(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 612 396 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
07.01.1998 Bulletin 1998/02

(21) Application number: **92923263.5**

(22) Date of filing: **13.11.1992**

(51) Int Cl.[6]: **F28D 9/00**

(86) International application number:
PCT/CA92/00496

(87) International publication number:
WO 93/10415 (27.05.1993 Gazette 1993/13)

(54) **IN TANK OIL COOLER**

ÖLKÜHLER IN EINEM TANK

REFROIDISSEUR D'HUILE INCORPORE DANS UN RESERVOIR

(84) Designated Contracting States:
DE FR GB IT SE

(30) Priority: **15.11.1991 US 792435**

(43) Date of publication of application:
31.08.1994 Bulletin 1994/35

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EP 0 612 396 B1

Printed by Jouve, 75001 PARIS (FR)

Description

This invention relates to a method of making a heat exchanger, and to heat exchangers, and in particular to automotive oil coolers which are located inside other heat exchangers, such as automotive radiators.

In motor vehicles, it is common to provide heat exchangers for cooling engine oil or transmission fluid. Due to the heat transfer characteristics of oil, liquid cooled heat exchangers are normally used as opposed to air cooled exchangers. The most convenient way to do this is to mount the oil cooler or heat exchanger inside the cooling system of the motor vehicle, and in particular inside the radiator.

In the past, the oil coolers of the type in question which have been mounted inside automotive radiators have consisted in concentric tubes closed at both ends to form an intemal passage for the oil. The engine coolant flows around the outside tube and through the inside tube. A difficulty with this type of oil cooler, however, is that it is relatively ineffective per volume of radiator occupied.

An improvement over the concentric tube type oil coolers is shown in EP-A-384612, which shows a plurality of stacked plate pairs having turbulizers located therebetween. The plate pairs in EP-A-384612 have first and second plates located back to back. The first plate has a planar central portion, a raised peripheral edge portion located above and in a plane parallel to the central portion, an intermediate portion between the central and edge portions, and opposed end bosses located below and in a plane parallel to the central portion. The second plate of each plate pair has a peripheral edge portion joined to the first plate peripheral edge portion, a central portion spaced from the first plate central portion, an intermediate portion between the central and edge portions and opposed end bosses located above and in a plane parallel to the second plate central portion. The first and second plate central portions have a planar expanded metal turbilizer located therebetween and a plurality of spaced-apart, outwardly disposed dimples formed therein, the dimples extending equidistant with the end bosses. The dimples and end bosses are joined together. Each plate pair has inlet and outlet openings for the flow of fluid therethrough past the turbulizer.

A difficulty with this prior art oil cooler, however, is that peripheral tabs are required to be crimped over to join the peripheral edge portions and form plate pair subassemblies prior to brazing the assembly together, otherwise poor joints could result between the turbulizer and the plates and between the plate peripheral edges, and this in tum results in the oil cooler not being able to withstand high enough internal pressures. This prior crimping step increases the cost of manufacture of the oil coolers, both in the material and time required for assembly.

It is an object of the invention to reduce the cost of manufacture and at the same time not to endanger the quality of the heat exchangers.

This object is accomplished by a method according to claim 1 and a heat exchanger according to claim 10.

The present invention results in a plate type heat exchanger which is less expensive to produce and more effective per volume of radiator occupied, and yet is strong enough to withstand the high oil pressures that are frequently encountered in such engine oil or transmission fluid cooling systems.

The inventive method is using the idea of having the plate peripheral edge portions separated and not mechanically joined prior to the brazing process. The peripheral edge portions are then melted together during the brazing process and this accommodates any misalignment and dimensional tolerance variations in the mating components. The peripheral edge portions are separated by placing a turbulizer in the hollow spaced between face-to-face brazing clad plates in each plate pair; the turbulizer being of a thickness equal to the distance between the plate planar central portions without the cladding layers formed thereon and thus the raised peripheral edges are separated. The plates are heated to melt the cladding layers causing the turbulizer to be embedded in the cladding layers and the peripheral edges to be drawn and melted together to form a fluid tight assembly.

Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which

- Figure 1 is a perspective view of a preferred embodiment of an in tank oil cooler according to the present invention;
- Figure 2 is an exploded perspective view of a subassembly of the oil cooler of Figure 1;
- Figure 3 is a partial sectional view taken along lines 3-3 of Figure 1 and showing an altemate embodiment;
- Figure 4 is a sectional view taken along lines 4-4 of Figure 1;
- Figure 5 is an enlarged sectional view taken along lines 5-5 of Figure 2;
- Figure 6 is an enlarged plan view taken along lines 6-6 of Figure 2;
- Figure 7 is a partial sectional view taken along lines 7-7 of Figure 6 but showing a plurality of stacked plate pairs prior to brazing; and
- Figure 8 is a partial sectional view similar to Figure 7 but showing the stacked plate pairs after brazing.

Referring to the drawings, a preferred embodiment of an oil cooler or heat exchanger is generally represented by reference numeral 10 in Figure 1. Heat exchanger 10 is formed of a plurality of face-to-face plate pairs 12 as described in detail below with reference to Figure 2. A top plate pair 14 has a smooth top plate 16 and a bot-

tom plate pair 18 has a smooth bottom plate 20, although top and bottom plates 16, 20 could be dimpled as shown in Figure 2 if desired. Heat exchanger 10 also has threaded nipples 22 swaged in place in suitable circular openings in top plate 16. One nipple 22 serves as an inlet and the other nipple 22 serves as an outlet for the flow of oil, such as engine oil or transmission fluid through heat exchanger 10.

Referring in particular to Figure 2, a typical face-to-face plate pair 12 is shown in an exploded perspective view. Plate pair 12 includes a first or bottom plate 24 and a second or top plate 26. First plate 24 has a planar central portion 28, and a raised peripheral, co-planar edge portion 30 which extends above or is located in a plane above central portion 28. First plate 24 also includes opposed, co-planar end bosses 32 extending below or located at a lower level than central portion 28.

In the preferred embodiment, the first and second plates 24, 26 are identical, so the terms "below" and "above" with reference to the central portion 28 of first plate 24 would, of course, be reversed with reference to the central portion 28 of second plate 26 as seen in Figure 2.

The ends of plates 16, 20, 24 and 26 are rounded and end bosses 32 of plates 24, 26 are formed with "D"-shaped openings 34, although any shaped opening could be used if desired. The "D"-shaped openings 34 have an opening edge portion 35 located around "D"-shaped openings 34. As mentioned above, smooth top plate 16 has circular openings to accommodate nipples 22. The smooth bottom plate 20 has no openings formed therein.

First and second plates 24, 26 are formed with a plurality of spaced-apart dimples 36 formed therein. With reference to first plate 24, dimples 36 extend below the central portion 28 equidistant or to the same planar level as end bosses 32, so that when two of the plates 24, 26 are located back-to-back as seen best in Figure 3, the respective dimples 36 and end bosses 32 are joined together along a common plane.

A turbulizer 38 is located inside each face-to-face plate pair 12, including top and bottom plate pairs 14, 18. Turbulizer 38 is a strip of expanded metal. The preferred configuration is parallel rows shaped in a sinusoidal, staggered configuration, although other configurations could be used as desired. The length of turbulizer 38 corresponds with the length of the plate central portions 28, and the width of turbulizer 38 corresponds with the distance between peripheral edge portions 30. The thickness of turbulizer 38 is such that after the plate pairs are assembled and heat exchanger 10 is joined together, such as by brazing, the plate central portions 28 are joined to and in good thermal contact with turbulizer 38, as discussed further below.

Dimples 36 are spaced uniformly over the plate central portions 28. One of the primary functions of dimples 36 is to support the plate central portions 28 and prevent these central portions from sagging when the plates are heated to brazing temperatures. Central portions 28 must be kept flat and in full contact with turbulizer 38 during the brazing process in order to obtain good thermal contact between the turbulizer and the plates. Another function of the dimples is to cause some turbulence in the coolant thereby increasing the heat transfer capabilities of the heat exchanger. When the plates are in back-to-back arrangement dimples 36 maintain the back-to-back plates in spaced apart relation so that the coolant would have an effective path between the back-to-back plates. The height of dimples 36 should be optimized in that the dimples should be tall enough to allow the coolant to flow between the back-to-back plates but not too tall because of the overall size of heat exchanger 10 should be minimized where possible.

Dimples 36 preferably are large enough to result in flat top surfaces to give a good joint between mating dimples 36. As seen best in Figures 3 and 4, the radius of the shoulders in the dimples should be such that sharp corners should be avoided or the dimples could break out as a result of high pressures in heat exchanger 10.

Dimples 36 should also not be too large in diameter, because the surface area of central portion 28 occupied by dimples 36 is area that is not in contact with turbulizer 38 and this detracts from the heat transfer efficiency of heat exchanger 10. It will be apparent to those skilled in the art that the number and size of the dimples 36 should be chosen so that sufficient strength and structural support for the plate central portions is provided during the brazing process, and so that the gain in heat transfer efficiency through turbulence in the coolant is balanced against loss of heat transfer efficiency by making the dimples too numerous or too large. It has been found that for plates with central portions 28 of approximately four centimetres in width, dimples that are 0.5 centimetres in diameter and spaced-apart longitudinally about 2.5 to 3.0 centimetres and transversely about 2 to 3 centimetres provides a preferred balance where aluminum of 0.07 to 0.08 centimetres thickness is used for the plates.

Referring to Figure 2, plates 24, 26 may be formed with inner tabs 42 extending transversely from opening edge portion 35. Inner tabs 42 are located at only one end of each plate so that upon assembly, inner tabs 42 on one plate such as first plate 24 are crimped over the opening edge portion 35 of the mating plate 26, when the plates are in a back-to-back arrangement to form a back-to-back plate pair 44. This prevents the plates of each back-to-back plate pair 44 from moving longitudinally or transversely relative to each other. Inner tabs 42 are not necessary, however, and may be eliminated if alignment of the plate pairs is not a problem.

Referring again to Figure 2, plates 24, 26 are formed with peripheral tabs 40 at opposed ends. Peripheral tabs 40 are located at respective diametrically opposed "corners" of each plate, so that upon assembly, the peripheral tabs 40 on one plate, such as first plate

24, are crimped over the peripheral edge portion 30 of the mating plate, such as second plate 26, when the plates are in face-to-face arrangement to form face-to-face plate pair 12 as seen best in Figure 1. This prevents the plates of each face-to-face plate pair 12 from moving longitudinally or transversely relative to each other. Again, peripheral tabs 40 are not necessary and may be eliminated if alignment of the plates is not a problem.

In an alternate embodiment shown in the left hand portion of Figure 3, the inner tabs 42 can be used to maintain the first and second plates, of the back-to-back plate pairs in alignment, without crimping over the inner tabs 42. Similarly the peripheral tabs 40 can be used to maintain the first and second plates of the face-to-face plate pair in alignment without crimping over the peripheral tabs 40. It will be apparent to those skilled in the art that the peripheral tabs 40 and the inner tabs 42 may be used to align the stacked plates or to mechanically attach the plates as desired. The heat exchanger can be further modified by eliminating the peripheral tabs 40 and inner tabs 42 and stacking plates in the pattern described above and shown in Figure 3.

In the preferred embodiment, aluminum is used for all of the components of heat exchanger 10. Nipples 22 and turbulizer 38 are formed of aluminum alloys, and plates 16, 20, 24 and 26 are formed of brazing clad aluminum, which is aluminum that has a lower melting point cladding or aluminum brazing alloy layer 50 on the outer surfaces, as seen best in Figures 5, 7 and 8 the cladding layers 50 are each about 8 to 10 per cent of the thickness of the plate.

As seen best in Figures 7 and 8 the thickness of turbulizer 38 is generally equal to the distance between the first and second plate central portions 28 without cladding layers 50. In other words, the thickness of turbulizer 38 is greater than the distance between the opposed cladding layers 50 of the first and second plate central portions 28 after final assembly. The reason for this is that as these cladding layers 50 melt during the brazing process, all of the high areas of turbulizer 38 are embedded in the cladding layers 50 and turbulizer 38 is brazed to the plate central portions 28 with good thermal heat transfer and minimum drag or pressure drop as the oil flows through or past turbulizer 38, as will be described further below.

The assembly of heat exchanger 10 starts by arranging the plates 24, 26 face-to-face or back-to-back as desired, as seen best in Figure 2, so that the "D"-shaped openings 34 and the respective peripheral edge portions 30 are in registration. If inner tabs 42 are used, these tabs may be first crimped over to form back-to-back plate pairs 44. A turbulizer 38 is then inserted into the hollow space between,the central portions 28 of each face-to-face plate pair 12. If peripheral tabs 40 are used, these may then be crimped over the peripheral edge portions 30 of the respective mating plate. Alternatively several of the assembled plate pairs 12 may be formed with turbulizers in them and then stacked together, in which case tabs 42 would not be crimped over or used at all. The particular method or sequence of stacking plates 24, 26 together does not matter, the result is a plurality of stacked plate pairs as illustrated in Figures 2 and 7.

The top plate pair 14 is then formed by swaging nipples 22 onto smooth top plate 16 and stacking this on top of one of the plates as shown in Figures 1 and 3. Bottom plate pair 18 is then formed using a smooth bottom plate 20 located below the bottom plate 26 as shown in Figures 3 and 4.

As seen best in Figure 6, turbulizer 38 typically is not longitudinally straight, but has a slight transverse camber in it because the metal from which it is formed usually comes in rolled form. This causes the corners 52 and the central portions 54 to overlap or ride into the radius or intermediate portion 29 between central portion 28 and peripheral edge 30. However, cladding layers 50 and these radii themselves accommodate this overlap in the brazing process as described next below.

Once the entire heat exchanger is assembled, it is then placed into a brazing furnace using a suitable fixture to maintain the orientation of the assembly, to braze together simultaneously all mating surfaces prior to entering the brazing furnace, the stacked plates appear as shown in Figure 7, with about a 0.3 m.m. gap between the peripheral edge portions 30 due to the thickness of turbulizer 38 as discussed above. The stacked plates are squeezed together and as the cladding layers 50 melt, peripheral edges 30 come together accommodating any misalignment and dimensional intolerances giving upon cooling a fluid tight assembly.

Having described preferred embodiments of the invention, it will be appreciated that various modifications may be made to the structures described. In certain instances it may be desirable to vary the location of the nipples 22 serving as inlets and outlets for the oil. For example, one nipple 22 could be positioned in the top plate 16 and the other nipple 22 in the bottom plate 20. In the case where the nipples 22 are located at the same end of respective top and bottom plates 16, 20 a central plate with no opening at that end could be positioned in the middle portion of heat exchanger 10.

Heat exchanger 10 can be made from other materials than aluminum, such as stainless steel or brass. In the case of stainless steel, either a brazing cladding layer of copper or thin copper sheets or shims could be used. For the purposes of this disclosure the term "cladding layer" is intended to include any type material to join respective components, such as a coating or metal deposit, a discreet or separate layer of brazing material, solder or even a suitable adhesive. Obviously, any number of plate pairs could be used. Soft soldering may also be used instead of brazing, however in general, this produces a weaker connection and therefore may not meet the strength requirements. The length of the plates can be varied simply by repeating longitudinally the dimple diameter and spacing described above. If both the

length and the width of the heat exchanger is to be varied, the diameter and spacing of the dimples may have to be varied slightly in keeping with the parameters discussed above.

From the above, it will be appreciated that the oil cooler of the present invention is a relatively high efficiency heat exchanger which is structurally strong with relatively low pressure drop.

Claims

1. A method of making a heat exchanger comprising:

   providing a plurality of plates (24, 26), each plate having a planar central portion (28), a raised, peripheral edge portion (30) located above and in a plane parallel to the central portion, and opposed end bosses (32) located below and in a plane parallel to the central portion, the end bosses having inlet and outlet openings (34) formed therein;
   arranging said plates into a face-to-face pair (12) having mating peripheral edge portions (30) and a hollow space therebetween;
   inserting a turbulizer (38) into said hollow space, the turbulizer being of such thickness that the mating peripheral edge portions (30) are spaced apart;
   heating and partially melting the plate pair (12) while said mating peripheral edge portions (30) are still spaced apart; compressing the turbulizer by pressing the plate pair (12) together thereby melting the turbulizer (38) into said plates drawing the mating peripheral edge portions together; and
   joining contacting areas of the plates and turbulizer after the mating peripheral edge portions are drawn together to form a fluid tight assembly.

2. A method as claimed in claim 1 wherein the step of compressing is done by squeezing together the planar central portions (28).

3. A method as claimed in claim 1 or 2 and further comprising the steps of providing a cladding layer (50) on the plates, melting the cladding layer while compressing the turbulizer (38) and embedding the turbulizer in the cladding layer until the peripheral edge portions (30) come into contact.

4. A method as claimed in claim 2 or 3 wherein the squeezing step is done by providing said central portions (28) with a plurality of spaced-apart, outwardly disposed dimples (36), the dimples extending equidistant with the end bosses (32); and squeezing one plate pair between two adjacent plate pairs positioned in a back-to-back arrangement, the dimples on the adjacent plate pairs being in alignment and transmitting compressive forces therebetween.

5. A method as claimed in any one of the preceding claims and further comprising the steps of assembling a plurality of said plate pairs (12) into a stack with said inlet and outlet openings (34) in registration, and joining said plate pairs together in a fluid-tight assembly.

6. A method as claimed in any one of the preceding claims and further comprising the step prior to compressing and heating the plate pair of assembling a plurality of said plate pairs (12) into a stack with the inlet and outlet openings (34) in registration, and then simultaneously heating and compressing all of the stacked plate pairs.

7. A method as claimed in any one of the preceding claims wherein the plates are formed of brazing clad aluminium, and wherein the step of joining is done by furnace brazing.

8. A method as claimed in any one of the preceding claims and further comprising the step, prior to heating and compressing all of the stacked plate pairs, of adding a top plate pair (14) having a smooth top plate (16) and a bottom plate pair (18) having a smooth bottom plate (20) to the stack of plate pairs.

9. A method as claimed in claim 8 and further comprising the step of providing inlet and outlet nipples (22) on one of the smooth top and bottom plates (14, 18), said nipples having inlet and outlet openings communicating with respective inlet and outlet openings (34) of the plate pairs.

10. A heat exchanger comprising:

    a plurality of stacked plates arranged in face-to-face pairs (12), each of said face-to-face pairs including first and second plates (24, 26);
    the first plate (24) having a planar central portion (28), a raised peripheral edge portion (30) located above and in a plane parallel to the central portion (28), an intermediate portion (29) between the central and edge portions, and opposed end bosses (32) located below and in a plane parallel to the central portion;
    the second plate (26) of each face-to-face plate pair (12) having a peripheral edge portion (30) joined to said first plate peripheral edge portion, a central portion (28) spaced from the first plate central portion, an intermediate portion (29) between the central and edge portions, and opposed end bosses (32) located above and in a

plane parallel to the second plate central portion (28);
a planar expanded metal turbulizer (38) located between the first and second plates (24, 26) of each face-to-face plate pair (12) and said turbulizer (38) having high areas;
the first and second plate central portions (28) having a plurality of spaced-apart, outwardly disposed dimples (36) formed therein, the dimples extending equidistant with the end bosses (32);
the first plate (24) of one plate pair (12) being located back-to-back with the second plate (26) of an adjacent plate pair, the respective dimples (36) and end bosses (32) being joined together; and
each plate pair defining inlet and outlet openings (34) for the flow of fluid through the plate pair (12) past the turbulizer (38);
wherein the first and second plate central portions (28) have opposed cladding layers (50) formed thereon,

characterized in that said turbulizer (38) is partially embedded within said cladding layers (50), and wherein the thickness of the turbulizer (38) is equal to the distance between the first and second plate central portions (28) without the cladding layers generally over all of the high areas of the turbulizer except for the areas of the dimples.

11. A heat exchanger as claimed in claim 10 wherein the turbulizer (38) is formed of a plurality of parallel rows of metal disposed in a sinusoidal, staggered arrangement.

12. A heat exchanger as claimed in claim 10 or 11 wherein the turbulizer (38) is generally the same transverse width as the distance between the plate intermediate portions (29).

13. A heat exchanger as claimed in any one of claims 10 through 12 wherein the plates (24, 26) are formed of aluminium having a brazing cladding layer (50) formed thereon.

14. A heat exchanger as claimed in claim 13 wherein the cladding layer (50) is 10 percent of the thickness of the plate (24, 26).

15. A heat exchanger as claimed in any one of claims 10 through 14 wherein the turbulizer (38) is formed of aluminium.

16. A heat exchanger as claimed in any one of claims 10 through 15 wherein the dimples (36) are spaced uniformly over the plate central portions (28).

17. A heat exchanger as claimed in any one of claims 10 through 16 wherein the dimples (36) are dimensioned such that the area of the dimples not in contact with the turbulizer (38) is minimized so as not to detract materially from the heat transfer between the turbulizer (38) and the plate central portions.

18. A heat exchanger as claimed in any one of claims 10 through 17 wherein the dimples are formed with generally flat tops.

19. A heat exchanger as claimed in any one of claims 10 through 18 wherein the dimples are arranged symmetrically about the longitudinal and transverse axes of the plates so that when two plate pairs are positioned back-to-back the dimples on the first plate will be in alignment with the dimples on the second plate.

20. A heat exchanger as claimed in any one of claims 10 through 19 wherein said inlet and outlet openings are formed in the respective opposed end bosses of each plate, so that in a stack of back-to-back plate pairs all inlet openings are in alignment and all outlet openings are in alignment.

Patentansprüche

1. Verfahren zur Herstellung eines Wärmetauschers mit folgenden Schritten:

- Vorsehen einer Mehrzahl an Platten (24, 26), von denen jede Platte einen ebenen Mittelabschnitt (28), einen erhobenen, peripheren Kantenabschnitt (30) oberhalb und in einer Ebene parallel zum Mittelabschnitt, und entgegengesetzte Endvorsprünge (32) unterhalb und in einer Ebene parallel zum Mittelabschnitt aufweist, wobei die Endvorsprünge Einlaß- und Auslaßöffnungen (34) in sich ausgebildet besitzen;

- Anordnen der Platten als ein Vorderseite-an-Vorderseite liegendes Paar (12) mit aneinander angrenzenden peripheren Kantenabschnitten (30) und einem Hohlraum zwischen sich;

- Einsetzen eines Verwirblers (38) in den Hohlraum, wobei der Verwirbler eine solche Dicke aufweist, daß die aneinander angrenzenden peripheren Kantenabschnitte (30) voneinander beabstandet sind;

- Erhitzen und teilweises Schmelzen des Plattenpaares (12) während die aneinander angrenzenden peripheren Kantenabschnitte (30) noch voneinander beabstandet sind; Zusam-

mendrücken des Verwirblers durch Zusammenpressen des Plattenpaares (12) wodurch der Verwirbler (38) mit den Platten verschmolzen wird und die aneinander angrenzenden peripheren Kantenabschnitte zusammengezogen werden; und

- Verbinden von kontaktierenden Gebieten der Platten und des Verwirblers nachdem die aneinander angrenzenden peripheren Kantenabschnitte zur Bildung einer fluiddichten Anordnung zusammengezogen sind.

2. Verfahren wie in Anspruch 1 beansprucht, in welchem der Schritt des Zusammendrückens durch Zusammenpressen der ebenen Mittelbereiche (28) erfolgt.

3. Verfahren wie in Anspruch 1 oder 2 beansprucht und außerdem aufweisend die Schritte des Vorsehens einer Mantelschicht (50) auf den Platten, Schmelzens der Mantelschicht während der Verwirbler (38) zusammengedrückt wird und Einbetten des Verwirblers in die Mantelschicht bis die peripheren Kantenabschnitte (30) in Kontakt miteinander kommen.

4. Verfahren wie in Anspruch 2 oder 3 beansprucht, bei dem der Zusammenpreßschritt erfolgt durch Versehen der Mittelabschnitte (28) mit einer Mehrzahl an voneinander beabstandeten, nach außen gerichteten Noppen (36), die in gleichen Abständen mit den Endvorsprüngen (32) sich erstrecken; und Zusammenpressen eines Plattenpaars zwischen zwei benachbarten Plattenpaaren in Rückseite-an-Rückseite-Anordnung, wobei die Noppen von benachbarten Plattenpaaren in Übereinstimmung sind und Druckkräfte zwischen sich übertragen.

5. Verfahren wie in einem der vorstehenden Ansprüche beansprucht, und außerdem aufweisend die Schritte des Zusammensetzens einer Mehrzahl von Plattenpaaren (12) in einem Stapel mit den Einlaß- und Auslaßöffnungen (34) in Übereinstimmung, und Zusammensetzen der Plattenpaare in einer fluiddichten Anordnung.

6. Verfahren wie in einem der vorstehenden Ansprüche beansprucht, und außerdem aufweisend einen Schritt,
bei dem vor dem Zusammendrücken und Erhitzen des Plattenpaares eine Mehrzahl an Plattenpaaren (12) in einem Stapel zusammengesetzt wird, wobei die Einlaß- und Auslaßöffnungen (34) in Übereinstimmung sind, und dann gleichzeitiges Erhitzen und Zusammendrücken von allen übereinandergeschichteten Plattenpaaren erfolgt.

7. Verfahren wie in einem der vorstehenden Ansprüche beansprucht,
bei dem die Platten mit hartlötbarem Aluminium gebildet werden, und in welchem der Schritt des Zusammenfügens mittels Lötens in einem Ofen geschieht.

8. Verfahren wie in einem der vorstehenden Ansprüche beansprucht und außerdem aufweisend vor dem Erhitzen und Zusammendrücken der übereinandergeschichteten Plattenpaare einen Schritt,
bei dem ein oberes Plattenpaar (14) mit einer glatten Deckplatte (16) und ein unteres Plattenpaar (18) mit einer glatten Bodenplatte (20) dem Stapel an Plattenpaaren hinzugefügt wird.

9. Verfahren wie in Anspruch 8 beansprucht und außerdem aufweisend einen Schritt,
bei dem Einlaß- und Auslaßstutzen (22) auf einer der glatten Deck- und Bodenplatten (14, 18) vorgesehen sind, wobei diese Stutzen Einlaß- und Auslaßöffnungen besitzen, die mit den entsprechenden Einlaß- und Auslaßöffnungen (34) der Plattenpaare in Verbindung stehen.

10. Ein Wärmetauscher mit:

einer Mehrzahl von übereinandergeschichteten Platten, die in Vorderseite-an-Vorderseite liegenden Paaren (12) angeordnet sind und, von denen jedes Vorderseite-an-Vorderseite liegende Paar eine erste und eine zweite Platte (24, 26) aufweist;

die erste Platte (24) besitzt einen ebenen Mittelbereich (28), einen erhobenen peripheren Kantenabschnitt (30) oberhalb und in einer Ebene parallel zum Mittelbereich (28), einen Zwischenabschnitt (29) zwischen dem Mittelbereich und den Kantenabschnitten, und gegenüberliegende Endvorsprünge (32) unterhalb und in einer Ebene parallel zum Mittelbereich;

die zweite Platte (26) eines jeden Vorderseite-an-Vorderseite liegenden Plattenpaares (12) besitzt einen peripheren Kantenabschnitt (30) verbunden mit dem peripheren Kantenabschnitt der ersten Platte, einen Mittelbereich (28) beabstandet von dem Mittelbereich der ersten Platte, einen Zwischenabschnitt (29) zwischen dem Mittelbereich und den Kantenabschnitten und entgegengesetzte Endvorsprünge (32) oberhalb und in einer Ebene parallel zum Mittelabschnitt (28) der zweiten Platte;

einen ebenen ausgedehnten metallischen Verwirbler (38) angeordnet zwischen den ersten

und zweiten Platten (24, 26) eines jeden Vorderseite-an-Vorderseite liegenden Plattenpaares (12), wobei der Verwirbler (38) erhobene Bereiche besitzt;

die Mittelbereiche (28) der ersten und zweiten Platte besitzen eine Mehrzahl an beabstandeten, nach außen gerichteten Noppen (36), die in ihnen ausgebildet sind, wobei die Noppen sich in gleichen Abständen mit den Endvorsprüngen (32) erstrecken;

die erste Platte (24) eines Plattenpaares (12) ist Rückseite-an-Rückseite angeordnet mit der zweiten Platte (26) des benachbarten Plattenpaares, wobei die einander entsprechenden Noppen (36) und Endvorsprünge (32) miteinander verbunden sind; und

jedes Plattenpaar bildet Einlaß- und Auslaßöffnungen (34) für den Fluß eines Fluides durch das Plattenpaar (12) hinter dem Verwirbler (38);

wobei die Mittelabschnitte (28) der ersten und zweiten Platte mit entgegengesetzten Mantelschichten (50) auf ihnen ausgebildet sind,

dadurch gekennzeichnet,
daß der Verwirbler (38) teilweise in den Mantelschichten (50) eingebettet ist, und wobei die Dicke des Verwirblers (38) gleich ist der Distanz zwischen den Mittelbereichen (28) der ersten und zweiten Platte ohne die Mantelschichten im wesentlichen über sämtliche der erhobenen Bereiche des Verwirblers mit Ausnahme der Bereiche der Noppen.

11. Wärmetauscher wie in Anspruch 10 beansprucht, bei dem der Verwirbler (38) aus einer Mehrzahl von parallelen Reihen aus Metall angeordnet in einer sinusförmigen Anordnung besteht.

12. Wärmetauscher wie in Anspruch 10 oder 11 beansprucht,
bei dem der Verwirbler (38) in Querrichtung im wesentlichen die gleiche Breite aufweist wie der Abstand zwischen den Zwischenabschnitten (29) der Platten beträgt.

13. Wärmetauscher wie in einem der Ansprüche 10 bis 12 beansprucht,
bei dem die Platten aus Aluminium mit einer darauf gebildeten Löt-Mantelschicht (50) gebildet sind.

14. Wärmetauscher wie in Anspruch 13 beansprucht, bei dem die Mantelschicht (50) eine Dicke von 10 % der Dicke der Platten (24, 26) hat.

15. Wärmetauscher wie in einem der Ansprüche 10 bis 14 beansprucht,
bei dem der Verwirbler (38) aus Aluminium gebildet ist.

16. Wärmetauscher wie in einem der Ansprüche 10 bis 15 beansprucht,
bei dem die Noppen (36) mit gleichmäßigem Abstand über die Mittelabschnitte (28) der Platten verteilt sind.

17. Wärmetauscher wie in einem der Ansprüche 10 bis 16 beansprucht,
bei dem die Noppen (36) solche Abmessungen haben, daß der Bereich der Noppen, der nicht in Kontakt mit dem Verwirbler (38) steht, minimal ist, so daß die Wärmeübertragung zwischen Verwirbler (38) und den Mittelabschnitten der Platten nicht beeinträchtigt ist.

18. Wärmetauscher wie in einem der Ansprüche 10 bis 17 beansprucht,
bei dem die Noppen mit im wesentlichen flachen Außenflächen gebildet sind.

19. Wärmetauscher wie in einem der Ansprüche 10 bis 18 beansprucht,
bei dem die Noppen symmetrisch um eine Längsachse und eine Querachse der Platten angeordnet sind, so daß wenn zwei Plattenpaare Rückseite-an-Rückseite angeordnet sind, die Noppen der ersten Platte zu den Noppen der zweiten Platte ausgerichtet sind.

20. Wärmetauscher wie in einem der Ansprüche 10 bis 19 beansprucht,
bei dem die Einlaß- und Auslaßöffnungen in entsprechend entgegengesetzten Endvorsprüngen einer jeden Platte gebildet sind, so daß in einem Stapel von Rückseite-an-Rückseite liegenden Plattenpaaren alle Einlaßöffnungen zueinander ausgerichtet und alle Auslaßöffnungen zueinander ausgerichtet sind.

Revendications

1. Procédé de fabrication d'un échangeur de chaleur, comprenant les étapes consistant à :

procurer une pluralité de plaques (24, 26), chaque plaque comportant une partie centrale plane (28), une partie de bord périphérique surélevée (30) située au-dessus de la partie centrale et dans un plan parallèle à celle-ci, et des bossages d'extrémité opposés (32) situés au-dessous de la partie centrale et dans un plan parallèle à celle-ci, les bossages d'extrémité

comportant des orifices d'entrée et de sortie (34) formés dans ceux-ci,
disposer lesdites plaques suivant une paire face à face (12) comportant des parties de bord périphériques (30) qui correspondent, ainsi qu'un espace creux entre celles-ci,
insérer un générateur de turbulence (38) dans ledit espace creux, le générateur de turbulence étant d'une telle épaisseur que les parties de bord périphériques (30) qui correspondent sont espacées l'une de l'autre,
chauffer et faire partiellement fondre la paire de plaques (12) tandis que lesdites parties de bord périphériques (30) qui correspondent sont toujours espacées l'une de l'autre,
comprimer le générateur de turbulence en pressant la paire de plaques (12) ensemble en faisant ainsi fondre le générateur de turbulence (38) dans lesdites plaques en rapprochant l'une de l'autre les parties de bord périphériques qui correspondent, et
joindre les surfaces en contact des plaques et du générateur de turbulence après que les parties de bord périphériques qui correspondent ont été rapprochées l'une de l'autre afin de former un ensemble étanche aux fluides.

2. Procédé selon la revendication 1, dans lequel l'étape de compression est réalisée en pressant l'une contre l'autre les parties centrales planes (28).

3. Procédé selon la revendication 1 ou 2, et comprenant en outre les étapes consistant à procurer une couche de placage (50) sur les plaques, à faire fondre la couche de placage tout en comprimant le générateur de turbulence (38) et à emprisonner le générateur de turbulence dans la couche de placage jusqu'à ce que les parties de bord périphériques (30) viennent en contact.

4. Procédé selon la revendication 2 ou 3, dans lequel l'étape consistant à presser est réalisée en munissant lesdites parties centrales (28) d'une pluralité de mamelons (36) espacés orientés vers l'extérieur, les mamelons s'étendant sur la même distance que les bossages d'extrémité (32), et en pressant une paire de plaques entre deux paires de plaques adjacentes disposées en agencement dos à dos, les mamelons présents sur les paires de plaques adjacentes étant alignés et transmettant les forces de compression entre celles-ci.

5. Procédé selon l'une quelconque des revendications précédentes, et comprenant en outre les étapes consistant à assembler une pluralité de dites paires de plaques (12) en une pile, lesdits orifices d'entrée et de sortie (34) étant en alignement, et à joindre lesdites paires de plaques ensemble pour former un ensemble étanche aux fluides.

6. Procédé selon l'une quelconque des revendications précédentes, et comprenant en outre l'étape consistant, avant de comprimer et de chauffer la paire de plaques, à assembler une pluralité de dites paires de plaques (12) en une pile, les orifices d'entrée et de sortie (34) étant en alignement, et à chauffer et à comprimer ensuite simultanément la totalité des paires de plaques empilées.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel les plaques sont faites d'aluminium revêtu d'un placage de brasage, et dans lequel l'étape consistant à joindre est réalisée par brasage au four.

8. Procédé selon l'une quelconque des revendications précédentes, et comprenant en outre l'étape consistant, avant de chauffer et de comprimer la totalité des paires de plaques empilées, à ajouter une paire de plaques supérieure (14) comportant une plaque supérieure lisse (16) et une paire de plaques inférieure (18) comportant une plaque inférieure lisse (20) à la pile de paires de plaques.

9. Procédé selon la revendication 8, et comprenant en outre l'étape consistant à disposer des raccords d'entrée et de sortie (22) sur l'une des plaques lisses supérieure et inférieure (14, 18), lesdits raccords comportant des orifices d'entrée et de sortie communiquant avec les orifices d'entrée et de sortie (34) respectifs des paires de plaques.

10. Echangeur de chaleur comprenant :

une pluralité de plaques empilées, agencées en paires (12) face à face, chacune desdites paires face à face comprenant des première et seconde plaques (24, 26),
la première plaque (24) comportant une partie centrale plane (28), une partie de bord périphérique surélevée (30) située au-dessus de la partie centrale (28) et dans un plan parallèle à celle-ci, une partie intermédiaire (29) comprise entre les parties centrale et de-bord, et des bossages d'extrémité opposés (32) situés au-dessous de la partie centrale et dans un plan parallèle à celle-ci,
la seconde plaque (26) de chaque paire de plaques (12) face à face comportant une partie de bord périphérique (30) jointe à la partie de bord périphérique de ladite première plaque, une partie centrale (28) espacée de la partie centrale de la première plaque, une partie intermédiaire (29) comprise entre les parties centrale et de bord, et des bossages d'extrémité opposés (32) situés au-dessus de la partie centrale

de la seconde plaque (28) et dans un plan parallèle à celle-ci,
un générateur de turbulence (38) plan, en métal déployé, placé entre les première et seconde plaques (24, 26) de chaque paire de plaques (12) face à face, ledit générateur de turbulence (38) comportant des parties hautes,
les parties centrales (28) des première et seconde plaques comportant une pluralité de mamelons (36) espacés, orientés vers l'extérieur, formés dans celles-ci, les mamelons s'étendant sur la même distance que les bossages d'extrémité (32),
la première plaque (24) d'une paire de plaques (12) étant placée dos à dos avec la seconde plaque (26) d'une paire de plaques adjacente, les mamelons (36) et les bossages d'extrémité (32) respectifs étant joints, et
chaque paire de plaques définissant des orifices d'entrée et de sortie (34) permettant à un fluide de s'écouler à travers la paire de plaques (12) en franchissant le générateur de turbulence (38),
dans lequel les parties centrales (28) de la première et la seconde plaque comportent des couches de placage (50) opposées formées sur celles-ci,

caractérisé en ce que ledit générateur de turbulence (38) est en partie emprisonné dans lesdites couches de placage (50),

et dans lequel l'épaisseur du générateur de turbulence (38) est égale à la distance entre les parties centrales (28) de la première et de la seconde plaque sans les couches de placage sur pratiquement la totalité des parties hautes du générateur de turbulence, excepté les parties occupées par les mamelons.

11. Echangeur de chaleur selon la revendication 10, dans lequel le générateur de turbulence (38) est formé d'une pluralité de rangées parallèles de métal disposées suivant un agencement sinusoïdal, décalé.

12. Echangeur de chaleur selon la revendication 10 ou 11, dans lequel le générateur de turbulence (38) présente une largeur dans son sens transversal qui est pratiquement identique à la distance séparant les parties intermédiaires (29) des plaques.

13. Echangeur de chaleur selon l'une quelconque des revendications 10 à 12, dans lequel les plaques (24,26) sont formées d'aluminium comportant une couche de placage de brasage (50) formée sur celui-ci.

14. Echangeur de chaleur selon la revendication 13, dans lequel la couche de placage (50) représente 10 pour cent de l'épaisseur de la plaque (24, 26).

15. Echangeur de chaleur selon l'une quelconque des revendications 10 à 14, dans lequel le générateur de turbulence (38) est formé d'aluminium.

16. Echangeur de chaleur selon l'une quelconque des revendications 10 à 15, dans lequel les mamelons (36) sont espacés de façon uniforme sur les parties centrales (28) des plaques.

17. Echangeur de chaleur selon l'une quelconque des revendications 10 à 16, dans lequel les mamelons (36) sont dimensionnés de façon que la surface des mamelons qui n'est pas en contact avec le générateur de turbulence (38) soit minimisée, de manière à ne pas nuire matériellement au transfert de chaleur entre le générateur de turbulence (38) et les parties centrales des plaques.

18. Echangeur de chaleur selon l'une quelconque des revendications 10 à 17, dans lequel les mamelons sont formés avec des sommets pratiquement plats.

19. Echangeur de chaleur selon l'une quelconque des revendications 10 à 18, dans lequel les mamelons sont disposés de façon symétrique par rapport aux axes longitudinal et transversal des plaques, de façon que lorsque l'on positionne deux paires de plaques dos à dos, les mamelons présents sur la première plaque soient en alignement avec les mamelons présents sur la seconde plaque.

20. Echangeur de chaleur selon l'une quelconque des revendications 10 à 19, dans lequel lesdits orifices d'entrée et de sortie sont formés dans les bossages d'extrémité opposés respectifs de chaque plaque, de sorte que dans une pile de paires de plaques dos à dos, tous les orifices d'entrée sont en alignement et tous les orifices de sortie sont en alignement.

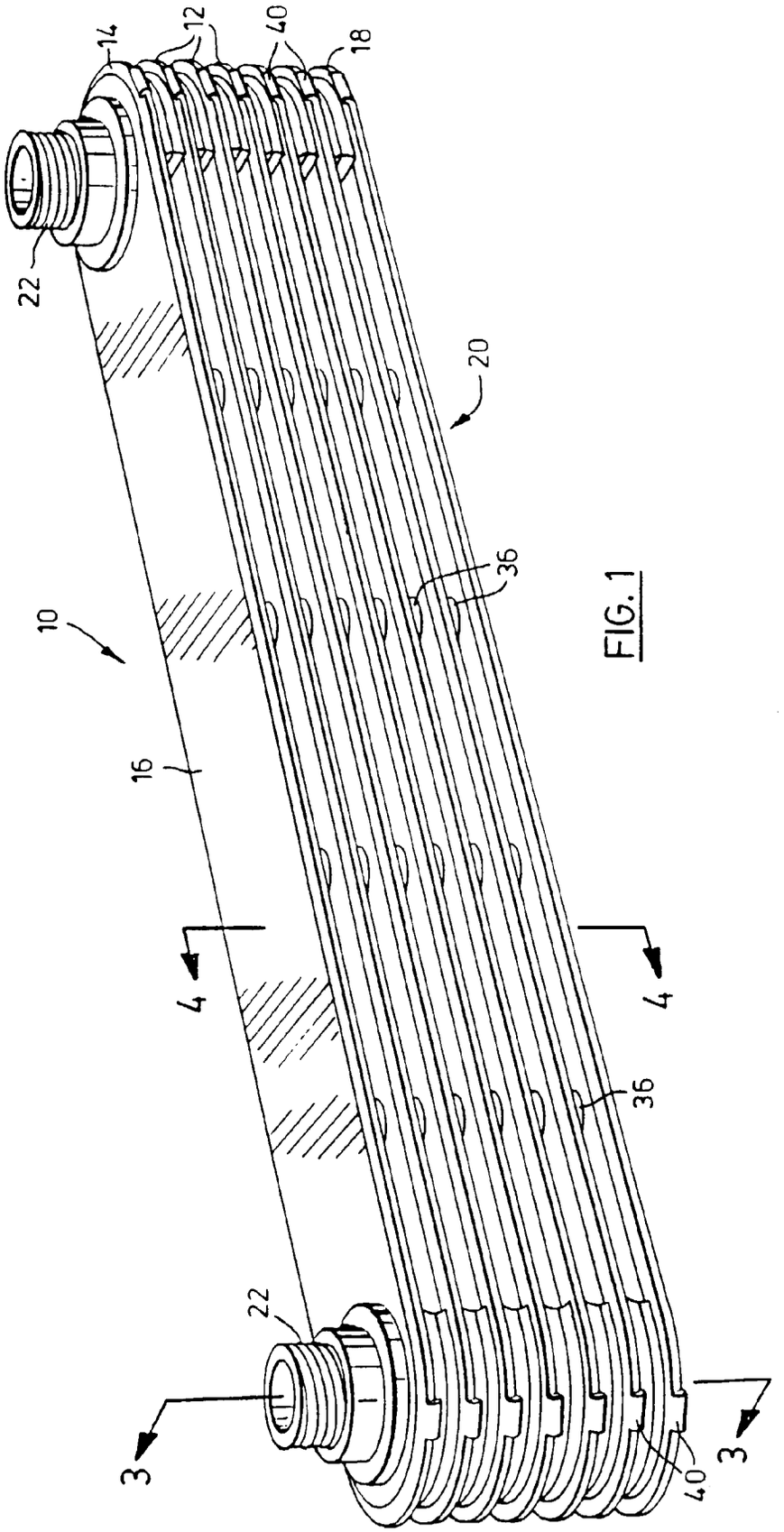


FIG. 1

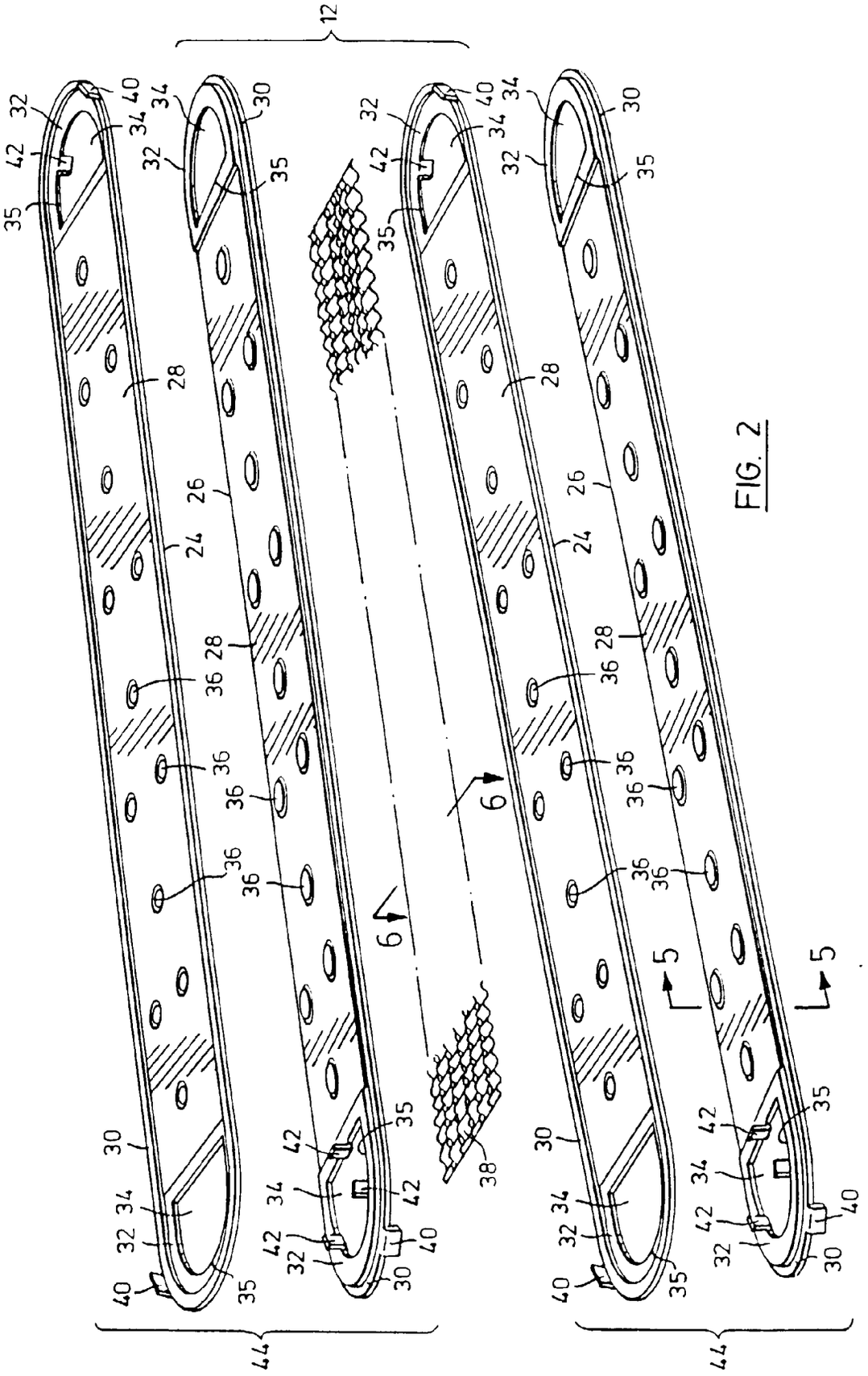


FIG. 2

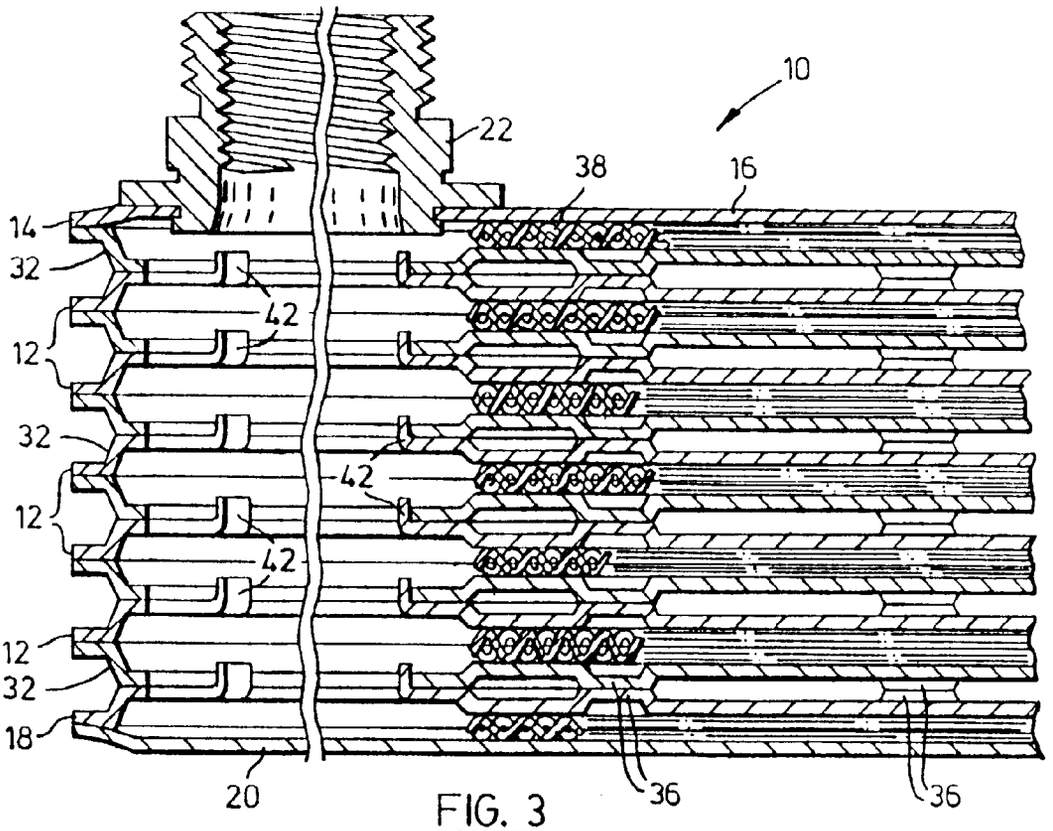

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FIG. 3

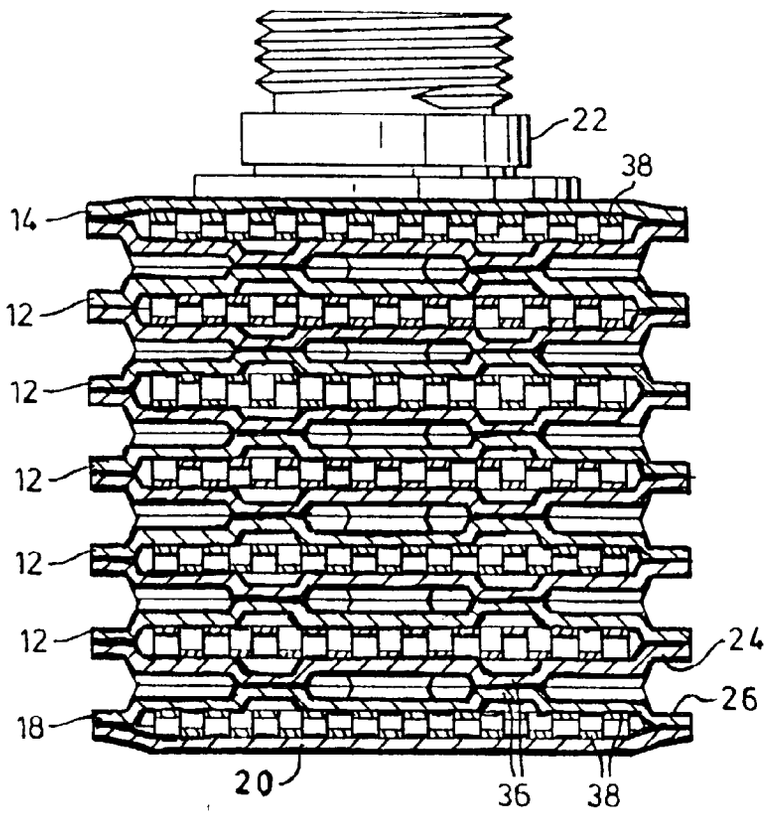

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FIG. 4

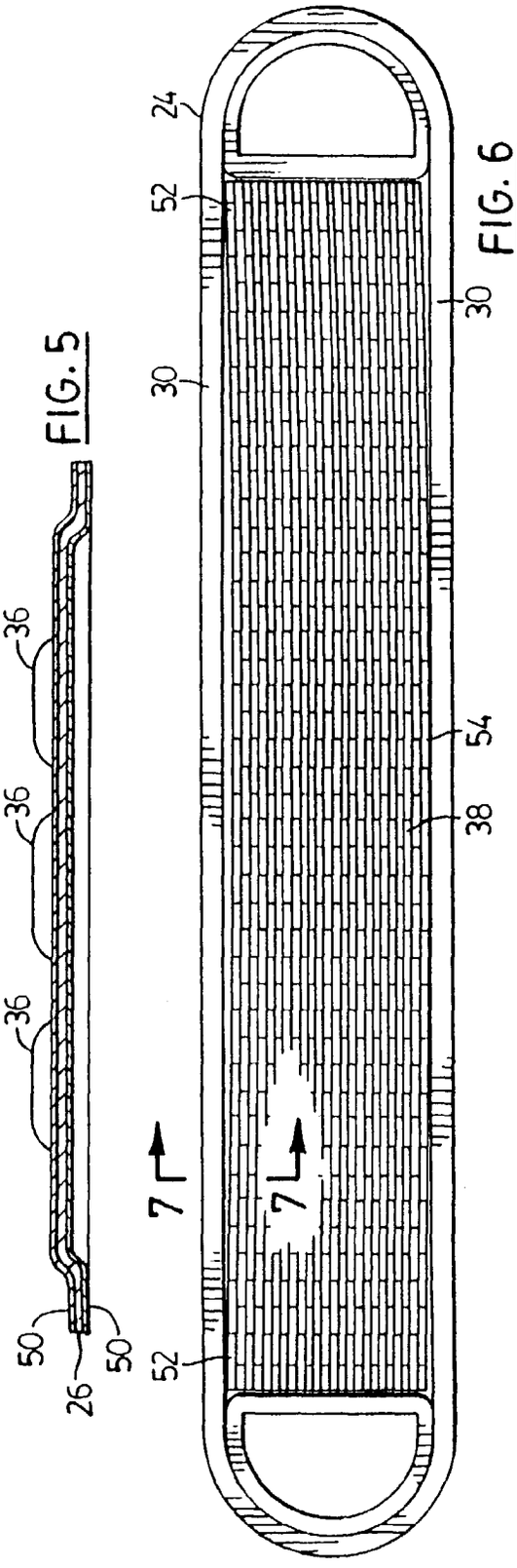


FIG. 5

FIG. 6

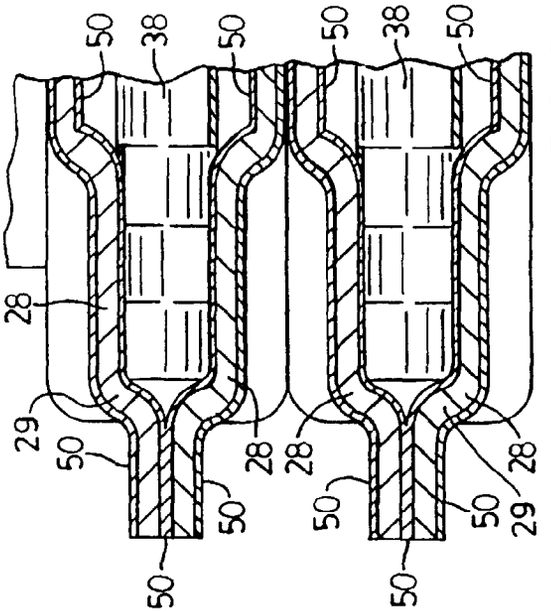


FIG. 8

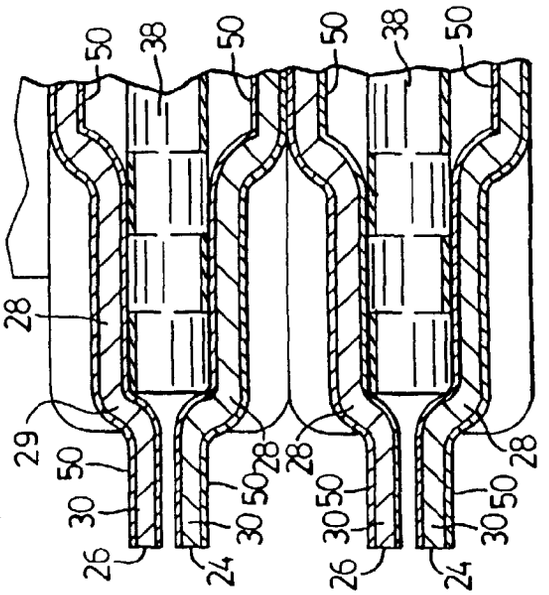


FIG. 7