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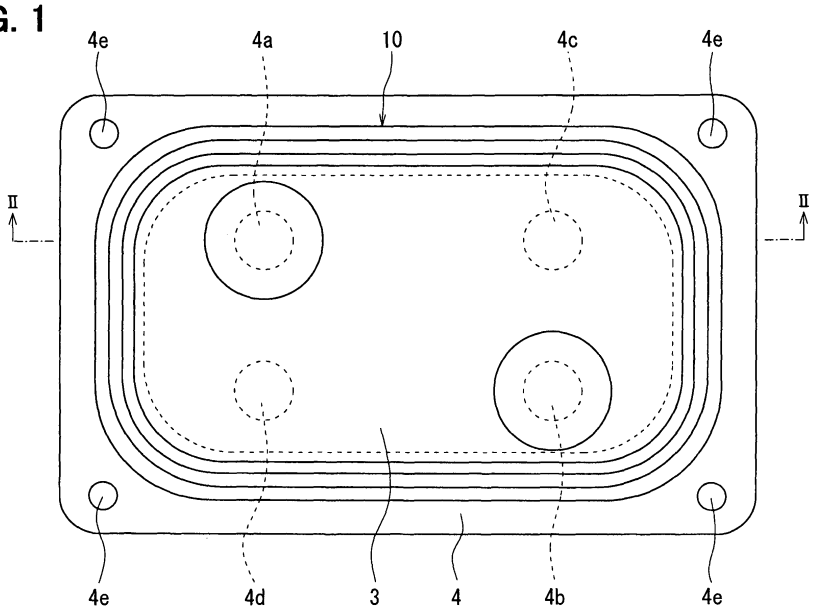
(54) **Stacked plate heat exchanger**

(57) The stacked plate oil cooler has a first plate 1 and a second plate 2. Both the first plate 1 and the second plate 2 are made of a three-layered aluminum alloy clad sheet. The second plate 2 is folded at an outer rim to place the brazing material layer 35 on both sides of the second plate 2. The first and second plates 1 and 2 are stacked alternately and brazed to define a water passage 21 between sacrificial layers 32 and 36, and to define an oil passage 22 between brazing material layers 33 and 35. The first plate 1 is folded at an outer rim to place the sacrificial layer 32 on a lateral outside of a core assembly to decrease exposure of the brazing material layer to the lateral outside.

FIG. 1



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Description

[0001] The present invention relates to a stacked plate heat exchanger, and is preferably applied to an oil cooler for an internal combustion engine used for an automobile.

[0002] Conventionally, the stacked plate heat exchanger such as an oil cooler is known in this field, also called as a housingless oil cooler. This type of oil cooler has a plurality of plates, typically made of metal such as aluminum or aluminum alloy. The plates include a first plate and a second plate formed in different shapes. The first and second plates are alternately stacked to define a plurality of passages therebetween. The passages include a first passage for coolant, such as cooling water and a second passage for hot medium, such as oil to be cooled. The first and second passages are alternately arranged. In one of conventional structures, each plate has a core layer and brazing material layers formed on both sides of the core layer. However, this oil cooler may have a leak hole on the plate due to corrosion by moisture or chlorine. Also, it is known that each plate may have a core layer, a brazing material layer on one side, and a corrosion resistant layer on the other side. The corrosion resistant layer may be a sacrificial layer. However, this oil cooler may also have a leak hole on the plate due to corrosion, since the brazing material layer on one of the first and second plates directly faces to the passage for coolant and causes corrosion.

[0003] In order to address such a corrosion problem, JP H05-1890A discloses an improved oil cooler having a first plate with cylindrical portion and a second plate with protruding portion. In this structure, the first plate is formed to have a cylindrical portion integrally on an outer rim of the first plate and to locate the sacrificial layer inside. The second plate is formed to have a protruding portion integrally along an outer rim of the second plate, protruding toward a main part of the first plate. Then, a brazing material layer on the outside of the protruding portion is brazed on the sacrificial layer on the inside the cylindrical portion. This improved structure may prevent corrosion from a coolant side, since the sacrificial layers on the first and second plates face to the passage for coolant, and the brazing material layers on the first and second plates face to the passage for oil.

[0004] In order to improve a brazing quality, it is required to make tightly contact the surfaces to be brazed. For this purpose, the above mentioned stacked plate oil coolers are usually employ a jig to hold and press the plates for brazing process.

[0005] However, the stacked plate oil cooler has brazing surfaces on a direction to which a pressing force can not apply. To overcome this problem, it is required to improve accuracy in size to reduce distance of gaps between the brazing surfaces, or to add a precise shaping process such as a sizing process to make contact the brazing surfaces.

[0006] Further, in case of attaching a support plate on a core formed by the stacked plates, it is difficult to braze such a support plate on the core, since the sacrificial layer exposed to the outside of the core hinders a brazing. To avoid this problem, it is required to form a brazing material layer on the support plate, or to add a further brazing member between the core and the support plate.

[0007] Considering the above mentioned problems, JP H10-185462A discloses a stacked plate oil cooler made of four-layered plates having a core layer, a first sacrificial layer being formed on one side of the core layer, a second sacrificial layer being formed on the other side of the core layer, and a brazing material layer being formed on the second sacrificial layer. The plate in this document is formed in a disc shape having a tapered outer rim. Therefore, it is possible to make the plate contact firmly by applying pressing force, since the tapered outer rims receive the pressing force.

[0008] However, it is not avoidable to increase material costs, and increase cost for the product, since the four-layered plates are required.

[0009] In view of the foregoing problems, it is an object of the present invention to provide a stacked plate oil cooler having sufficient resistance to corrosion and reliable joint of brazing.

[0010] It is a further object of the present invention to provide a stacked plate oil cooler having sufficient resistance to corrosion and reliable joint of brazing by using three-layered plates.

[0011] An embodiment of the invention provides a stacked plate heat exchanger for a first medium and a second medium. The oil cooler has a core section including alternately stacked first plates and second plates, each of the first and second plates being made of a three-layered plate having a core layer (31, 34), a sacrificial layer (32, 36) formed on one side of the core layer, and a brazing material layer (33, 35) formed on the other side of the core layer. The oil cooler comprises a first tapered portion (44) formed on an outer rim of each of the first plates. The first tapered portion is enlarged toward an opening. The first tapered portion includes a first folded portion (45) formed by bending an outer rim of the first plate (1) to place the sacrificial layer (32) on the first plate (1) outside the first tapered portion (44). The oil cooler further has a second tapered portion (54) formed on an outer rim of each of the second plates. The first plates (1) and the second plates (2) are stacked alternately to define first passages (21) for the first medium between the sacrificial layers (32, 36) on the first plate and the second plate, and to define second passages (22) for the second medium between the brazing material layers (33, 35) on the first plate and the second plate. The first tapered portion (44) and the brazing material layer (35) on the second tapered portion (54) are placed next to each other.

[0012] According to the invention, it is possible to prevent corrosion on a surface defining the first passages (21), since the first passages (21) are completely surrounded by the sacrificial layers (32, 36) on the first plate and the second plate. Additionally, the first tapered portion (44) and the second tapered portion (54) enables to apply pressing force onto a brazing interface. Therefore, it is possible to improve brazing quality. Further, it is possible to achieve sufficient resistance to corrosion and reliable joint of brazing by using relatively low cost three-layered plates.

[0013] In a preferred embodiment, the second tapered portion (54) may be enlarged toward an opening. The first plate (1) may have a corner portion on the outer rim, and the corner portion may have a recess extending at least along the first folded portion (45). The recess ease to form the tapered portion without wrinkle even it has a folded portion.

[0014] Further, the second tapered portion (54) may include a second folded portion (55) formed by bending an outer rim of the second plate (2) to place the brazing material layer (35) on the second plate (2) outside the second tapered portion (54).

[0015] The second tapered portion (54) may have a brazing passage (55a) corresponding to the second folded portion (55) to introduce brazing material to an interface between the sacrificial layers (36) on the second plate (2). The second plate (2) may have a corner portion on the outer rim, and the corner portion has a recess extending at least along the second folded portion (55). Further, at least one of the first and second tapered portions may be formed into a U-turn shape that is easy to manufacture.

[0016] The first fluid may be cooling water. The second fluid may be oil. The core layer (31, 34) of the first and second plates (1, 2) may be made of aluminum alloy.

[0017] Other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings, in which:

Fig. 1 is an upper view of a stacked plate oil cooler according to a first embodiment of the invention;
Fig. 2 is a sectional view of the stacked plate oil cooler taken along the line A-A in Fig. 1;
Fig. 3 is an enlarged sectional view of the stacked plate oil cooler according to a first embodiment of the invention;
Fig. 4 is an upper view showing a deployed shape of a semi-processed plate for a first plate according to a first embodiment of the invention;
Fig. 5 is a perspective view showing a press formed shape of the first plate according to a first embodiment of the invention;
Fig. 6 is a sectional view of a second plate according to a first embodiment of the invention;
Fig. 7 is an enlarged sectional view of the stacked plate oil cooler according to a second embodiment of the invention;
Fig. 8 is an enlarged sectional view of the stacked plate oil cooler according to a third embodiment of the invention; and
Fig. 9 is an enlarged sectional view of the stacked plate oil cooler according to a fourth embodiment of the invention.

(First Embodiment)

[0018] A first embodiment of the invention is described below with the drawings. The first embodiment is an oil cooler also called as a housingless oil cooler for cooling oil lubricating an internal combustion engine mounted on a vehicle. The oil cooler is attached on a side wall of an engine cylinder block and performs heat exchange between oil and engine cooling water.

[0019] Referring to Figs. 1 and 2, the oil cooler has a core 10 formed by stacking a plurality of plates for performing heat exchange between oil and cooling water. The core 10 has alternately stacked first plates 1 and second plates 2. The first plates 1 and second plates 2 are formed to have a predetermined shape having protrusions and depressions by pressing processes. The oil cooler has a cover plate 3 made of aluminum alloy, and attached on one end of the core 10. The oil cooler further has a support plate 4 made of aluminum alloy, and attached on the other end of the core 10. In Fig. 2, the core 10 has the cover plate 3 on its upper end, and has the support plate on its lower end.

[0020] The cover plate 2 is made of a double-layered plate having a core layer made of aluminum alloy and a sacrificial layer having galvanic potential lower than that of the core layer. The sacrificial layer is a clad layer covering the side of the core layer opposite from the core 10.

[0021] The support plate 4 has a water inlet 4a for introducing the cooling water into the core 10, a water outlet 4b for flowing out the cooling water from the core 10, an oil inlet 4c for introducing the oil into the core 10, and an oil outlet 4d for flowing out the oil from the core 10. The support plate 4 further has through holes 4e or recesses formed on corners for accepting attaching member such as bolts for attaching the support plate 4 on the cylinder block.

[0022] The core 10 has a plurality of disc shaped plates. The plates include the first plates 1 and the second plates 2 alternately stacked along thickness directions to define water passages 21 and oil passages 22 alternately therebetween. The water passage 21 provides a first passage, and is a flat and thin passage for cooling water. The water passage 21 is surrounded by sacrificial layers formed on the first and second plates 1 and 2. The oil passage 22 provides a second passage, and is a flat and thin passage for oil. The oil passage 22 is surrounded by brazing material layers formed on the first and second plates 1 and 2. Therefore, a pair of the second plate 2 and the first plate 1 defines a fluid passage for cooling water. Similarly, a pair of the first plate 1 and the second plate 2 defines a fluid passage for oil.

[0023] The water passages 21 and the oil passages 22 respectively have first inner fins 23 and second inner fins 24 therein. The inner fins 23 and 24 are offset fins to facilitate heat transfer. The first inner fins 23 located inside the water passages 21 are made of a clad plate having brazing material layers on both sides of a core layer. The second inner fins 24 located inside the oil passages 22 are made of a bare plate without brazing material layer.

[0024] The oil cooler has four connecting passages penetrating the core 10 in a stacking direction for connecting the passages 21 and 22, since the water passages 21 and the oil passages 22 are arranged in parallel with respect to the stacking direction. The connecting passages include a water inlet passage connecting the water passages 21 at inlet portions thereof, and include a water outlet passage connecting the water passages 21 at outlet portions thereof. In Fig. 2, the water inlet passage 25 is illustrated. Similarly, the connecting passages include an oil inlet passage connecting the oil passages 22 at inlet portions thereof, and include an oil outlet passage connecting the oil passages 22 at outlet portions thereof. In Fig. 2, the oil inlet passage 26 is illustrated. The connecting passages 25 and 26 are provided by through holes formed on the plates 1 and 2. The plates 1 and 2 are joined by brazing around the through holes.

[0025] Referring to Fig. 3, the first plate 1 is made of a first three-layered aluminum alloy clad sheet. The first plate 1 has a first core layer 31 made of aluminum alloy, a first sacrificial layer 32 having lower galvanic potential than that of the first core layer 31, and a first brazing material layer 33 having a lower melting point than the first core layer 31. The first sacrificial layer 32 is formed on one side surface of the first core layer 31 which faces to the water passage 21. The first brazing material layer 33 is formed on the other side surface of the first core layer 31 which faces to the oil passage 22. The first sacrificial layer 32 has a higher melting point than the first brazing material layer 33, and poorer resistance to corrosion than the first core layer 31. The first sacrificial layer 32 provides anti-corrosion protection for the first core layer 31 by its sacrificial corrosion.

[0026] The second plate 2 is made of a second three-layered aluminum alloy clad sheet. The second plate 2 has a second core layer 34 made of aluminum alloy, a second brazing material layer 35 having a lower melting point than the second core layer 34, and a second sacrificial layer 36 having lower galvanic potential than that of the second core layer 34. The second sacrificial layer 36 is formed on one side surface of the second core layer 34 which faces to the water passage 21. The second brazing material layer 35 is formed on the other side surface of the second core layer 34 which faces to the oil passage 22. The second sacrificial layer 36 has a higher melting point than the second brazing material layer 35, and poorer resistance to corrosion than the second core layer 34. The second sacrificial layer 36 provides anti-corrosion protection for the second core layer 34 by its sacrificial corrosion.

[0027] Back to Fig. 2, the first plate 1 has a partitioning portion 41 formed in flat and having four through holes, ring shaped joining margins 42 (joining portions) formed on the partitioning portion 41 around the through holes for the connecting passages 25, and ring shaped burring portions 43 (joining portions) formed around the through holes for the connecting passages 25. The burring portion 43 is formed in a funnel shape from the partitioning portion 41 toward the second passage 22, and has an enlarged rim extending to overlap the second plate 2.

[0028] The second plate 2 has a partitioning portion 51 formed in flat and having four through holes, ring shaped first protrusions 52 (joining portions) formed on the partitioning portion 51 around the through holes for the connecting passages 25, and ring shaped second protrusions 53 (joining portions) formed around the through holes for the connecting passages 25. The first protrusions 52 and the second protrusions 53 have ring shaped frat tops respectively, and protrude toward opposite direction to each other. The flat tops of the first protrusions 52 are brazed with the joining margins 42. Inside surfaces of the flat tops of the second protrusions 53 are brazed with insides of the burring portions 43 and are mechanically clamped by the burring portions 43. The flat tops of the second protrusions 53 may be brazed with the base region of the burring portions 43 by the brazing material supplied from the first and second brazing material layers 35.

[0029] Referring to Figs. 2 and 3, the first plate 1 has a first tapered portion 44 on an outer rim surrounding the partitioning portion 41. The first tapered portion 44 provides enlarged rim from the partitioning portion 41 toward the outer end. The first tapered portion is formed to enlarge a span of its opening toward its opening side. The first tapered portion 44 is formed by bending the outer rim into a U-turn shape and stacking a sloping rim and a first folded portion 45. The first folded portion 45 is formed to fold the outer rim of the first plate 1 to make the first sacrificial layer 32 exposed to the outside at the first tapered portion 44. The first folded portion 45 is formed to cover entire area of the first tapered portion 44. Therefore, the distal end of the first folded portion 45 reaches to a boundary between the partitioning portion 41 and the first tapered portion 44. As a result, the lateral outside surface of the first plate 1 is fully covered with the first sacrificial layer 32.

[0030] Similarly, the second plate 2 has a second tapered portion 54 on an outer rim surrounding the partitioning portion 51. The second tapered portion 54 provides enlarged rim from the partitioning portion 51 toward the outer end. The second tapered portion is formed to enlarge a span of its opening toward its opening side. The second tapered portion 54 is formed by stacking a sloping rim and a second folded portion 55. The second folded portion 55 is formed to fold the outer rim of the second plate 2 to make the second brazing material layer 35 exposed to the outside at the second tapered portion 54. The second folded portion 55 is formed to cover entire area of the second tapered portion 54. Therefore, the distal end of the second folded portion 55 reaches to a boundary between the partitioning portion 51 and the second tapered portion 54. As a result, the lateral outside surface of the second plate 2 is fully covered with the second brazing material layer 35.

[0031] In an assembled form, the first plates 1 and the second plates 2 are alternately stacked to place the first plate 1 on one end and the second plate 2 on the other end. The first plate 1 and the second plate 2 are placed and stacked so that the first tapered portion 44 comes into contact with the second brazing material layer 35. In detail, the first sacrificial layer 32 on the first folded portion 45 comes into contact with the second brazing material layer 35 on the second folded portion 55. The first plate 1 is folded at an outer rim to place the first sacrificial layer 32 on a lateral outside of a core assembly to decrease exposure of the brazing material layer to the lateral outside.

[0032] The core assembly has at least one combination of one of the first plate 1 and two of the second plates 2 stacked on both sides of the first plate 1. In this combination, the sacrificial layer 32 placed on both sides of the first tapered portion 44 of the first plate 1 are brazed with the brazing material layer 35 on the second tapered portion 54 of one of the second plates 2 and brazed with the brazing material layer 35 on the second tapered portion 54 of the other one of the second plates 2. This combination enables brazing between the first and second plates, and improves resistance to corrosion.

[0033] The stacked plate oil cooler can be manufactured by the following process. First, the first three-layered aluminum alloy clad sheet is prepared by forming the first brazing material layer 33 on one side of the first core layer 31 and forming the first sacrificial layer 32 on the other side of the first core layer 31. Similarly, the second three-layered aluminum alloy clad sheet is prepared by forming the second brazing material layer 35 on one side of the second core layer 34 and forming the second sacrificial layer 36 on the other side of the second core layer 34. The first and second three-layered aluminum alloy clad sheets can be the same and used in reversed fashion.

[0034] The first and second core layers 31 and 34 are made of Al-Mn alloy for decreasing weight and improving heat conductivity. The first and second brazing material layers 33 and 35 are made of Al-Si alloy. The first and second sacrificial layers 32 and 36 are made of Al-Zn alloy. The layers 32, 33, 35, 36 can be formed by a clad process in which a film shaped brazing material and a film shaped sacrificial material are firmly fixed onto the core material by pressing them below the melting temperature of the materials.

[0035] In a cutting process, the first and second three-layered aluminum alloy clad sheets are cut into a predetermined shape, a rectangular shape, by pressing machines. Simultaneously, the through holes and recesses are formed on predetermined locations. As a result, predetermined shaped plates are prepared.

[0036] In a bending and folding process, the plates are processed into a predetermined shape as illustrated in Figs. 2 and 3.

[0037] In an assembling process, the first plates 1 and the second plates 2 are stacked alternately along their thickness direction. The inner fins 23, 24 are also alternately placed between the first plates 1 and the second plates 2. The first plate 1 and the second plate 2 are placed as illustrated in Figs. 2 and 3. On one side of one of the first plates 1, bottom side in the drawings, the first brazing material layer 33 on the joining margin 42 comes in contact with the second brazing material layer 35 on the flat top of the first protrusion 52. On the other side of one of the first plates 1, the first sacrificial layer 32 on the burring portion 43 comes in contact with the second sacrificial material layer 36 on the flat top of the second protrusion 53. When stacking the second plate 2 onto the first plate 1, the burring portion 43 is placed through the through hole on the second plate 2 and is enlarged in diameter to form a flared end to mechanically clamp the second plate 2 onto the first plate 1. As a result, the first sacrificial layer 32 inside the burring portion 43 comes in contact with the second brazing material layer 35 inside the flat top of the second protrusion 53. At the tapered portion 44 of the first plates 1, the first sacrificial layers 32 comes in contact with the second brazing material layer 35 on the tapered portion 54 of the second plates 2. As a result, the first brazing material layer 33 and the second brazing material layer 35 are placed on ends of a core assembly.

[0038] Then, the cover plate 3 is assembled onto the second plate 2 placed on one end of the core assembly. The support plate 4 is assembled onto the first plate 1 placed on the other end of the core assembly. As a result, an oil cooler assembly is assembled. In order to keep the assembled condition to the end of the following brazing process, the oil cooler assembly is preferably tightened along its stacking direction by an appropriate tightening jig. The jig also applies pressing force to the oil cooler assembly to make the plates 1 and 2 come in contact firmly in order to improve brazing quality.

[0039] In a brazing process, the oil cooler assembly is brought into a brazing furnace such a vacuum furnace. In the brazing process, the oil cooler assembly is integrally brazed into a single unit by heating to a temperature equal to or higher than a melting point of the first and second brazing material layers 33 and 35, and lower than a melting point of the first and second sacrificial layers 32 and 36. As a result, the first brazing material layer 33 is brazed with the second sacrificial layer 36. The first brazing material layer 33 is brazed with the second brazing material layer 35. The first sacrificial layer 32 is brazed with the second brazing material layer 35. It is possible to prevent an excessive sacrificial corrosion on the brazed portion on the tapered portions 44 and 54, since the sacrificial material in the first sacrificial layer 32 and the brazing material in the second brazing material layer 35 are mixed and diffused to each other, and form an alloy having a higher galvanic potential than that of the original first sacrificial material.

[0040] Referring to Fig. 4, the bending and folding process is described in detail. The broken line indicates a mountain fold line. The chain line indicates a valley fold line.

[0041] The recess 46 is formed on each corner of the plates in the cutting process. The corner has a recess extending at least along the first folded portion 45. The recess 46 is formed in a triangular shape to enable the corner deformed upwardly without wrinkle. The recess 46 is formed to cross the mountain fold line. The plates are pressed to have generally a disc like shape. An outer rim of the plate is bent and folded into the tapered portions 44. The recess 46 is closed during the pressing process as shown in Fig. 5 to provide smooth inner and outer surfaces at the corner of the tapered portion 44. Although, the recess 46 is illustrated as a part of the first plate 1, the second plate 2 also formed from a base plate having similar recesses.

[0042] Referring to Fig. 6, a plurality of brazing passages 55a such as through hole or recesses are formed on the folded portion 55 to communicate a contacting interface between the second sacrificial layers 36 in the second tapered portion 54 and the second brazing material layer 35. Number and distribution of the brazing passages 55a are determined to introduce appropriate amount of the brazing material from the second brazing material layer 35 to the contacting interface of the second sacrificial layers 36.

[0043] The first inner fins 23 located inside the water passages 21 are made of a clad plate having brazing material layers on both sides of a core layer, since the water passages 21 are completely covered with the sacrificial materials. The second inner fins 24 located inside the oil passages 22 can be made of a bare plate without brazing material layer, since the oil passages 22 are completely covered with the brazing material.

[0044] As described above, the first plate 1 and the second plate 2 are stacked to define the water passages 21 between the first sacrificial layer 32 and the second sacrificial layer 36. Therefore, it is possible to decrease corrosion of the first plates 1 and the second plates 2 from the water passages 21. In addition, it is possible to improve brazing quality between the first and second tapered portions 44 and 54, since the first and second tapered portions 44 and 54 enables to apply pressing force on brazing interfaces and make the first and second plates 1 and 2 come into contact firmly. Further, it is possible to decrease cost of the oil cooler, since the oil cooler can be assembled by using relatively cheaper three-layered sheet.

[0045] It is possible to improve resistance to corrosion against moisture or chlorine on a lateral outside of the oil cooler, since the first sacrificial layer 32 is exposed to the lateral outside of the first plate 1 by forming the folded portion 45.

[0046] It is possible to attach the cover plate 3 and the support plate 4 in a single brazing process, since the first brazing material layer 33 and the second brazing material layer 35 are placed on the ends of the core assembly. It is also possible to improve resistance to corrosion against moisture or chlorine on the cover plate 3 by forming a sacrificial layer on a side opposite to the core 10.

(Second Embodiment)

[0047] A second embodiment of the invention is described below with the drawings. Referring to Fig. 7, the same or corresponding structures are indicated by the same reference numbers as described in the first embodiment. In this embodiment, a first plate 201 has a first tapered portion 244 apparently longer than that of the second plate 202 and that of the first plate 1 in the first embodiment. The first tapered portion 244 is higher formed from the partitioning portion 41 than the second tapered portion 254. The first plate 201 has a folded portion 245 having a distal end that does not reach the boundary between the partitioning portion 51 and the tapered portion 244. As a result, the folded portion 245 only covers an outer end region of the lateral outside surface of the tapered portion 244. The first plate 201 and the second plate 202 are stacked so that the first sacrificial layer 32 comes in contact with the second brazing material layer 35, and that the first brazing material layer 33 directly exposed laterally on the tapered portion 244 comes in contact with the second brazing material layer 35 on the second tapered portion 254. The core assembly has at least one combination of one of the first plate 201 and two of the second plates 202 stacked on both sides of the first plate 201. In this combination, the sacrificial layer 32 placed on both sides of the first tapered portion 244 of the first plate 201 is brazed with the brazing material layer 35 on the second tapered portion 254 of one of the second plate 202, and the blazing material layer 33 placed on the first tapered portion 244 on the first plate 201 is brazed with the brazing material layer 35 on the second tapered portion 254 of the other one of the second plate 202.

(Third Embodiment)

[0048] A third embodiment of the invention is described below with the drawings. Referring to Fig. 8, the same or corresponding structures are indicated by the same reference numbers as described in the first embodiment. In this embodiment, a first plate 301 has a first tapered portion 344 apparently longer than that of the second plate 302 and that of the first plate 1 in the first embodiment. The first tapered portion 344 is higher formed from the partitioning portion 41 than the second tapered portion 354. The first plate 301 has a folded portion 345 having a distal end that does not reach the boundary between the partitioning portion 51 and the tapered portion 344. As a result, the folded portion 345 only covers an outer end region of the lateral outside surface of the tapered portion 344. The folded portion 345 is much longer than the folded portion 355. The first plate 301 and the second plate 302 are stacked alternately. The first sacrificial layer 32 is brazed with the second brazing material layer 35. The first plate 301 directly comes in contact with the other first plate 301. For instance, the first brazing material layer 33 on a lateral outside surface of the tapered portion 344 of one of the first plate 301 comes in contact with the first sacrificial layer 32 on a lateral inside surface of the tapered portion 344 of the other next one of the first plate 301. In this embodiment, the second plates 302 are completely covered with the first plates 301 and prevented from exposure to the lateral outside of the oil cooler. The core assembly has at least one combination of one of the second plate 302 and two of the first plates 301 stacked on both sides of the second plate 302. In this combination, the sacrificial layer 32 placed on the first tapered portion 344 of one of the first plate 301 is brazed with the brazing material layer 33 on the first tapered portion 344 of the other one of the first plate 301, and the sacrificial layer 32 placed on the first tapered portion 344 of the other one of the first plate 301 is brazed with the brazing material layer 35 placed on the second tapered portion 354 of the second plate 302.

(Fourth Embodiment)

[0049] A fourth embodiment of the invention is described below with the drawings. Referring to Fig. 9, the same or corresponding structures are indicated by the same reference numbers as described in the first embodiment. In this embodiment, a first plate 401 has a first tapered portion 444 as same as the first plate 301 in the third embodiment. The second plate 402 has a second tapered portion 454 extending opposite to the above described embodiments. The second tapered portion 454 defines slightly shrinking taper from the partitioning portion 51 and has a contracted opening on the end. In this embodiment, the first plates 401 come in direct contact each other. The first sacrificial layer 32 is brazed with the second brazing material layer 35 placed on a lateral outside by forming the second tapered portion 454. In this embodiment, the second plates 302 are completely covered with the first plates 301 and prevented from exposure to the lateral outside of the oil cooler. In addition, it is possible to reduce a manufacturing process to form the folded portion on the second plate.

(Other Embodiments)

[0050] In the above described embodiments, the oil coolers are mounted on the cylinder block, alternately, the oil coolers may be mounted on an outside surface of a crank case of an engine or a body of a transmission for vehicles. Further, the invention may be applied to an oil cooler integrally formed with an oil filter.

[0051] Further, the invention may be applied to a heat exchanger other than the oil cooler, for example, a heat exchanger for automatic transmission fluid (ATF), a heat exchanger for pneumatic oil for a power steering mechanism, and a heat exchanger for other fluid.

[0052] Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

Claims

1. A stacked plate heat exchanger for a first medium and a second medium having a core section including alternately stacked first plates and second plates, each of the first and second plates being made of a three-layered plate having a core layer (31, 34), a sacrificial layer (32, 36) formed on one side of the core layer, and a brazing material layer (33, 35) formed on the other side of the core layer, comprising:

    a first tapered portion (44) formed on an outer rim of each of the first plates, being enlarged toward an opening, the first tapered portion including a first folded portion (45) formed by bending an outer rim of the first plate (1) to place the sacrificial layer (32) on the first plate (1) outside the first tapered portion (44); and
    a second tapered portion (54) formed on an outer rim of each of the second plates, wherein
    the first plates (1) and the second plates (2) are stacked alternately to define first passages (21) for the first medium between the sacrificial layers (32, 36) on the first plate and the second plate, and to define second passages (22) for the second medium between the brazing material layers (33, 35) on the first plate and the second plate; and wherein
    the first tapered portion (44) and the brazing material layer (35) on the second tapered portion (54) are placed next to each other.

2. The stacked plate heat exchanger claimed in claim 1, wherein the second tapered portion (54) is enlarged toward an opening.

3. The stacked plate heat exchanger claimed in one of claims 1 and 2, wherein the first plate (1) has a corner portion on the outer rim, and the corner portion has a recess extending at least along the first folded portion (45).

4. The stacked plate heat exchanger claimed in one of claims 1 through 3, wherein the second tapered portion (54) includes a second folded portion (55) formed by bending an outer rim of the second plate (2) to place the brazing material layer (35) on the second plate (2) outside the second tapered portion (54).

5. The stacked plate heat exchanger claimed in claim

4, wherein the second tapered portion (54) has a brazing passage (55a) corresponding to the second folded portion (55) to introduce brazing material to an interface between the sacrificial layers (36) on the second plate (2).

6. The stacked plate heat exchanger claimed in one of claims 4 and 5, wherein the second plate (2) has a corner portion on the outer rim, and the corner portion has a recess extending at least along the second folded portion (55).

7. The stacked plate heat exchanger claimed in one of claims 1 through 6, wherein the first fluid is cooling water.

8. The stacked plate heat exchanger claimed in one of claims 1 through 7, wherein the second fluid is oil.

9. The stacked plate heat exchanger claimed in one of claims 1 through 8, wherein the core layer (31, 34) of the first and second plates (1, 2) are made of aluminum alloy.

10. The stacked plate heat exchanger claimed in claim 1, wherein

the first plates (1) and the second plates (2) are stacked alternately to place the brazing material layer (33) on the first plate (1) on one end of a core assembly, and to place the brazing material layer (35) on the second plate (2) on the other end of the core assembly, and are stacked to have at least one combination of the first plate (1) and the second plates (2) stacked on both sides of the first plate (1) in which the sacrificial layer placed on both sides of the first tapered portion (44) of the first plate (1) are brazed with the brazing material layers (35) on the second tapered portions (54) of the second plates (2) respectively, and further comprises:

a support plate (4) brazed on the one end of the core assembly by the brazing material on the brazing material layer on the first plate (1), and
a cover plate (3) brazed on the other end of the core assembly by the brazing material on the brazing material layer on the second plate (2).

11. The stacked plate heat exchanger claimed in claim 1, wherein the first plates (201) and the second plates (202) are stacked alternately to place the brazing material layer (33) on the first plate (201) on one end of a core assembly, and to place the brazing material layer (35) on the second plate (202) on the other end of the core assembly, and are stacked to have at least one combination of the first plate (201) and the second plates (202) stacked on both sides of the first plate (201) in which the sacrificial layer (32) placed on both sides of the first tapered portion (244) of the first plate (201) is brazed with the brazing material layer (35) on the second tapered portion (254) of one of the second plate (202), and the blazing material layer (33) placed on the first tapered portion (244) of the first plate (201) is brazed with the brazing material layer (35) on the second tapered portion (254) of the other one of the second plate (202), and further comprises:

a support plate (4) brazed on the one end of the core assembly by the brazing material on the brazing material layer on the first plate (201), and
a cover plate (3) brazed on the other end of the core assembly by the brazing material on the brazing material layer on the second plate (202).

12. The stacked plate heat exchanger claimed in claim 1, wherein the first plates (301, 401) and the second plates (302, 402) are stacked alternately to place the brazing material layer (33) on the first plate (301, 401) on one end of a core assembly, and to place the brazing material layer (35) on the second plate on the other end of the core assembly, and are stacked to have at least one combination of the second plate (302, 402) and the first plates (301, 401) stacked on both sides of the second plate (302, 402) in which the sacrificial layer (32) placed on the first tapered portion (344, 444) of one of the first plate (301, 401) is brazed with the brazing material layer (33) on the first tapered portion (344, 444) of the other one of the first plate (301, 401), and the sacrificial layer (32) placed on the first tapered portion (344, 444) of the other one of the first plate (301, 401) is brazed with the brazing material layer (35) placed on the second tapered portion (354, 454) of the second plate (302, 402), and further comprises:

a support plate (4) brazed on the one end of the core assembly by the brazing material on the brazing material layer on the first plate (301, 401), and
a cover plate (3) brazed on the other end of the core assembly by the brazing material on the brazing material layer on the second plate (2).

13. The stacked plate heat exchanger claimed in claim 1, wherein the first tapered portion (44) is formed into a U-turn shape.

14. A stacked plate heat exchanger for a first medium and a second medium having a core section including alternately stacked first plates and second plates, each of the first and second plates being made of a three-layered plate having a core layer (31, 34), a sacrificial layer (32, 36) formed on one side of the core layer, and a brazing material layer (33, 35) formed on the other side of the core layer, comprising:

a first tapered portion (44) formed on an outer rim of each of the first plates, being enlarged toward an opening; and

a second tapered portion (54) formed on an outer rim of each of the second plates, the second tapered portion (54) including a second folded portion (55) formed by bending an outer rim of the second plate (2) into a U-turn shape to place the brazing material layer (35) on the second plate (2) outside the second tapered portion (54), wherein

the first plates (1) and the second plates (2) are stacked alternately to define first passages (21) for the first medium between the sacrificial layers (32, 36) on the first plate and the second plate, and to define second passages (22) for the second medium between the brazing material layers (33, 35) on the first plate and the second plate; and wherein

the first tapered portion (44) and the brazing material layer (35) on the second tapered portion (54) are placed next to each other.

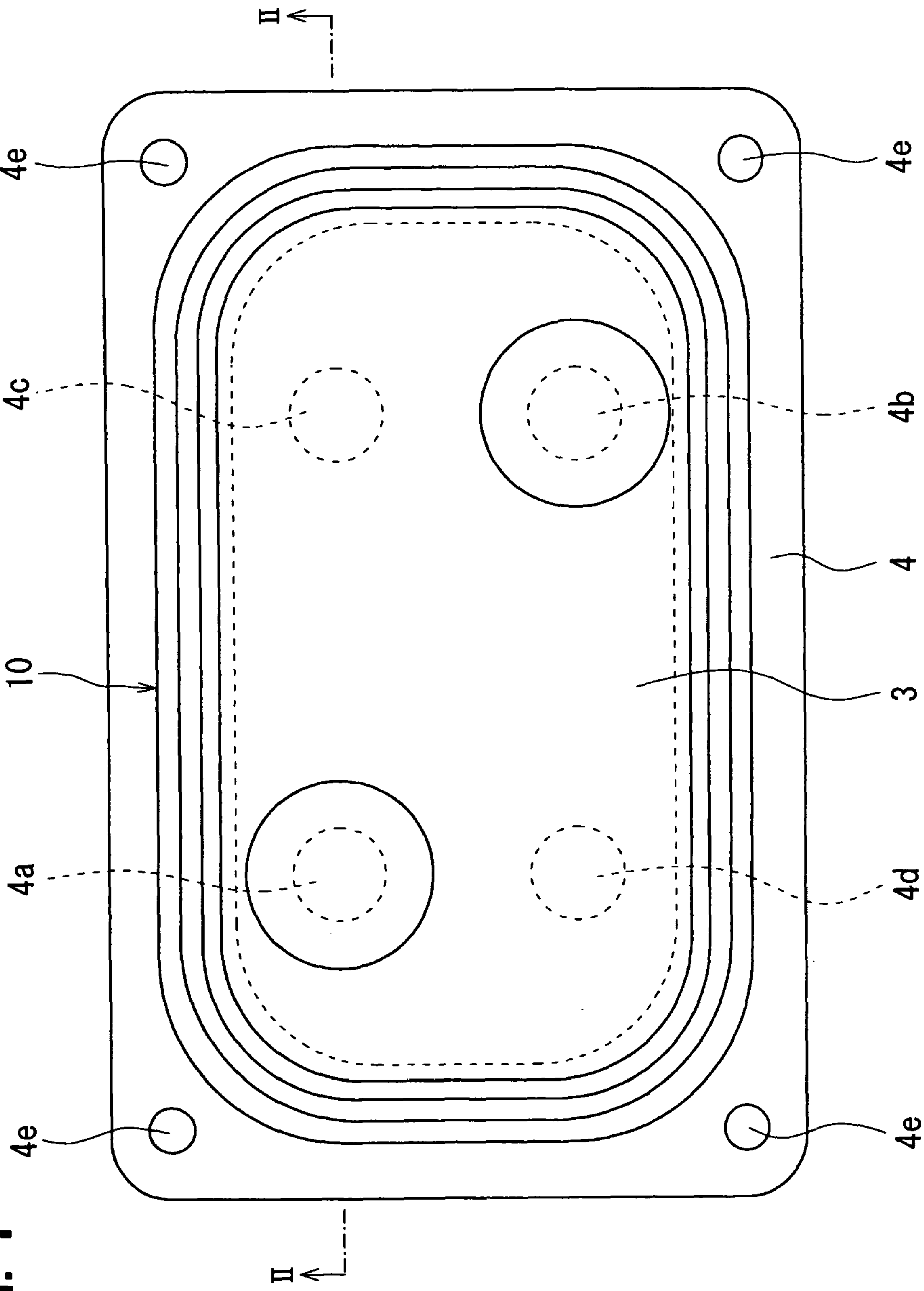

FIG. 1

FIG. 2

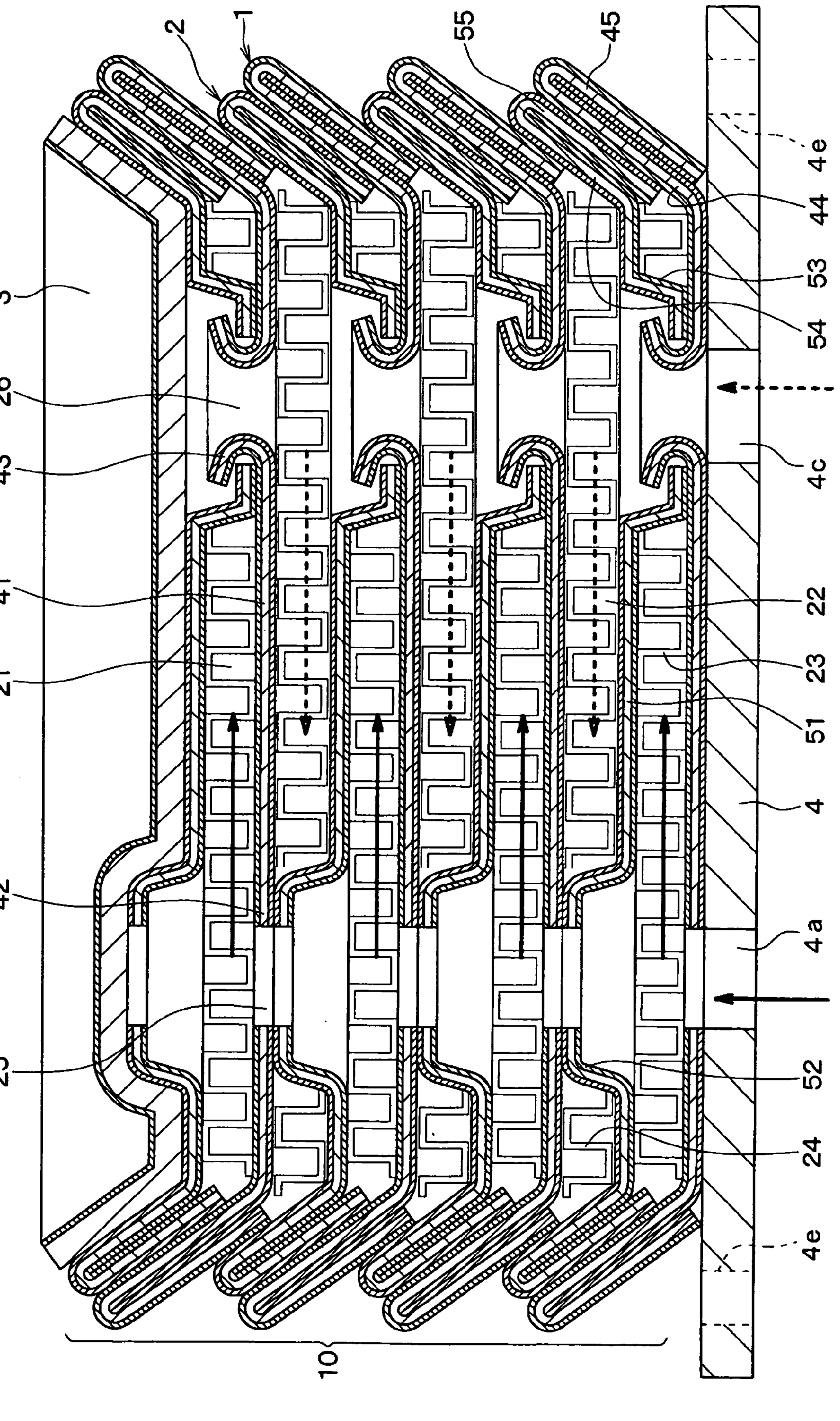

FIG. 3

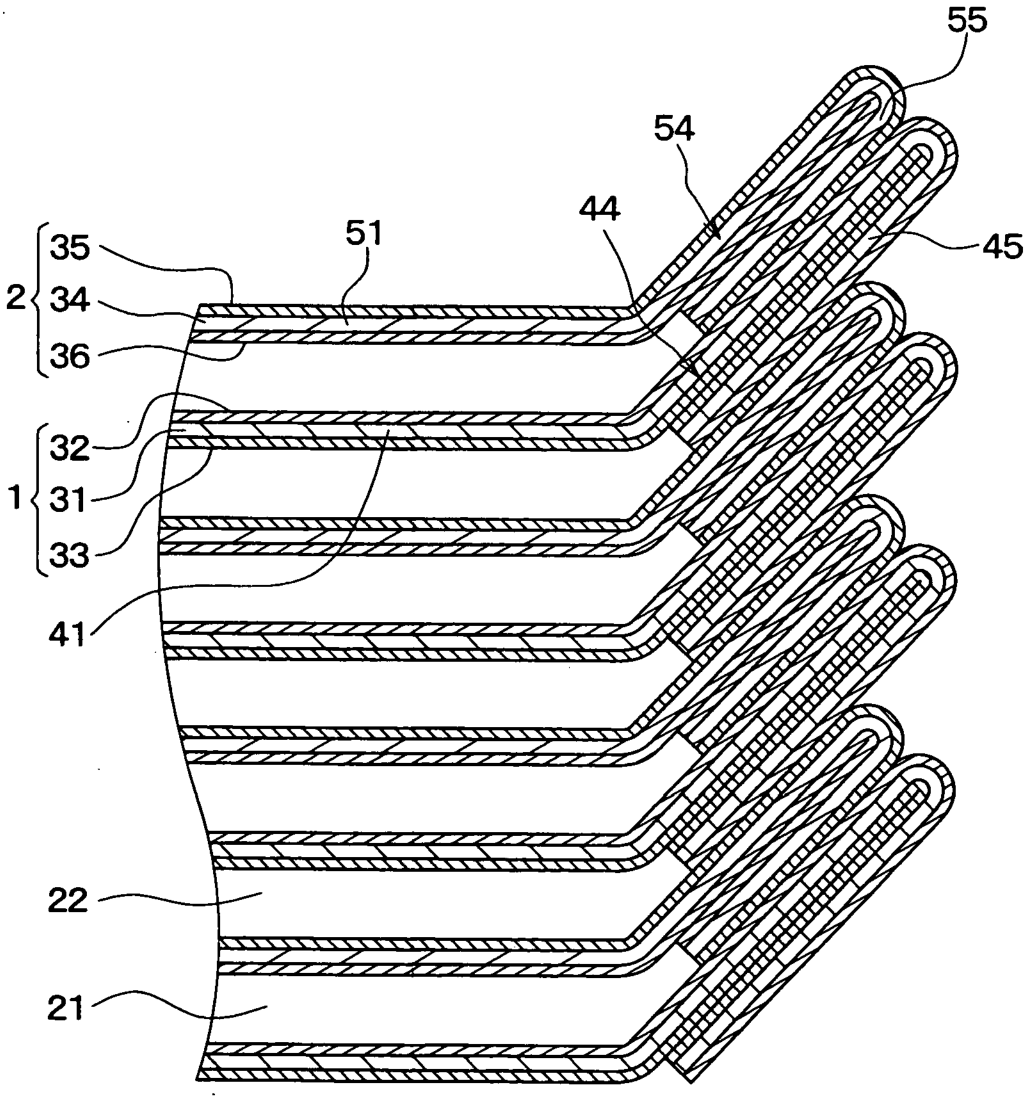

FIG. 4

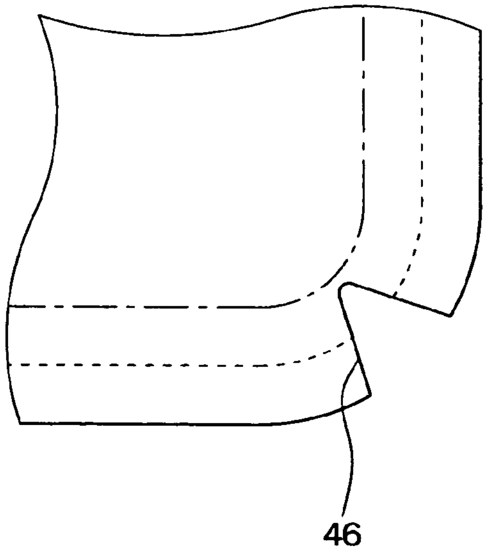

FIG. 5

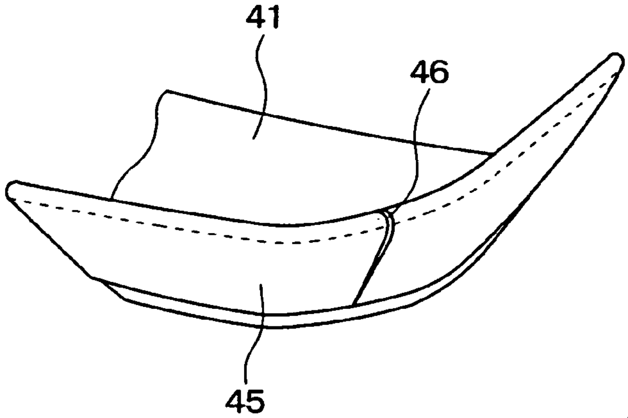

FIG. 6

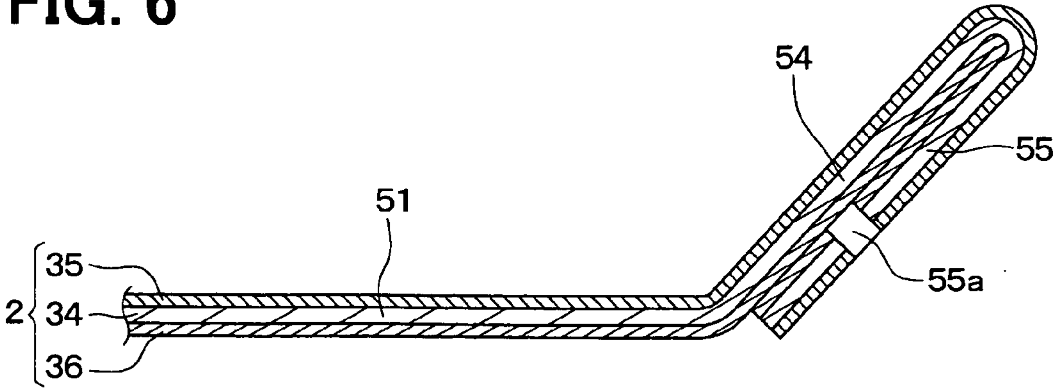

FIG. 7

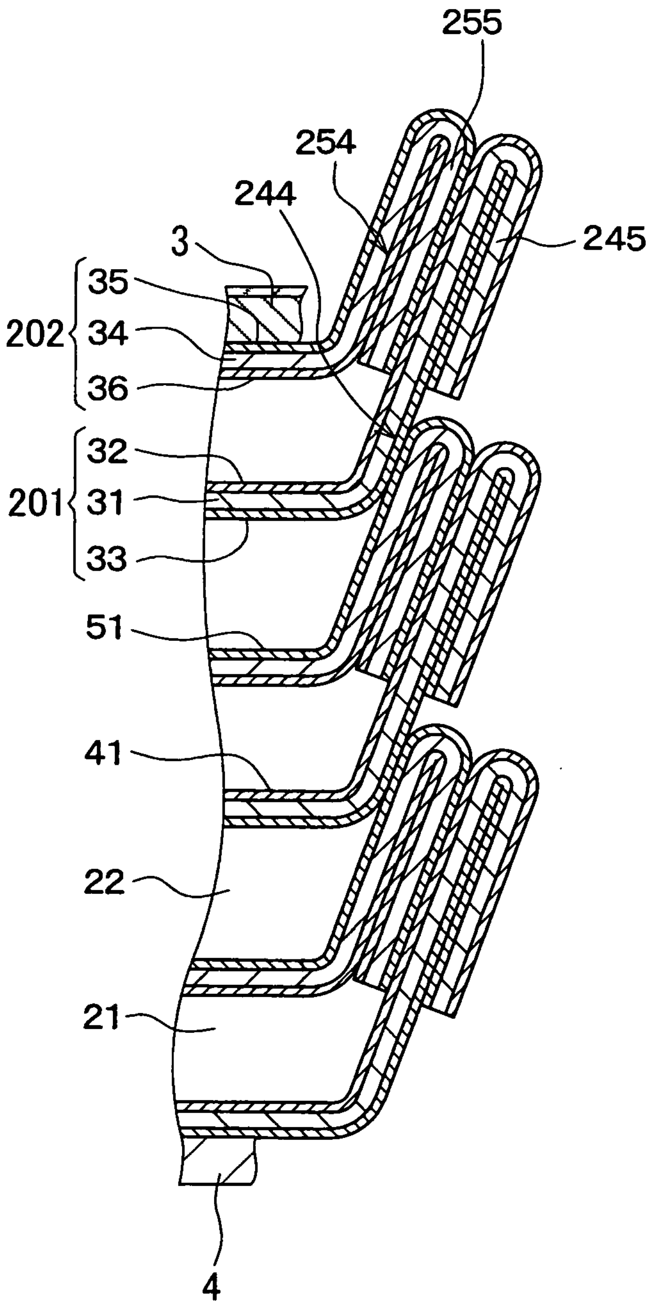

FIG. 8

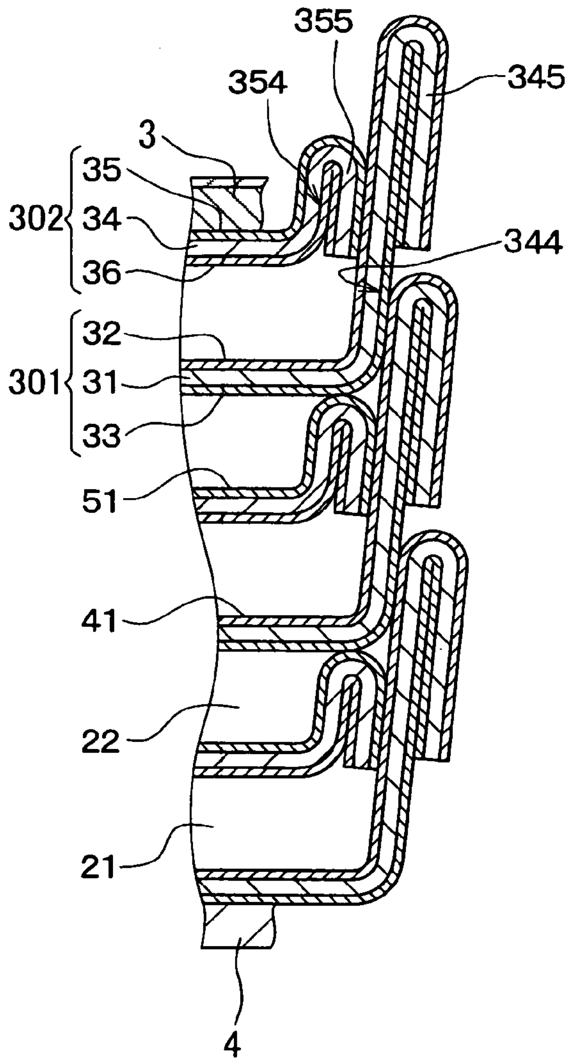
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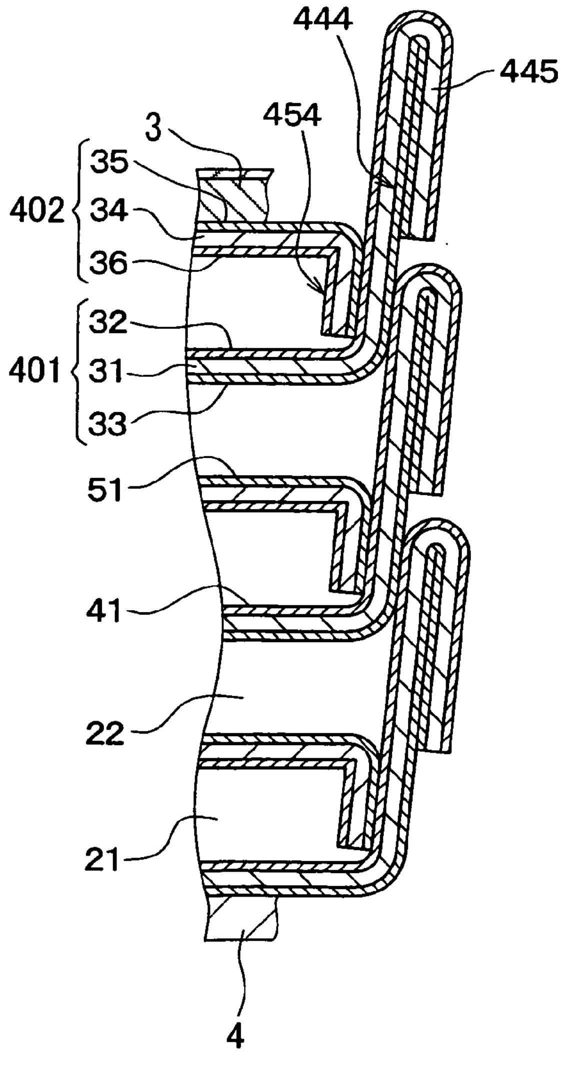
FIG. 9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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H051890 A **[0003]**
- JP H10185462 A **[0007]**