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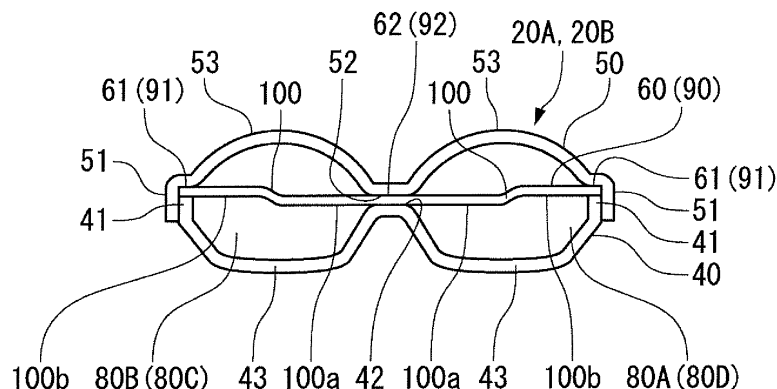
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(54) **HEAT EXCHANGER AND VEHICLE AIR CONDITIONING APPARATUS PROVIDED WITH THE SAME**

(57) There is provided a heat exchanger 10 in which each of header tanks 20A and 20B is configured so that each of intermediate plates 60 and 90 is held between a header plate 40 and a tank plate 50. The intermediate plate 60, 90 functions as a reinforcing member, so that the strength of the header tank 20A, 20B is improved. The intermediate plate 60, 90 serving as a reinforcing element comprises bent parts 100 between the central

portion and both the end portions in the width direction of the header tank 20A, 20B. By the elastic deformation of the bent parts 100, for example, the stresses developed in brazing of the header tank 20A, 20B, and the stresses at the time when a refrigerant pressure is applied can be prevented from concentrating in the joint portion of the header plate 40, the tank plate 50, and the intermediate plate 60, 90.

FIG. 4



Description

Technical Field

5 [0001] The present invention relates to a heat exchanger and a vehicle air conditioning apparatus provided with the same.

Background Art

10 [0002] Some heat exchangers provided in an air conditioning apparatus include a plurality of heat exchange tubes, which constitute a refrigerant flow path, and heat exchange fins, which are provided between the heat exchange tubes, between a pair of header tanks arranged oppositely to each other (for example, refer to Patent Document 1).

[0003] The header tank of the heat exchanger of this type is formed by combining a plurality of plates and by brazing them together. The spaces formed between these plates serve as the refrigerant flow path.

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Citation List

Patent Document

20 [0004]

Patent Document 1: Japanese Patent Laid-Open No. 2005-300135

Summary of Invention

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Technical Problem

[0005] If the above-described conventional heat exchanger is used as a heat exchanger for heating a heat pump, there arises a problem of insufficient pressure-tightness because the refrigerant pressure is high in the heat exchanger for the heat pump.

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[0006] The reason for this is that, as shown in FIG. 12, since the cross-sectional shapes of two flow paths 3a and 3b of a header tank 3 formed by a plurality of plates 1 and 2 are odd-shaped, when a high pressure is applied to the header tank 3, stresses concentrate in bent parts 3c, joint parts 3d of the plates 1 and 2, joint parts 3e of the plate 2 and heat exchange tubes 4, and the like parts.

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[0007] On the other hand, it is conceivable that sufficient pressure-tightness is assured by making the configuration such that, as shown in FIG. 13, a header tank 6 is formed by two tank tubes 7 and 8 each having a circular cross section.

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[0008] In this case, however, in order to return the refrigerant flowing into one tank tube 7 from the heat exchange tube 4 to the other tank 8, a return flow path 9 must be provided additionally, which leads to an increase in the number of parts, an increase in size of heat exchanger caused by the provision of the return flow path 9, and the like. In the configuration shown in FIG. 12, the refrigerant is returned from the one flow path 3a to the other flow path 3b through holes formed in a partition wall 5 provided between the flow paths 3a and 3b, so that the above-described problems do not occur.

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[0009] The present invention has been accomplished to solve the above-described technical problems, and accordingly an object thereof is to provide a heat exchanger having sufficient pressure-tightness without an increase in the number of parts and an increase in size of the heat exchanger.

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Solution to Problem

[0010] The heat exchanger of the present invention, which has been accomplished to achieve the above object, comprises a plurality of heat exchange tubes arranged in parallel with each other, a fin provided between the heat exchange tubes adjacent to each other, a first header tank connected to one end side of the plurality of heat exchange tubes, and a second header tank connected to the other end side of the plurality of heat exchange tubes. The first header tank and the second header tank each comprises a header plate into which the end parts of the plurality of heat exchange tubes are inserted, a tank plate facing the header plate, and an intermediate plate held between the header plate and the tank plate. The header plate, the tank plate, and the intermediate plate are joined to each other in end parts on both sides and a middle part in the width direction thereof, whereby between the header plate and the tank plate, refrigerant flow paths are formed on one side and the other side with the middle part being held therebetween. The intermediate plate crosses the refrigerant flow paths in the direction in which the end parts and the middle part are connected in the

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refrigerant flow paths, and the intermediate plate has an elastically deformed part which allows the end parts and the middle part to be displaced relatively in the direction where they move closer to or away from each other.

[0011] By the intermediate plate that is provided between the header plate and the tank plate and crosses the refrigerant flow paths, the first header tank and the second header tank are reinforced. Further, the intermediate plate has the elastically deformed part. When the end part on each side and the middle part in the width direction, in which the header plate, the tank plate, and the intermediate plate are joined to each other, are displaced relatively in the direction where they move closer to or away from each other, the elastic deformation of the elastically deformed part can allow this displacement.

[0012] The intermediate plate can have a concave part, which is continuous in the longitudinal direction of the intermediate plate, on at least one surface thereof. In this case, at least one of the header plate and the tank plate has a convex part having a shape corresponding to the concave part. It is preferable that the concave part of the intermediate plate be formed in the middle part in the width direction of the intermediate plate, the convex part of the at least one of the header plate and the tank plate be formed in a portion facing the concave part, and the concave part and the convex part be joined to each other. By the use of such a configuration, the joint strength between the header plate and the intermediate plate and between the tank plate and the intermediate plate can be enhanced.

[0013] At least one of the intermediate plate of the first header tank and the intermediate plate of the second header tank may be characterized by a communicating port which is continuous to both sides with the middle part being straddled, and the refrigerant flow path on one side and the refrigerant flow path on the other side communicate with each other via the communicating port with the middle part being held therebetween. Thereby, the refrigerant can be returned from the refrigerant flow path on one side to the refrigerant flow path on the other side with the middle part being held therebetween.

[0014] At this time, the width in the header tank longitudinal direction of the communicating port in the intermediate plate is preferably not narrower than 2.0 mm and not wider than 3.8 mm. This can provide an optimal width capable of assuring the flowability of refrigerant and preventing the performance of heat exchanger from decreasing while assuring the strength of the intermediate plate.

[0015] The plate thicknesses of the header plate, the tank plate, and the intermediate plate each are preferably not smaller than 1.0 mm and not larger than 2.0 mm. Thereby, the strength can be assured while the increase in weight of the whole of heat exchanger is restrained. In addition, an optimal plate thickness capable of restraining the increase in pressure loss and preventing the performance of heat exchanger from decreasing without decreasing the volumes in the first and second header tanks than necessary can be provided.

[0016] Further, a vehicle air conditioning apparatus provided with any of the above-described heat exchangers can be configured. Thereby, the size of the whole of an air conditioning unit can be inhibited from increasing and the performance of the heat exchanger can be prevented from decreasing, so that a compact and high-performance air conditioning apparatus can be provided.

Advantageous Effects of Invention

[0017] According to the present invention, by the intermediate plate that is provided between the header plate and the tank plate and crosses the refrigerant flow paths, the first header tank and the second header tank are reinforced. Further, the intermediate plate has the elastically deformed part. When the end part on each side and the middle part in the width direction, in which the header plate, the tank plate, and the intermediate plate are joined to each other, are displaced relatively in the direction where they move closer to or away from each other, the elastically deformed part can allow this displacement. Thereby, stresses are prevented from concentrating in the joint portion of the header plate, the tank plate, and the intermediate plate, and the like portions, so that the strength performance of the first header tank and the second header tank can be improved. As a result, a heat exchanger having sufficient pressure-tightness can be configured without an increase in the number of parts and an increase in the size of the heat exchanger.

Brief Description of Drawings

[0018]

[FIG. 1] FIG. 1 is a perspective view showing a general configuration of a heat exchanger in accordance with an embodiment of the present invention.

[FIG. 2] FIG. 2 is an exploded perspective view showing a configuration of one header tank.

[FIG. 3] FIG. 3 is a perspective transparent view of one header tank.

[FIG. 4] FIG. 4 is a sectional view of a header tank.

[FIG. 5] FIG. 5A is a sectional view showing a configuration of an intermediate plate provided in a header tank, and FIG. 5B is a perspective sectional view showing the same.

[FIG. 6] FIG. 6 is an exploded perspective view showing a configuration of the other header tank.

[FIG. 7] FIG. 7 is a perspective transparent view of the other header tank.

[FIG. 8] FIG. 8 is a graph showing the relationship between plate thicknesses of a header plate, a tank plate, and an intermediate plate of the present embodiment and breaking pressure.

[FIG. 9] FIG. 9 is a graph showing the relationship between slit width of a communicating slit in an intermediate plate of the present embodiment and breaking pressure.

[FIG. 10] FIG. 10 is an enlarged sectional view of a concave part provided on an intermediate plate.

[FIG. 11] FIG. 11 is a plan view showing another example of an intermediate plate.

[FIG. 12] FIG. 12 is a sectional view showing one example of a conventional header tank.

[FIG. 13] FIG. 13 is schematic views showing one example of a conventional heat exchanger provided with a return flow path on a header tank, FIG. 13A being a schematic view of the heat exchanger, and FIG. 13B being a schematic view showing a configuration near a return flow path.

Description of Embodiment

[0019] The present invention will now be described in detail based on an embodiment shown in the accompanying drawings.

[0020] FIG. 1 is a perspective view showing a general configuration of a heat exchanger 10 in accordance with the embodiment of the present invention.

[0021] The heat exchanger 10 includes a pair of header tanks, a first header tank 20A and a second header tank 20B, a plurality of flat heat exchange tubes 30 provided in parallel with each other between these header tanks 20A and 20B, and a corrugated fin 31 provided between the heat exchange tubes 30 adjacent to each other.

[0022] As shown in FIGS. 1 to 4, the header tank 20A is formed by a header plate 40 disposed on the heat exchange tube 30 side of the header tank 20A, a tank plate 50 disposed on the outside of the heat exchanger 10 so as to face the header plate 40, and an intermediate plate 60 held between the header plate 40 and the tank plate 50.

[0023] The header plate 40 is configured so that the cross section thereof on a plane perpendicular to the axis line direction of the header tank 20A substantially has a W shape, joint wall parts 41 for joining the header plate 40 to the tank plate 50 are formed on both sides in the width direction thereof, and a joint surface part 42 is formed in the middle portion in the width direction thereof.

[0024] The joint wall part 41 is formed so as to rise toward the side facing the tank plate 50.

[0025] The joint surface part 42 is formed in the direction (on the surface) such as to connect the both-side joint wall parts 41 to each other.

[0026] Between the both-side joint wall parts 41 and the joint surface part 42 of the middle portion, swelling parts 43 swelling toward the side opposite to the facing tank plate 50 are formed. To insert the end portions of the heat exchange tubes 30, the swelling part 43 comprises a plurality of slits 44 each having a shape corresponding to the cross-sectional shape of the heat exchange tube 30.

[0027] The tank plate 50 is configured, like the header plate 40, so that the cross section thereof on a plane perpendicular to the axis line direction of the header tank 20A substantially has a W shape, joint wall parts 51 for joining the tank plate 50 to the header plate 40 are formed on both sides in the width direction thereof, and a joint surface part 52 is formed in the middle portion in the width direction thereof.

[0028] The joint wall part 51 is formed so as to rise toward the side facing the header plate 40.

[0029] The joint surface part 52 is formed in the direction (on the surface) such as to connect the both-side joint wall parts 51 to each other.

[0030] Between the both-side joint wall parts 51 and the joint surface part 52 of the middle portion, swelling parts 53 swelling toward the side opposite to the facing header plate 40 are formed.

[0031] The intermediate plate 60 is of a substantially planar shape, and is configured so that both end parts 61 and a middle part 62 in the width direction thereof are held between the header plate 40 and the tank plate 50.

[0032] The intermediate plate 60 comprises a plurality of openings 63 between the both end parts 61 and the middle part 62 on one side extending from an intermediate portion in the longitudinal direction of the intermediate plate 60.

[0033] Also, in the intermediate plate 60, communicating slits (communicating ports) 64 that are continuous to both sides with a middle part 62 being straddled are formed on the other side extending from the intermediate portion in the longitudinal direction of the intermediate plate 60.

[0034] Between the header plate 40 and the tank plate 50, closing plates 70A, 70B and 70C are provided on one end side and the other end side and in an intermediate portion in the longitudinal direction of the header plate 40 and the tank plate 50, so that the space between the header plate 40 and the tank plate 50 is dividedly closed.

[0035] The header plate 40, the tank plate 50, the intermediate plate 60, and the closing plates 70A, 70B and 70C are joined integrally with each other by brazing, thereby forming the header tank 20A.

[0036] Since the header plate 40 and the tank plate 50 are joined to each other via the intermediate plate 60 in the

joint wall parts 41 and 51 at both ends and the joint surface parts 42 and 52 at the middle portions, the header tank 20A has an eyeglasses-shaped cross section as the whole, and refrigerant flow paths 80A and 80B are formed on one side and on the other side of the joint surface part 52 in the width direction. These refrigerant flow paths 80A and 80B each are divided into refrigerant flow paths 80A-1 and 80A-2 and into refrigerant flow paths 80B-1 and 80B-2, respectively, by closing plate 70C.

[0037] As shown in FIGS. 3 and 5, on the side on which the communicating slits 64 are formed in the intermediate plate 60 with respect to the closing plate 70C, the refrigerant flow path 80A-2 and the refrigerant flow path 80B-2 are caused to communicate with each other by the communicating slits 64 between the joint surface part 42 of the header plate 40 and the joint surface part 52 of the tank plate 50.

[0038] On the other hand, as shown in FIGS. 1, 6 and 7, the header tank 20B is formed by the header plate 40 disposed on the heat exchange tube 30 side of the header tank 20B, the tank plate 50 disposed on the outside of the heat exchanger 10 so as to face the header plate 40, and an intermediate plate 90 held between the header plate 40 and the tank plate 50.

[0039] For the header tank 20B, many constituent elements common to those of the header tank 20A are used. In the explanation below, the same signs are applied to the constituent element common to that of the header tank 20A, and the explanation thereof is sometimes omitted.

[0040] The intermediate plate 90 is of a substantially planar shape, and is configured so that both end parts 91 and a middle part 92 in the width direction thereof are held between the joint wall parts 41 in both-end portions of the header plate 40 and the joint wall parts 51 in both-end portions of the tank plate 50 and between the joint surface part 42 in the middle portion of the header plate 40 and the joint surface part 52 in the middle portion of the tank plate 50.

[0041] The intermediate plate 90 comprises a plurality of openings 93 along the longitudinal direction thereof.

[0042] Between the header plate 40 and the tank plate 50, closing plates 70A and 70B are provided in both-end portions in the longitudinal direction of the header plate 40 and the tank plate 50, so that the space between the header plate 40 and the tank plate 50 is dividedly closed.

[0043] The header plate 40, the tank plate 50, the intermediate plate 90, and the closing plates 70A and 70B are joined integrally with each other by brazing, thereby forming the header tank 20B.

[0044] As shown in FIG. 4, since the header plate 40 and the tank plate 50 are joined to each other via the intermediate plate 90 in the joint wall parts 41 and 51 at both ends and the joint surface parts 42 and 52 at the middle portions, the header tank 20B has an eyeglasses-shaped cross section as the whole, and refrigerant flow paths 80C and 80D are formed on one side and on the other side of the joint surface part 52 in the width direction. These refrigerant flow paths 80C and 80D do not communicate with each other.

[0045] Herein, the plate thicknesses of the header plate 40, the tank plate 50, and the intermediate plate 60, 90 were studied.

[0046] FIG. 8 shows the analysis result, showing the relationship between plate thicknesses of the header plate 40, the tank plate 50, and the intermediate plate 60, 90 and breaking pressure.

[0047] The breaking pressure is defined as an internal pressure applied on the header tank 20A, 20B in the case where there is a possibility that the header tank 20A, 20B may be broken, for example, in the state in which the refrigerant evaporates and the volume thereof increases after being heat-exchanged with air.

[0048] In the case where the refrigerant design pressure is made about 3.0 MPa as one example of this embodiment, as shown in FIG. 8, a plate thickness that can withstand a breaking pressure of at least about 10.0 MPa is necessary.

Therefore, it is found that the plate thickness of the intermediate plate 60, 90 must be 1.0 mm or larger in terms of the assurance of the strength thereof as indicated by the solid line in FIG. 8. Also, as the plate thickness of the intermediate plate 60, 90 are increased, the strength is assured more; however, the weight of the whole of the heat exchanger 10 increases undesirably. In addition, if the plate thickness of the intermediate plate 60, 90 are increased excessively, the volume in the header tank 20A, 20B decreases undesirably, which may present a problem that the pressure loss increases, leading to the deterioration in performance of the heat exchanger 10. Therefore, considering the strength of the header tank 20A, 20B, and the performance and further the safety of the heat exchanger 10, it is important to make the plate thickness optimal.

[0049] From the above-described analysis result, in the case where the design pressure of this embodiment is about 3.0 MPa, the plate thickness of the intermediate plate 60, 90 for assuring the strength withstanding a breaking pressure up to 20.0 MPa is made 2.0 mm or smaller. According to this, the optimal plate thickness that assures the safety sufficiently and does not decrease the performance of the heat exchanger 10 can be provided. Therefore, each of the plate thicknesses of the header plate 40, the tank plate 50, and the intermediate plate 60, 90 should be preferably not smaller than 1.0 mm and not larger than 2.0 mm, further preferably not smaller than 1.3 mm and not larger than 1.5 mm.

[0050] Hereunder, the method for determining the plate thickness is explained. For example, in the case where the header tank is of a cylindrical shape, from the formula for stress on a thin-wall cylinder, the stress occurring in the circumferential direction in the header tank is determined by Expression (1).

[Expression 1]

$$\sigma = \frac{rP}{t} \quad \dots (1)$$

in which σ is the occurring stress, P is the internal pressure, r is the inside radius of cylindrical shape, and t is the plate thickness.

[0051] The header tank is broken when the occurring stress σ exceeds the tensile strength σ_B , so that the relationship of Expression (2) holds.

[Expression 2]

$$\sigma < \sigma_B \quad \dots (2)$$

[0052] In the case where the inner periphery (circumference) of the cylindrical header tank is taken as L , and the inner area (cross-sectional area) thereof is taken as A , the occurring stress σ is expressed by Expression (3).

[Expression 3]

$$\sigma = \frac{rP}{t} = \frac{2A}{L} \times \frac{P}{t} < \sigma_B \quad \dots (3)$$

[0053] Therefore, the plate thickness t in the case where the header tank is of a cylindrical shape is determined by Expression (4), and at least this plate thickness t is necessary to assure the strength.

[Expression 4]

$$t > \frac{2A}{L} \times \frac{P}{\sigma_B} \quad \dots (4)$$

[0054] In this embodiment and the like in which the header tank is not of a cylindrical shape, a thickness not smaller than the plate thickness t determined by Expression (4) is necessary to consider the safety. Therefore, a factor α (a factor considering the safety) in Expression (5) is calculated based on the above-described analysis result of plate thickness and breaking pressure, and finally the optimal plate thickness t is determined by Expression (5).

[Expression 5]

$$t \geq \alpha \times \frac{2A}{L} \times \frac{P}{\sigma_B} \quad \dots (5)$$

[0055] FIG. 9 shows the analysis result, showing the relationship between slit width of the communicating slit 64 in the intermediate plate 60 and breaking pressure.

[0056] In this embodiment, in the case where the intermediate plate 60 has a plate thickness capable of withstanding a breaking pressure not lower than 10.0 MPa as described above, from the analysis result shown in FIG. 9, as indicated by the solid line in FIG. 9, it is preferable that the communicating slit 64 have a slit width at most not wider than 3.8 mm to assure the strength of the intermediate plate 60. As the slit width of the communicating slit 64 is decreased, the strength of the intermediate plate 60 is assured more. However, if the slit width is made too narrow, the refrigerant is less liable to pass through the communicating slit 60, and the flowability of refrigerant is impaired, which may resultantly lead to the deterioration in performance of the heat exchanger 10. Upon this consideration, the slit width of the communicating slit 64 is preferably made not narrower than 2.0 mm. If it is desired to further enhance the performance and safety (to assure the strength) of the heat exchanger 10, the slit width of the communicating slit 64 is preferably made not narrower than 2.5 mm and not wider than 3.0 mm.

[0057] In the heat exchanger 10 configured as described above, the refrigerant, which has flown into the refrigerant flow path 80A-1 of the one header tank 20A through an inflow port 22A, passes through the heat exchange tubes 30 and flows into the refrigerant flow path 80C of the other header tank 20B (refer to FIG. 1). At this time, in the refrigerant flow path 80C, the refrigerant flows into one side corresponding to the refrigerant flow path 80A-1. Then, in the refrigerant flow path 80C, the refrigerant moves to the other side, that is, the side corresponding to the refrigerant flow path 80A-2, and flows into the refrigerant flow path 80A-2 of the one header tank 20A after passing through the heat exchange tubes 30.

[0058] The refrigerant having flown into the refrigerant flow path 80A-2, flows into the refrigerant flow path 80B-2 through the communicating slits 64. Thereafter, the refrigerant flows into the refrigerant flow path 80D of the other header tank 20B from the refrigerant flow path 80B-2 after passing through the heat exchange tubes 30 (refer to FIG. 1). At this time, in the refrigerant flow path 80D, the refrigerant flows into one side corresponding to the refrigerant flow path 80B-2. Then, in the refrigerant flow path 80D, the refrigerant moves to the other side, that is, the side corresponding to the refrigerant flow path 80B-1, flows into the refrigerant flow path 80B-1 of the one header tank 20A after passing through the heat exchange tubes 30, and is discharged to the outside of the heat exchanger 10 through an outflow port 22B.

[0059] In this embodiment, as shown in FIGS. 4 and 5A, the intermediate plate 60 comprises bent parts (elastically deformed parts) 100 between the central portion and the both-end portions in the width direction of the header tank 20A.

[0060] In the bent part 100, the intermediate plate 60 is bent into, for example, a crank shape between a central portion side 100a and an end portion side 100b of the header tank 20A, and is formed so that the heights of the central portion side 100a and the end portion side 100b are different from each other. The bent part 100 is elastically deformed when the middle part 62 and the end part 61 on each side are displaced relatively in the direction where they move closer to or away from each other. In this embodiment, a tip end part 30a of the heat exchange tube 30 inserted through the slit 44 hits the central portion side 100a of the intermediate plate 60, and a clearance is formed between the tip end part 30a of the heat exchange tube 30 and the end portion side 100b.

[0061] Also, the configuration can be made such that the tip end part 30a of the heat exchange tube 30 penetrates the intermediate plate 60, 90 so as to be located on the tank plate 50 side rather than being located on the intermediate plate 60, 90. In this configuration, the rigidity of the header tank 20A, 20B can be improved by the heat exchange tubes 30.

[0062] Also, as shown in FIGS. 5 and 10, in this embodiment, the middle part 62, 92 of the intermediate plate 60, 90 comprises concave parts 95A and 95B, which are continuous in the longitudinal direction of the intermediate plate 60, 90, on one surface and the other surface thereof. The joint surface part 42 of the header plate 40 and the joint surface part 52 of the tank plate 50 are formed with convex parts 96A and 96B, respectively, having external shapes corresponding to the concave parts 95A and 95B. By these concave parts 95A and 95B and the convex parts 96A and 96B, the contact length of the header plate 40, the tank plate 50, and the intermediate plate 60 can be made longer, and therefore the joint strength can be improved.

[0063] In the above-described heat exchanger 10, since the header tank 20A, 20B is configured so that the intermediate plate 60, 90 is held between the header plate 40 and the tank plate 50, the intermediate plate 60, 90 functions as a reinforcing member, so that the strength can be improved. Therefore, the heat exchanger 10 capable of sufficiently accommodating a high-pressure refrigerant can be configured. Moreover, for the header tanks 20A and 20B having the above-described configuration, the manufacturing process thereof need not be changed greatly as compared with the conventional header tank, and time and labor are not required for manufacturing the header tanks 20A and 20B. Also, for the header tank 20A, 20B having the above-described configuration, the plate thicknesses of the header plate 40 and the tank plate 50 need not be increased, so that the increase in size and weight of the heat exchanger 10 and the increase in material cost can be prevented.

[0064] In the header tank 20A, the intermediate plate 60 comprises the communicating slits 64, and the refrigerant flow paths 80A-2 and 80B-2 communicate with each other, and thereby a return flow path of refrigerant in the header tank 20A is secured. Therefore, a return flow path 9 as shown in FIG. 13 need not be provided additionally to secure the return flow path of refrigerant. In this respect as well, the increase in size and the like of the heat exchanger 10 can be avoided.

[0065] Also, since the intermediate plate 60, 90 comprises the openings 63, 93, the flow of refrigerant is not hindered in portions other than the portion in which the communicating slits 64 are provided.

[0066] Since the intermediate plate 60, 90 serving as a reinforcing element comprises the bent parts 100 between the central portion and the both end portions in the width direction of the header tank 20A, 20B, the rigidities of these portions can be reduced as compared with other portions. The elastic deformation of the bent parts 100 can prevent, for example, the stresses developed in brazing of the header tank 20A, 20B, and the stresses at the time when a refrigerant pressure is applied from concentrating in the joint portion of the header plate 40, the tank plate 50, and the intermediate plate 60, 90. Thereby, the strength of the header tank 20A, 20B can be improved.

[0067] Further, since the intermediate plate 60, 90 comprises the concave parts 95A and 95B corresponding to the external shapes of the joint surface part 42 of the header plate 40 and the joint surface part 52 of the tank plate 50, respectively, the contact length of the header plate 40, the tank plate 50, and the intermediate plate 60 can be made longer, and therefore the joint strength can be improved.

[0068] In the above-described embodiment, the specific shapes of the header tanks 20A and 20B have been shown typically. However, the cross-sectional shapes of the header tanks 20A and 20B, the shape and size, the number, the arrangement etc. of each of the openings 63 and 93 and the communicating slits 64 formed in the intermediate plates 60 and 90 can be changed as appropriate without departing from the spirit and scope of the present invention. For example, as shown in FIG. 11, the opening 63 can be an elongated hole that is long in the longitudinal direction of the intermediate plate 60 so as not to hinder the flow of refrigerant as far as possible.

[0069] Also, the bent part 100 may be formed into any shape and of any material if it is formed on the intermediate plate 60, 90 between the central portion side 100a and the end portion side 100b of the header tank 20A, 20B, and can allow the middle part 62 and the end part 61 on each side to be displaced relatively in the direction where they move closer to or away from each other.

[0070] Besides, the configurations described in this embodiment can be selected, or can be changed as appropriate to any other configurations without departing from the spirit and scope of the present invention.

Reference Signs List

[0071] 10 ... heat exchanger, 20A ... header tank (first header tank), 20B ... header tank (second header tank), 30 ... heat exchange tube, 31 ... fin, 40 ... header plate, 41, 51 ... joint wall part, 42, 52 ... joint surface part, 43, 53 ... swelling part, 50 ... tank plate, 60, 90 ... intermediate plate, 61, 91 ... end part, 62, 92 ... middle part, 63, 93 ... opening, 64 ... communicating slit (communicating port), 70A, 70B, 70C ... closing plate, 80A, 80B, 80C, 80D ... refrigerant flow path, 95A, 95B ... concave part, 96A, 96B ... convex part, 100 ... bent part (elastically deformed part)

Claims

1. A heat exchanger comprising:

a plurality of heat exchange tubes arranged in parallel with each other;
fins provided between the heat exchange tubes adjacent to each other;
a first header tank connected to one end side of the plurality of heat exchange tubes; and
a second header tank connected to the other end side of the plurality of heat exchange tubes, wherein the first header tank and the second header tank each comprises:
a header plate into which the end parts of the plurality of heat exchange tubes are inserted;
a tank plate facing the header plate; and
an intermediate plate held between the header plate and the tank plate;
the header plate, the tank plate, and the intermediate plate are joined to each other in end parts on both sides and a middle part in the width direction thereof, whereby between the header plate and the tank plate, refrigerant flow paths are formed on one side and the other side with the middle part being held therebetween; and
the intermediate plate crosses the refrigerant flow paths in the direction in which the end parts and the middle part are connected in the refrigerant flow paths, and the intermediate plate has an elastically deformed part which allows the end parts and the middle part to be displaced relatively in the direction where they move closer to or away from each other.

2. The heat exchanger according to claim 1, wherein the intermediate plate has a concave part, which is continuous in the longitudinal direction of the intermediate plate, on at least one surface thereof;
at least one of the header plate and the tank plate has a convex part having a shape corresponding to the concave part; the concave part of the intermediate plate is formed in the middle part in the width direction of the intermediate plate, and the convex part of the at least one of the header plate and the tank plate is formed in a portion facing the concave part; and
the concave part and the convex part are joined to each other.

3. The heat exchanger according to claim 1 or 2, wherein
at least one of the intermediate plate of the first header tank and the intermediate plate of the second header tank is provided with a communicating port which is continuous to both sides with the middle part being straddled; and the refrigerant flow path on one side and the refrigerant flow path on the other side communicate with each other via the communicating port with the middle part being held therebetween.

4. The heat exchanger according to claim 1, wherein the plate thicknesses of the header plate, the tank plate, and the intermediate plate each are not smaller than 1.0 mm and not larger than 2.0 mm.

5. The heat exchanger according to claim 3, wherein the width of the communicating port in the intermediate plate is not narrower than 2.0 mm and not wider than 3.8 mm.

6. A vehicle air conditioning apparatus provided with the heat exchanger according to claim 1.

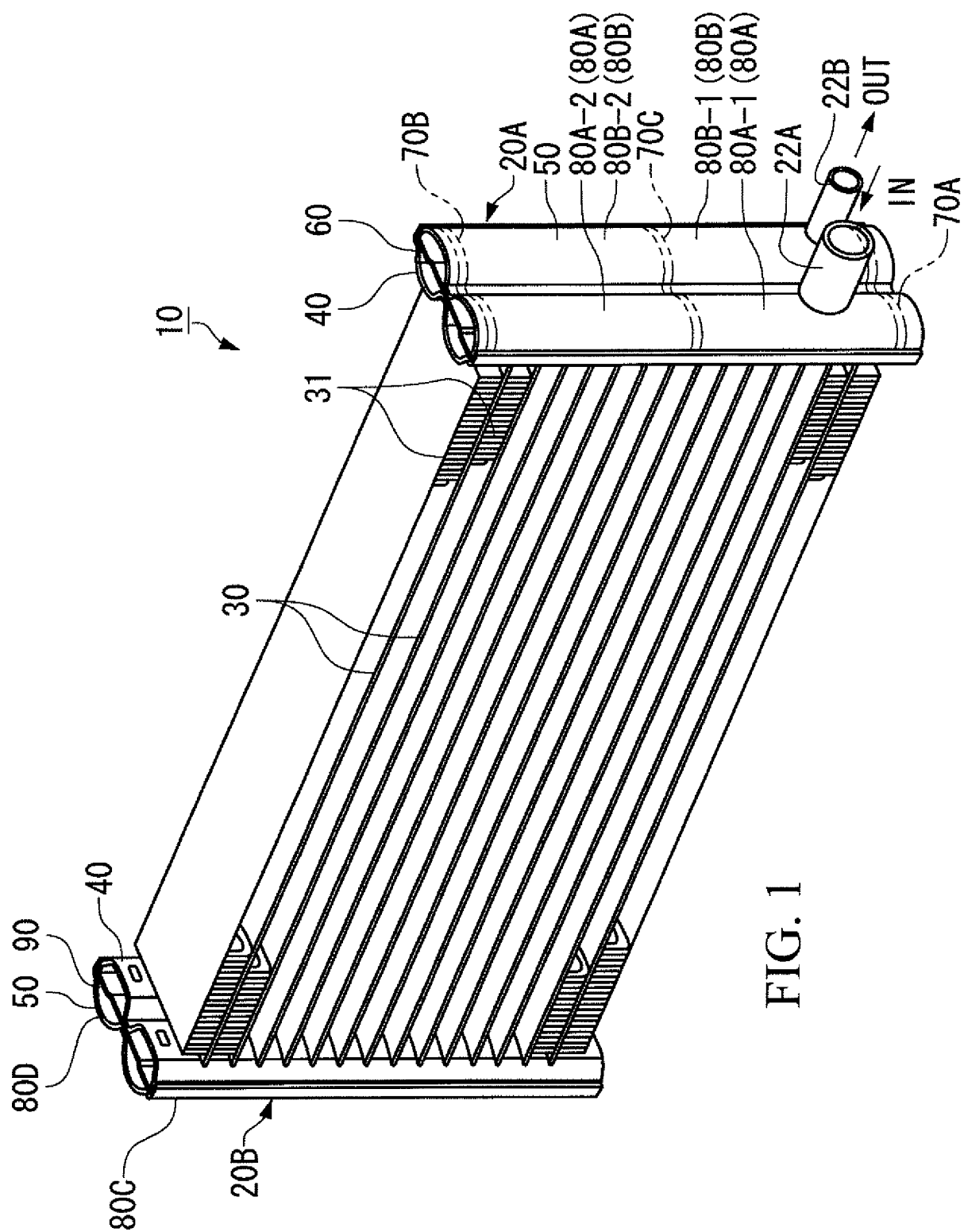


FIG. 2

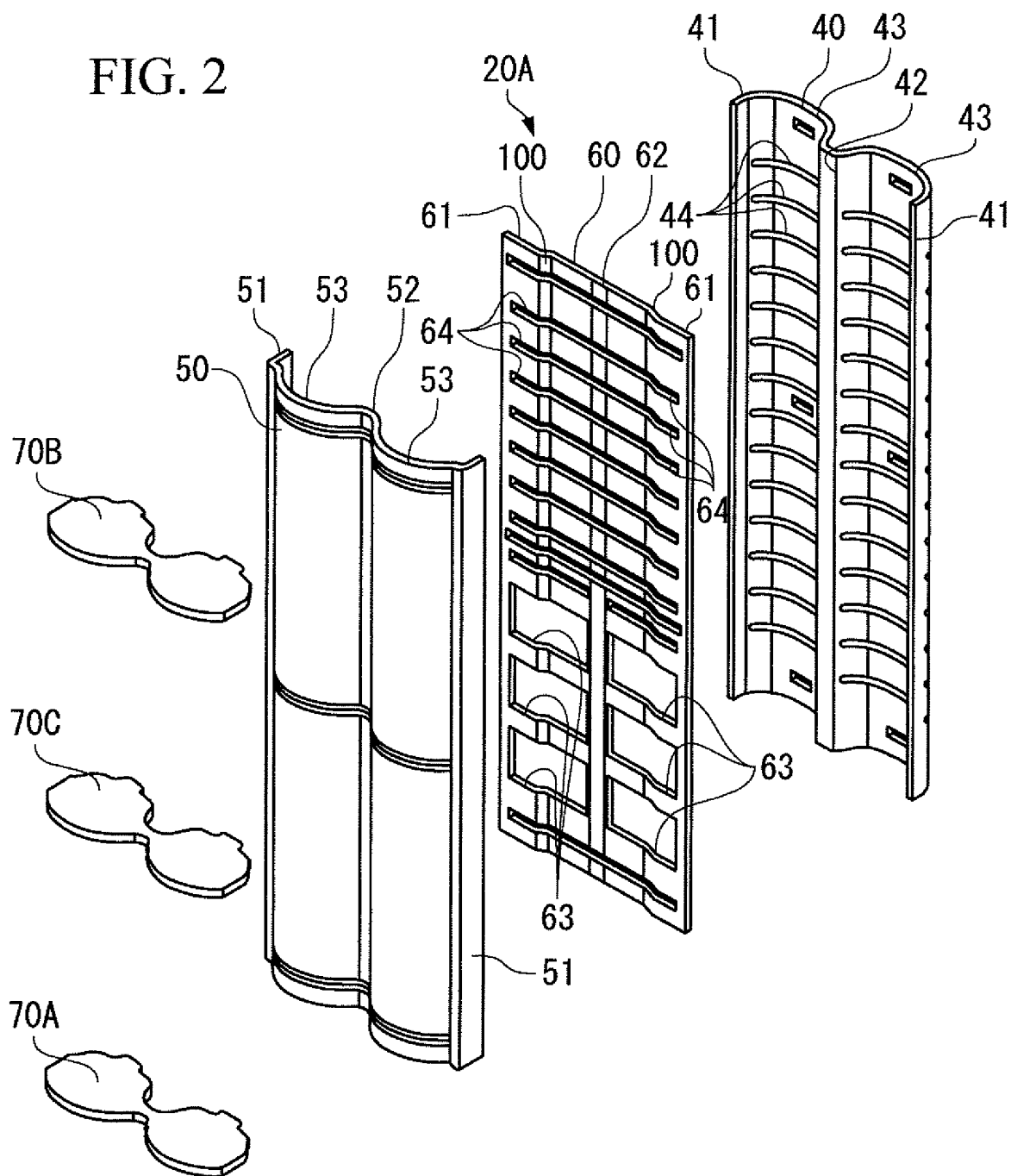


FIG. 3

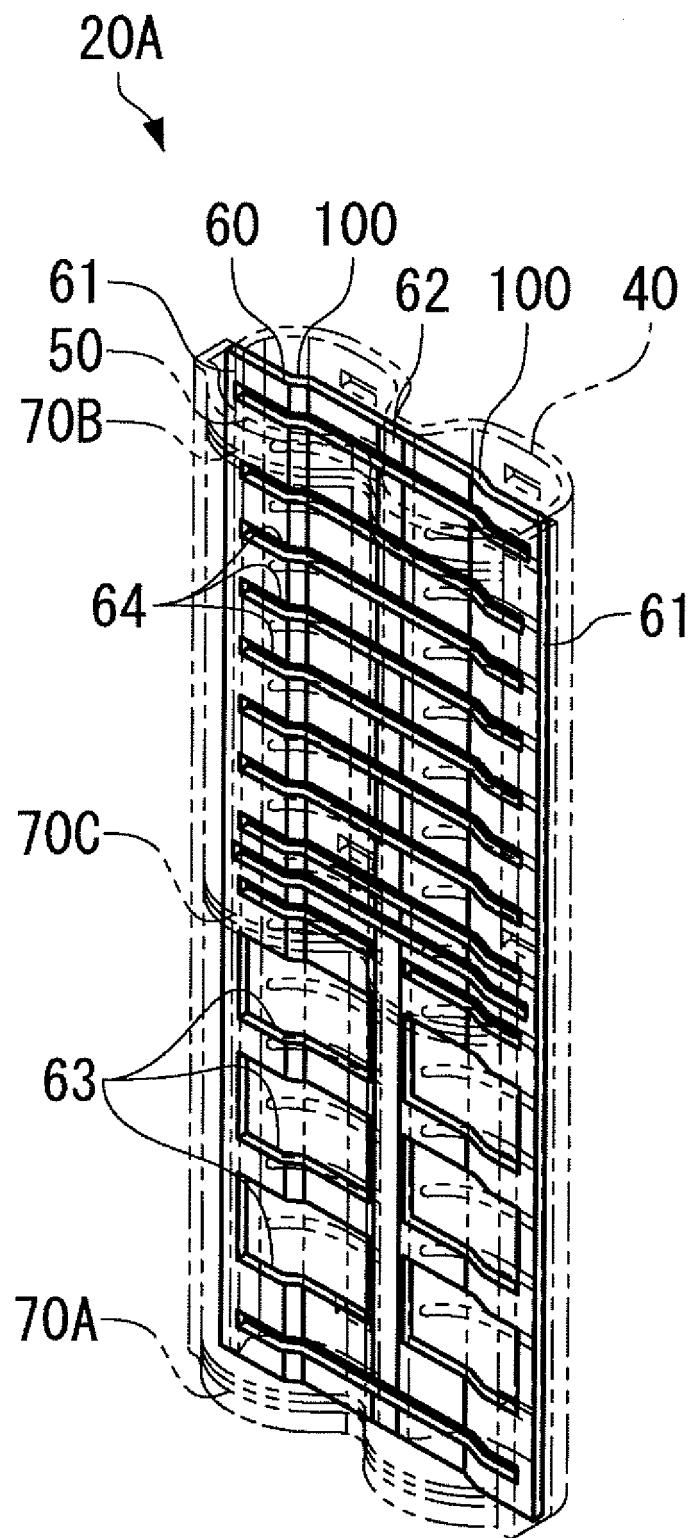


FIG. 4

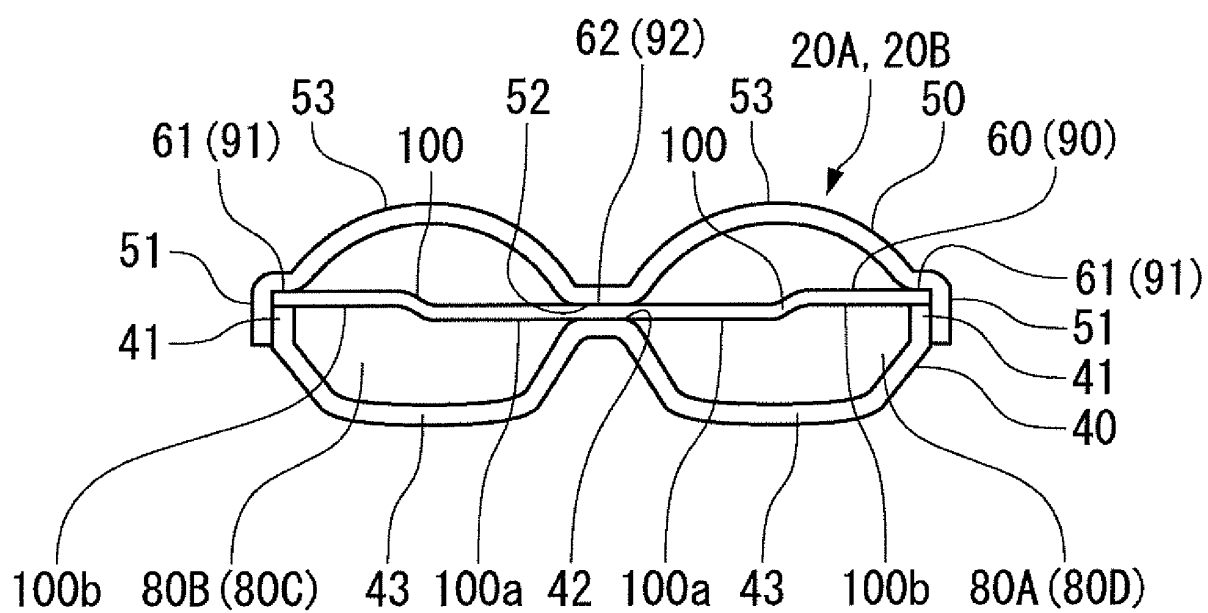


FIG. 5A

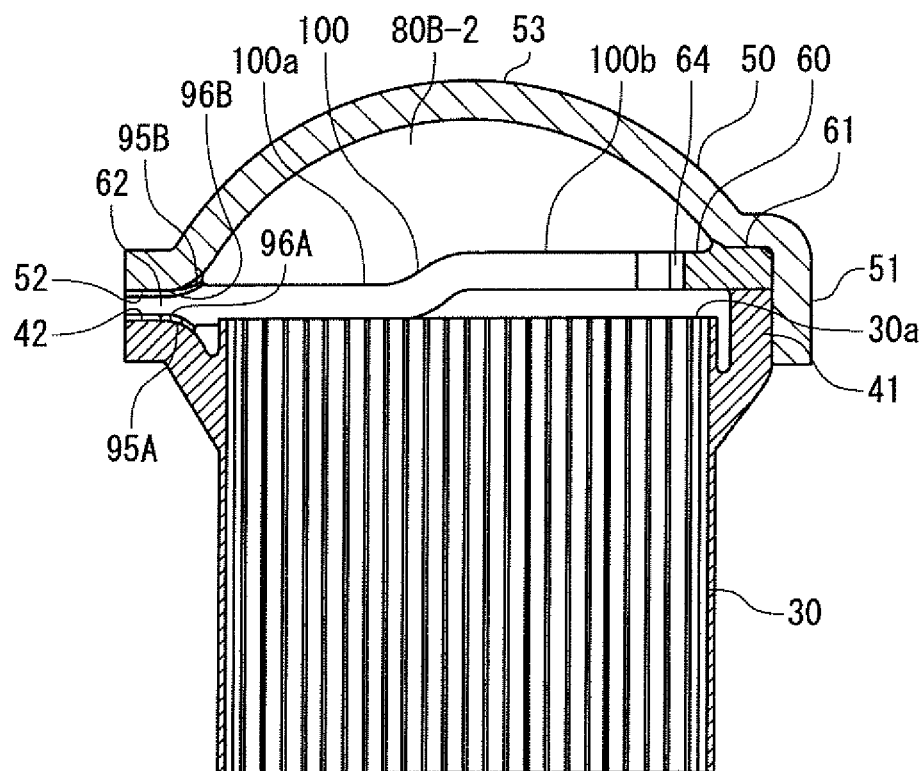


FIG. 5B

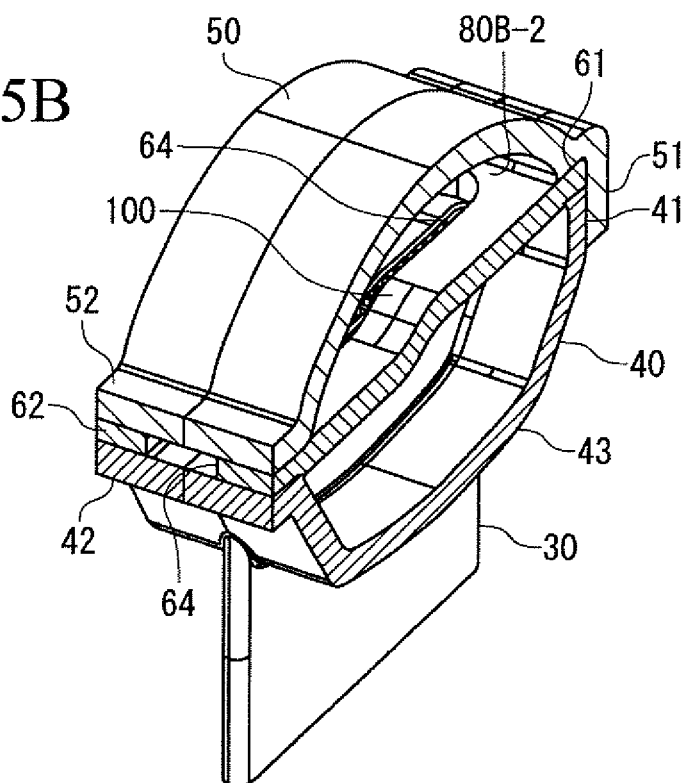


FIG. 6

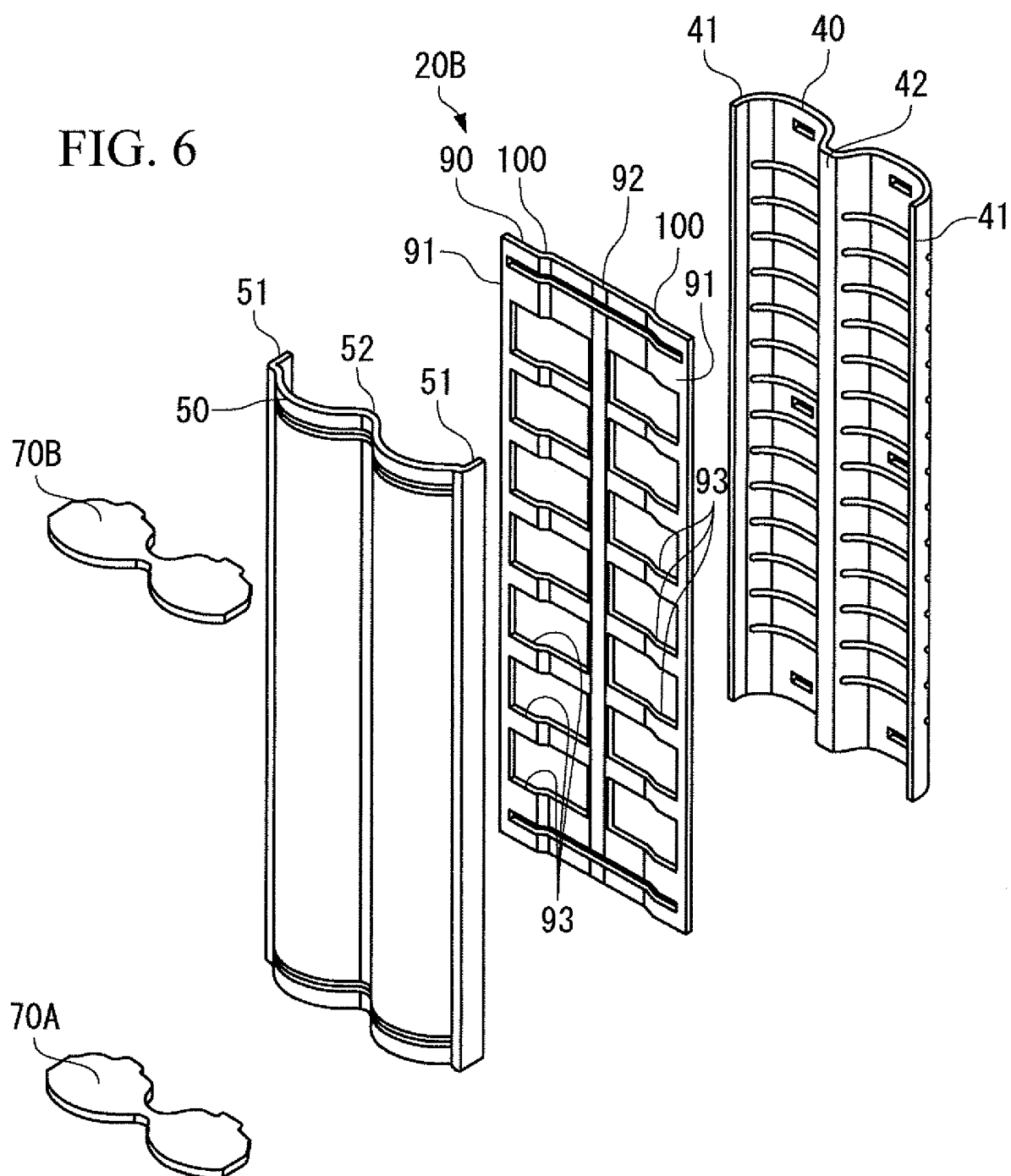


FIG. 7

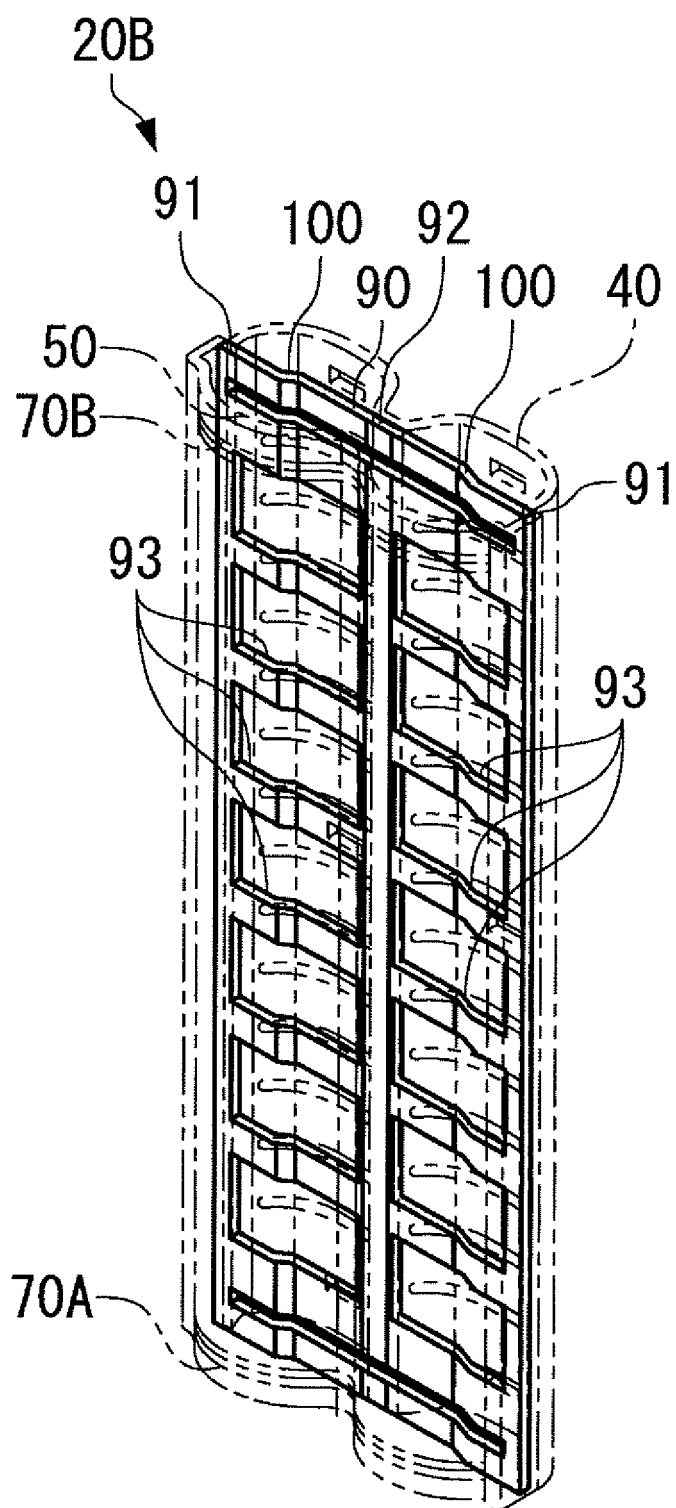


FIG. 8

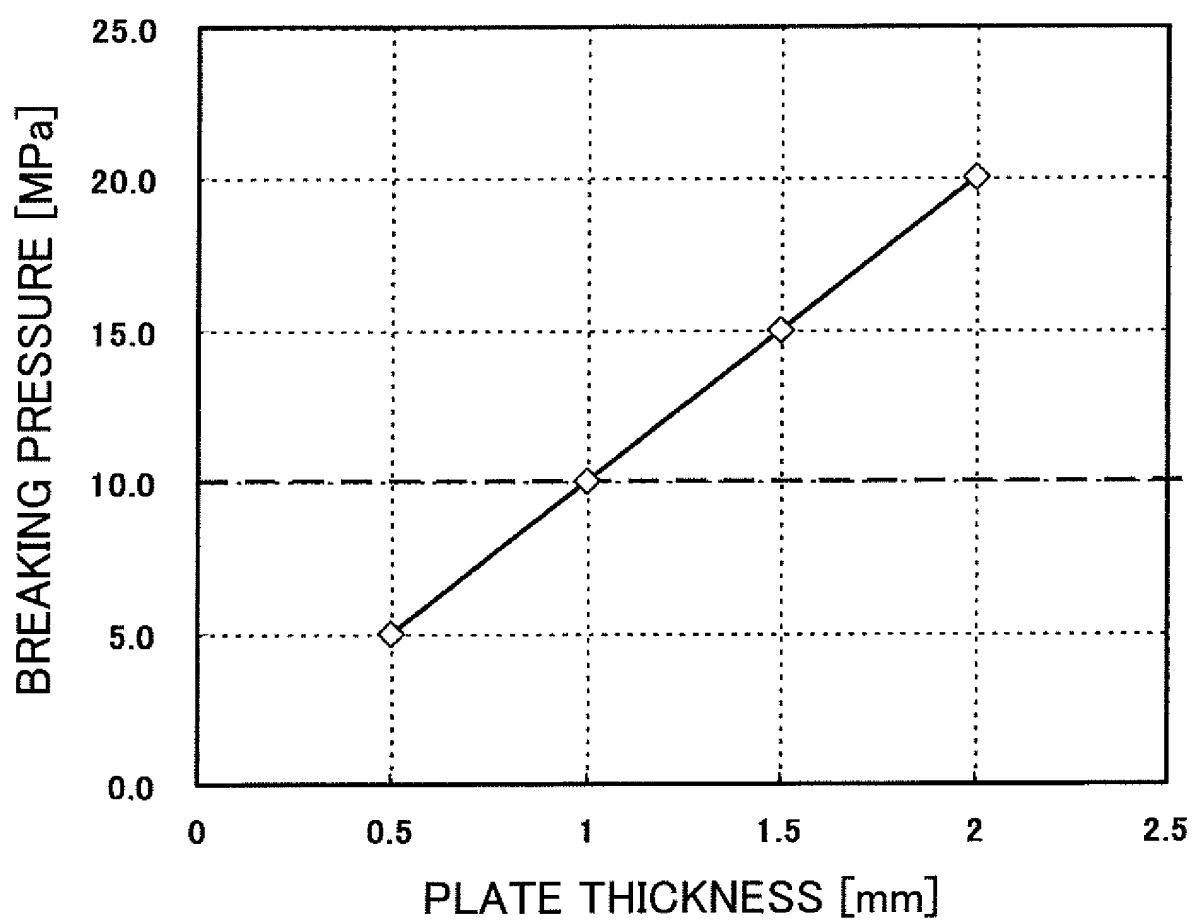


FIG. 9

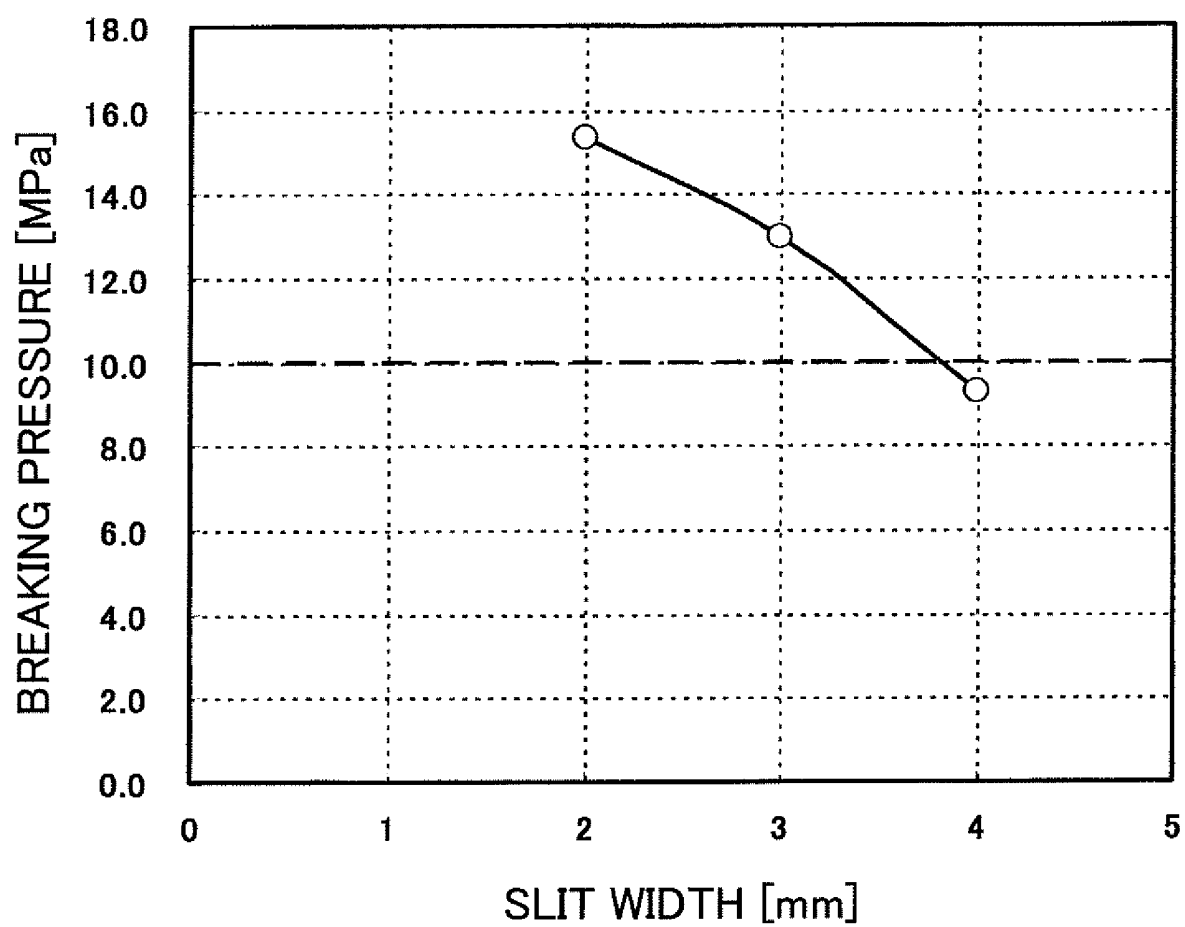


FIG. 10

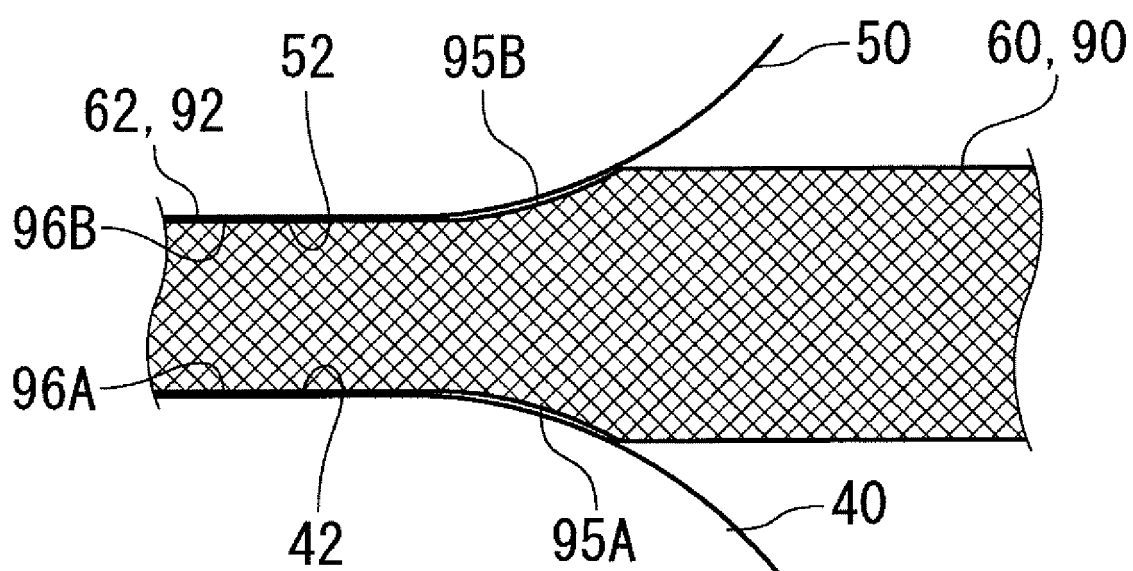


FIG. 11

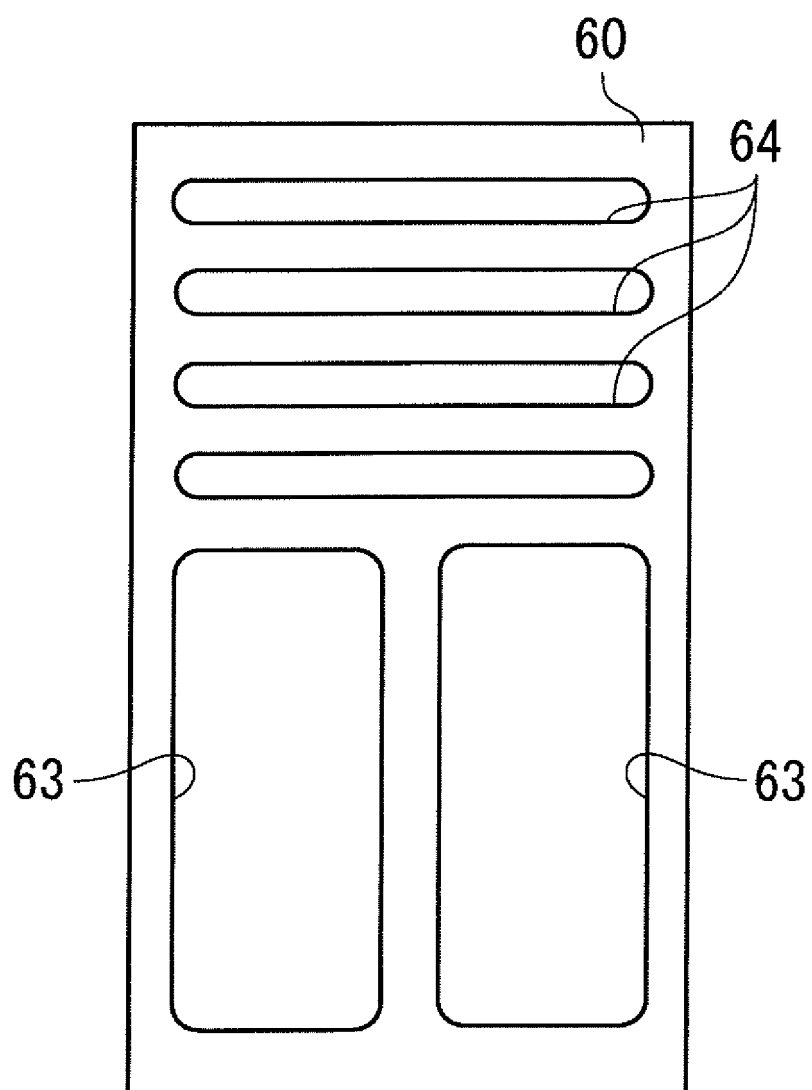


FIG. 12

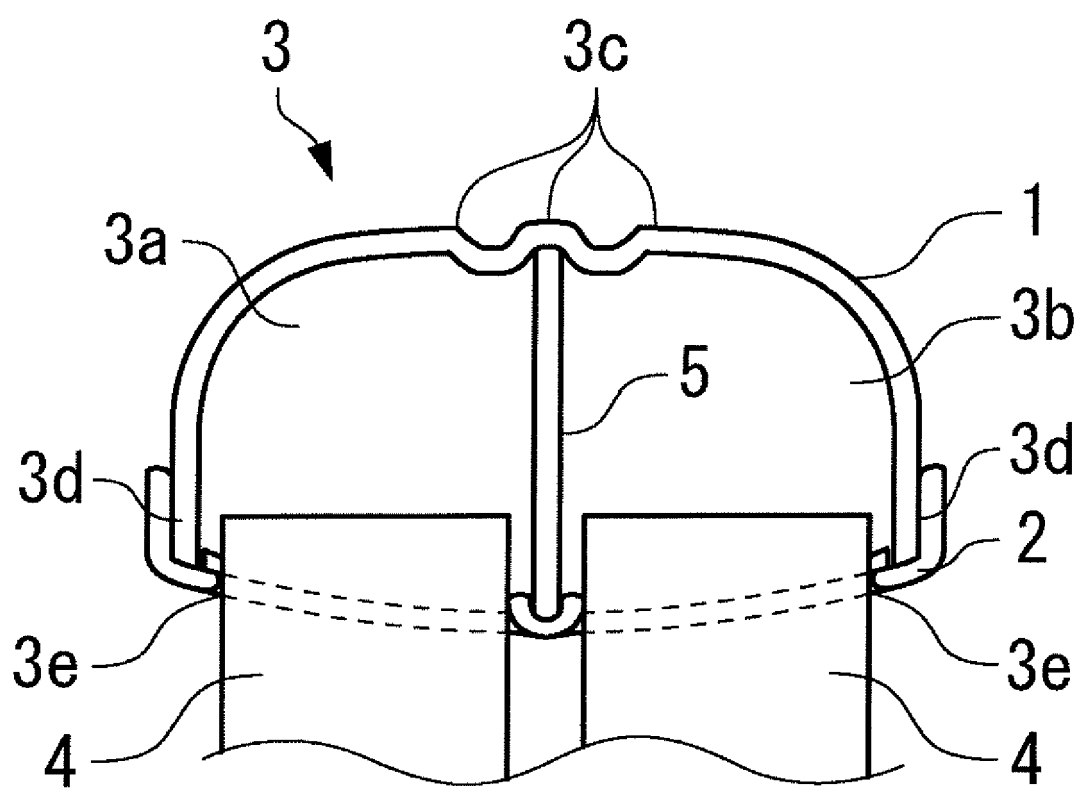


FIG. 13A

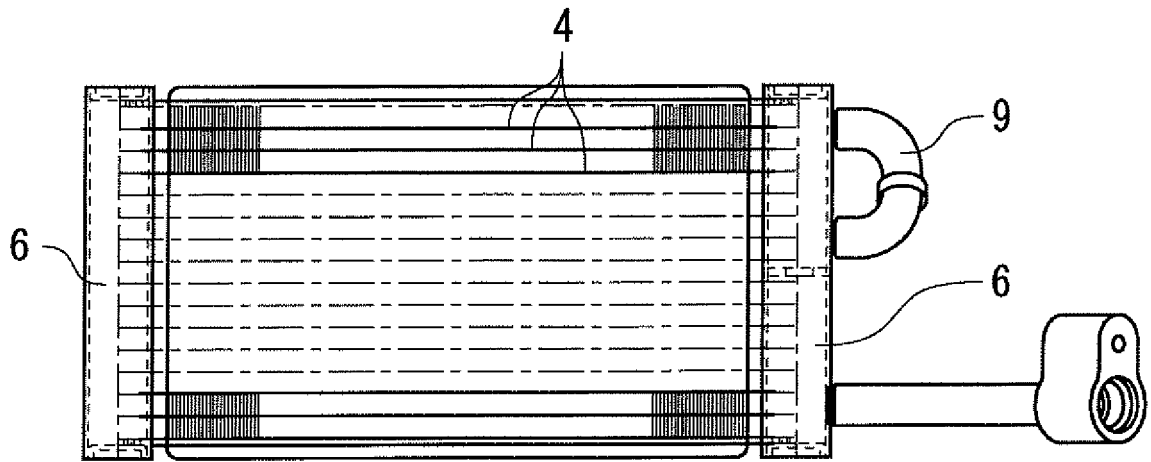
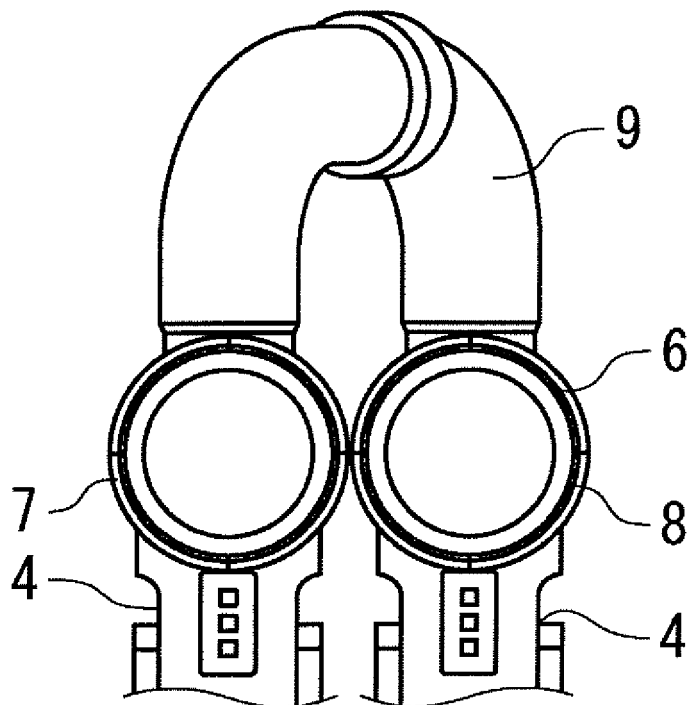


FIG. 13B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/005089

A. CLASSIFICATION OF SUBJECT MATTER

F28F9/02 (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)
F28F9/02

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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 2009-97776 A (Showa Denko Kabushiki Kaisha), 07 May 2009 (07.05.2009), fig. 1 to 10; paragraphs [0020] to [0058] (Family: none)	1-6
Y	JP 2006-189205 A (Denso Corp.), 20 July 2006 (20.07.2006), paragraphs [0020] to [0053]; fig. 1 to 6 & US 2006/0151158 A1	1-6
Y	JP 2007-155268 A (Denso Corp.), 21 June 2007 (21.06.2007), fig. 1 to 6; paragraphs [0035] to [0062] & DE 102006057585 A & FR 2896859 A & IT MI20062357 A & IT MI20062357 A1	3, 5

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

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Date of the actual completion of the international search
05 October, 2010 (05.10.10)Date of mailing of the international search report
12 October, 2010 (12.10.10)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/005089

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-532525 A (Behr GmbH & Co. KG.), 27 October 2005 (27.10.2005), fig. 7, 8 & US 2006/0037740 A1 & EP 1530701 A & WO 2004/005827 A1 & BR 305422 A & CN 1666076 A	2

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005300135 A [0004]