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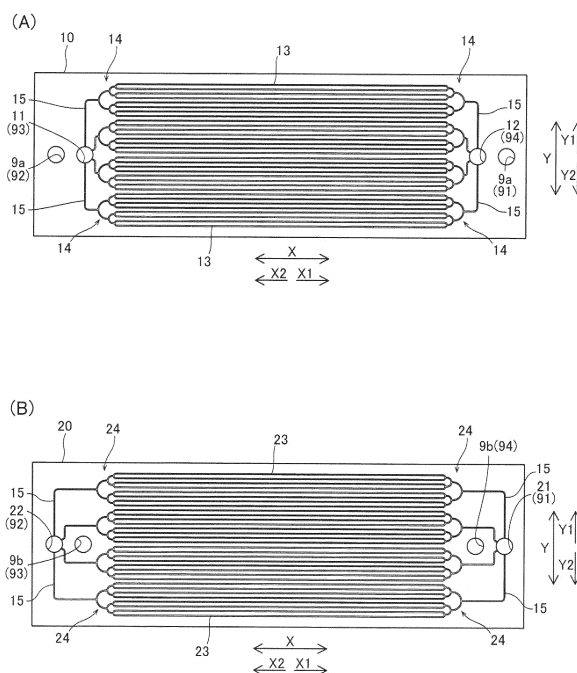
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(54) **HEAT EXCHANGER**

(57) The heat exchanger is equipped with a heat transfer member (10, 20) including a flow port (11, 12, 21, 22) for receiving or discharging a fluid (6, 7), a plurality of heat exchange passages (13, 23), and a connection passage part (14, 24) having both ends, one of the ends

being connected to the flow port and the other thereof being connected to the plurality of heat exchange passages (13, 23). The connection passage part has a tournament shape branched into two by two as it advances toward the heat exchange passages.

FIG.3



Description

Technical Field

[0001] The present invention relates to a heat exchanger, and more particularly to a heat exchanger equipped with a heat transfer member in which heat exchange passages and connection passage parts are formed.

Background Art

[0002] Conventionally, a heat exchanger equipped with a heat transfer member in which heat exchange passages and connection passage parts are formed is known. Such a heat exchanger is disclosed in, for example, Japanese Patent Laying-Open No. H04-227481.

[0003] In Japanese Patent Laying-Open No. H04-227481, a plate fin type heat exchanger equipped with a metal plate in which an inlet portion for a fluid, a plurality of heat exchange passages, and a connection passage part for distributing the fluid from the inlet portion to each heat exchange passage are formed is disclosed. In Japanese Patent Laying-Open No. H04-227481, a structure as a connection passage part in which a number of dot-shaped convex portions called dot cores are arranged in a distributed manner in a distribution region connected in parallel with a number of heat exchange passages is disclosed. In Japanese Patent Laying-Open No. H04-227481, the fluid dispersed by each dot core in the distribution region is distributed to each heat exchange passage.

Prior Art Document

[0004] [Patent Document 1] Japanese Patent Laying-Open No. H04-227481

Summary of the Invention

Problems to be Solved by the Invention

[0005] However, in the connection passage part of the aforementioned Japanese Patent Laying-Open No. H04-227481, since the fluid dispersed by a number of dot cores is distributed to each heat exchange passage, the flow rate of the fluid distributed to each heat exchange passage cannot be controlled, resulting in a random flow. Therefore, there is a problem that it is difficult to precisely suppress the flow rate variations of each heat exchange passage. When the flow rate of each heat exchange passage varies, the variations of the heat exchange performance for each flow passage becomes large, which makes it difficult to design a heat exchanger to obtain a desired performance.

[0006] The present invention has been proposed in order to solve the aforementioned problems, and an object of the present invention is to provide a heat exchanger

capable of precisely suppressing flow rate variations of a plurality of heat exchange passages.

Means for Solving the Problems

[0007] In order to achieve the aforementioned object, a heat exchanger according to the present invention is equipped with a heat transfer member. The heat transfer member includes a flow port for receiving or discharging a fluid, a plurality of heat exchange passages for making the fluid exchange heat, and a connection passage part having both ends, one of the ends being connected to the flow port and the other thereof being connected to the plurality of heat exchange passages. In the connection passage part has a tournament shape branched into two by two as it advances toward the heat exchange passages. Note that the "tournament shape" of the present invention is a broad concept indicating a branch shape repeating two-branching, the shape and length of the branched part, and the branching number are not limited. For this reason, the flow passage constituting the connection passage part is not only limited to a flow passage branched at right angles like a so-called tournament table, but also may be a flow passage branched into a curved shape such as a circular-arc shape, or branched in an oblique direction such as a Y-shape.

[0008] In the heat exchanger according to the present invention, as described above, the connection passage part is formed into a tournament shape in which the connection passage part is branched into two by two as it advances toward the heat exchange passages. With this, when the connection passage part is provided on the fluid inlet side, it is possible to divide the fluid entering and exiting the heat exchange passage into two and distribute it to each of the plurality of heat exchange passages. Here, when branching (dividing) one flow passage into three or more passages, the flow rate for each passage tends to vary due to the flow deviation, etc. On the other hand, when a flow passage is branched into two, the distribution amount to each flow passage can be easily equalized. Therefore, by repeating two-branching by the number corresponding to the number of heat exchange passages, when compared with a structure in which a fluid is distributed to a large number of heat exchange passages at one time, the flow rate variations of a plurality of heat exchange passages can be accurately suppressed.

[0009] In the heat exchanger according to the aforementioned invention, it is preferable that the connection passage part include a pair of branch passages branched into two from a branch origination part, and the branch origination part is connected to the pair of branch passages with the branch origination part directed in an extending direction of a bisector of an angle formed by the pair of branch passages. With such a configuration, it becomes possible to introduce the fluid from the branch origination part to each branch passage in the intermediate direction (direction along which the bisector ex-

tends) of the pair of branch passages, resulting in a more even distribution of the fluid to each of the branch passages. As a result, it is possible to more effectively suppress the flow rate fluctuations of the plurality of heat exchange passages.

[0010] In this case, it is preferable that the branch passage include a first part branched from the branch origination part and a linear second part as a branch connection part, the second part being extended from the first part and connected a pair of branch passages on a heat exchanger passage side. With such a configuration, when introducing a fluid from a branch passage on an upstream side to branch passages on a downstream side, it is possible to introduce the fluid into the branch passages on the downstream side in a state in which the flow direction is aligned by the linear second part. As a result, the fluid can be introduced into each branch passage on the downstream side in a state in which the flow direction is aligned toward the middle of the pair of branch passages, resulting in a more even distribution of the fluid.

[0011] In the heat exchanger according to the aforementioned invention, it is preferable that the connection passage part include a pair of branch passages branched into two from the origination part and the pair of branch passages have an equal flow passage length to each other. With such a configuration, it is possible to equalize the flow passage resistance of the pair of branch passages branched into two, so that the distribution amount of the fluid to the pair of branch passages can be equalized even more. By repeating two-branching with the same passage length by the number of the heat exchange passages, the flow rate variations of each heat exchange passage can be more effectively suppressed.

[0012] In this case, it is preferable that the pair of branch passages be formed symmetrically with respect to the branch origination part. With such a configuration, since the same branch passage can be branched symmetrically, the flow passage resistance of the pair of branch passages can be more reliably equalized. As a result, it is possible to further suppress the flow rate variations of the plurality of heat exchange passages.

[0013] In the configuration in which the aforementioned pair of branch passages is formed symmetrically, it is preferable that the pair of branch passages be respectively branched from the branch origination part so as to form a semi-elliptical shape. With such a configuration, since the flow of the semi-elliptical flow passage is aligned with the tangential direction of the elliptic curve, the pair of branch passages can be branched in the lateral direction from the branch origination part with respect to the flow from the upstream side, then the fluid flow can be directed gradually in the downstream direction along the semi-elliptical shape. As a result, the fluid flow can be approached to the downstream direction so that the fluid can be evenly distributed.

[0014] In this case, it is preferable that the pair of branch passages be respectively branched from the

branch origination part in a circular arc-shape so as to form a semicircular shape. With such a configuration, after branching the branch passage from the branch origination part in a lateral direction, it is possible to direct the fluid flow gradually in the downstream direction along the circular arc. Also, since the branch passage does not suddenly bend after being branched at the branch origination part, the flow passage resistance is less likely to increase. As a result, it is possible to approach the fluid flow to the downstream direction so that an even distribution of fluid can be realized while suppressing the increase of the flow passage resistance.

[EFFECT OF THE INVENTION]

[0015] According to the present invention, as described above, the flow rate variations of a plurality of heat exchange passages can be precisely suppressed.

Brief Description of the Drawings

[0016]

[Fig. 1] A schematic view of a heat exchanger according to a first embodiment of the present invention as viewed from an upper surface side thereof.

[Fig. 2] A schematic view of the heat exchanger according to the first embodiment of the present invention as viewed from a side surface side thereof.

[Fig. 3(A)] A plan view showing a first heat transfer member of the heat exchanger according to the first embodiment of the present invention.

[Fig. 3(B)] A plan view showing a second heat transfer member of the heat exchanger according to the first embodiment of the present invention.

[Fig. 4] An enlarged plan view showing a connection passage part of the first heat transfer member.

[Fig. 5] A schematic diagram showing connection passage parts according to a comparative example;

[Fig. 6] A diagram showing flow rate simulation results of connection passage parts according to the comparative example.

[Fig. 7] A diagram showing flow rate simulation results of connection passage parts in the heat exchanger according to the first embodiment.

[Fig. 8] A schematic diagram showing flow velocity vectors in a connection passage part of the heat exchanger according to the first embodiment.

[Fig. 9] A schematic diagram showing flow velocity vectors of a connection passage part according to the comparative example.

[Fig. 10] A plan view showing connection passage parts of a heat exchanger according to a second embodiment of the present invention.

[Fig. 11] An enlarged plan view showing a detailed structure of the connection passage part of the heat exchanger according to the second embodiment of

the present invention.

[Fig. 12] A diagram showing flow rate simulation results of the connection passage parts in the heat exchanger according to the second embodiment.

[Fig. 13] A schematic diagram showing a first modified example of the connection passage part according to the first embodiment.

[Fig. 14] A schematic diagram showing flow velocity vectors when the second part of the connection passage part according to the first embodiment is extended.

[Fig. 15] A schematic view showing a second modified example of the connection passage part of the heat exchanger according to the first embodiment.

Modes for Carrying Out the Invention

[0017] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

(First Embodiment)

[0018] First, with reference to Figs. 1 to 4, the configuration of the heat exchanger 100 according to the first embodiment will be described.

[0019] The heat exchanger 100 is a plate-type heat exchanger. As shown in Figs. 1 and 2, the heat exchanger 100 includes a core 1 and header portions 2 to 5 (see Fig. 2). The core 1 includes a plurality of first heat transfer members 10 through which a first fluid 6 flows and a plurality of second heat transfer members 20 through which a second fluid 7 flows. The core 1 is a heat exchanging portion which performs heat exchange between the first fluid 6 flowing through the first heat transfer member 10 and the second fluid 7 flowing through the second heat transfer member 20. Both the first fluid 6 and the second fluid 7 each are an example of the "fluid" of the present invention. Both the first heat transfer member 10 and the second heat transfer member 20 each are an example of the "heat transfer member" of the present invention.

[0020] In the first embodiment, the first fluid 6 is a gas on a high temperature side and the second fluid 7 is a liquid on a low temperature side. Note that either the first fluid 6 or the second fluid 7 may be on the high temperature side, and the first fluid 6 and the second fluid 7 may be either a gas or a liquid. In Figs. 1 and 2, the hollow arrow indicates a flow direction of the first fluid 6, and the hatched arrow indicates a flow direction of the second fluid 7.

[0021] The core 1 is configured by alternately stacking a plurality of plate-shaped first heat transfer members 10 and a plurality of plate-shaped second heat transfer members 20. Further, side plates 8 are respectively provided on both ends of the core 1 in the stacking direction (Z-direction). The core 1 is formed into a rectangular box shape (rectangular parallelepiped shape) as a whole by sandwiching the stacked members of the first heat transfer member 10 and the second heat transfer member 20

alternately stacked with a pair of side plates 8 and joining them with fastening members, diffusion bonding, brazing, etc. The first heat transfer member 10 and the second heat transfer member 20 are made of a high thermal conductive metallic material, etc. In the first heat transfer member 10 and the second heat transfer member 20, flow passages for flowing the first fluid 6 and flow passages for flowing the second fluid 7 are formed, respectively. The detailed configuration of the first heat transfer member 10 and that of the second heat transfer member 20 will be described later. Note that, in Fig. 1, the upper surface side plate 8, the first heat transfer member 10, and the second heat transfer member 20 are respectively shown in a manner separated by break lines. Hereinafter, the stacking direction of the first heat transfer member 10 and the second heat transfer member 20 shown in Fig. 2 is defined as a Z-direction. Also, as shown in Fig. 1, the longitudinal direction of the core 1 when viewed in the Z-direction is defined as an X-direction, and the transverse direction of the core 1 is defined as a Y-direction.

[0022] A header portion 2 is an inlet flow passage for the second fluid 7 that allows the second fluid 7 to flow into the core 1 (second heat transfer member 20). A header portion 3 is an outlet flow passage for the second fluid 7 that flows out of the core 1 (second heat transfer member 20). The header portions 2 and 3 are attached to one surface (Z1 side) of the core 1, the header portion 2 is arranged in the vicinity of the X1 side end portion, and the header portion 3 is arranged in the vicinity of the X2 side end portion. Both the header portions 2 and 3 are cylindrical pipe members. The header portions 2 and 3 are respectively connected to the inlet passage 91 and the outlet passage 92 for the plurality of the second heat transfer members 20 through which the second fluid 7 flows. The header portion 2 collectively introduces the second fluid 7 into the plurality of second heat transfer members 20, and the header portion 3 collectively discharges the second fluid 7 from the plurality of second heat transfer members 20.

[0023] The header portion 4 is an inlet flow passage for the first fluid 6 for allowing the first fluid 6 to flow into the core 1 (first heat transfer member 10). The header portion 5 is an outlet flow passage for the first fluid 6 for allowing the first fluid 6 to flow out of the core 1 (first heat transfer member 10). The header portions 4 and 5 are attached to the other surface (Z2 side) of the core 1. The header portion 4 is arranged in the vicinity of the X2 side end portion, and the header portion 5 is disposed in the vicinity of the X1 side end portion. Both the header portions 4 and 5 are cylindrical pipe members. The header portions 4 and 5 are respectively connected to the inlet passage 93 and the outlet passage 94 of the first fluid 6 for the plurality of first heat transfer members 10. The header portion 4 collectively makes the first fluid 6 flow into the plurality of first heat transfer members 10, and the header portion 5 collectively makes the first fluid 6 flow out of the plurality of first heat transfer members 10.

[0024] The first fluid 6 is introduced from the header

portion 4 on the X2 side into respective first heat transfer members 10, flows through the flow passages of the first heat transfer member 10 in the X1-direction, and flows out of the header portion 5 on the X1 side. The second fluid 7 is introduced from the header portion 2 on the X1 side into respective second heat transfer members 20, flows through the flow passages of the second heat transfer member 20 in the X2-direction, and flows out of the header portion 3 on the X2 side. As a result, heat exchange occurs between the first fluid 6 flowing through the first heat transfer members 10 in the X1-direction and the second fluid 7 flowing through the second heat transfer members 20 in the X2-direction via the first heat transfer members 10 and the second heat transfer members 20. As described above, the heat exchanger 100 according to the first embodiment is configured as a counter-flow type heat exchanger. In the first embodiment, the first fluid 6 on the high temperature side is cooled by the second fluid 7 on the low temperature side and taken out of the header portion 5 in a state in which the temperature is lowered. The second fluid 7 functions as a coolant for the first fluid 6.

[0025] Next, the detailed configurations of the first heat transfer member 10 and the second heat transfer member 20 will be described.

[0026] As shown in Fig. 3(A), the first heat transfer member 10 is a metal plate member including an inlet port 11, an outlet port 12, a plurality of heat exchange passages 13, and connection passage parts 14. Note that the inlet port 11 and the outlet port 12 each are an example of the "flow port" of the present invention. The plurality of heat exchange passages 13 and the connection passage parts 14 are groove-like flow passages integrally formed in the first heat transfer member 10. The heat exchange passages 13 are linear flow passages provided to make the fluids exchange heat, and extend in the X-direction and are arranged in parallel in the Y-direction. In the first embodiment, thirty-two (32) heat exchange passages 13 are formed. Note that it is sufficient that the number of the heat exchange passages 13 is an even number and may be any number other than thirty-two (32).

[0027] Both the inlet port 11 and the outlet port 12 are circular through-holes penetrating the first heat transfer member 10 in the thickness direction. The inlet port 11 is arranged in the vicinity of the end portion of the first heat transfer member 10 on the X2-direction side and the outlet port 12 is arranged in the vicinity of the end portion of the first heat transfer member 10 on the X1-direction side. The inlet port 11 and the outlet port 12 each are connected to the connection passage parts 14 via a plurality (four) of communication passages 15. The inlet port 11 is provided for introducing the first fluid 6 into the flow passages and the outlet port 12 is provided for discharging the first fluid 6 out of the flow passages. Further, through-holes 9b (see Fig. 3 (B)) similar to the inlet port 11 and the outlet port 12 are provided at the corresponding positions of the second heat transfer member

20. Therefore, the respective inlet ports 11 and the respective through-holes 9b of the stacked first heat transfer members 10 and second heat transfer member 20 are connected in the thickness direction (Z-direction) to constitute an inlet passage 93 penetrating the core 1 in the Z-direction as a whole (see Fig. 2). Similarly, the respective outlet ports 12 and the respective through-holes 9b are connected to constitute an outlet passage 94 penetrating the core 1 in the Z-direction as a whole (see Fig. 2). Through-holes are also provided in the side plate 8 on the Z2 side (see Fig. 2) to connect the header portions 4 and 5 and the inlet and outlet passages 93 and 94, respectively.

[0028] A plurality of connection passage parts 14 are provided between the inlet port 11 and the plurality of heat exchange passages 13 and between the outlet port 12 and the plurality of heat exchange passages 13. The number of the connection passage parts 14 corresponds to the number of the heat exchange passages 13. In the first embodiment, four connection passage parts 14 are respectively provided on the inlet port 11 side and the outlet port 12 side. Since the structure of the connection passage part 14 is common to the inlet port 11 side and the outlet port 12 side, only the connection passage part 14 of the inlet port 11 will be described. Note that the four connection passage parts 14 have the same structure.

[0029] The connection passage part 14 has both ends, one end being connected to the inlet port 11 (communication passage 15) and the other being connected to the plurality of heat exchange passages 13, and has a function of distributing the first fluid 6 from the inlet port 11 to each of the heat exchange passages 13. In the first embodiment, the connection passage part 14 has a tournament shape branched into two by two as it advances toward the heat exchange passages 13.

[0030] Specifically, as shown in Fig. 4, the connection passage part 14 is branched in three stages, a first stage 31, a second stage 32, and a third stage 33, so that one flow passage (communication passage 15) is ultimately branched into eight (8) flow passages. The four connection passage parts 14 are respectively branched into eight (8) passages and connected to thirty-two (32) heat exchange passages 13. In the first embodiment, the connection passage part 14 includes a pair of branch passages 34 branched into two from the branch origination part 35 (second part 37 or communication passage 15 which will be described later). Therefore, one pair of the branch passages 34 is provided in the first stage 31, two pairs are provided in the second stage 32, and four pairs are provided in the third stage 33. The branch passages 34 of the first stage 31 are branched into two with the end portion of the communication passage 15 as a branch origination part 35. The branch passages 34 in the second stage 32 and thereafter are branched into two with a second part 37, which will be described later, as a branch origination part 35. In the entire connection passage part 14, the dimension in the X-direction is L1.

[0031] The pair of branch passages 34 is branched

from the branch origination part 35 toward both sides in the Y-direction, respectively. The pair of branch passages 34 has an equal flow passage length. More specifically, the pair of branch passages 34 is formed into a symmetrical shape with respect to the branch origination part 35. That is, the pair of branch passages 34 is symmetrical in the Y-direction centering the branch origination part 35. The flow passage widths W1 of the pair of branch passages 34 are identical to each other, and although not illustrated, in the pair of branch passages 34, the flow passage cross-sectional area is the same. In Fig. 4, an example of the connection passage part 14 is shown in which the flow passage width W1 is constant and the passage cross-sectional area is constant throughout the whole connection passage part.

[0032] Here, it is preferable that the pair of branch passages 34 be branched from the branch origination part 35 so as to form a semi-elliptical shape. In the first embodiment, the pair of branch passages 34 is branched in a circular arc-shape from the branch origination part 35 so as to form a semicircular shape which is one type of a semi-elliptical shape. Therefore, the pair of branch passages 34 is branched from the branch origination part 35 in the Y1-direction and the Y2-direction which are tangential directions, extend so as to form a quarter circle, and extend along the X1-direction at the terminal end of the circular arc. More specifically, each branch passage 34 includes a first part 36 and a second part 37 continued from the first part 36.

[0033] The first part 36 of the pair of branch passages 34 is a flow passage branched from the branch origination part 35, and is a quarter circular section. In each of the first stage 31, the second stage 32, and the third stage 33, the radius of the first part 36 is a radius R1, a radius R2, and a radius R3, respectively. The radius R1 is larger than (R2+R3). The radius R2 is larger than the radius R3.

[0034] The second part 37 of the pair of branch passages 34 is a straight passage as a branch origination part extended from the first part 36 and connected to a pair of branch passages 34 on the heat exchange passage 13 side (X1 side in Fig. 4). In other words, the second part 37 of the branch passage 34 in the first stage 31 is connected, as a branch origination part 35, to a branch passage 34 in the second stage 32, the second part 37 of the branch passage 34 in the second stage 32 is connected, as a branch origination part 35, to the branch passage 34 in the third stage 33. The branch passage 34 of the third stage 33 is connected to the straight heat exchange passage 13 at the end portion of the heat exchange passage 13, and is not equipped with a second part 37. The second part 37 is an example of the "branch origination part" of the present invention.

[0035] The second part 37 of each branch passage 34 extends linearly along the X-direction. In other words, the second part 37 extends parallel to the heat exchange passage 13. The length of the second part 37 is approximately equal in the first stage 31 and the second stage 32, and each second part 37 has a length L2. The X-

direction dimension (length) L2 of the second part 37 is smaller than the X-direction dimension (R1, R2, or R3) of the first part 36. In the example of Fig. 4, the length L2 is about 1/9 of R1 and about 1/5 of R2. The length of the second part 37 may be different in the first stage 31 and the second stage 32, but it is preferable that the lengths of the plurality of second parts 37 included in the same stage be the same.

[0036] Here, in the first embodiment, the branch origination part 35 is connected to the pair of branch passages 34 with the branch origination part 35 directed in the extending direction of the bisector BS of the angle θ formed by the pair of branch passages 34. That is, in Fig. 4, since the first part 36 of the pair of branch passages 34 is branched in the Y1-direction and the Y2-direction each of which is a tangential direction, the angle θ formed by the pair of branch passages 34 is 180 degrees. On the other hand, the branch origination part 35 (second part 37, communication passage 15) linearly extends in the X1-direction, and is connected to the pair of branch passages 34 from the upstream side. Therefore, the branch origination part 35 is connected to the pair of branch passages 34 at 90 degrees perpendicular to the tangential direction of the first part 36, and is connected to the branch passages 34 in the extending direction (X1-direction) of the bisector BS of the angle θ (180 degrees) formed by the pair of branch passages 34. Further, the tangent line of the inner wall portion (inner wall point) 34a opposed to the branch origination part 35 is a vertical line orthogonal to the branch origination part 35.

[0037] With the aforementioned configuration, in the first heat transfer member 10, as shown in Fig. 3(A), the first fluid 6 flowed into from the inlet port 11 flows in each connection passage part 14 via the communication passages 15. In each connection passage part 14, the first fluid 6 is branched into two in each of three stages and is finally divided into eight, and each divided fluid flows into the corresponding one of eight heat exchange passages 13. The first fluid 6 cooled by passing through the heat exchange passage 13 flows into each connection passage part 14 on the downstream side, merges from eight to one, and then flows out of the outlet port 12 via the communication passages 15 on the downstream side.

[0038] As shown in Fig. 3(B), the second heat transfer member 20 is a metal plate member including an inlet port 21, an outlet port 22, a plurality of heat exchange passages 23, and a plurality of connection passage parts 24. Note that the inlet port 21 and the outlet port 22 each are an example of the "flow port" of the present invention.

[0039] The inlet port 21 is arranged in the vicinity of the end portion of the second heat transfer member 20 on the X1-direction side and the outlet port 22 is arranged in the vicinity of the end portion of the second heat transfer member 20 on the X2-direction side. The inlet port 21 and the outlet port 22 each are arranged at a position shifted outward in the X-direction from the respective through-holes 9b. Through-holes 9a (see Fig. 3(A)) sim-

ilar to the inlet port 21 and the outlet port 22 are also provided at corresponding positions of the first heat transfer member 10. With this, the through-hole 9a and the inlet port 21 of the first heat transfer member 10 and the second heat transfer member 20 are connected in the thickness direction (Z-direction) to constitute an inlet passage 91 (see Fig. 2) penetrating the core 1 in the X-direction as a whole. In the same manner, the outlet port 22 and the through-hole 9a are connected to constitute an outlet passage 92 (see Fig. 2) penetrating the core 1 in the Z-direction as a whole.

[0040] In the first embodiment, the configuration of the second heat transfer member 20 is basically the same as that of the first heat transfer member 10 except for the positions of the inlet port 21 and the outlet port 22 (and the positions of the through-holes 9a or 9b). Therefore, the configuration of each connection passage part 24 of the second heat transfer member 20 is the same as that of the connection passage part 14 of the first heat transfer member 10. For this reason, the detailed description on the structure of the second heat transfer member 20 will be omitted.

[0041] In the second heat transfer member 20 having the configuration described above, the second fluid 7 flowed in from the inlet port 21 passes through each connection passage part 24 and flows into the corresponding heat exchange passage 23. The second fluid 7 heated (took heat) by passing through the heat exchange passages 23 flows into each connection passage part 24 on the downstream side, and then flows out of the outlet port 22.

[0042] The first heat transfer member 10 and the second heat transfer member 20 are configured as described above.

[0043] In the first embodiment, the following effects can be obtained.

[0044] In the first embodiment, as described above, the connection passage part 14 (24) is formed into a tournament shape branched two by two as it advances toward the heat exchange passages 13(23). With this, in the connection passage part 14(24), the first fluid 6 (second fluid 7) entering into and leaving from the heat exchange passages 13 (23) can be divided two by two to be distributed to each of the plurality of heat exchange passages 13(23). Here, when branching (dividing) one flow passage into three or more flow passages, the flow rate for each flow passage becomes likely to vary due to the flow deviation, etc. On the other hand, when branching one passage into two, the distribution flow rate to each passage can be easily equalized. Therefore, by repeating two-branching by the number corresponding to the number of heat exchange passages 13 (23), the flow rate variations of the plurality of heat exchange passages 13(23) can be precisely suppressed as compared with the structure in which a first fluid 6 (second fluid 7) is distributed to a large number of heat exchange passages 13 (23) at one time.

[0045] In the first embodiment, as described above, a

pair of branch passages 34 branched into two from the branch origination part 35 are provided in the connection passage part 14(24). The branch origination part 35 is configured to be connected to the pair of branch passages 34 along the extending direction of the bisector BS of the angle θ formed by the pair of branch passages 34. With this, since the first fluid 6 (second fluid 7) can be made to flow in the intermediate direction (the extending direction of the bisector BS) of the pair of branch passages 34 from the branch origination part 35 with respect to each branch passage 34, it is possible that the first fluid 6 (second fluid 7) can be more evenly distributed to each of a pair of branch passages 34. As a result, the flow rate variations of the plurality of heat exchange passages 13(23) can be more effectively suppressed.

[0046] In the first embodiment, as described above, the first part 36 branched from the branch origination part 35 and the linear second part 37 as a branch origination part extended from the first part 36 and connected to the pair of branch passages 34 on the heat exchange passage 13(23) side are provided in the branch passage 34. Thereby, when making the first fluid 6 (second fluid 7) flow from the branch passage 34 on the upstream side to the branch passage 34 on the downstream side, it is possible to make the first fluid 6 (second fluid 7) flow into the branch passages 34 in a state in which the flow direction is aligned by the linear second part 37. As a result, since the first fluid 6 (second fluid 7) can be made to flow into each branch passage 34 on the downstream side with the direction of flow aligned toward the middle of the pair of branch passages 34, the first fluid 6 (second fluid 7) can be more evenly distributed.

[0047] Further, in the first embodiment, as described above, the pair of branch passages 34 are formed to have an equal flow passage length. With this, since the flow passage resistances of the pair of branch passages 34 branched into two can be equalized, the distribution amounts of the first fluid 6 (second fluid 7) to the pair of branch passages 34 can be more equalized. By repeating two-branching with the same passage length by the number corresponding to the number of heat exchange passages 13 (23), the flow rate variations of each heat exchange passage 13(23) can be more effectively suppressed.

[0048] In the first embodiment, as described above, the pair of branch passages 34 are formed symmetrically with respect to the branch origination part 35. With this, since the same branch passage 34 can be symmetrically branched, the flow passage resistances of the pair of branch passages 34 can be more reliably equalized. As a result, the flow rate variation of the plurality of heat exchange passages 13(23) can be further suppressed.

[0049] In the first embodiment, as described above, the pair of branch passages 34 are branched from the branch origination part 35 so as to form a semi-elliptical shape. With this, after branching the pair of branch passages 34 in the lateral direction from the branch origination part 35 with respect to the flow from the upstream

side, the flow of the first fluid 6 (second fluid 7) can be gradually directed in the downstream direction along the semi-ellipse. As a result, it is possible to change the flow of the first fluid 6 (second fluid 7) in a direction closer to the downstream direction so as to attain an even distribution of the first fluid 6 (second fluid 7).

[0050] In the first embodiment, as described above, the pair of branch passages 34 each are branched in a circular arc shape from the branch origination part 35 so as to form a semicircular shape. As a result, since the flow of the circular arc-shaped flow passage becomes directed in the tangential direction of the circular arc, after branching the branch passage 34 from the branch origination part 35 in the lateral direction, the flow of the first fluid 6 (second fluid 7) can be gradually directed in the downstream direction along the circular arc. Since the branch passage 34 does not bend sharply after being branched at the branch origination part 35, the flow passage resistance is less likely to increase. As a result, it is possible to direct the flow of the first fluid 6 (second fluid 7) to approach the downstream direction so as to enable an uniform distribution of the first fluid 6 (second fluid 7) while suppressing the increase of the flow passage resistance.

(Description of Simulation Results)

[0051] Next, referring to Figs. 5 to 9, in order to confirm the effects of the connection passage parts 14 of the first heat transfer member 10 (connection passage parts 24 of the second heat transfer member 20) in the heat exchanger 100 according to the first embodiment, the results of the simulation performed will be described. In the simulation, a first fluid 6 at a predetermined flow rate was caused to flow into connection passage parts 14, and the flow rate of the first fluid 6 for each of thirty-two (32) flow passages (channels) flowing out of the connection passage part 14 was calculated. Further, the same calculation was performed for the connection passage parts 50 according to a comparative example shown in Fig. 5, and the flow rate variations of each connection passage part was compared.

[0052] First, the structure of the connection passage part 50 according to the comparative example shown in Fig. 5 will be described. The connection passage part 50 of the comparative example is configured to branch the first fluid 6 from the communication passage 15 into six at a time. In the comparative example, five sets of the six-branched connection passage part 50 are provided to constitute thirty (30) flow passages (channels). Each connection passage part 50 includes a branch part 52 linearly extending from the connection part 51 connected to the communication passage 15 on both sides of the Y-direction, and an individual part 53 linearly extending from the branch part 52 in the X1-direction. In the branch part 52, the connection part 51 of the communication passage 15 is arranged at the center in the Y-direction. The individual parts 53 are arranged at equal intervals in

the Y-direction.

[0053] Fig. 6 shows simulation results of the connection passage parts 50 according to the comparative example, and Fig. 7 is simulation results of the connection passage parts 14 according to the first embodiment. In each figure, the horizontal axis shows the flow passage number (channel number), and the vertical axis shows the flow rate of the first fluid 6. In the first embodiment, since the four connection passage parts 14 have a total of 32 flow passages, in Fig. 7, there are 1st to 32nd channels in order from the Y1-direction side. The vertical axis shows the ratio when the average value of all the channels is set as 100%. The simulation was performed under the conditions that the first fluid 6 was supplied from the inlet port 11 at a mass flow rate of 1.0×10^{-3} Kg/s.

[0054] In the connection passage part 50 of the comparative example shown in Fig. 6, the flow rate for each channel largely varies in the range VR1 of about 0% to about 180%. Further, in the connection passage part 50 of the comparative example, the flow rate is divided into a group having a relatively low flow rate (channels 3, 4, 9, 10, 15, 16, etc.) and a group having a relatively high flow rate (channels 1, 6, 7, 12, 13, 18, etc.).

[0055] On the other hand, as shown in Fig. 7, in the connection passage part 14 of the first embodiment, the variations in the flow rate for each channel is remarkably small. The flow rate of each channel falls within a range VR2 of approximately 20% on the upper and lower sides centering the average value of 100%.

[0056] Fig. 8 is a view showing the velocity vectors of the first fluid 6 passing through the pair of branch passages 34 (first stage 31) in the connection passage part 14 according to the first embodiment. Fig. 9 is a view showing the velocity vectors of the first fluid 6 passing through the connection passage part 50 according to the comparative example. In each figure, the speed vector at an arbitrary position in the flow passage is shown as a representative point, and the length of the vector indicates the magnitude of the velocity.

[0057] As shown in Fig. 8, in the connection passage part 14 of the first embodiment, it is understood that the distribution of the velocity vectors is symmetrical between the pair of branch passages 34 and that the dispersion is small. In addition, it is understood that the speed vectors roughly extend in the tangential direction at the first part 36 of each branch passage 34, and the direction of the velocity vector changes so as to approach the X-direction at the second part 37. For this reason, the same result is obtained for the second stage 32 and subsequent stages. As a result, as shown in Fig. 7, the fluctuations of the flow rate was reduced.

[0058] As shown in Fig. 9, in the connection passage part 50 of the comparative example, it is found that the flow of the first fluid 6 advances to both ends of the branch part 52 in the Y-direction and the first fluid 6 intensively flows into the individual parts 53 at both ends in the Y-direction. As a result, the first fluid 6 hardly flowed into the central individual parts 53. For this reason, as shown

in Fig. 6, in the connection passage part 50, the flow rate was increased in the channels at both ends in the Y-direction (channels 1 and 6, etc.) and the flow rate was decreased at the center channels (channels 3 and 4, etc.).

[0059] From the above, the effect of equalizing the distribution flow rate to each flow passage by the connection passage part 14(24) of the heat exchanger 100 according to the first embodiment was confirmed. With this, it was confirmed that the flow rate variations of the plurality of heat exchange passages 13(23) distributed by the connection passage part 14(24) can be suppressed with high accuracy.

(Second Embodiment)

[0060] Next, with reference to Fig. 10 and Fig. 11, a second embodiment will be described. In this second embodiment, unlike the first embodiment in which the connection passage part 14 having circular arc-shaped branch passages 34 is provided in the heat exchanger 100, an example of a heat exchanger 200 in which a connection passage part 114 having branch passages 134 branched in a Y-shape is provided will be described.

[0061] In the heat exchanger 200 of the second embodiment, only the connection passage part 114 is different from the first embodiment, and other configurations of the heat exchanger 200 are the same as those of the first embodiment. Therefore, as to the same configuration as the first embodiment, the same reference numerals will be allotted and the description thereof will be omitted, and only the connection passage part 114 will be described. Here, only an example in which the connection passage part 114 is provided in the first heat transfer member will be described, and the description on the second heat transfer member will be omitted.

[0062] As shown in Fig. 10, the connection passage part 114 of the second embodiment has a tournament shape branched two by two as it advances toward the heat exchange passage 13 similarly to the aforementioned first embodiment. Also in this second example, the connection passage part 114 is branched in three stages and connected to thirty-two heat exchange passages 13. In the second embodiment, the connection passage part 114 includes a pair of branch passages 134 branched into two in a Y-shape.

[0063] As shown in Fig. 11, the pair of branch passages 134 is branched from the common branch origination part 135 in a Y-shape (inverted Y-shape) on both sides in the Y-direction. The pair of branch passages 134 has an equal passage length and is formed symmetrically with respect to the branch origination part 135. In addition, the flow passage widths W2 of the pair of branch passages 134 are the same with each other. In the second embodiment, the entire flow passage of the connection passage part 114 has a flow passage width W2 and has the same flow passage cross-sectional area.

[0064] Each of the pair of branch passages 134 in-

cludes a first part 136 diagonally branched from the branch origination part 135 in the Y-direction and in the X1-direction, and a linear second part 137 continued from the first part 136. Note that the second part 137 is an example of the "branch origination part" of the present invention.

[0065] The first part 136 of the pair of branch passages 134 is extended diagonally and linearly from the branch origination part 135. A Y-shaped branch is formed by the first part 136 of each of the pair of branch passages 134 and the second part 137 on the upstream side which is a branch origination part 135. The angle θ formed by the pair of first parts 136 is about 120 degrees. In each of the first stage 31, the second stage 32, and the third stage 33, the X-direction dimension of each first part 136 is L3, L4, and L5, respectively. The Y-direction dimensions of the first parts 136 are W3, W4, and W5. In each first part 136, the lengths L3, L4, and L5 in the X-direction are smaller than the lengths W3, W4, and W5 in the Y-direction, respectively. Therefore, when W3, W4, and W5 are equal to R1, R2, and R3 (see Fig. 4), respectively, the branch passage 134 of the second embodiment can reduce the X-direction dimension in comparison with the first embodiment branch passage 34. As a result, the connection passage part 114 of the second embodiment can reduce the dimension L6 in the X-direction compared to the connection passage part 14 of the first embodiment.

[0066] The second part 137 of the pair of branch passages 134 is a straight flow passage, and is extended along the X-direction. The second part 137 in the first stage 31 has a length L7 and the second part 137 of the second stage 32 has a length L8. The length L7 is longer than the length L8. The length L7 is about 1/8 of W3. The length L8 is about 1/5 of W4.

[0067] Further, the branch origination part 135 is connected to the pair of branch passages 134 in the extending direction of the bisector BS of the angle θ formed by the pair of branch passages 134. That is, with respect to the angle θ =about 120 degrees formed by the pair of branch passages 134 (first part 136), the branch origination part 135 (second part 137, communication passage 15) is connected in the extending direction (X1 direction) of the bisector BS of the pair of branch passages 134. Therefore, the inner wall portion 134a opposed to the branch origination part 135 is a triangular wall of about 120 degrees with respect to the branch origination part 135. Therefore, as compared with the inner wall portion 34a of the first embodiment, which is a wall of 180 degrees, the flow passage resistance can be reduced by the amount corresponding to the angle of the inner wall portion 134a.

[0068] The other configurations of the second embodiment are the same as those of the first embodiment.

[0069] Even in the second embodiment, in the same manner as in the first embodiment, by forming the connection passage part 114 into a tournament shape branched two by two as it advances toward the heat ex-

change passages 13, the distribution flow rate to each flow passage can be easily equalized. Therefore, by repeating the two-branching by the number corresponding to the number of heat exchange passages 13, the flow rate variations of the plurality of heat exchange passages 13 can be precisely suppressed.

(Description of Simulation Results)

[0070] Next, with reference to Fig. 12, the simulation results performed to confirm the effects of the connection passage part 114 in the heat exchanger 200 according to the second embodiment will be described. The contents of the simulation are the same as those in the first embodiment.

[0071] As shown in Fig. 12, in the connection passage part 114 of the second embodiment, although some of the thirty-two (32) channels show values higher than 150%, most of the other channels fall within a range of the average value of $100\% \pm 50\%$ (hatched area). That is, twenty-six (26) channels (about 72%) out of the thirty-two (32) channels fall within the range of the average value $\pm 50\%$.

[0072] Compared with the connection passage part 50 of the comparative example shown in Fig. 6, in the comparative example, only ten (10) channels (about 33%) out of thirty (30) channels fall within the range of the average value $\pm 50\%$. With this, the effect of equalizing the distribution flow rate to each passage by the connection passage part 114 of the heat exchanger 200 according to the second embodiment was confirmed. As a result, it was confirmed that the flow rate variations of the plurality of heat exchange passages 13 distributed by the connection passage part 114 can be suppressed with high accuracy.

[0073] Compared with the connection passage part 14 according to the first embodiment of Fig. 7, in the first embodiment, all of the thirty-two (32) channels fall within the range of the average value $\pm 50\%$. For this reason, in the second embodiment, it is found that the X-direction dimension L6 (see Fig. 11) of the connection passage part 114 can be reduced as compared with the first embodiment, while in terms of equalization of the distribution flow rate, the first embodiment is higher in effect.

[0074] It should be understood that the embodiments described herein are examples in all respects and are not restrictive. The scope of the present invention is shown by the claims rather than the descriptions of the embodiments described above, and includes all changes (modifications) within the meaning of equivalent and the claims.

[0075] For example, in the first and second embodiments, an example of a counter-flow type heat exchanger 100 (200) in which the first fluid 6 and the second fluid 7 flow in the opposite directions to each other in the X-direction is shown, but the present invention is not limited to this. In the present invention, the heat exchanger may be a parallel-flow type in which the first fluid 6 and the

second fluid 7 flow in the same direction, or a cross-flow type in which the flow of the first fluid 6 and the flow of the second fluid 7 cross.

[0076] Further, in the aforementioned first and second embodiments, an example is shown in which the core 1 is formed by alternately stacking a plurality of first heat transfer members 10 and a plurality of second heat transfer members 20, but the present invention is not limited thereto. In the present invention, it is not always required to alternately stack the first heat transfer member and the second heat transfer member. For example, two layers (plural layers) of the second heat transfer members may be stacked for one layer of the first heat transfer member so that a first heat transfer member, a second heat transfer member, a second heat transfer member, a first heat transfer member, a second heat transfer member, and so on along the Z-direction are stacked. To the contrary, one layer of the second heat transfer member may be stacked on two layers (plural layers) of the first heat transfer members.

[0077] Further, in the aforementioned first and second embodiments, an example in which the connection passage part 14 (114) of the tournament shape is provided for both the first heat transfer member 10 and the second heat transfer member 20 is shown, but the present invention is not limited thereto. In the present invention, it may be configured such that a connection passage part of a tournament shape is provided at one of the first heat transfer member and the second heat transfer member and no connection passage part of a tournament shape is provided at the other.

[0078] In the aforementioned first and second embodiments, an example of the heat exchanger in which the first heat transfer member 10 and the second heat transfer member 20 are provided and the heat exchange is performed between the two types of fluids is shown, but the present invention is not limited thereto. In the present invention, the heat exchanger may perform heat exchange between three or more types of fluids. In that case, three or more types of heat transfer members, such as a third transfer member, may be provided. At that time, each of three or more types of heat transfer members may include a connection passage part of a tournament shape.

[0079] Further, in the aforementioned first and second embodiments, an example is shown in which the connection passage part 14 (114) of the tournament shape is branched in three stages and eventually branched to eight (8) flow passages, but the present invention is not limited to this. The number of stages (that is, the number of branches) of the connection passage part is not particularly limited. The connection passage part may be branched in two, four or more stages.

[0080] In the aforementioned first and second embodiments, an example is shown in which four connection passage part 14 (114) which is finally branched to eight (8) flow passages, corresponding to thirty-two (32) heat exchange passages 13, but the present invention is not

limited to this. The number of connection passage parts may be set according to the number of heat exchange passages. In cases where the number of heat exchange passages 13 is thirty-two (32), instead of providing four (4) connection passage parts 14 including eight (8) flow passages, eight (8) connection passage parts including four (4) flow passages may be provided by being branched in two stages, two connection passage parts including sixteen (16) passages may be provided by being branched in four (4) stages, and one connection passage part including thirty-two (32) passages may be provided by being branched in five (5) stages.

[0081] Further, in the first embodiment, an example in which a pair of branch passages 34 branched into a semi-elliptical (semicircular) shape is provided, and in the second embodiment, an example is shown in which a pair of branch passages 134 branched into a Y-shape are provided, but the present invention is not limited to them. In the present invention, the pair of branch passages may be branched into a shape other than a semicircular shape and a Y-shape. For example, as shown in the first modification of Fig. 13, the connection passage part 214 may have a pair of branch passages 234 branched at right angles. The pair of branch passages 234 includes a first part 236 linearly extended along the Y-direction and a second part 237 linearly extended from the first part 236 in the X-direction. The second part 237 is an example of the "branch origination part" of the present invention. With this configuration, the X-direction dimension of the first part 236 can be minimized. Therefore, in the connection passage part 214, it is possible to further reduce the X-direction dimension L10 than the connection passage part 114 of the second embodiment. As a result, it is possible to reduce the size of the entire heat exchanger by suppressing the X-direction dimension. Other than the above, a pair of branch passages may be formed so that a pair of branch passages forms a semi-elliptical shape having a long axis and a short axis different in length.

[0082] Further, in the aforementioned first embodiment, between the heat exchange passages 13(23) and the inlet port 11(21) and between the heat exchange passages 13(23) and the outlet port 12(22), the connection passage parts 14 (24) are provided. However, the present invention is not limited to the example. In the present invention, a connection passage part having a tournament shape may be provided only between the heat exchange passage and the inlet port, or a connection passage part of a tournament shape may be provided only between the heat exchange passage and the outlet port.

[0083] In the aforementioned first and second embodiments, an example in which the branch passage 34 (134) includes the linear second part 37 (137) is shown, but the present invention is not limited thereto. In the present invention, the branch passage may not include the second part.

[0084] In the first embodiment, the length L2 of the second part 37 of the branch passage 34 is about 1/9 of the

radius R1 of the first part 36 and about 1/5 of R2, but the present invention is not limited to this. In the present invention, the length of the second part may be made relatively larger than the radius of the first part.

[0085] Fig. 14 is a view showing changes of the velocity vector of the first fluid 6 when the length of the second part 37 is increased in the branch passage 34 of the first embodiment. As shown in Fig. 14, the flow (vector) of the first fluid 6 is unevenly distributed to the outside in the radial direction when passing through the first part 36 and slightly inclined in the Y-direction at the position (the end position of the 1/4 circular arc) entering the second part 37. Thereafter, the flow (vector) of the first fluid 6 is gradually decreased in the Y-direction component in the linear second part 37 and is aligned in the X-direction. As a result of this simulation, it is found that if the length L2 of the second part 37 is $R/2$ with respect to the radius R of the first part 36, the flow (vector) of the first fluid 6 can be sufficiently aligned in the X-direction in practice. On the other hand, in the region of length $L2 > R/2$ of the second part 37, the merit of the rectification effect obtained becomes relatively small with respect to the disadvantage that the size of the connection passage part 14 in the X-direction increases.

[0086] As can be seen from Fig 14, the rectification effect is larger toward the upstream side of the second part 37, and the improvement of the rectification effect can be expected by the amount that the second part 37 is provided in the range of $0 < L2 < R/2$. The length of the second part 37 is preferably $L2 \geq R/4$, more preferably $R/4 < \text{length } L2 < R/2$. Although not shown in the figure, in the simulation in the case where the length L2 of the second part 37 was made sufficiently large, it was possible to suppress the fluctuations of the flow rate of each channel within a range of about $\pm 5\%$.

[0087] Further, in the first and second embodiments, an example in which the connection passage part 14(114) has a constant flow passage cross-sectional area with a constant flow passage width W1 (W2) is shown, but the present invention is not limited to this. In the present invention, the passage width (passage cross-sectional area) of the connection passage part may change. For example, as in the second modification shown in Fig. 15, the connection passage part 314 may have branch passages 334 of different passage widths in each of the first stage 31 to the third stage 33. Preferably, the passage cross-sectional area (passage width) of the pair of the branch passage 334 is approximately 1/2 of the passage cross-sectional area (passage width) before being branched. That is, the total of the passage cross-sectional areas (passage widths) of the branch passages 334 branched into two coincides with the passage cross-sectional area (passage width) before being branched. In connection passage part 314, with respect to the passage width (passage cross-sectional area) W11 of the communication passage 15, the passage width (passage cross-sectional area) $W12 = (W11/2)$ of the branch passage 334 of the first stage 31, the passage

width (passage cross-sectional area) $W_{13}=(W_{12}/2)$ of the branch passage 334 of the second stage 32, and the passage width (passage cross-sectional area) $W_{14}=(W_{13}/2)$ of the branch passage 334 of the third stage 33. As a result, since the change of the passage cross-sectional area before and after the branching can be suppressed, the pressure loss can be suppressed. Here, it was described by assuming that the passage width is constant and the passage width and the passage cross-sectional area correspond to each other. However, when the flow passage depths are different, in the above description, the passage width is replaced with the cross-sectional area.

[0088] Further, in the aforementioned first and second embodiments, although an example in which the straight heat exchange passages 13(23) are provided, the present invention is not limited to this example. In the present invention, the heat exchange passage may be a curved shape other than a straight shape. For example, the heat transfer passage may be extended from one end to the other end of the heat transfer member and then bent so as to be folded back in the opposite direction. Reference Numerals

[0089]

6: first fluid (fluid)

7: second fluid (fluid)

10: first heat transfer member (heat transfer member)

11, 21: inlet port (flow port)

12, 22: outlet port (flow port)

13, 23: heat exchange passage

14, 24, 114, 214, 314: connection passage part

20: second heat transfer member (heat transfer member)

34, 134, 234, 334: branch passage

35, 135: branch origination part

36, 136, 236: first part

37, 137, 237: second part (branch origination part)

100, 200: heat exchanger

θ : angle formed between a pair of branch passages

BS: bisector

advances toward the heat exchange passages.

2. The heat exchanger according to claim 1, wherein the connection passage part includes a pair of branch passages branched into two from a branch origination part, and the branch origination part is connected to the pair of branch passages with the branch origination part directed in an extending direction of a bisector of an angle formed by the pair of branch passages.
3. The heat exchanger according to claim 2, wherein the branch passage includes a first part branched from the branch origination part and a linear second part as a branch connection part, the second part being extended from the first part and connected a pair of branch passages on a heat exchanger passage side.
4. The heat exchanger according to claim 1, wherein the connection passage part includes a pair of branch passages branched into two from a branch origination part, and the pair of branch passages have an equal flow passage length to each other.
5. The heat exchanger according to claim 4, wherein the pair of branch passages is formed symmetrically with respect to the branch origination part.
6. The heat exchanger according to claim 5, wherein the pair of branch passages is respectively branched from the branch origination part so as to form a semi-elliptical shape.
7. The heat exchanger according to claim 6, wherein the pair of branch passages is respectively branched from the branch origination part in a circular arc-shape so as to form a semicircular shape.

Claims

1. A heat exchanger comprising:

a heat transfer member including a flow port for receiving or discharging a fluid, a plurality of heat exchange passages for making the fluid exchange heat, and a connection passage part having both ends, one of the ends being connected to the flow port and the other thereof being connected to the plurality of heat exchange passages, wherein the connection passage part has a tournament shape branched into two by two as it

FIG. 1

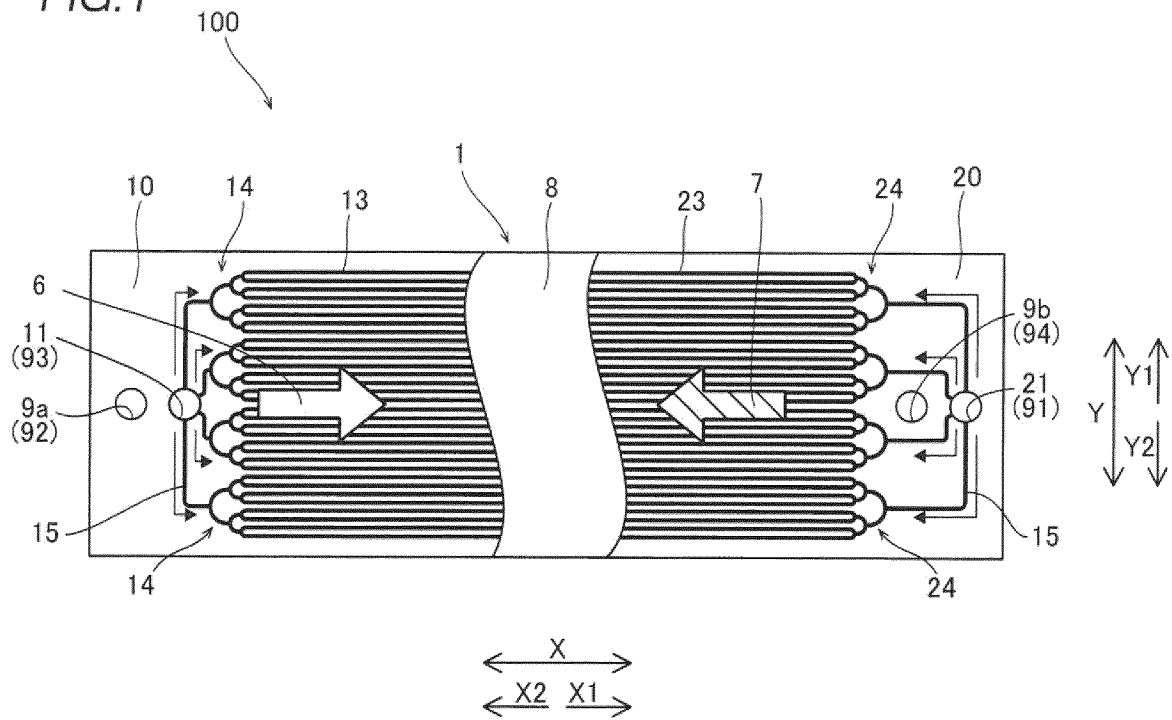


FIG. 2

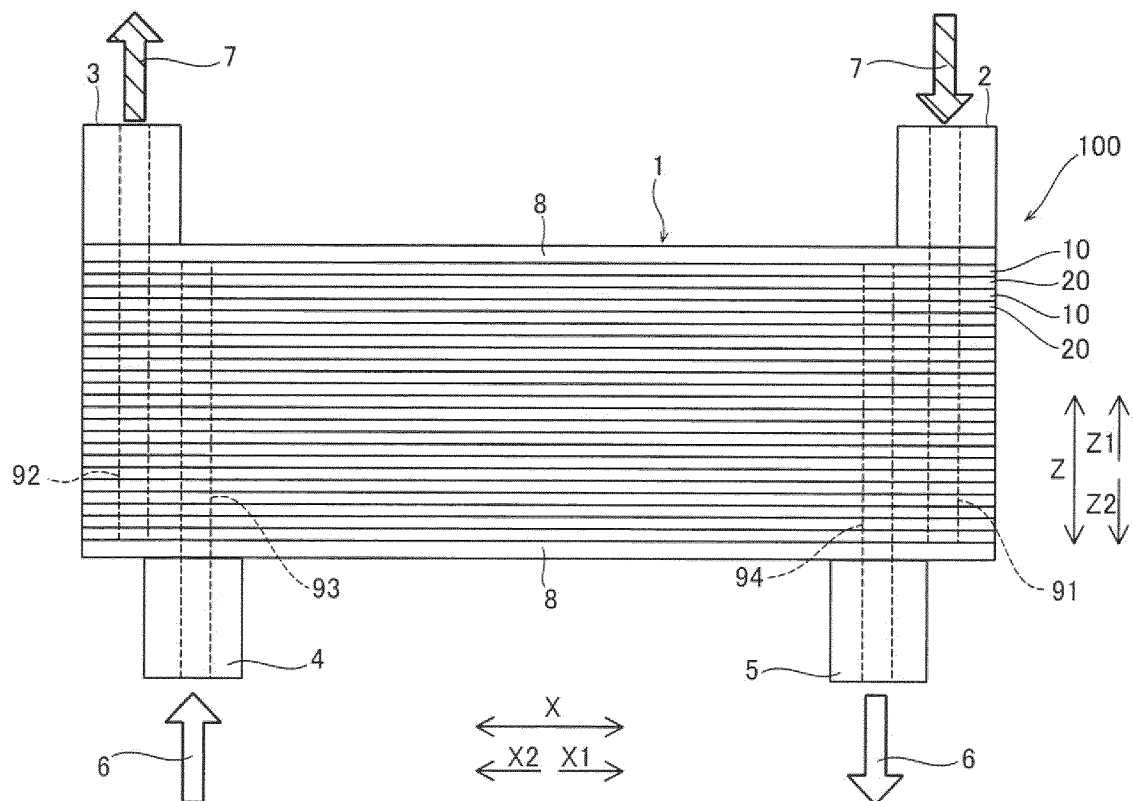


FIG.3

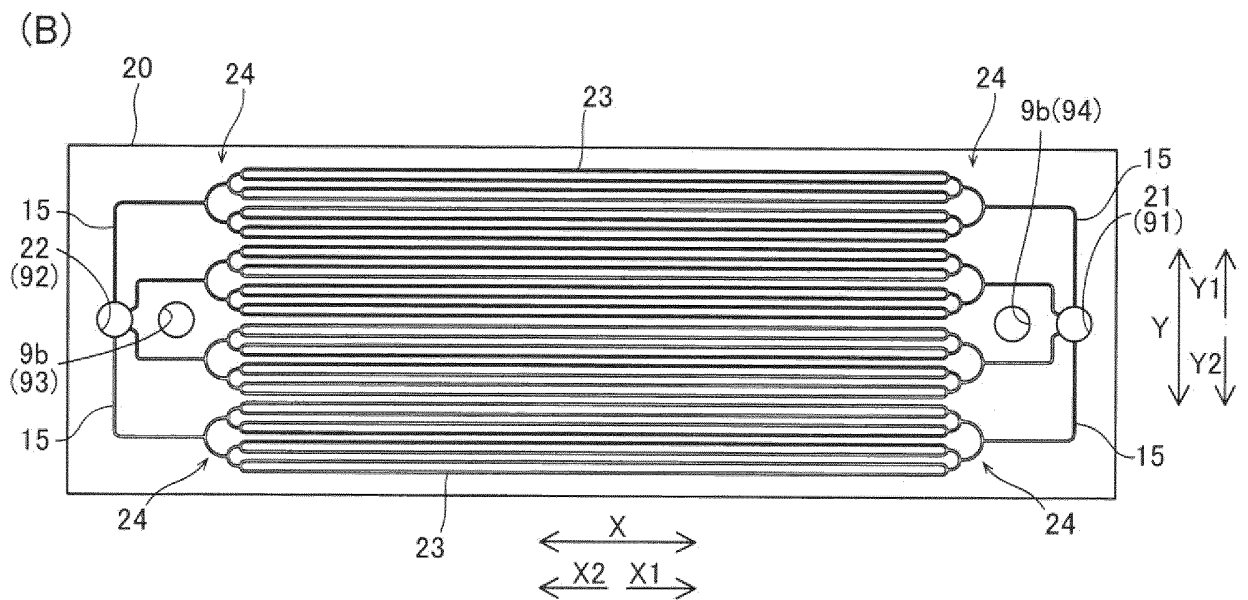
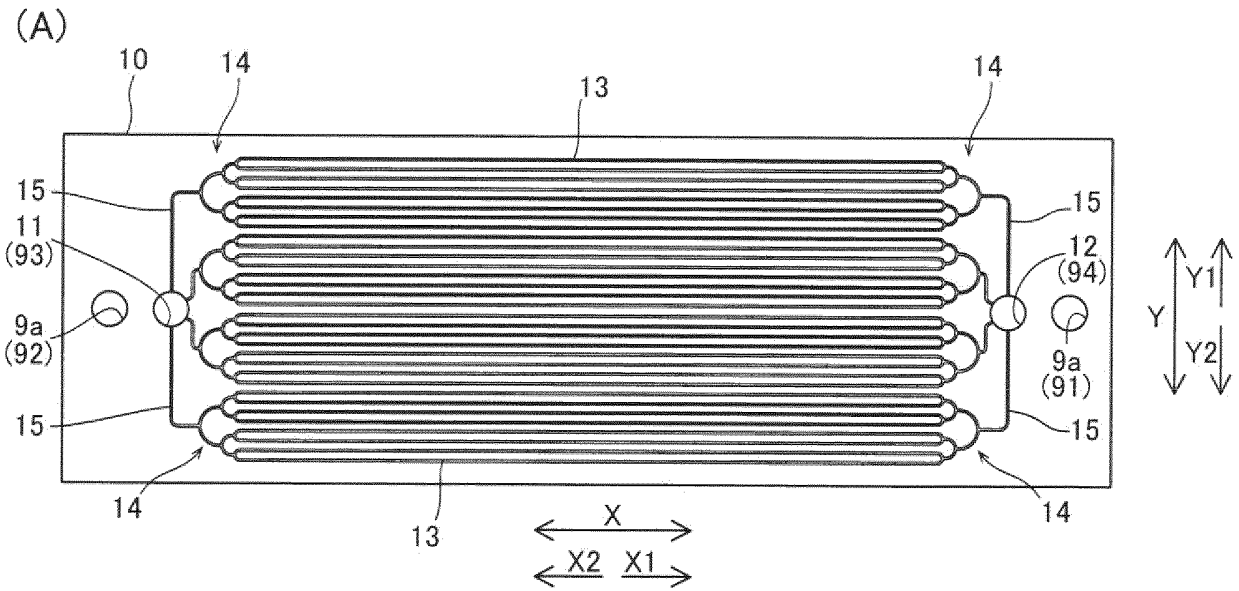


FIG.4

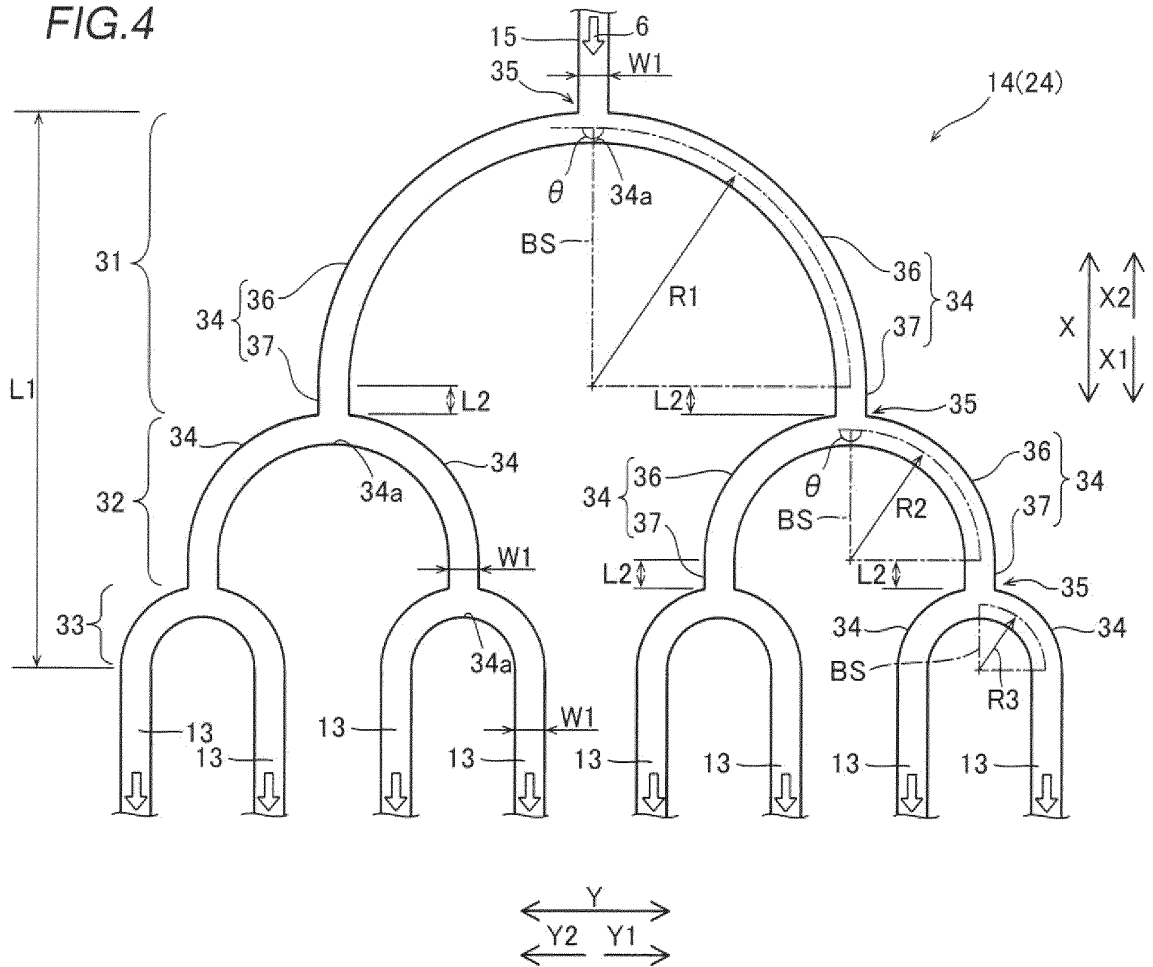


FIG.5

(Comparative example)

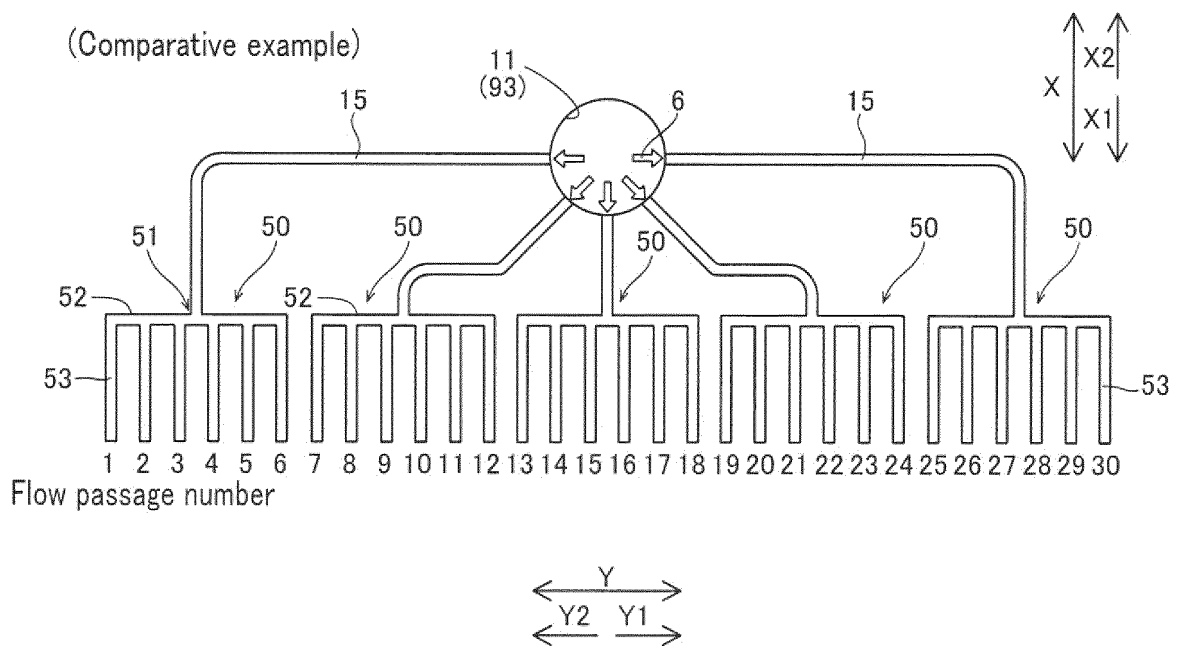
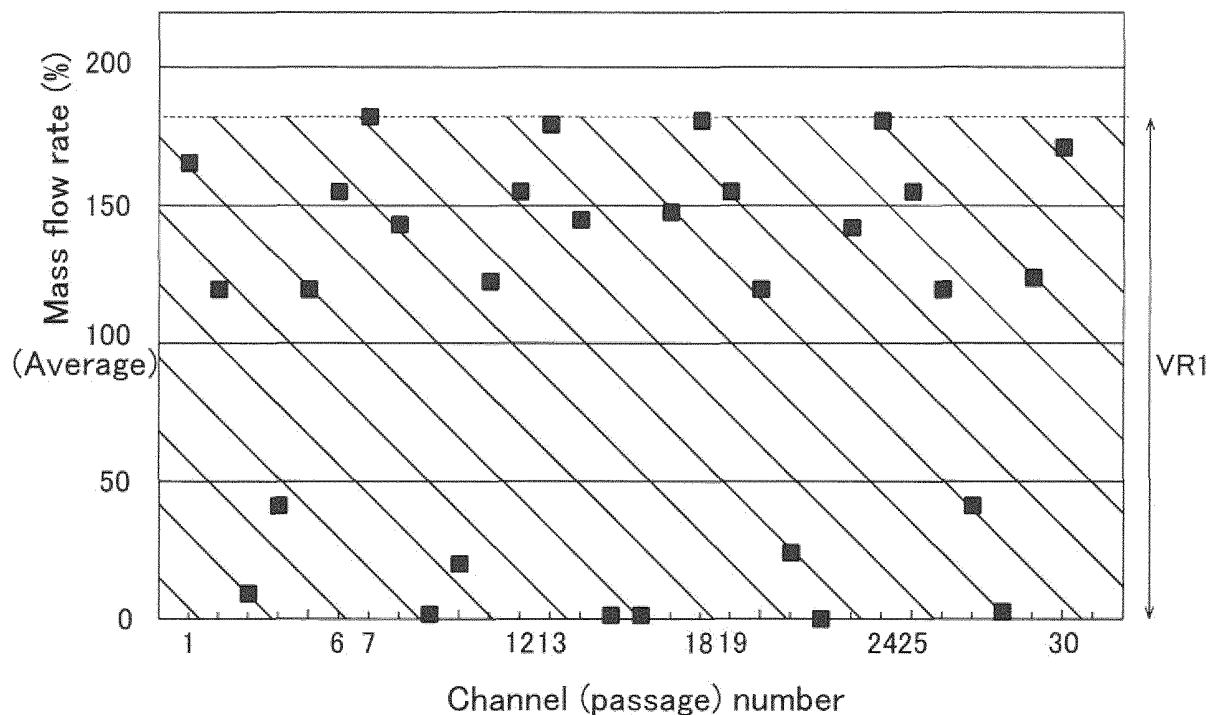


FIG.6

(Comparative example)

Flow rate simulation results of connection passage parts

**FIG.7**

(First embodiment)

Flow rate simulation results of connection passage parts

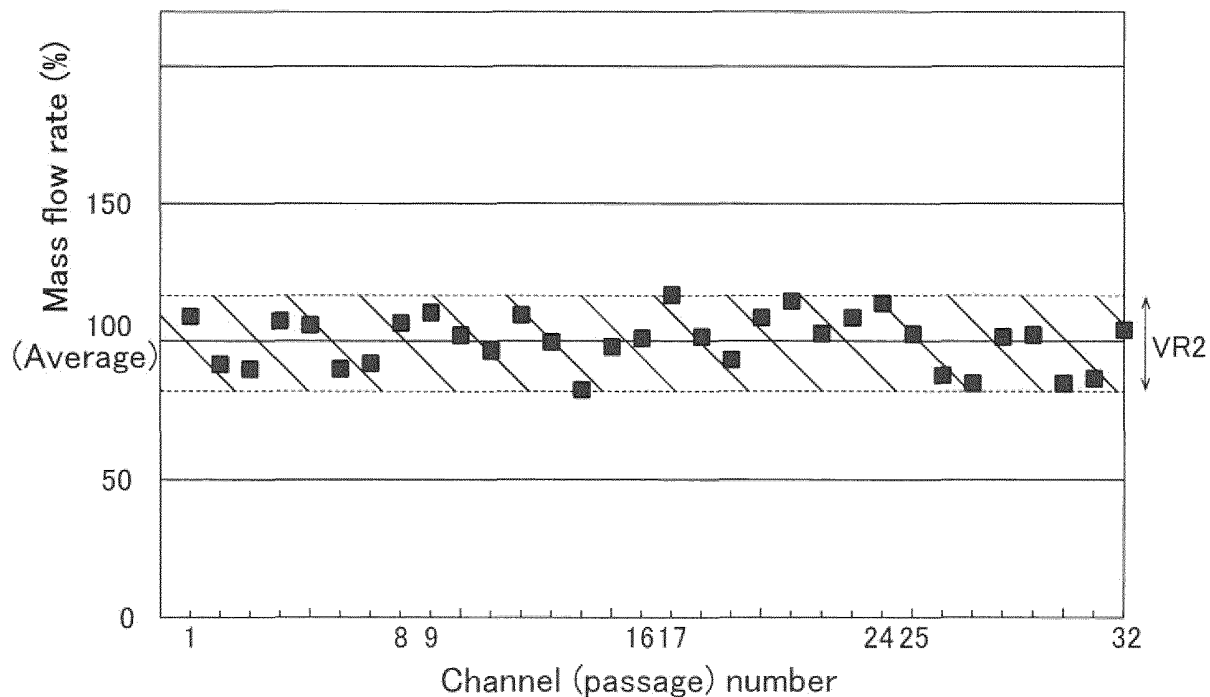
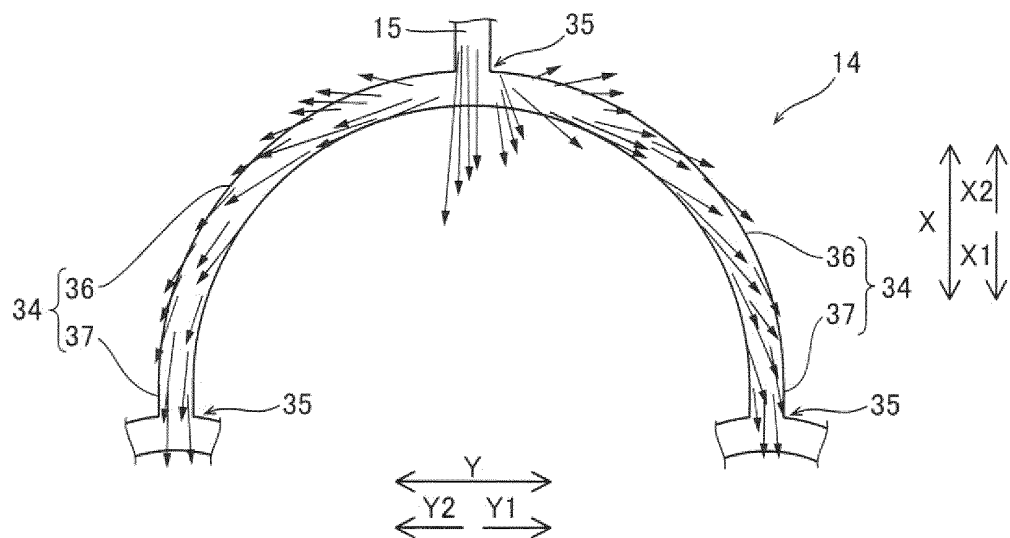


FIG.8

(First embodiment)

Flow velocity vectors in a connection passage part

**FIG.9**

(Comparative example)

Flow velocity vectors of a connection passage part

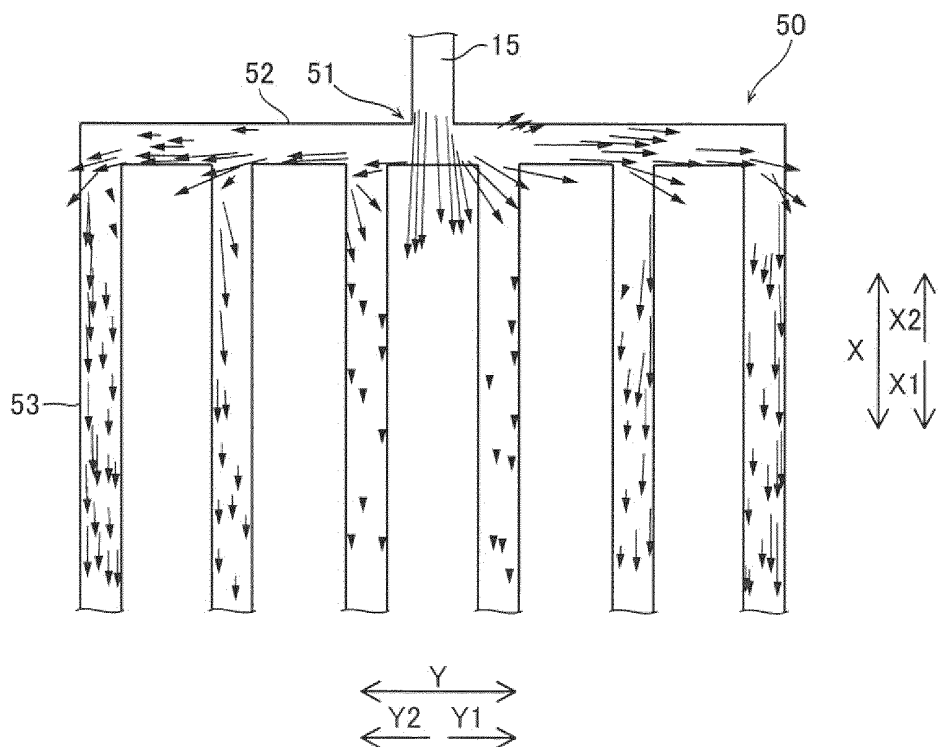


FIG. 10

(Second embodiment)

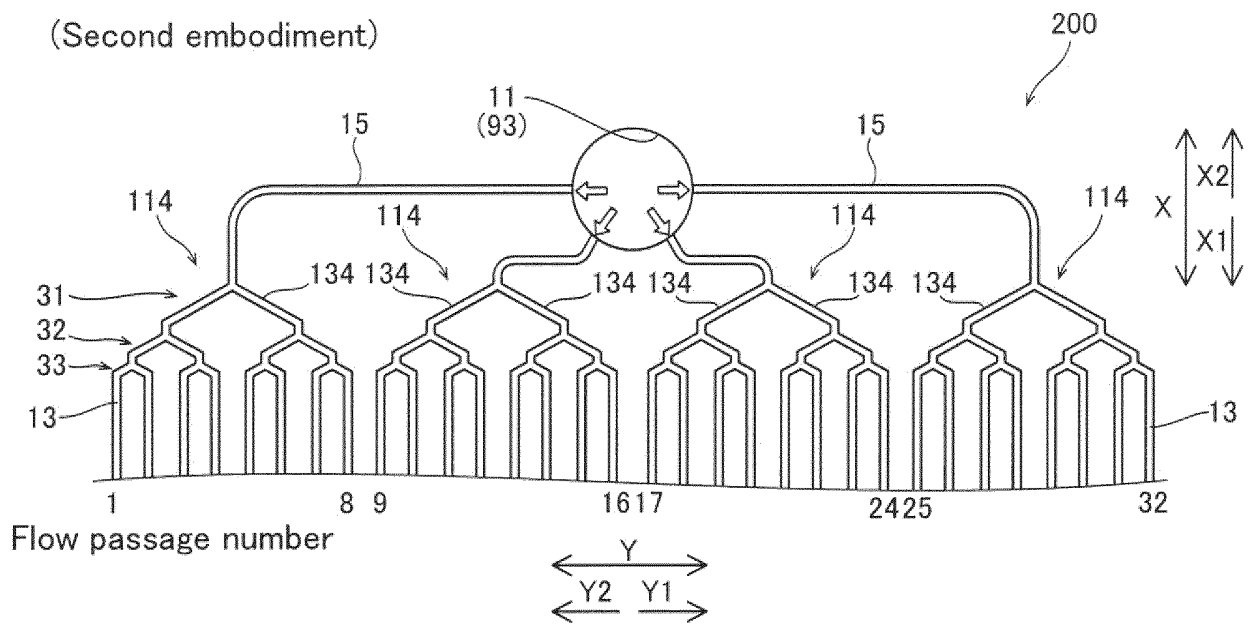


FIG. 11

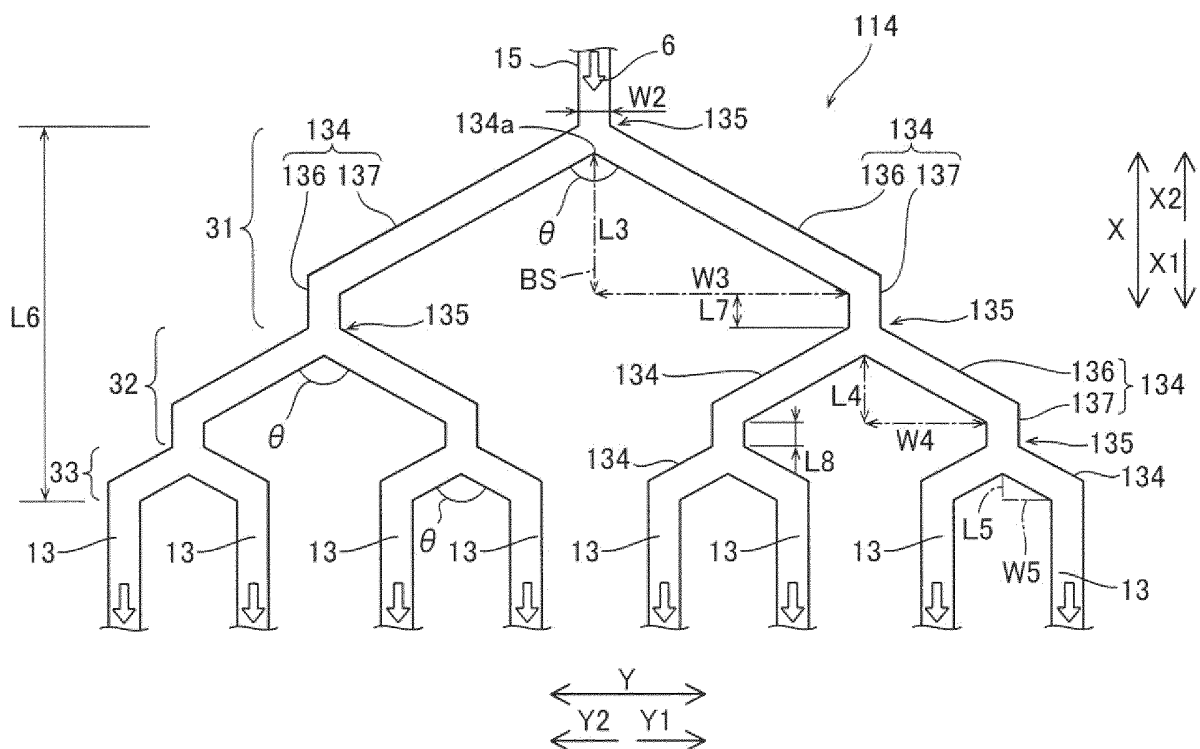
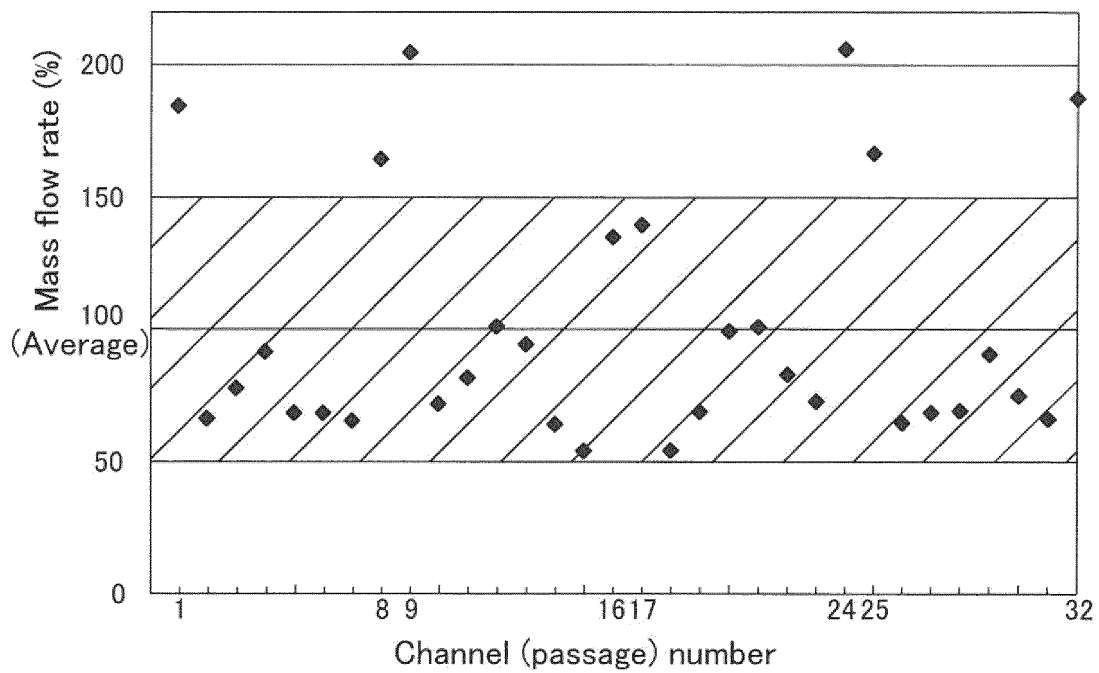


FIG. 12

(Second embodiment)

Flow rate simulation results of connection passage parts

**FIG. 13**

(First modified example)

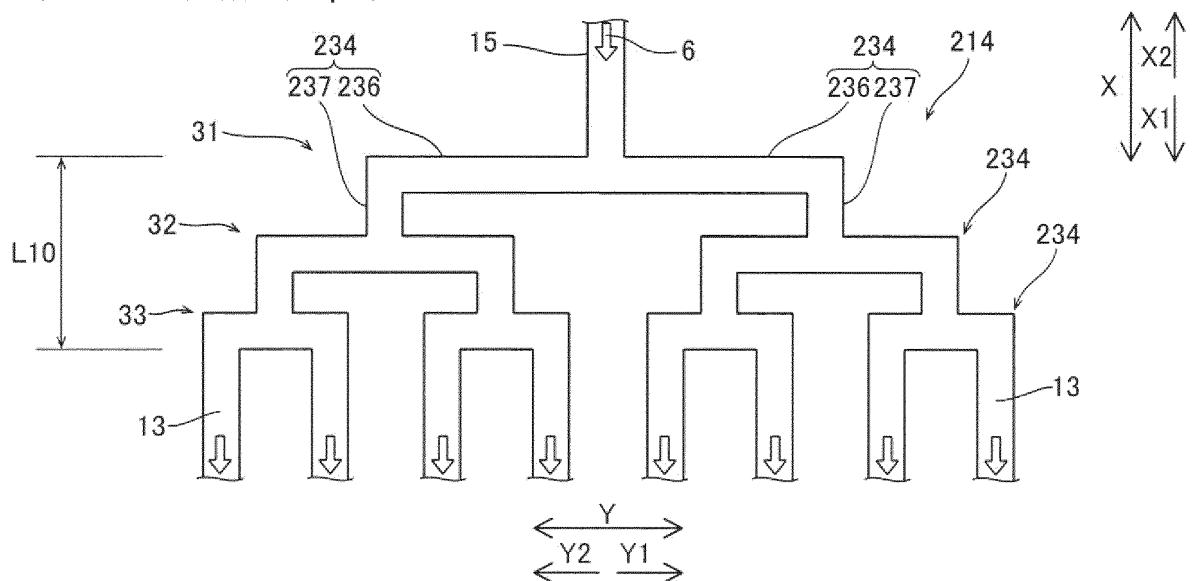


FIG. 14

(Flow velocity vectors when the second part is extended)

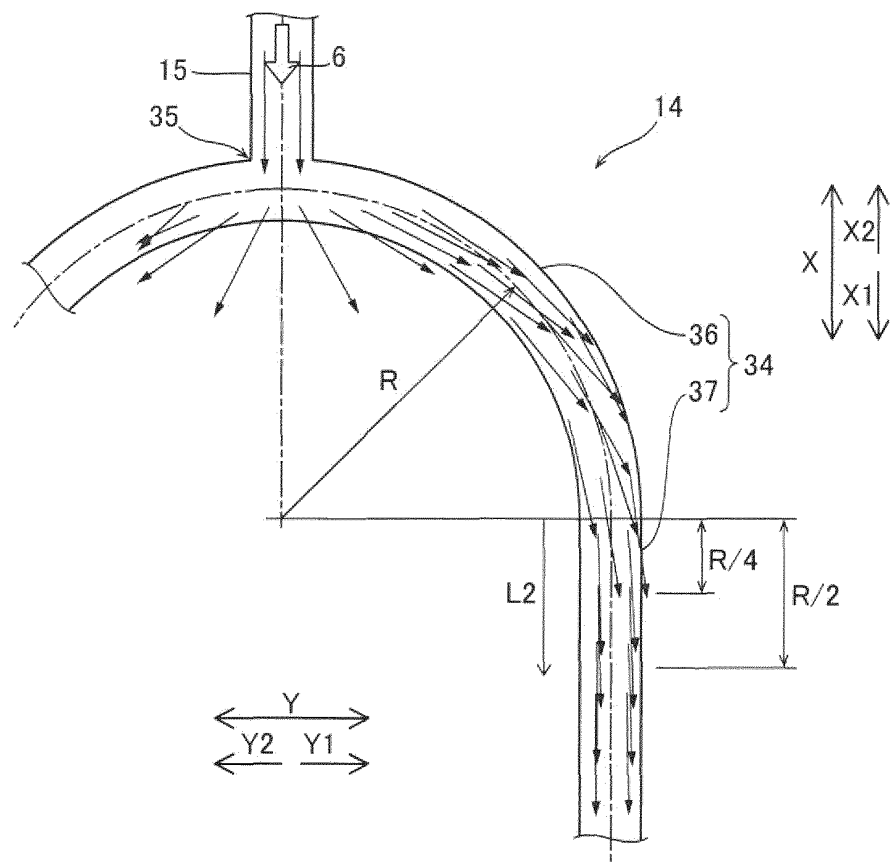
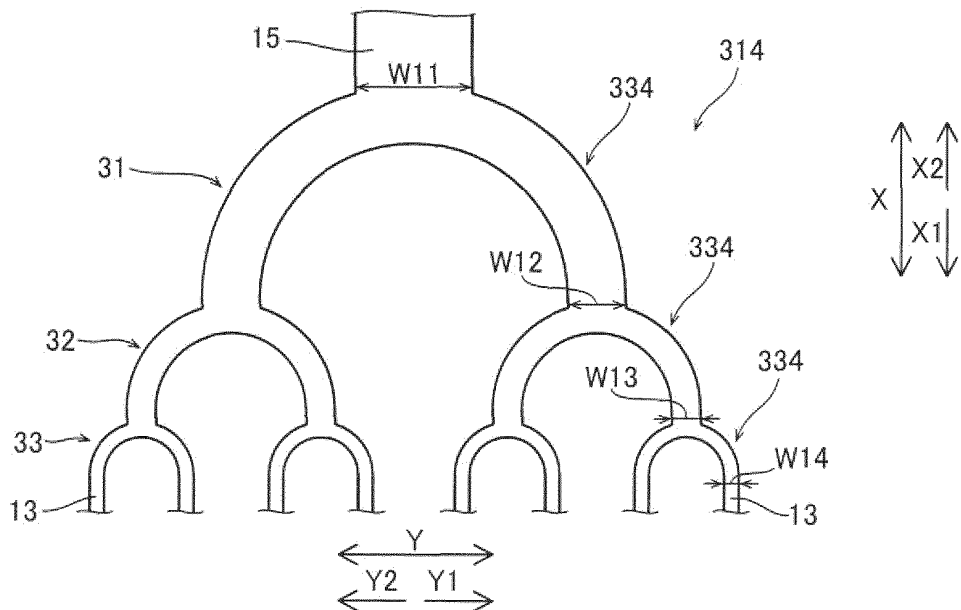


FIG. 15

(Second modified example)



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/054289

A. CLASSIFICATION OF SUBJECT MATTER F25B41/00(2006.01)i, F28F3/00(2006.01)i, F28F9/22(2006.01)i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F25B41/00, F28F3/00, F28F9/22		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015 Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015		
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	JP 9-189490 A (Mitsubishi Electric Corp.), 22 July 1997 (22.07.1997), paragraphs [0001], [0011], [0023] to [0026]; fig. 1 (Family: none)	1-7
Y	JP 10-267468 A (Mitsubishi Electric Corp.), 09 October 1998 (09.10.1998), paragraphs [0001], [0008], [0033] to [0037]; fig. 6 (Family: none)	1-7
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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INTERNATIONAL SEARCH REPORT

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