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(54) Heat exchanger

(57) A heat exchanger for the heat exchange between a first fluid and a second fluid, which achieves an unusual strength comprises a plurality of casings (2), of substantially flattened shape and of predetermined width (L), arranged in a pile (2a), with an air space (3) defined between adjacent casings in the pile, and each formed from two half-shells (6) welded along a peripheral strip (6a), said casings (2) being in fluid communication with each other through respective holes (7) opening into said air space (3), and at least one spacer (8), substantially of the sleeve type, in said air space (3), made integral at the top end with said adjacent casings around the respective holes (7) opening into said air space (3).

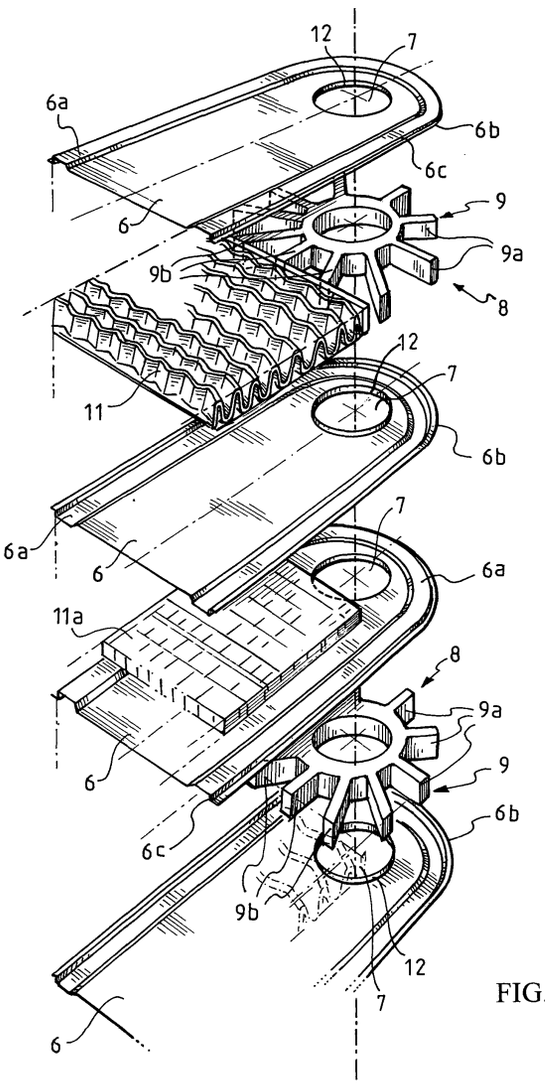

FIG. 5

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Description

Field of application

[0001] The present invention, in its most general aspect, refers to a heat exchanger for the heat exchange between a first and a second fluid.

[0002] Particularly, but not exclusively, the invention concerns a heat exchanger for the heat exchange between pressurized fluids, of the type comprising a plurality of casings, of substantially flattened shape and of predetermined width, arranged in a pile, with an air space defined between adjacent casings in the pile, and each formed from two half-shells welded along a peripheral strip, which are in fluid communication with each other through respective holes opening into said air space.

Prior art

[0003] Heat exchanger for the heat exchange between two fluids of the type comprising a plurality of casings or flattened tubes are known.

[0004] Each casing is formed from two half-shells on which respective holes are open, in corresponding positions, at which adjacent casings are joined through collectors.

[0005] In such an arrangement, each pair of adjacent casings defines an air space through which a first flow of fluid is conveyed, whereas a second flow of fluid at a different temperature crosses the plurality of casings.

[0006] In this way, such flows carry out a heat exchange, which is generally made more effective by making their motion highly turbulent through the use of small corrugated plates, or turbulators, arranged in the cavities and inside the casings, respectively.

[0007] The aforementioned joining collectors between adjacent casings are, according to the prior art, pieces of tubes interfacing with the half-shells and forced, through plastic deformation, around respective conical edges foreseen at the holes open on the casings.

[0008] Heat exchangers thus realized, although advantageous, are not free from drawbacks, including the main one represented by the low mechanical resistance that they possess and that impairs its use, in particular in the case of heat exchange between flows of fluids at high pressure values.

[0009] Such a low mechanical resistance is substantial both at the joints between adjacent casings, where the plastic deformation does not ensure an adequate seal, and at the half-shells which, for an effective heat exchange between the fluids, must be realized with a small thickness.

[0010] It follows from this that heat exchangers thus realized cannot be used, or in any case are of little industrial interest, in the case of heat exchange between flows of fluids of which at least one is at a high pressure value; where by high pressure value we mean a value greater than 10-13 bar.

Summary of the invention

[0011] The technical problem forming the basis of the present invention is that of devising a heat exchanger for the heat exchange between a first fluid and a second fluid, of the type comprising a plurality of casings, of substantially flattened shape and of predetermined width, arranged in a pile, with an air space defined between adjacent casings in the pile, and each formed from two half-shells welded along a peripheral strip, in which the aforementioned casings are in fluid communication with each other through respective holes opening into the aforementioned air space, having structural and functional characteristics such as to overcome the aforementioned drawbacks, in other words such as to ensure an unusual strength and mechanical resistance.

[0012] The aforementioned problem is solved according to the invention by a heat exchanger of the type considered above, comprising, in the aforementioned air space, at least one spacer, substantially of the sleeve type, abutting on at the top end and made integral with said adjacent casings around the respective holes opening into said air space.

[0013] Advantageously, the heat exchanger comprises irregularities associated with the aforementioned at least one spacer, which extend in the air space to rigidify the half-shells.

[0014] Preferably, the aforementioned irregularities are radial spokes extending radially from said at least one spacer.

[0015] Advantageously, the aforementioned radial spokes are practically equally angularly spaced.

[0016] Again preferably, the aforementioned radial spokes are formed integrally with the spacer, and more preferably radial spokes and spacer are a piece of an extruded profile.

[0017] Advantageously, the aforementioned extruded profile is made from metallic material selected from the group comprising aluminium, aluminium alloys, copper, copper alloys and similar metallic materials.

[0018] The characteristics and further advantages of a heat exchanger according to the present invention shall become clearer from the description, made hereafter, with reference to the attached drawings given for indicating and not limiting purposes.

Brief description of the drawings

[0019] In such drawings:

Figure 1 shows a schematic front section view of a heat exchanger in accordance with the present invention, made along the line I-I;

Figure 2 shows a plan view of the heat exchanger

of figure 1, made according to the arrow II;

Figure 3 shows an enlarged view of a detail of the exchanger of figure 1;

Figure 4 shows a section view of a detail of the heat exchanger of figure 1, made according to the line IV-IV of figure 3;

Figure 5 shows a perspective, exploded view of a portion of the exchanger of figure 1;

Figure 6 shows the portion of figure 5 of the heat exchanger in accordance with a variant embodiment of the invention;

Figure 7 shows a detail of the portion of figure 5 in accordance with a further variant embodiment of the invention;

Figure 8 shows the detail of figure 4 in accordance with a further variant embodiment of the invention.

Detailed description

[0020] With reference to the aforementioned figures, a heat exchanger for the heat exchange between a first fluid, for example oil, and a second fluid, for example air, realized according to the present invention, is globally and schematically represented with 1.

[0021] The heat exchanger 1 essentially comprises a plurality of casings 2, of substantially flattened shape, associated together in a predetermined distanced relationship in a pile 2a, with respective cavities 3 defined between casings.

[0022] The casings 2, of predetermined width L, are clamped, in a known way, between a first plate 4 and a second plate 5, the latter provided with joints 5a for the passage, for example, of the first of the aforementioned fluids.

[0023] In the example, the described exchanger has joints 5a of 1" (one inch).

[0024] Each of the casings 2 is formed from two half-shells 6 welded along a peripheral strip 6a each of which is equipped, in corresponding positions, with respective holes 7.

[0025] It should be noted that the aforementioned peripheral strip 6a has an outer edge 6b comprising a trim 6c bent square, and that the half-shells 6 are realized in aluminium sheet of small thickness of between 0.1 and 0.4 mm, preferably 0.3 mm.

[0026] Such respective holes 7, which in the pile 2a are aligned, place the aforementioned casings 2 in fluid communication with each other.

[0027] In such casings 2, a flow of the aforementioned first fluid is made to flow, whereas the second fluid is made to flow in the aforementioned cavities 3, all in a *per se* known way.

[0028] In accordance with a first characteristic of the invention, the heat exchanger 1 comprises, in each of said cavities 3, a spacer 8, substantially of the sleeve type, abutting on at the top end and made integral with the aforementioned adjacent casings around each of the respective holes 7 of the half-shells 6, realizing an inviolable mechanical connection between adjacent casings.

[0029] Such spacers 8 made integral with the casings 2, for example through brazing or welding, define, at the respective holes 7, passage collectors for the aforementioned first fluid, communicating with the inside of the casings 2.

[0030] In accordance with a second characteristic of the invention, the heat exchanger 1 comprises irregularities 9 associated with each spacer 8, which extend in each air space 3, constituting rigidifying elements of the half-shells 6.

[0031] With particular reference to the example of figures 4 and 5, it should be noted how such irregularities are in the form of radial spokes 9, projecting radially towards the outside of said spacer 8 and practically equally angularly spaced on such a spacer 8.

[0032] Advantageously and in accordance with a further characteristic of the invention, a predetermined number of such radial spokes 9 extending outside of the spacer 8, in the example a number equal to seven spokes indicated with 9a, extends up to the aforementioned peripheral strip 6a.

[0033] In particular, such a predetermined number of radial spokes 9a extends up to, and abuts upon, the aforementioned trim 6c bent square.

[0034] Again advantageously, the remaining radial spokes 9 of the same spacer 8, in the example three spokes indicated with 9b, are sheared according to a transversal plane, indicated with T, which constitutes the plane of reference and support for a corrugated plate, globally indicated with 11, arranged in each of the cavities 3 and called "turbulator" by the man skilled in the art.

[0035] Regarding this, it should also be stated that a second corrugated plate or turbulator 11a is arranged inside each casing 2.

[0036] The aforementioned corrugated plates 11, 11a have the purpose of increasing the efficiency of the heat exchange of the heat exchanger 1, increasing the turbulence, by means of their corrugated surfaces, of the flows of fluids intended for the heat exchange.

[0037] Preferably, the aforementioned radial spokes 9 are formed integrally with the spacer 8 from which they project, and more preferably radial spokes and spacer are a piece of an extruded profile made from a metallic material selected from the group comprising aluminium, copper, aluminium alloys, copper alloys and similar metallic materials.

[0038] It should be noted that the thickness s of the spacer 8 and the thicknesses of the radial spokes 9 have values of between 2 and 4 mm, preferably 3.5 mm.

[0039] Again preferably, each of the aforementioned respective holes 7 of each half-shell 6 is foreseen equipped with a centring edge 12, projecting from the half-shell 6 in the direction of the air space 3, for the alignment of the spacer 8.

[0040] The main advantage of the heat exchanger according to the present invention lies in its unusual strength.

[0041] Indeed, thanks to the spacers welded and made integral at the top end on the casings, a particularly strong structure is given to the pile of casings themselves.

[0042] In this way, an inviolable mechanical connection is realized between adjacent casings, forming a seal and capable of withstanding violent stresses.

[0043] In particular, the portions of exchanger that according to the prior art were most subject to explosion are reinforced, in the exchanger according to the invention, both through the spacers made integral with the casings and through the radial spokes projecting from each spacer which constitute rigidifying elements for each of the half-shells.

[0044] The heat exchanger according to the invention, in this way, is particularly suitable for the heat exchange between pressurized flows of fluids, also for pressures of up to 35 bar and more.

[0045] Furthermore, the mechanical resistance of the exchanger is improved by the radial spokes of the spacers, which constitute support elements for each corrugated plate arranged in the cavities.

[0046] In this way, the corrugated plates are stably locked by the radial spokes in an optimal position that allows an excellent increase in turbulence of the flow of fluid that crosses the cavities, and an optimal heat exchange in particular at high pressure values of such a flow.

[0047] In other words, the heat exchanger according to the present invention allows a heat exchange to be carried out between a first fluid conveyed inside the casings, and a second fluid conveyed into the cavities between adjacent casings, in particular and at most when both of the respective flows of such fluids are at high pressure values, thanks to the special structure described above.

[0048] Such an unusual strength of the heat exchanger according to the invention is achieved, advantageously, simultaneously maintaining a compact structure of the exchanger, through half-shells realized with a low thickness as required for an effective heat exchange.

[0049] A further advantage achieved by the heat exchanger according to the invention lies in the minimal or negligible pressure drop that the fluids undergo during the heat exchange, thanks to the aforementioned mechanical connection that ensures a better seal than that which has been provided up to now by the prior art.

[0050] It should be stated, furthermore, that radial spokes extending up to the trim of the peripheral strip, advantageously bent square, give the heat exchanger according to the invention an effective mechanical resistance also against accidental knocks, preserving the heat exchanger from dents and similar undesired damage that could derive from such knocks.

[0051] Now, with particular reference to the example of figure 6, a variant embodiment of the present invention is described for which details and cooperating parts having the same structure and operation as the previous example embodiment shall be indicated with the same reference numerals and symbols.

[0052] In such a variant embodiment, the heat exchanger comprises spacers 8, substantially shaped like a sleeve, made integral at the top end on adjacent casings 2 and comprising radial spokes 90 projecting towards the inside of the spacer 8.

[0053] The aforementioned radial spokes 90 projecting towards the inside of the spacer are sheared, at their free ends, so as to surround the centring edge 12 of the respective holes 7.

[0054] Again with reference to the example of figure 6, it should be noted that the spacer 8 comprises a first portion 80a with a curved profile, and a second portion 80b with a squared profile constituting the reference plane for the turbulator 11.

[0055] In such a variant embodiment it should be noted that, advantageously, the pressure that from the inside acts upon the spacer, due to the fluid that crosses the casings, is completely counterbalanced by a pressure that acts from the outside on the spacer, due to the fluid that crosses the cavities.

[0056] In the example of figure 7 a further variant embodiment of the heat exchanger in accordance with the invention is represented.

[0057] In such a variant embodiment the heat exchanger comprises spacers 8, substantially shaped like a sleeve, each equipped with radial spokes projecting towards the inside of the spacer, indicated with 90a, and radial spokes projecting towards the outside of the spacer and indicated with 90b.

[0058] It can be seen that the aforementioned radial spokes 90b extending towards the outside of the spacer 8 are in prolongation of the radial spokes 90a extending towards the inside of the spacer.

[0059] It is important to note that, in accordance with a further variant embodiment shown with reference to the example of figure 8, the holes 7 open on the half-shells 6 of the casings 2 are oblong.

[0060] Holes extending transversally are particularly advantageous in the case of large widths of the exchanger, foreseen to withstand high flow rates of the fluid circulating in the half-shells of the exchanger itself.

[0061] The man skilled in the art can bring numerous modifications to each of the four variant embodiments of the heat exchanger described above in order to satisfy contingent and specific requirements, all of these modifications in any case being covered by the scope of protection of the invention, as defined by the claims

listed hereafter.

Claims

1. Heat exchanger for the heat exchange between a first fluid and a second fluid, of the type comprising a plurality of casings (2), of substantially flattened shape and of predetermined width (L), arranged in a pile (2a), with an air space (3) defined between adjacent casings in the pile, and each formed from two half-shells (6) welded along a peripheral strip (6a), said casings (2) being in fluid communication with each other through respective holes (7) opening into said air space (3), **characterized in that** it comprises, in said air space (3), at least one spacer (8), substantially of the sleeve type, made integral at the top end with said adjacent casings (2) around the respective holes (7) opening into said air space (3).

2. Heat exchanger according to claim 1, **characterized in that** it comprises irregularities (9) associated with said at least one spacer (8), said irregularities (9) extending in said air space (3) to rigidify the half-shells (6).

3. Heat exchanger according to claim 2, **characterized in that** said irregularities (9) are radial spokes (9a, 9b, 90, 90a, 90b) extending radially from said at least one spacer (8).

4. Heat exchanger according to claim 3, **characterized in that** said radial spokes (9a, 9b, 90b) extend outwards.

5. Heat exchanger according to claim 3, **characterized in that** said radial spokes (9o, 90a) extend inwards.

6. Heat exchanger according to claim 3, **characterized in that** said radial spokes are radial spokes extending outwards (90b) and radial spokes extending inwards (90a).

7. Heat exchanger according to claim 6, **characterized in that** said radial spokes extending outwards (90b) are in prolongation of said radial spokes extending inwards (90a).

8. Heat exchanger according to claim 4 or 6, **characterized in that** a predetermined number of said radial spokes (9a) extending towards the outside of said at least one spacer (8) extends at least up to said peripheral strip (6a).

9. Heat exchanger according to claim 8, **characterized in that** each half-shell (6) comprises, at an outer edge (6b) of said peripheral strip (6a), a trim (6c) bent square, and **in that** said predetermined number of radial spokes (9a) extending on the outside extends up to said trim (6c).

10. Heat exchanger according to claim 2, **characterized in that** said irregularities (9) are formed integrally with said at least one spacer (8).

11. Heat exchanger according to any one of claims 2 to 10, **characterized in that** said at least one spacer (8) and said irregularities (9) are a piece of an extruded profile.

12. Heat exchanger according to claim 11, **characterized in that** said piece of extruded profile is made from a metallic material selected from the group comprising aluminium, aluminium alloys, copper, copper alloys and similar metallic materials.

13. Heat exchanger according to claim 3, **characterized in that** said radial spokes (9a, 9b, 90, 90a, 90b) are practically equally angularly spaced.

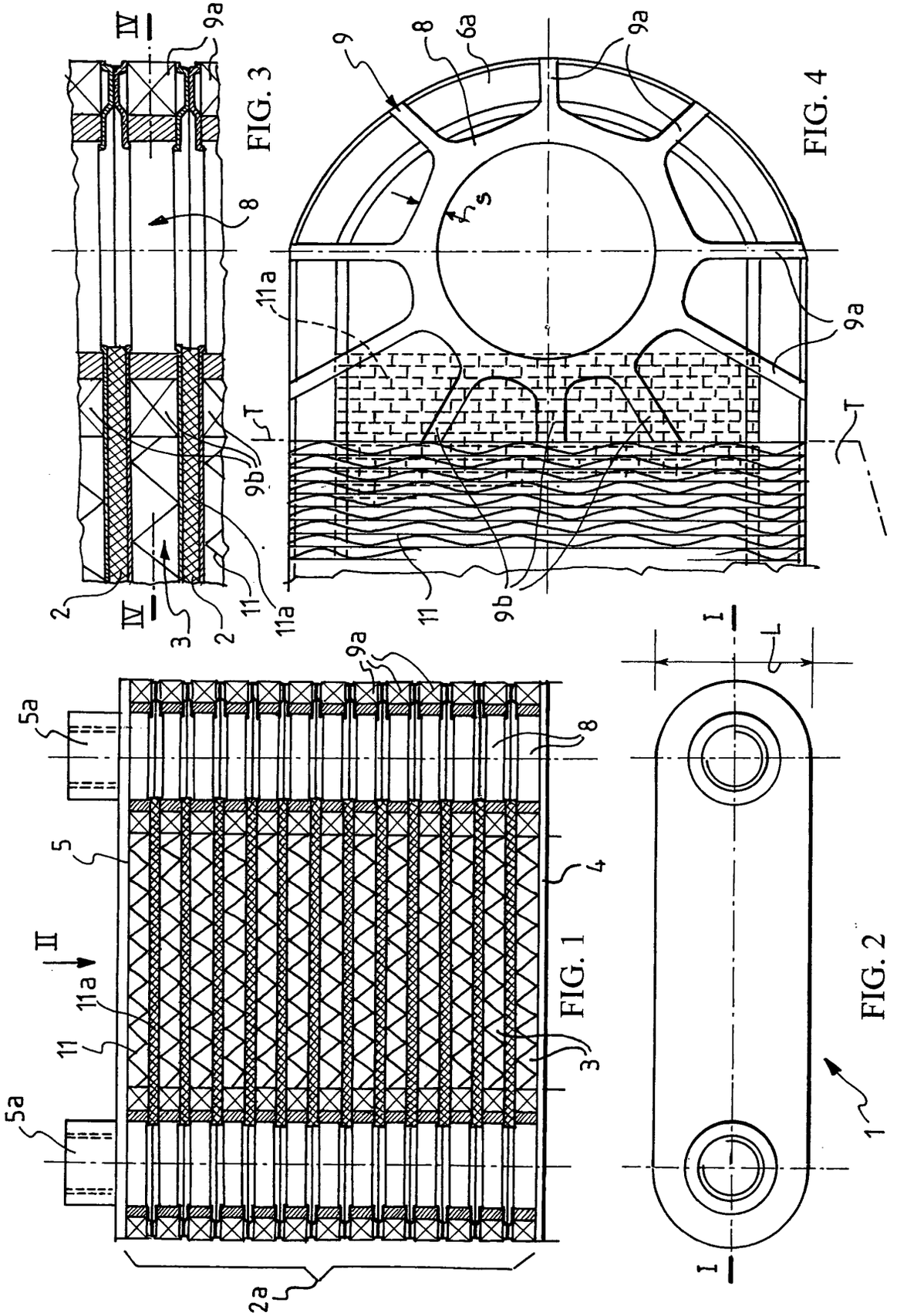
14. Heat exchanger according to claim 3, **characterized in that** a predetermined number of said radial spokes (9b) are sheared according to a plane (T) constituting the reference and support plane for a corrugated plate (11) arranged in said air space (3).

15. Heat exchanger according to any one of the previous claims, **characterized in that** at least one of said respective holes (7) opening into said air space (3) is equipped with a centring edge (12) for said at least one spacer (8).

16. Heat exchanger according to any one of the previous claims, **characterized in that** said respective holes (7) are oblong in a predetermined direction.

17. Heat exchanger according to claim 16, **characterized in that** said respective holes (7) are oblong in the direction of the width (L) of said casings (2).

18. Heat exchanger according to any one of the previous claims, **characterized in that** said at least one spacer (8) has a predetermined thickness of between 2 and 4 mm, preferably 3.5 mm.


IV
9a
8
9b
T
2
3
11
11a
FIG. 3
9
6a
h_s
FIG. 4
5a
5
II
FIG. 1
I
L
FIG. 2
2a
4

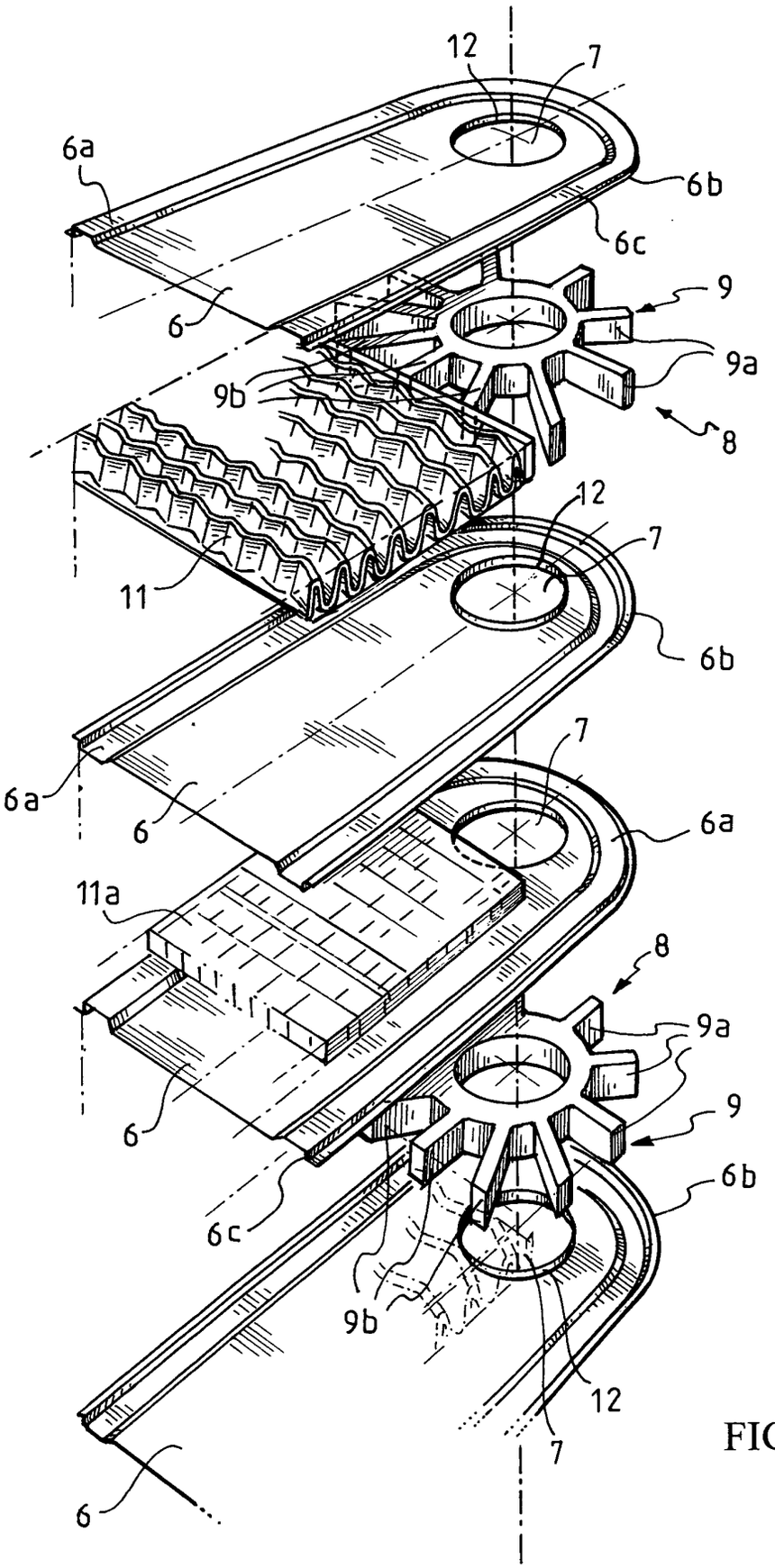
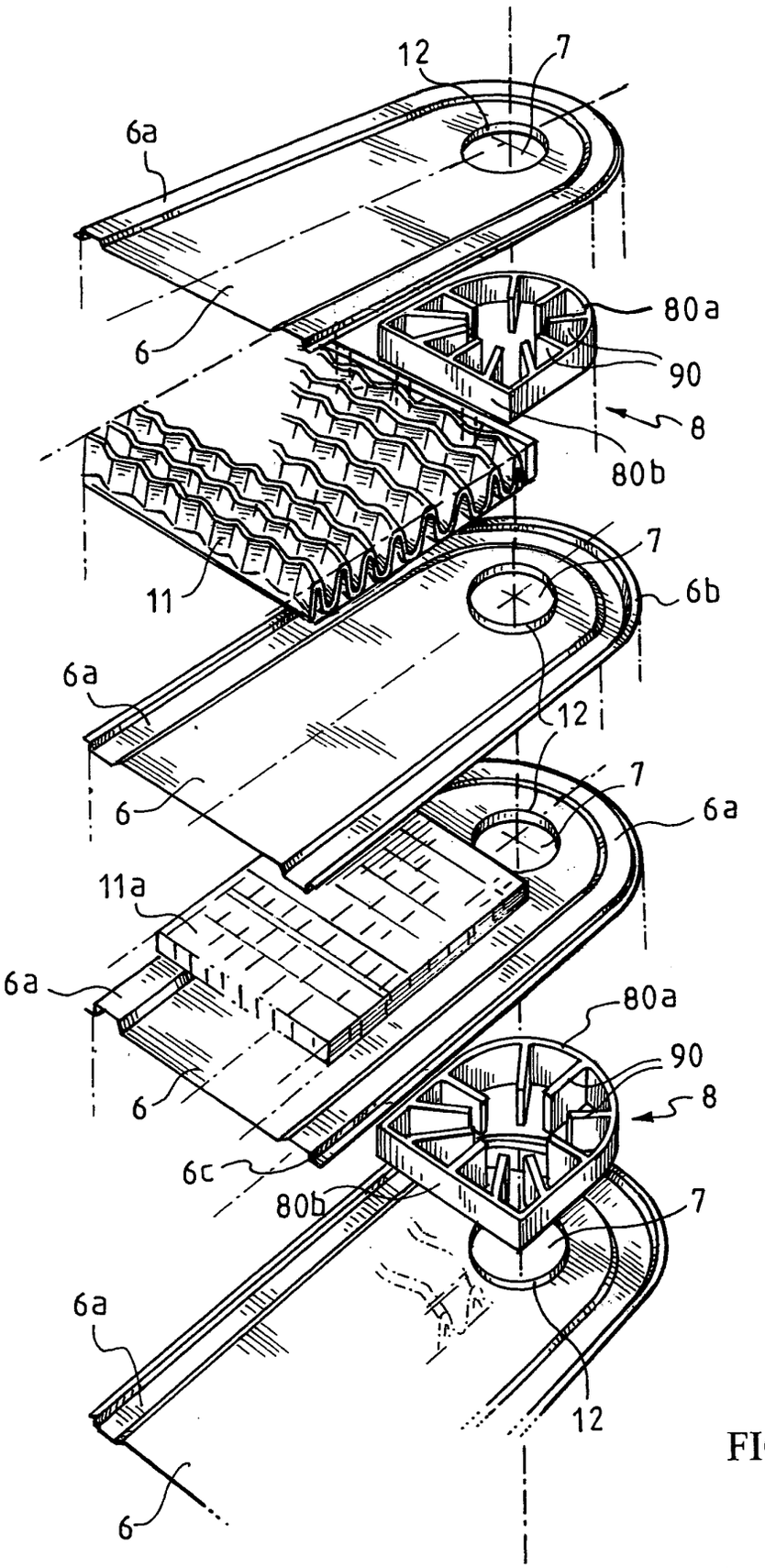


FIG. 5


12
7
6a
80a
6
90
8
80b
7
11
6b
6a
12
6
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6a
11a
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6
8
6c
80b
7
6a
12
6

FIG. 6

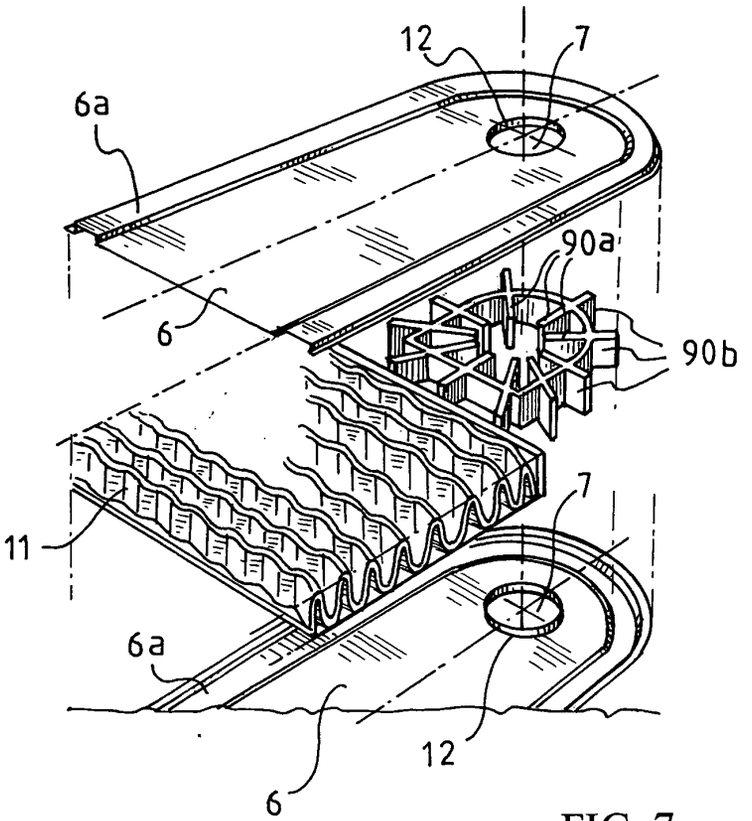

FIG. 7

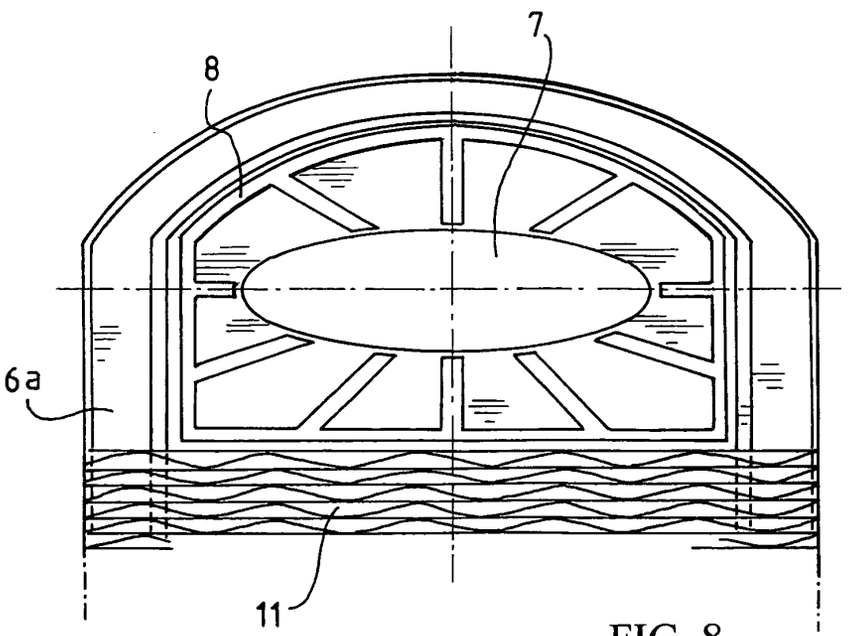

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5322

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 October 2004	Van Dooren, M

CATEGORY OF CITED DOCUMENTS

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