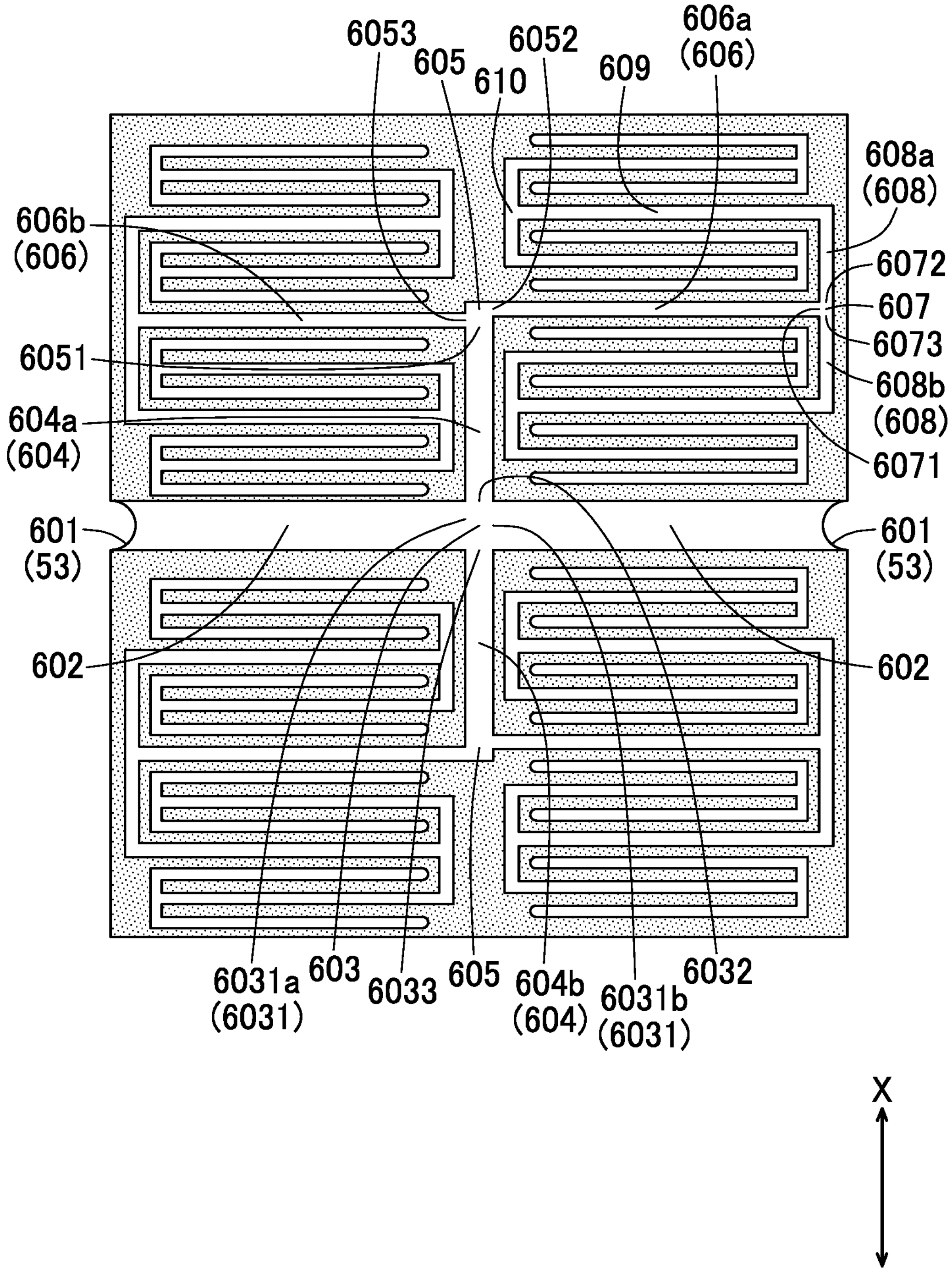
Fig.15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6033
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604b
(604)
6031b
(6031)
6032
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Fig.16A

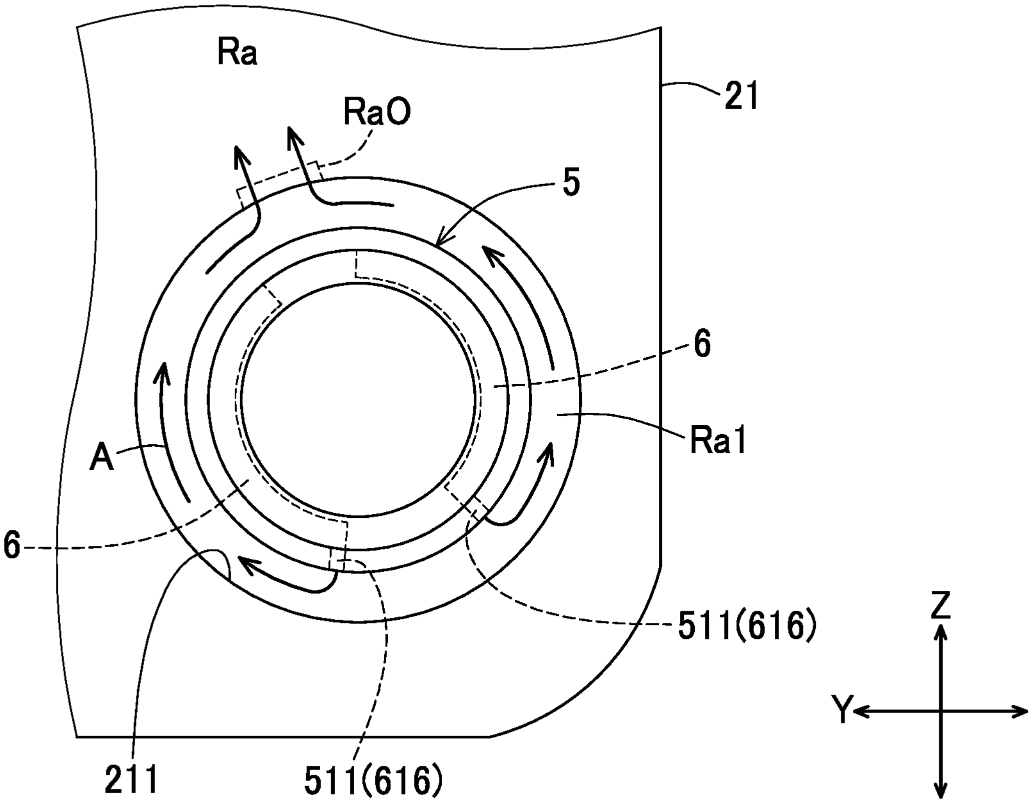

Fig.16B

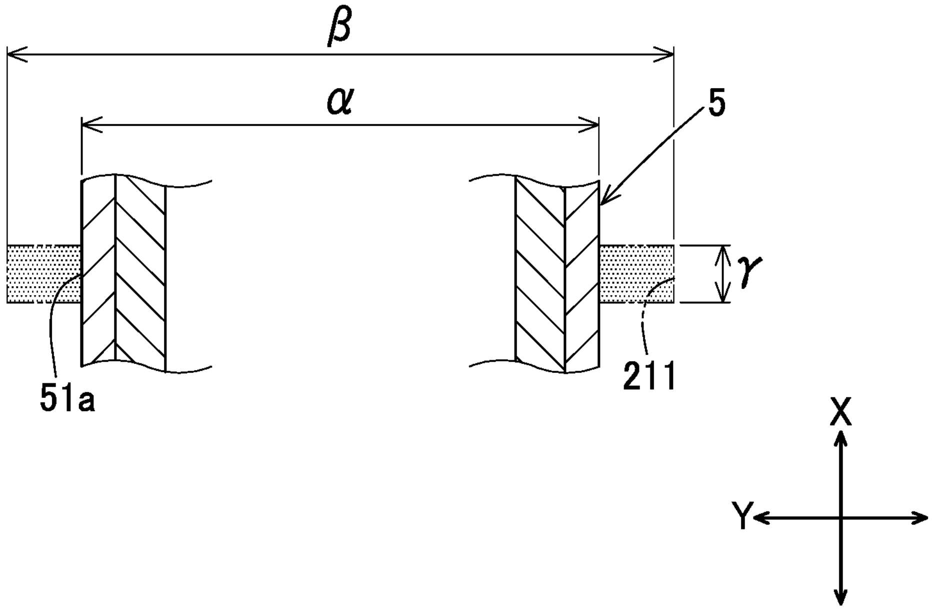

Fig.17

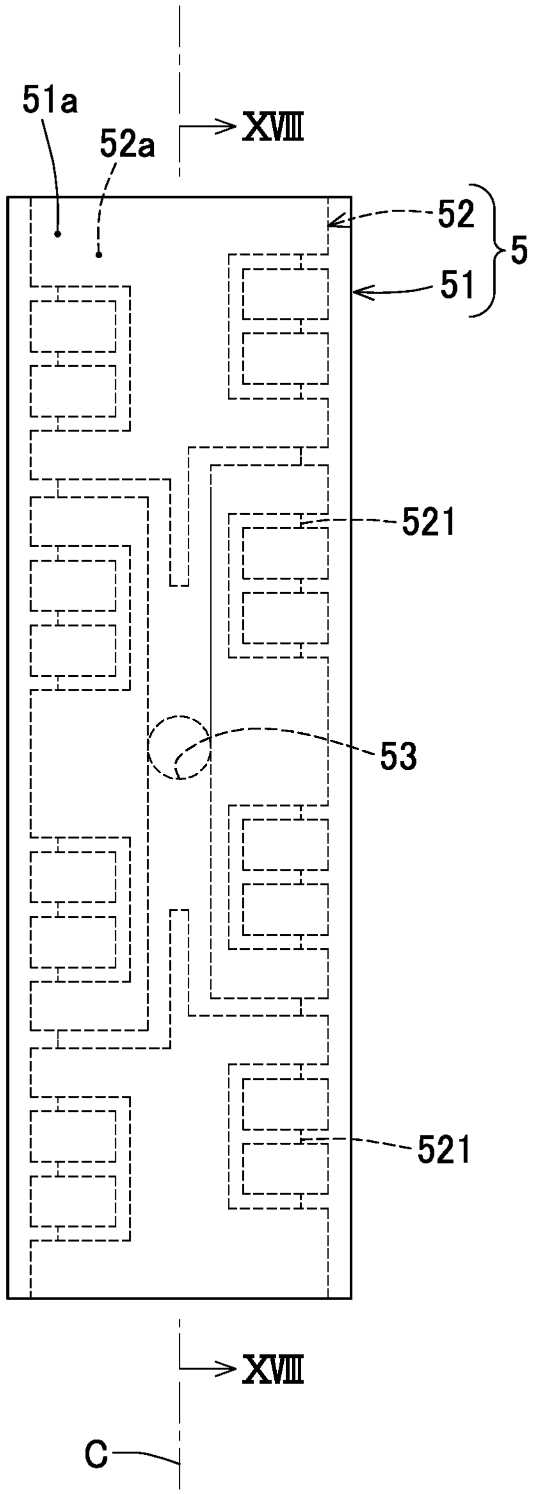

Fig.18

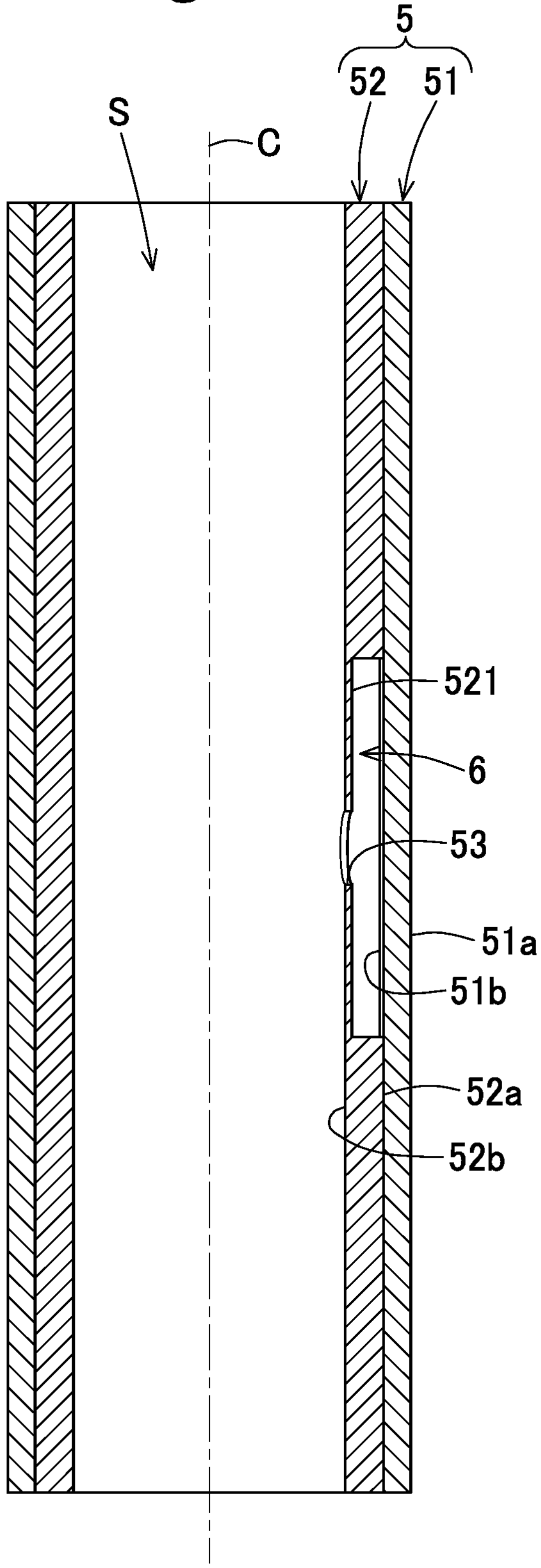

Fig.19

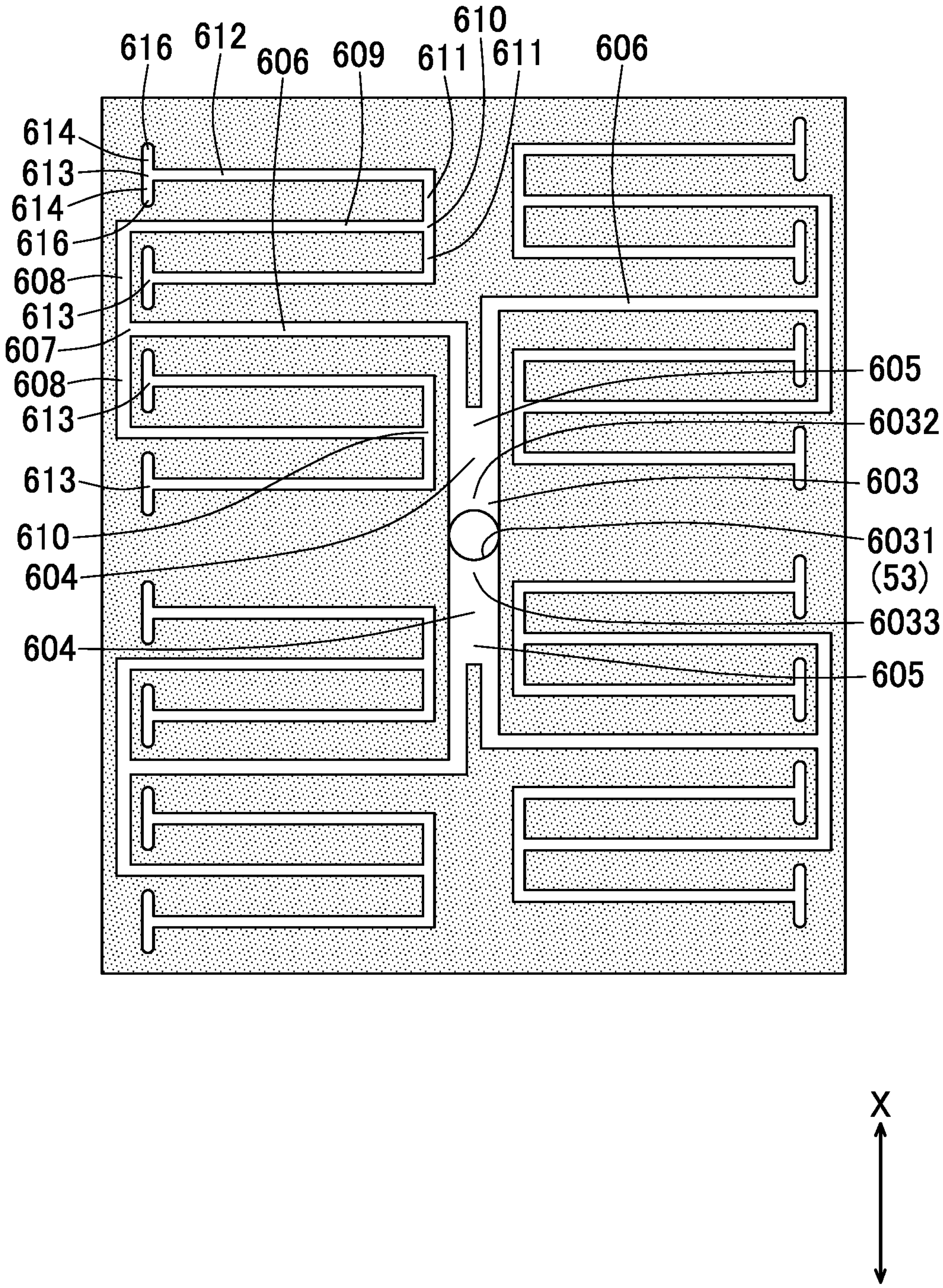
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Fig.20

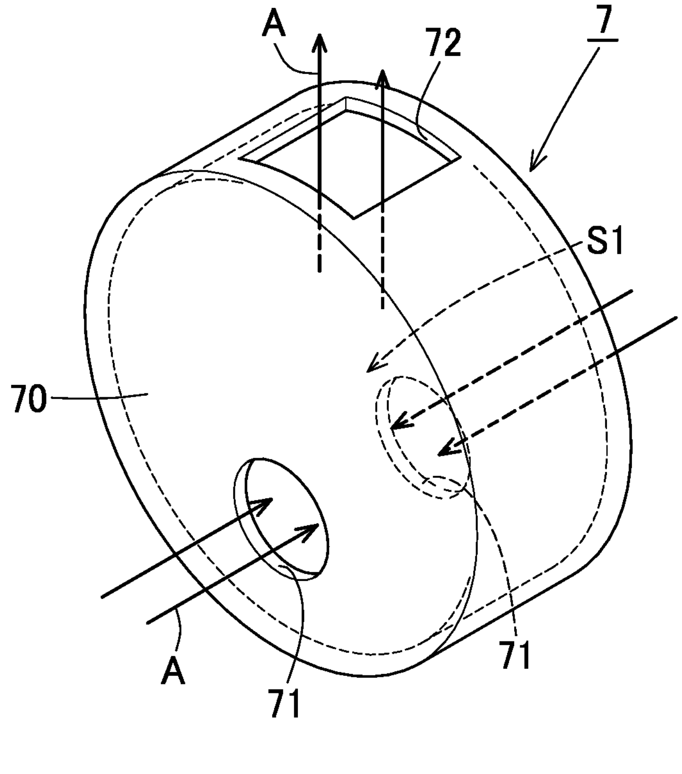


Fig.21

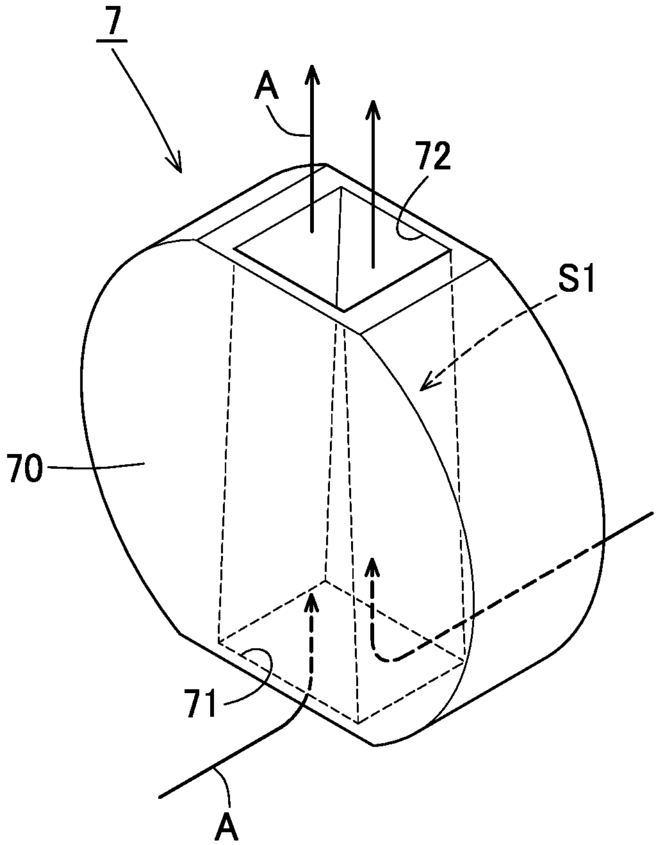


Fig.22

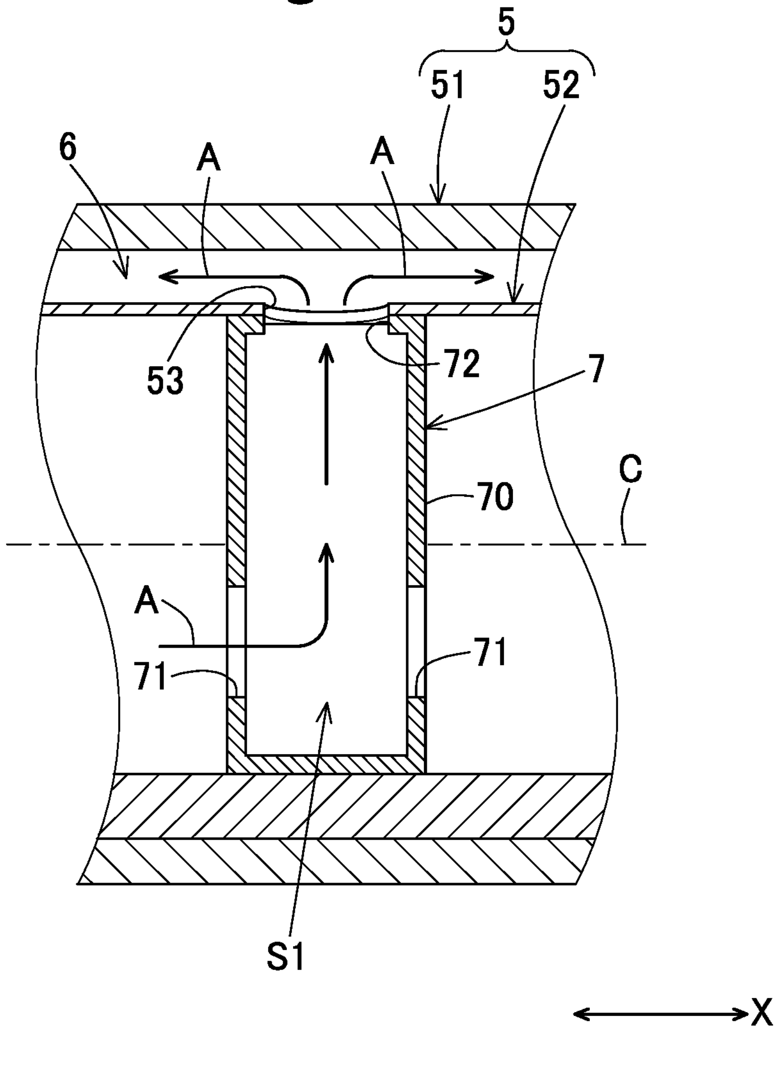


Fig.23

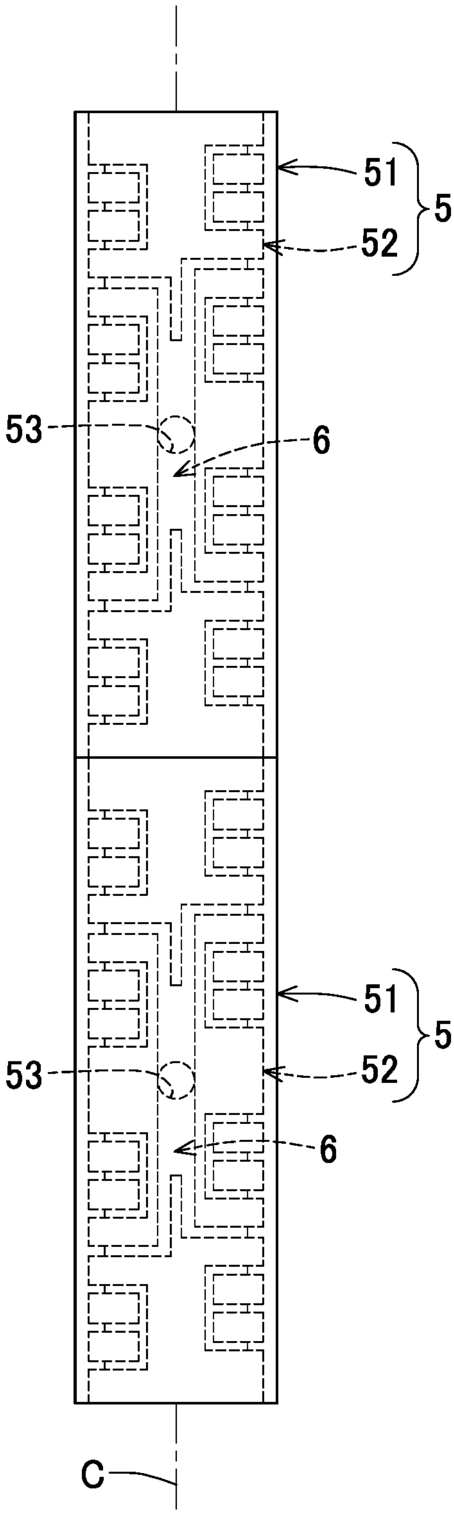


Fig.24

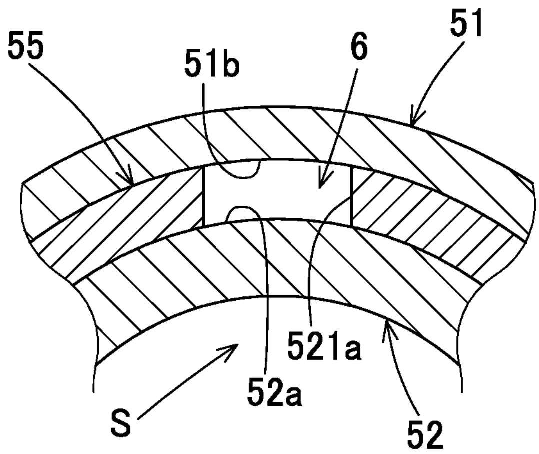


Fig.25

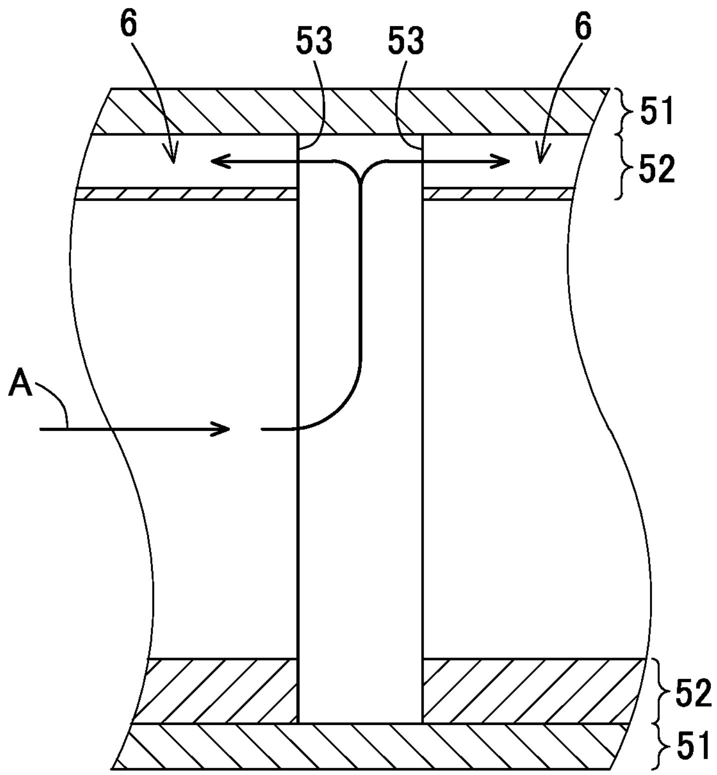


Fig.26

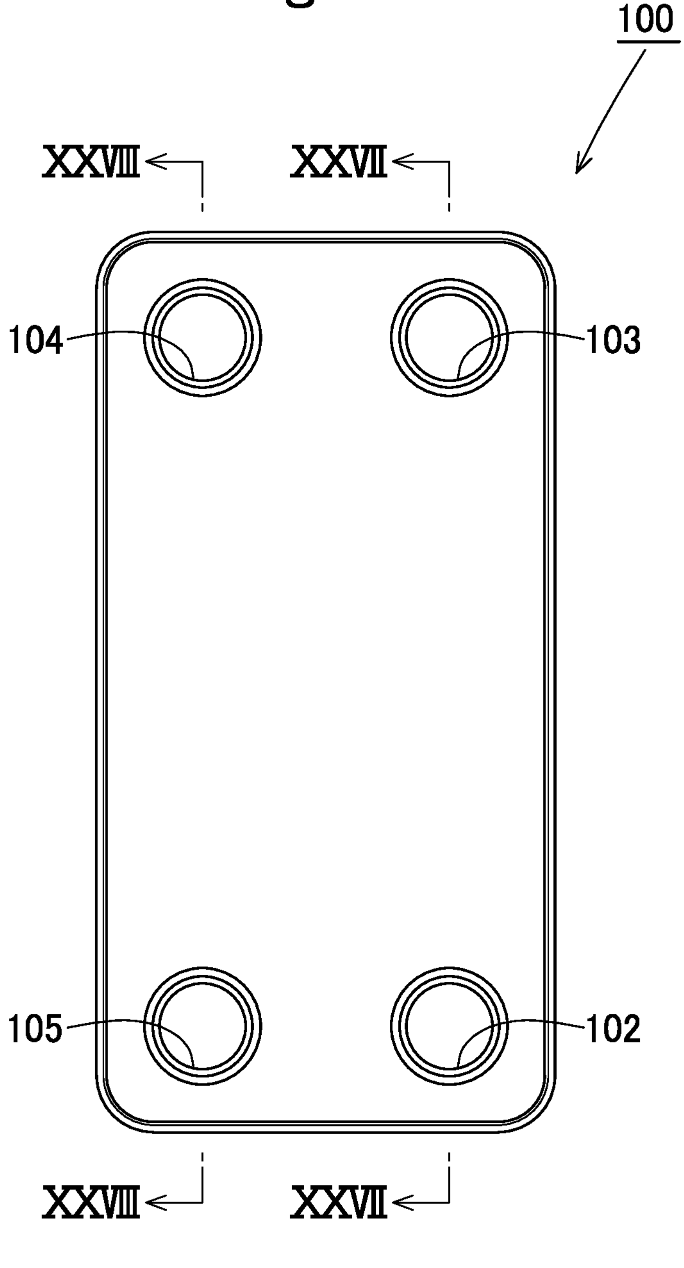


Fig.27

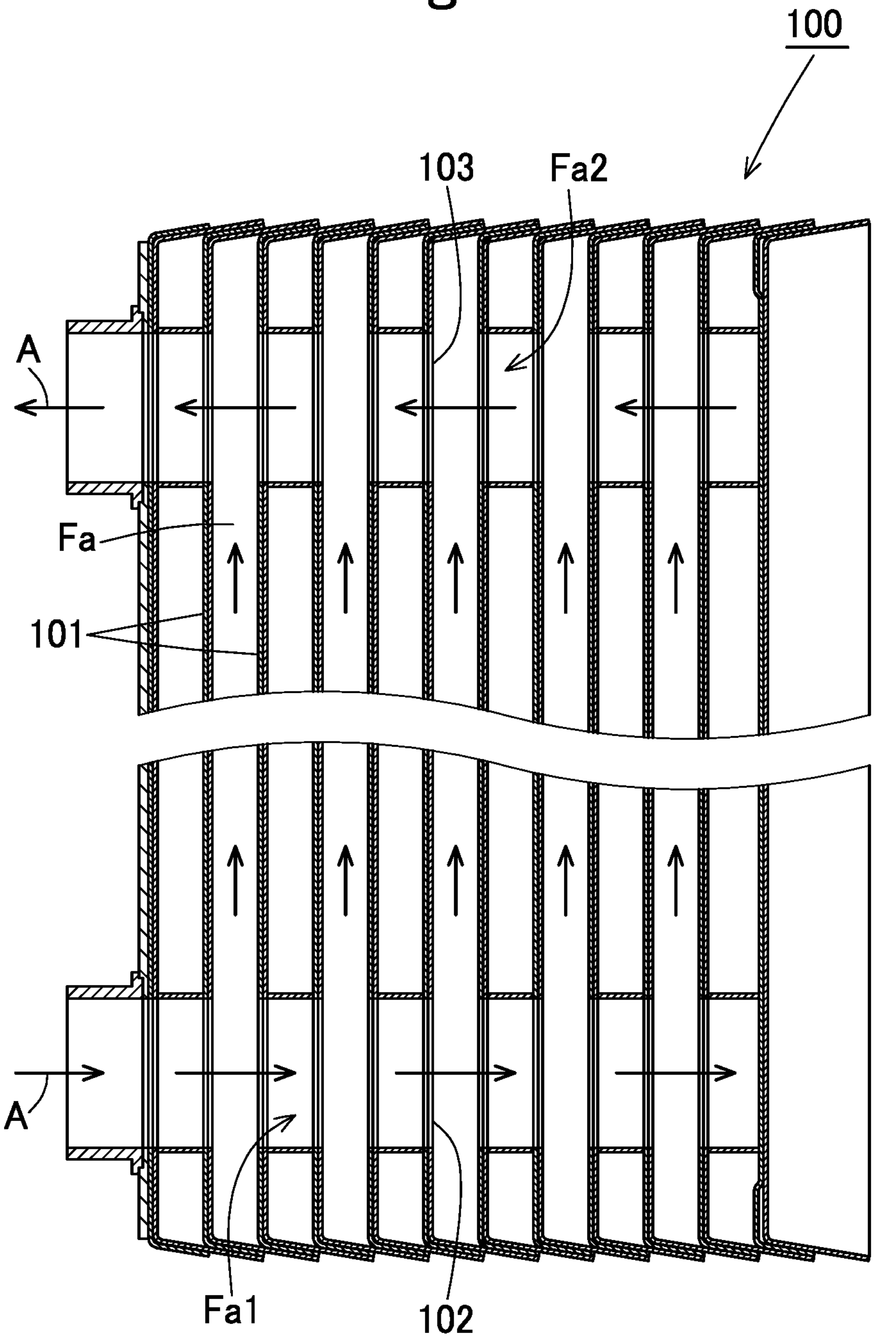
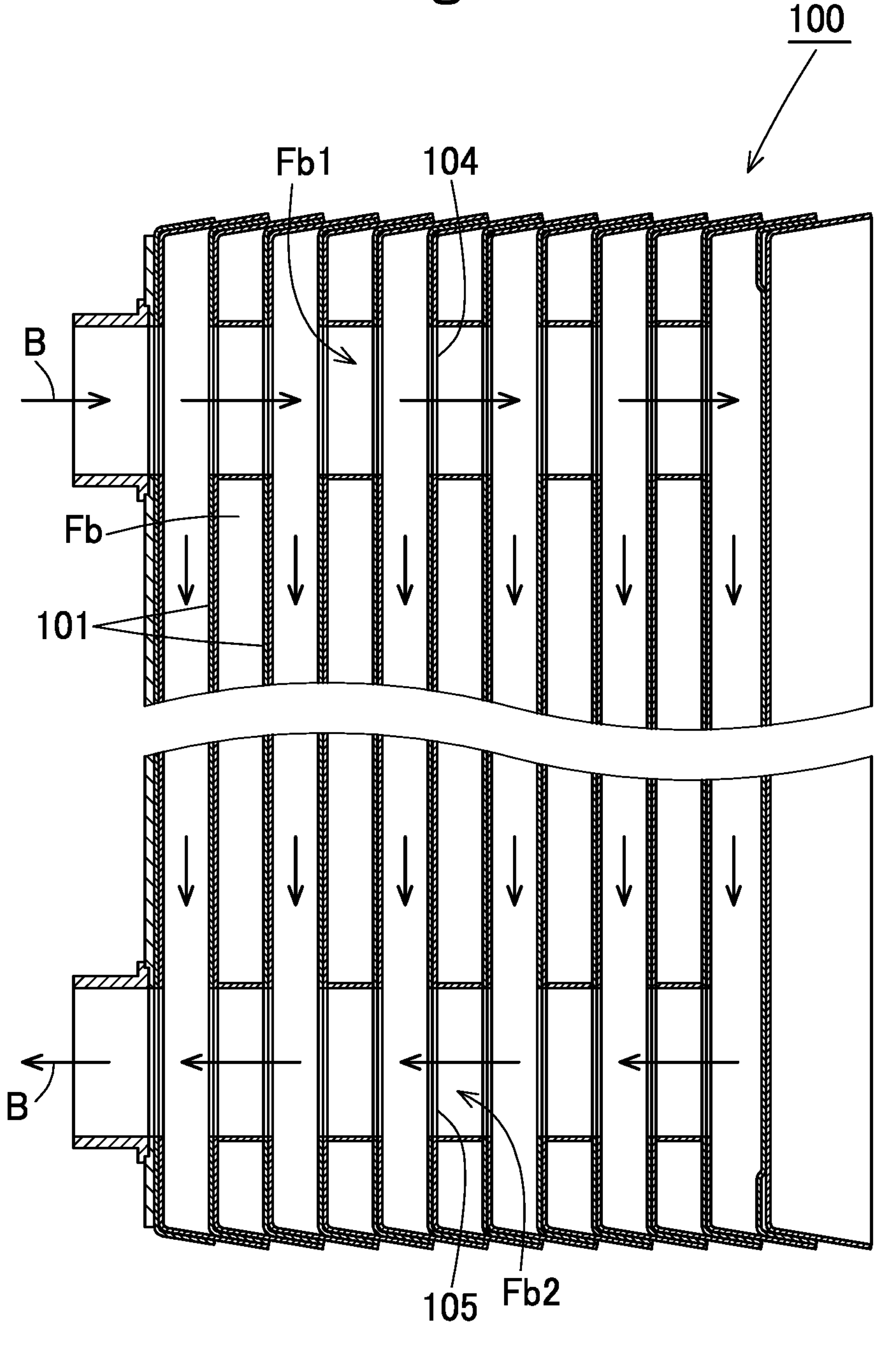


Fig.28



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/021530

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F28D9/02(2006.01)i, F28F3/08(2006.01)i
FI: F28D9/02, F28F3/08301Z
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F28D9/02, F28F3/08

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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.
Y A	JP 4-86492 A (HISAKA WORKS LTD.) 19.03.1992 (1992-03-19), page 1, lower left column, line 15 to page 4, upper left column, line 7, fig. 1-3	1-2, 4-5 3
Y	JP 2016-23926 A (HAMILTON SUNDSTRAND SPACE SYSTEMS INTERNATIONAL, INC.) 08.02.2016 (2016-02-08), paragraphs [0001]-[0030], fig. 1A-9	1-2, 4-5
A	JP 2011-503509 A (SWEP INTERNATIONAL AB) 27.01.2011 (2011-01-27), entire text, all drawings	1-5
A	US 2017/0227303 A1 (HAMILTON SUNDSTRAND CORPORATION) 10.08.2017 (2017-08-10), entire text, all drawings	1-5
A	US 2014/0345837 A1 (HAMILTON SUNDSTRAND CORPORATION) 27.11.2014 (2014-11-27), entire text, all drawings	1-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22.07.2020	11.08.2020

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/021530

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	JP 2555249 Y2 (HISAKA WORKS LTD.) 19.11.1997 (1997-11-19), entire text, all drawings	1-5
A	US 2018/0156544 A1 (CARRIER CORPORATION) 07.06.2018 (2018-06-07), entire text, all drawings	1-5
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/021530

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP H11287572 A **[0011]**