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(54) **A HEAT EXCHANGER PLATE, AND A PLATE HEAT EXCHANGER**

(57) A heat exchanger plate (1) for a plate heat exchanger for heat exchange between at least a first fluid and a second fluid, the heat exchanger plate (1) having a quadrilateral shape with two opposite parallel primary sides (5) and two opposite parallel secondary sides (6), and a longitudinal central axis (x) being parallel with the primary sides (5). The heat exchanger plate (1) comprising a heat exchanging area having a corrugation of ridges and valleys having a longitudinal extension defining an inclination in relation to the longitudinal central axis (x), four portholes (11, 12, 13, 14), of which at least two are located at a respective corner of the heat exchanger plate (1) extending through the heat exchanger plate (1), a first set of ridges (8a) and valleys (9a) and a second set of ridges (8b) and valleys (9b), wherein the longitudinal extension of the first set of ridges and valleys (8a, 9a) define a first angle (α) in relation to a first primary side (5a) and the longitudinal extension of the second set of ridges and valleys (8b, 9b) define a second angle (β) in relation to a second primary side (5b), wherein an intersection between the first set of ridges and valleys (8a, 9a) and the second set of ridges and valleys (8b, 9b) being defined as a transition area (10) comprising a curvature of ridges and valleys being concentric with a porthole.

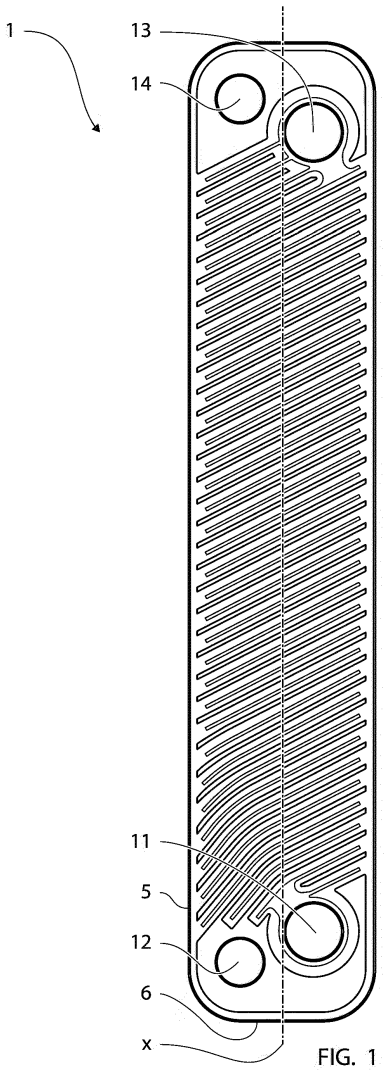

FIG. 1

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention refers to a heat exchanger plate according to the preamble of claim 1. The invention also refers to a plate heat exchanger according to the preamble of claim 10.

BACKGROUND OF THE INVENTION AND PRIOR ART

[0002] Plate heat exchangers, PHEs, typically consist of two end plates in between which a number of heat transfer plates are arranged in a stack or pack. The heat transfer plates of a PHE may be of the same or different types and they may be stacked in different ways. In some PHEs, the heat transfer plates are stacked with the front side and the back side of one heat transfer plate facing the front side and back side, respectively, of other heat transfer plates, and every other heat transfer plate turned upside down in relation to the rest of the heat transfer plates. Typically, this is referred to as the heat transfer plates being "flipped" in relation to each other. In other PHEs, the heat transfer plates are stacked with the front side and the back side of one heat transfer plate facing the back side and the front side, respectively. Typically, this is referred to as the heat transfer plates being "rotated" in relation to each other.

[0003] In some kind of plate heat exchangers, it may be so that the heat carrying media flowing around the closed porthole area meets a high flow resistance when entering the heat exchanger area. This may be due to the relatively high theta pattern of the heat exchanger area, i.e. a pattern of a corrugation that may have a larger inclination (chevron angle) in relation to the longitudinal central axis of the heat exchanger plate. A relatively high theta pattern creates more turbulence and thus more heat transfer, higher pressure drop and higher flow resistance.

[0004] In other plate heat exchanger applications, such as for cooling of electric components, cooling need to be done with high efficiency. Electric components might be mounted in a rack of a data center server, where components are arranged close to each other. When cooling electric components, the fluid being in contact with the components must be carefully chosen so that the efficiency of the components is not compromised.

SUMMARY OF THE INVENTION

[0005] It is an objective of the present invention to overcome the problems discussed above. More precisely, the objective of the invention is to provide a heat exchanger plate and a plate heat exchanger that achieve low disturbance of flow. It is a further objective to have a low pressure drop over the heat exchanger.

[0006] The objectives are achieved by providing a heat exchanger plate with seamless integration of the heat transfer area and distribution area with no sharp changes of direction of corrugations.

[0007] According to one aspect of the present invention there is provided a heat exchanger plate for a plate heat exchanger for heat exchange between at least a first fluid and a second fluid, the heat exchanger plate having a quadrilateral shape with two opposite parallel primary sides and two opposite parallel secondary sides, and a longitudinal central axis being parallel with the primary sides, wherein the heat exchanger plate comprising a heat exchanging area having a corrugation of ridges and valleys having a longitudinal extension defining an inclination in relation to the longitudinal central axis, four portholes, of which at least two are located at a respective corner of the heat exchanger plate extending through the heat exchanger plate, a first set of ridges and valleys and a second set of ridges and valleys, wherein the longitudinal extension of the first set of ridges and valleys define a first angle in relation to a first primary side and the longitudinal extension of the second set of ridges and valleys define a second angle in relation to a second primary side, wherein an intersection between the first set of ridges and valleys and the second set of ridges and valleys being defined as a transition area comprising a curvature of ridges and valleys being concentric with a porthole.

[0008] Accordingly, the concentric transition area between the corrugations having a first angle and the corrugations having a second angle achieves a low disturbance of flow.

[0009] Preferably, the ridges and valleys are extending continuously from the first primary side to the second primary side. So, there is a smooth transition of the corrugations from first to second primary side and vice versa.

[0010] Preferably, the first angle is larger than the second angle.

[0011] Preferably, the first angle is in the range of 50° to 70°. More specifically, the first angle might be 55°, 60°, or 65°.

[0012] Preferably, the second angle is in the range of 30° to 60°. More specifically, the second angle might be 35°, 40°, 45°, 50°, or 55°.

[0013] Preferably, the portholes comprising a first porthole, a second porthole, a third porthole and a fourth porthole, and wherein the transition area is concentric with the first porthole. This gives a radius with no sharp change of direction of the corrugations over the entire plate, which leads to a good distribution of the fluid with low disturbance of the flow.

[0014] Preferably, the first porthole and the third porthole have the same diameter and wherein the second porthole and the fourth porthole have the same diameter and wherein the first and third portholes have a larger diameter than the second and fourth portholes.

[0015] Preferably, the distance between the two primary sides is maximum 90 mm.

[0016] Preferably, the distance between the two primary sides is maximum 45 mm.

[0017] According to a second aspect of the present invention there is provided a plate heat exchanger comprising first heat exchanger plates and second heat exchanger plates arranged side by side, first plate interspaces for a first fluid, each first plate interspace being formed by one of the first heat exchanger plates and an adjacent one of the second heat exchanger plates, and second plate interspaces for a second fluid, each second plate interspace being formed by one of the second heat exchanger plates and an adjacent one of the first heat exchanger plates, at least one of the first heat exchanger plates is a heat exchanger plate according to the first aspect.

[0018] Preferably, the first and second heat exchanger plates are permanently joined to each other.

[0019] Preferably, the second heat exchanger plates are mirrored versions of the first heat exchanger plates.

[0020] Preferably, the first porthole and the third porthole communicate with the first plate interspaces, and wherein the second porthole and the fourth porthole communicate with the second plate interspaces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The present invention is now to be explained more closely through a description of various embodiments and with reference to the drawings attached hereto.

Fig 1 discloses schematically a top view of a heat exchanger plate according to an embodiment of the invention.

Fig 2A discloses schematically an enlarged view of fig 1.

Fig 2B discloses a cross section along line A-A' in fig 2A.

Fig 2C discloses a cross section along line B-B' in fig 2A.

Fig 3 discloses schematically a side view of a plate heat exchanger with at least one plate of the fig 1 embodiment.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0022] The plate heat exchanger may be configured to be operated as an evaporator or a condenser. However, the plate heat exchanger may also be used for other heat exchanging applications. Fig 3 discloses an embodiment of a plate heat exchanger, where first and second heat exchanger plates A, B are arranged side by side in such a way that first plate interspaces 3 for a first fluid and second plate interspaces 4 for a second fluid are formed. At least one of the first heat exchanger plates A may be a heat exchanger plate 1 as described in relation to figure 1.

[0023] In the application of the embodiment disclosed, the first fluid may be a heat carrying fluid, such as a dielectric fluid, and the second fluid may be water.

[0024] Fig 1 discloses a heat exchanger plate 1 having a corrugation of ridges and valleys and having a quadrilateral shape with two opposite parallel primary sides 5 and two opposite parallel secondary sides 6. In the embodiments disclosed the quadrilateral shape is rectangular with rounded corners, wherein the primary sides 5 form long sides, and the secondary sides 6 form short sides. The plate comprises a first primary side 5a and a second primary side 5b. The heat exchanger plate comprising a heat exchanger area extending in parallel with the extension plane.

[0025] A longitudinal central axis x extends through the secondary sides 6 and is parallel with the primary sides 5. The longitudinal central axis x is parallel with the extension plane of each of the first and second heat exchanger plates A, B (fig 3).

[0026] The heat exchanger plate 1 has a first porthole 11, a second porthole 12, a third porthole 13 and a fourth porthole 14. Two of the four portholes are located close to the secondary side, the other two portholes are located close to the opposite secondary side. The second porthole 12 is located closer to the corner of the plate than the first porthole 11. The fourth porthole 14 is located closer to the corner of the plate than the third porthole 13.

[0027] In a package of heat exchanger plates the portholes may be grouped as 11 and 12 being used as inlet portholes for a first fluid and a second fluid, respectively. Portholes 13 and 14 are then used as outlet portholes for a first fluid and a second fluid, respectively. The first porthole 11 being an inlet and the third porthole 13 being an outlet for a first fluid, wherein these two portholes have the same diameter. The second porthole 12 being an inlet and the fourth porthole 14 being an outlet for a second fluid, wherein these two portholes have the same diameter and which diameter is smaller than the portholes for the first fluid. The first and third portholes 11, 13 are arranged in a recessed heat plate area. The first and second fluids may also be directed in the opposite direction through the heat exchanger plate package, so that the first porthole 11 is an outlet and the third porthole 13 is an inlet for a first fluid, and the second porthole 12 is an outlet and the fourth porthole 14 is an inlet for a second fluid.

[0028] The heat exchanger plate 1 has a configuration that is rather elongated where the primary sides 5 have a length that is more than four times the length of the secondary sides 6.

[0029] Fig 2A discloses the heat exchanger plate 1 in the vicinity of the first and the second inlet portholes 11, 12 having a corrugation of ridges 8a, 8b and valleys 9a, 9b. The ridges and valleys have a constant width along their extension, from one first primary side 5a to a second primary side 5b. A first set of ridges 8a and a first set of

valleys 9a are located close to the first primary side 5a and a second set of ridges 8b and a second set of valleys 9b are located close to the second primary side 5b. The first inlet porthole 11 is closer to the first primary side 5a and the second inlet porthole 12 is closer to the second primary side 5b.

[0030] The ridges 8a, 8b and valleys 9a, 9b have an inclination in relation to the primary side 5a, 5b, respectively (the primary sides being parallel to the longitudinal central axis x). The first set of ridges 8a and valleys 9a incline with a first angle α in relation to the first primary side 5a. The second set of ridges 8b and valleys 9b incline with a second angle β in relation to the second primary side 5b. The first angle α is larger than the second angle β. The first angle α is in the range of 50° to 70°, or a value there between such as 55°, 60°, or 65°. The second angle β is in the range of 30° to 60°, or a value there between such as 35°, 40°, 45°, 50°, or 55°.

[0031] A transition area 10 is defined where the first set of ridges 8a and valleys 9a meet the second set of ridges 8b and valleys 9b. The curvature of the ridges and valleys in the transition area 10 is concentric with the first porthole 11.

[0032] The corrugation of ridges 8a, 8b and valleys 9a, 9b extends between a top plane and a bottom plane. The top plane and bottom plane are parallel with each other and with the extension plan. The ridges extend along the top plane and the valleys extend along the bottom plane.

[0033] Fig 2B discloses a cross section taken along line A-A' in fig 2A and depicting top plane of the first set of ridges 8a and the bottom plane of the first set of valleys 9a. The second set of ridges 8b and valleys 9b has a corresponding cross-sectional profile.

[0034] Fig 2C discloses a cross section taken along line B-B' in fig 2A wherein the first and the second portholes 11, 12 are disclosed to be located in different planes.

[0035] Fig 3 discloses a plate heat exchanger comprising a plurality of first heat exchanger plates A and a plurality of second heat exchanger plates B arranged beside each other in an alternating order in the plate heat exchanger. The side view is taken as a cross section through the center of the second and the fourth portholes 12, 14 with a cut parallel to the longitudinal central axis x.

[0036] As can be seen in fig 3, each of the first plate interspaces 3 is formed by one of the first heat exchanger plates A and an adjacent one of the second heat exchanger plates B. Each of the second plate interspaces 4 is formed by one of the second heat exchanger plates B and an adjacent one of the first heat exchanger plates A.

[0037] The first and second plate interspaces 3, 4 are arranged beside each other in an alternating order. A first inlet channel connected to the first inlet porthole and a first outlet channel connected to the first outlet porthole communicate with the fist plate interspaces 3 in order to supply the first fluid to the first plate interspaces 3 and to discharge the first fluid from the first plate interspaces 3. The second inlet channel connected to the first inlet porthole and a second outlet channel connected to the second outlet porthole communicate with the second plate interspaces 4 in order to supply the second fluid to the second plate interspaces 4 and to discharge the second fluid from the second plate interspaces 4.

[0038] In the embodiments disclosed, the first and second heat exchanger plates A, B are permanently joined to each other, preferably brazed to each other. The first and second heat exchanger plates A, B may however be mounted together in other ways, for instance be means of tie bolts.

[0039] The flange of the edge area of one of the first heat exchanger plates A may be joined to the corresponding flange of the edge area of an adjacent one of the second heat exchanger plates B.

[0040] As mentioned above, the embodiment disclosed refers to an evaporator. According to another embodiment, the heat exchanger plate and the plate heat exchanger may be used as a condenser.

[0041] The embodiments disclosed and discussed above are configured for counter-current flow of the first and second fluids. However, the embodiments may alternatively be configured for co-current flow of the first and second fluids, wherein, for instance, the first outlet channel forms an inlet for the first fluid, and the first inlet channel forms an outlet for the first fluid.

[0042] The present invention is not limited to the embodiments disclosed but may be modified and varied within the scope of the following claims.

Claims

1. A heat exchanger plate (1) for a plate heat exchanger for heat exchange between at least a first fluid and a second fluid, the heat exchanger plate (1) having a quadrilateral shape with two opposite parallel primary sides (5) and two opposite parallel secondary sides (6), and a longitudinal central axis (x) being parallel with the primary sides (5), the heat exchanger plate (1) comprising

   a heat exchanging area having a corrugation of ridges and valleys having a longitudinal extension defining an inclination in relation to the longitudinal central axis (x),
   four portholes (11, 12, 13, 14), of which at least two are located at a respective corner of the heat exchanger plate (1) extending through the heat exchanger plate (1),

   characterized in a first set of ridges (8a) and valleys (9a) and a second set of ridges (8b) and valleys (9b), wherein the longitudinal extension of the first set of ridges and valleys (8a, 9a) define a first angle (a) in relation to a first primary side (5a) and the longitudinal extension of the second set of ridges and valleys

(8b, 9b) define a second angle (β) in relation to a second primary side (5b), wherein an intersection between the first set of ridges and valleys (8a, 9a) and the second set of ridges and valleys (8b, 9b) being defined as a transition area (10) comprising a curvature of ridges and valleys being concentric with a porthole.

2. The heat exchanger plate according to claim 1, wherein the ridges (8a, 8b) and valleys (9a, 9b) are extending continuously from the first primary side (5a) to the second primary side (5b).

3. The heat exchanger plate according to any one of claims 1 or 2, wherein the first angle (a) is larger than the second angle (β).

4. The heat exchanger plate according to any one of claims 1 to 3, wherein the first angle (a) is in the range of 50° to 70°.

5. The heat exchanger plate according to any one of the preceding claims, wherein the second angle (β) is in the range of 30° to 60°.

6. The heat exchanger plate according to any one of the preceding claims, wherein the portholes comprising a first porthole (11), a second porthole (12), a third porthole (13) and a fourth porthole (14), and wherein the transition area (10) is concentric with the first porthole (11).

7. The heat exchanger plate according to claim 6, wherein the first porthole (11) and the third porthole (13) have the same diameter and wherein the second porthole (12) and the fourth porthole (14) have the same diameter and wherein the first and third portholes (11, 13) have a larger diameter than the second and fourth portholes (12, 14).

8. The heat exchanger plate according to any one of the preceding claims, wherein the distance between the two primary sides (6) is maximum 90 mm.

9. The heat exchanger plate according to any one of the preceding claims, wherein the distance between the two primary sides (6) is maximum 45 mm.

10. A plate heat exchanger comprising

first heat exchanger plates (A) and second heat exchanger plates (B) arranged side by side,
first plate interspaces (3) for a first fluid, each first plate interspace (3) being formed by one of the first heat exchanger plates (A) and an adjacent one of the second heat exchanger plates (B), and
second plate interspaces (4) for a second fluid, each second plate interspace (4) being formed by one of the second heat exchanger plates (B) and an adjacent one of the first heat exchanger plates (A),
characterized in that at least one of the first heat exchanger plates (A) is a heat exchanger plate (1) according to any one of the preceding claims.

11. The plate heat exchanger according to claim 10, wherein the first and second heat exchanger plates (A, B) are permanently joined to each other.

12. The plate heat exchanger according to any one of claims 10 or 11, wherein the second heat exchanger plates (B) are mirrored versions of the first heat exchanger plates (A).

13. The plate heat exchanger according to claim 11, wherein the first porthole (11) and the third porthole (13) communicate with the first plate interspaces (3), and wherein the second porthole (12) and the fourth porthole (14) communicate with the second plate interspaces (4).

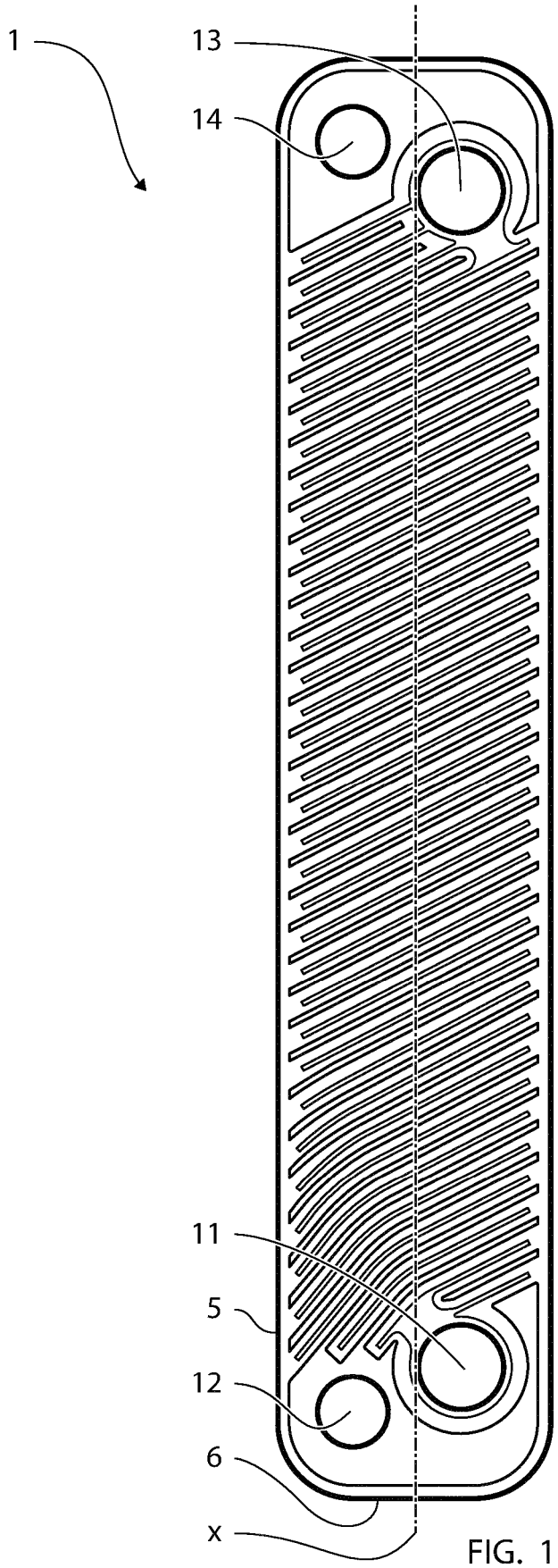

FIG. 1

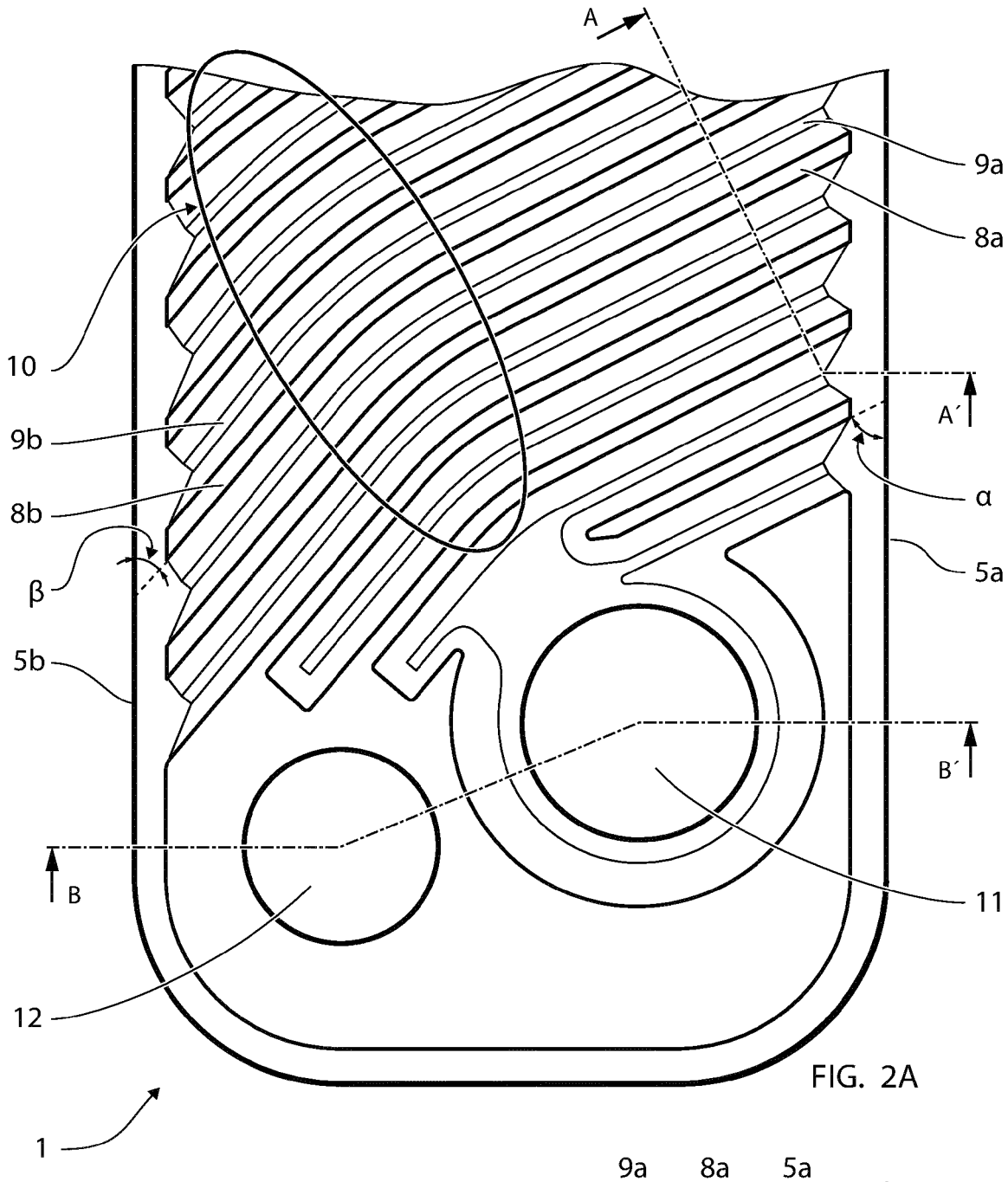

FIG. 2A

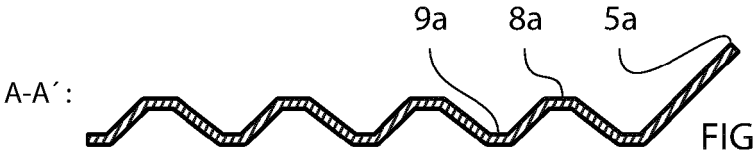

FIG. 2B

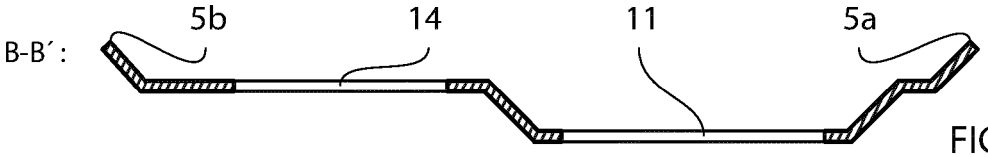

FIG. 2C

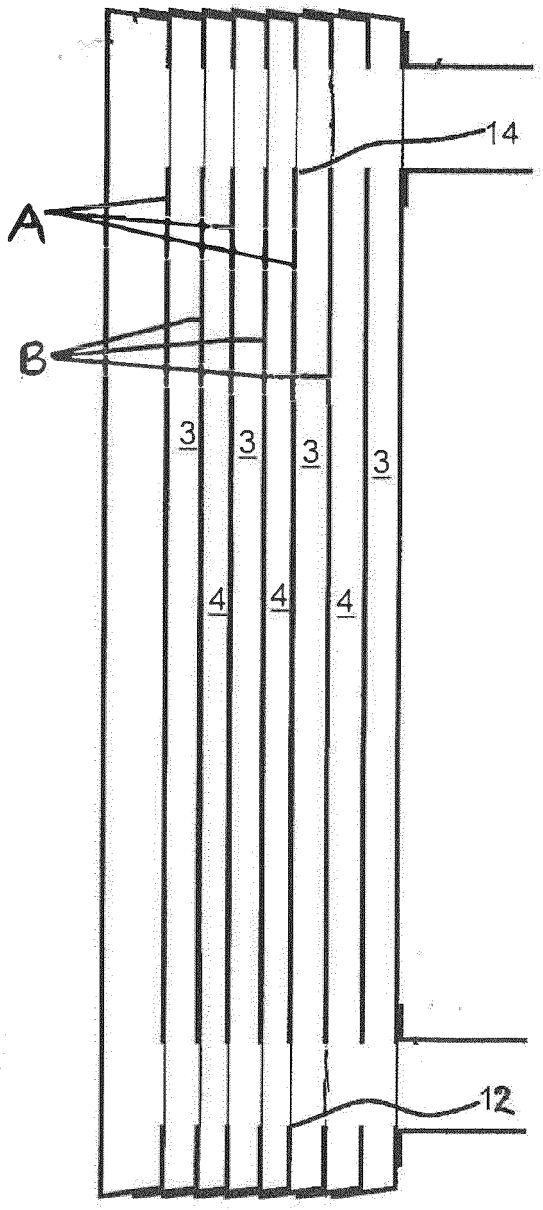

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 4918

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TECHNICAL FIELDS SEARCHED (IPC)

F28D
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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
Munich	15 March 2023	Axters, Michael

CATEGORY OF CITED DOCUMENTS

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