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(54) PLATE-AND-SHELL HEAT EXCHANGER AND A HEAT TRANSFER PLATE FOR A PLATE-AND-SHELL HEAT EXCHANGER

(57) A plate-and-shell heat exchanger comprising a shell and a plurality of heat transfer plates within the shell, said plates forming fluidly connected first cavities for providing a first fluid flow path for a first fluid flow and the shell forming a second cavity in which the plates are arranged and providing a second fluid flow path for a second fluid flow separated from the first fluid flow path by the plates, wherein the first fluid flow path leads through inlet and outlet plate openings between adjacent plates and the second fluid flow path leads through second inlet and outlet openings of the shell, wherein an opening is positioned in a first distribution area, and were a central transferring regions extend between the openings, wherein a furrow is formed between the central heat transferring region and the first distribution area.7

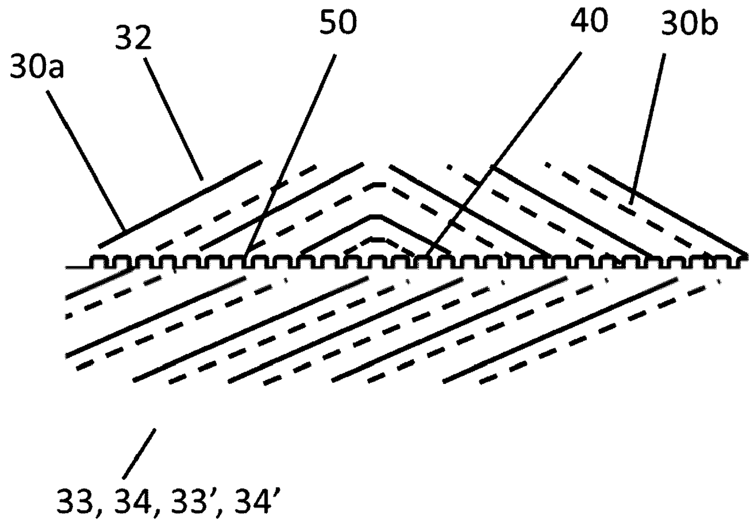

Fig. 5

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Description

BACKGROUND

[0001] The present invention relates to a plate-and-shell heat exchanger and a heat transfer plate for a plate-and-shell heat exchanger.

[0002] Plate-and-shell heat exchangers comprise a plurality of stacked structured plates positioned within a shell or casing. The plates are connected in pairs such that a first fluid flow path for a first fluid is provided at least partially within the connected pairs of plates. The pairs of connected plates are designed to fluidly connect a first inlet opening to a first outlet opening of the heat exchanger, thereby forming the first fluid flow path. A second fluid flow path for a second fluid is provided outside of the connected pairs of plates and separated from the first fluid flow path by the plates. The second fluid flow path fluidly connects a second inlet opening to a second outlet opening.

[0003] The second fluid enters the shell of the heat exchanger through the second inlet opening, flows along the complex second fluid flow path inside the shell and out through the second outlet opening. As the second fluid enters the shell of the heat exchanger it undergoes a complex change from a tubular or cylindrical flow through e.g. a pipe into a branched flow past the various components of the inside of the heat exchanger.

[0004] Depending on the inside layout of the heat exchanger, the first and second fluid flows may be obstructed in some regions and/or guided in a non-uniform way, such that the heat transfer rate between the two fluids inside the heat exchanger is reduced. Further, the pressures, such as in the area of the openings and in the centre flow sections of the plates may be significant, and thus it is a goal to make a better pressure distribution over the plates.

[0005] The problem of the present invention's is how to enhance the heat exchanger efficiency.

SUMMARY OF THE INVENTION

[0006] This problem is solved according to the features as given in the claims.

[0007] This includes introducing a plate-and-shell heat exchanger comprising a shell and a plurality of heat transfer plates within the shell, where the plates form fluidly connected first cavities for providing a first fluid flow path for a first fluid flow and where the shell form a second cavity in which the plates are arranged and providing a second fluid flow path for a second fluid flow separated from the first fluid flow path by the plates, wherein the first fluid flow path leads through inlet and outlet plate openings between adjacent plates and the second fluid flow path leads through second inlet and outlet openings of the shell, wherein an opening is positioned in a first distribution area, and were a central transferring regions extend between the openings, wherein a furrow is formed between the central heat transferring region and the first distribution area.

[0008] The central transferring regions may be formed with a corrugated pattern and the first distribution area may be formed with a first distribution corrugated pattern.

[0009] In an embodiment neither the first distribution corrugations or the central heat transferring region corrugations cross the furrow to extend between the central heat transferring region and the first distribution area.

[0010] The furrow may be formed with a reinforcement pattern.

[0011] The reinforcement pattern may be formed as reinforcement corrugations with a series of parallel ridges and grooves extending in the direction a line P being perpendicular to the length direction L of the furrow.

[0012] The reinforcement corrugations may reach across the furrow connecting the respective first distribution area to the central heat transferring region.

[0013] The reinforcement corrugations may be narrower than the corrugations in the respective first distribution area and the central heat transferring region.

[0014] The furrow may be formed with a section where at least one reinforcement corrugation merges one or both ends of a top or bottom into a top or bottom of a corrugation in the respective first distribution area and the central heat transferring region.

[0015] The furrow may be formed with a section where at least one reinforcement corrugation merges one or both ends of a top or bottom connection to a bottom or top of a corrugation in the respective first distribution area and the central heat transferring region.

[0016] The furrow may be formed with a section where at least one reinforcement corrugation merges one or both ends of a top or bottom of into the side wall connecting a top and bottom of a corrugation in the respective first distribution area and the central heat transferring region.

[0017] The second opening may be formed in a second distribution area and where a furrow as in any of the previous claims is formed in connection to the second opening and second distribution area the same manner as the furrow in relation to the first opening of the previous claims.

[0018] The corrugations may be lower than the corrugations in the respective first and/or second distribution areas and the central heat transferring region.

[0019] The distribution furrow could extend across the whole of the plate from rim to rim.

[0020] The furrow may be formed of a first part and a second part, each extending from the rim of the of opening to the rim of the plate.

[0021] The opening in the area between the first furrow part and second furrow part may be in direct fluidic contact with the central heat transferring region.

FIGURES

[0022]

Fig. 1A and 1B Illustration of a plate-and-shell heat exchanger.

Fig. 2A and 2B A plate for a plate pair and a side view of a stack of plate pairs in a plate-and-shell heat exchanger.

Fig. 3 Illustration of the flows at the opposing sides of the plates.

Fig. 4A and 4B Plates for a plate and-shell heat exchanger according to the present invention.

Fig. 5 A distribution furrow separating areas of the plate according to the present invention.

Fig. 6 Reinforcement corrugations of the distribution furrow according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Figure 1a shows an exploded view of a plate-and-shell heat exchanger 100. The heat exchanger 100 comprises a shell 20 and a plurality of sealed pairs of heat transfer plates 10 within the shell 20.

[0024] The shell 20 may be of a hollow cylindrical shape and the plates 10 may be of a corresponding shape and size such that they can be fit into the shell 20. Other shapes of the shell 20 and plates 10 are also possible, however shapes are preferred, which allow for a substantially close positioning of the plates 10 within the shell 20.

[0025] The plates 10 in the pairs are in the heat transfer sections 32 contacting each other by intersecting patterns 30. This forms fluidly connected first cavities 11 for providing a first fluid flow path 12 for a first fluid flow indicated by the corresponding arrows. The first fluid flow enters and leaves the heat exchanger through first inlet and outlet openings 23, 23'. The first cavities 11 are surrounded by two adjacent plates 10, which are connected to each other, as is shown more clearly in figure 1b and as will be described below in more detail. Figure 1b shows the heat exchanger 100 in a sectional view and in an assembled state.

[0026] The plates 10 in the pairs may be connected e. g. by welding or brazing at their rims 14A, possible also at the connected intersecting patterns 30. Two and two this forms first cavities 11 for a sealed first fluid flow path 12 from a first inlet opening 23 to a first outlet opening 23'.

[0027] The plates 10 comprise plate openings 13, 13' for connecting fluidly adjacent plates 10 to each other and to the first inlet and outlet opening 23, 23'. The two adjacent plates 10 of two connected pairs may be connected and sealed together by e.g. a welding or brazing along the edge of the plate openings 13, 13'.

[0028] A second fluid flow path 22 is formed at the outside surfaces of the plates 10 by the connected patterns 30 projecting outwardly relative to the first cavities 11 of the connected pairs of plates 10, thus at the opposite side of the plates 10. The second fluid flow path 22 thus is formed outside of the sealed pairs of plates 10 and inside of the shell 20 and is connected to second inlet and outlet openings 24, 24'. A second fluid flow enters and leaves the heat exchanger 100 through second inlet and outlet openings 24, 24'.

[0029] The shell 20 forms a second cavity 21 in which the plates 10 are arranged and in which a second fluid flow path 22 for a second fluid flow is provided. The second fluid flow enters and leaves the heat exchanger 100 through second inlet and outlet openings 24, 24'.

[0030] The first flow path 12 and second fluid flow path 22 are separated and sealed from each other respectively by the plate pairs connected at the rims 14a and the pairs being connected by being connected at their rim 14b of the openings 13, 13'. The heat exchange occurs between the two fluids flowing separated from each other by the plates 10.

[0031] Fluid for the first flow path 12 is sealed from the inside of the second cavity 21 inside the shell 20, and therefore the second flow paths 22, but each cavity 11 is fluidically contacted with the other cavities 11 of the connected plate 10 pairs in the stack by the openings 13. 13', and thereby also first inlets and outlets 23, 23'.

[0032] Fluid for the second flow path 22 is in fluid contact to the second cavity 21, and thereby the second inlets and outlets 24, 24', over the rims 14A of the plates 10, but is sealed from the cavities 11 as the two plates 10 in each pair is connected at their rims 14A and pairs are connected to neighbouring pairs at the (outer) rims 14B of the openings 13, 13'.

[0033] Figure 2a shows a detailed view of a heat transfer plate 10 of a prior art plate-and-shell heat exchanger 100. The plate 10 sheet is possibly made of metal.

[0034] The pattern 30 at the heat transfer sections 32 is seen as being corrugated having a series of parallel ridges and grooves. It may be formed by pressing the corrugations into a flat sheet preform. The plates 10 then are connected such that every second plate is turned, or formed, with the corrugated patterns 30 of neighbouring plates crossing each other rather than extending in parallel. The crossing points then forms the contacts of the plates 10 in the heat transfer sections.

[0035] Figure 2b shows a detailed sectional view of a plurality of connected heat transfer plates 10. Two adjacent plates 10 at their outer circumferences, in at the rims 14A of their outer edges. Thus, sealed pairs of connected plates 10 are provided for allowing the first fluid to flow through the first fluid flow path 12 bounded by the connected pairs of plates 10.

[0036] The second fluid flow path 22 is guided between two adjacent pairs of connected plates 10 and separated from the first fluid flow path 12 by the plates 10. It comprises flat, narrow channels between closely positioned plates 10. For efficient heat exchange, the second fluid flow rate in the vertical direction and between the pairs of connected plates 10 as shown in figure 2b is essential. This flow component corresponds in approximation to a radial or tangential component of the second fluid flow with respect to the shell 20.

[0037] Figure 3 is a schematic view of parts of the first and second fluid flow paths 12, 22 through the heat exchanger 100 along the heat transfer sections 32. The arrows at the one plate 10 indicates the first fluid flow path 12 inside a pair of connected plates 10. The fluid flow path 12 enters the pair of connected plates 10 through one of the two plate openings 13 and leaves the pair of connected plates 10 through the other of the two plate openings 13.

[0038] The second plate shows a part of the second fluid flow path 22 in a cross section of the heat exchanger 100. This time, not the inside of a pair of connected plates 10 is shown, but the space between two such connected pairs of plates 10. The second fluid flow path 22 fills the second cavity 21. The second cavity 21 is bounded by the inside of the shell 20, the outsides of the pairs of connected plates 10, one of which is shown in figure 3b and possibly further structures contained within the shell 20. The second flow path 22 enters the shell 20 through the second inlet and outlet openings 24, 24', which may be positioned on opposite sides of the shell surface.

[0039] Since a first fluid flow path 12 for a first fluid is formed at the one side of a plate 10, and a second fluid flow path 22 for a second fluid at the opposite side, the heat transfer between the first fluid in the first cavity 11 and the second fluid outside the first cavity 11 is hence facilitated over the plate 10.

[0040] To ensure a high efficiency of the heat exchanger 100 the fluids preferably should distribute sufficiently over the entire plates 10.

[0041] Figs. 4A and 4B illustrate an embodiment pair of plates 10A, 10B according to the present invention to be connected in a pair. Each plate comprises a pair of openings 13, 13' arranged opposite each other relative to a central heat transferring regions 32 formed corrugated patterns 30 and possible positioned near the rim 14A.

[0042] The corrugated pattern 30 in the central transferring regions 32 may be chevron shaped, W-shaped, straight parallel corrugations etc.

[0043] The first opening 13 is arranged in a first distribution area 33, 34 having a first distribution corrugated pattern 30.

[0044] The second opening 13' may be arranged in a second distribution area (33', 34') having a second distribution corrugated pattern 30.

[0045] A distribution furrow 40 may be formed in the connection of the first distribution area 33, 34 to the central heat transferring region 32, and may extend parallel to a line P being perpendicular to the line L reaching from the first opening 13 to the second opening 13', possible through the opening 13, 13' centres.

[0046] The first distribution pattern 30 in the first distribution area 33, 34 may be formed with differently to the corrugated pattern 30 in the central transferring region.

[0047] In the illustrated embodiment of fig. 4A the first plate 10A in a plate pair is formed a first part first distribution area 33 where the corrugations 30 extend from the rim portion 14A of the first part first distribution area 33 towards the central heat transferring region 32.

[0048] In the illustrated embodiment of fig. 4A the first plate 10A further is formed with a second part first distribution area 34 where the corrugations 30 extend from the rim portion 14A of the first part first distribution area 34 towards the central heat transferring region 32.

[0049] The first part first distribution area 33 and second part first distribution area 34 are positioned at opposite sides of the opening 13 and may be mirroring each other over opening 13 corresponding to the line L.

[0050] In general, the first part first distribution area 33 and second part first distribution area 34 are formed with different corrugations 30, where different, or opposite, may indicate they are oriented differently, or opposite to each other. As an explanation, in the illustrated preferred embodiment, the first part first distribution area 33 corrugations 30 incline downwards seen in the direction from the left towards the right along the line P, this being a first direction of inclination, whereas the second part first distribution area 34 is inclining in a second direction being in an upwards inclination in the direction from the left towards the right along the line P,

[0051] The first direction of inclination thus is opposite to the second direction of inclination.

[0052] In other wordings, defining the direction of angle to be counter-clockwise, the corrugations in the second part first distribution area 34 may have an angle relative to the line L in the range of 10 to 45 degrees, or in the range of 10 to 30 degrees. The corrugations in the first part first distribution area 33 may have an angle relative to the line L in the range of 135 to 170 degrees, or in the range of 150 to170 degrees.

[0053] In the illustrated embodiment of fig. 4A the first plate 10A in a plate pair is formed a first part second distribution area 33' where the corrugations 30 may extend from the central heat transferring region 32 to the rim 14B of the opening 13'. The corrugations 30 in first part first distribution area 33 may be inclined in the same orientation, or direction, as those in the second part first distribution area 33'. In the illustration they are inclined in the first direction of inclination.

[0054] In one embodiment they are parallel and in others they are inclined with slightly different angles of the first direction of inclination.

[0055] In the illustrated embodiment of fig. 4A the first plate 10A further is formed with a second part second distribution area 34' where the corrugations 30 may extend from the central heat transferring region 32 to the rim 14B of the opening 13'. The corrugations 30 in second part first distribution area 34 may be inclined relative to the line L with an inclination in the same orientation, or direction, as those in the second part second distribution area 34', such as illustrated with a second direction of inclination. In one embodiment they are parallel and in others they are inclined with slightly different angles.

[0056] The first part second distribution area 33' and second part second distribution area 34' are positioned at opposite sides of the opening 13' and may be mirroring each other over opening 13' corresponding to the line L.

[0057] In general, the first part second distribution area 33' and second part second distribution area 34' are formed with different corrugations 30, where different may indicate they are oriented different.

[0058] The corrugations 30 in the second part second distribution area 34' may have an angle relative to the line L in the range of 10 to 45 degrees, or in the range of 10 to 30 degrees. The corrugations in the first part second distribution area 33' may have an angle relative to the line L in the range of 135 to 170 degrees, or in the range of 150 to170 degrees.

[0059] Fig. 4B shows the second plate 10B in the pair. The second plate 10B may be like the plate 10A of fig. 4A, only turned 180 degrees, or it may be formed differently. The first plate 10A in the pair is aligned with the second plate 10B such that:

- a first part first distribution area 33 is aligned with second part second distribution area 34', and/or
- a second part first distribution area 34 is aligned with first part second distribution area 33', and/or
- a first part second distribution area 33' is aligned with a first part second distribution area 34, and/or
- a second part second distribution area 34' is aligned with a first part first distribution area 33.

[0060] This construction of the pair of plates 10A, 10B ensure their connection by intersecting corrugations 30 in the distribution areas 33, 34, 33', 34', and at the same time defines respectively the first flow path 12 and the second flow path 22 when a stack of pairs is formed.

[0061] Further in relation to the first flow path 12, for each opening 13, 13' the corrugations of one of the plates 10A, 10B are arranged such as to respectively assist fluid distributing from the inlet opening 13 to the full width of the plate 10A, 10B, and at the other end, assist fluid being directed into the outlet opening 13'. This also helps lowering the pressures in the first flow path 12.

[0062] Further, for the second flow path 22 where fluid enters and leaves over the rim 14A of the plates 10A, 10B, such as in the area of the openings 13, 13', the corrugations of one of the plates 10A, 10B are arranged such as to respectively assist fluid distributing to the full width of the plate 10A, 10B, and at the other end, assist fluid being directed out of the second flow paths 22. This also helps lowering the pressures in the second flow path 22.

[0063] The pressure distribution furrow 40 could extend across the whole of the plates 10A, 10B from a rim 14A to an opposite rim 14A, or as in the illustrated embodiment, it may be formed of a first part 41 and a second part 42, each extending from the rim 14B of opening 13, 13' to the rim 14A of the plate 10A, 10B, parallel to the line P.

[0064] At the area 43 between the first furrow part 41 and second furrow part 42, the opening may be in direct fluidic contact with the central heat transferring region 32. In this embodiment, the pressure distribution furrow 40 assists in directing the fluid respectively directly from or to the opening 13, 13' to the full width of the plates 10A, 10B where this in addition reduces the pressures in the areas of the openings 13, 13'.

[0065] In another more preferred embodiment, a sealing 44 is formed in the area between the from the central heat transferring region 32 and at least one of the openings 13, 13' thus forcing the fluids entering towards the sides of the plates 10A, 10B when entering the inlet of the respective openings 13, 13', and correspondingly being directed from the heat central transferring region 32 towards the outlet of the respective openings 13, 13'. In an embodiment a sealing 44 is formed in connection to each opening 13, 13'. The sealing(s) may be formed as projections in the plate 10A, 10B formed in the section between the opening 13, 13' and the central heat transferring region 32 and connected to a similar projection of the connected plate 10A, 10B forming the flow barrier. The sealing 44 projection may be semi-circular covering the opening 13, 13' edge towards the central heat transferring region 32.

[0066] In one embodiment the sealing 44 is formed in the area 43 between the first furrow part 41 and second furrow part 42, possible connecting to them.

[0067] In the illustration of fig. 4A the sealings 44 of plate 10A is marked as white to illustrate an upwards projection, whereas in fig. 4b, where the plate 10B is turned with the opposite side up, the black sealings 44 illustrate a downwards projection. When the plate 10B is positioned on the plate 10A the respective projections 44 will align to form the sealing.

[0068] Alternatively, a sealing element is positioned in the position possible in some groove formed or fixed in position otherwise.

[0069] The furrow 40 is formed between the central heat transferring region 32 and respectively the first 33, 33' and second 34, 34' distribution areas. The corrugations (30, 30a, 30b) therefore does not extend between the central heat transferring region 32 and respectively the first 33, 33' and second 34, 34' distribution areas. In the illustration of figs. 5 and 6 corrugation tops 30a are illustrated as solid lines, whereas corrugation bottoms 30b are illustrated as dashed lines.

[0070] To increase strength of the furrow 40, it may be formed with a reinforcement pattern 50. One such embodiment is seen in fig. 5, where this pattern forms reinforcement corrugations with a series of parallel ridges and grooves extending in the direction of the line P along the length direction L of the furrow 40. The reinforcement corrugations 50 reach across the furrow 40 connecting the respective first 33, 33' and second 34, 34' distribution area to the central heat transferring region 32.

[0071] In some sections 51 the reinforcement corrugations 50 top or bottom merges into a top a corrugation 30 in the respective first 33, 33' and second 34, 34' distribution area. See fig. 6.

[0072] In some sections 52 the reinforcement corrugations 50 top or bottom ends in connection to a bottom of a corrugation 30 in the respective first 33, 33' and second 34, 34' distribution area.

[0073] In some sections 53 the reinforcement corrugations 50 top or bottom of merges into the side wall connecting a top and bottom of a corrugation 30 in the respective first 33, 33' and second 34, 34' distribution area.

[0074] The reinforcement furrow 40 may be formed with all kinds of sections 51, 52 and 53, or with only one kind of either section 51, 52, 53, or with the sections 51 and 52, or sections 51 and 53, or sections 52 and 53.

[0075] The reinforcement corrugations 50 may extend continuous along the length of the furrow 40 or may be positioned in sections having flat section (top or bottom) between the sections.

[0076] The reinforcement corrugations 50 may be significantly narrower than the corrugations 30 in the respective first 33, 33' and second 34, 34' distribution areas and the central heat transferring region 32. By narrower is meant the distance from top to top (respective bottom to bottom) is significantly smaller. This automatically enables the different sections 51, 52 and/or 53 along the furrow 40.

[0077] The reinforcement corrugations 50 may be lower than the corrugations 30 in the respective first 33, 33' and second 34, 34' distribution areas and the central heat transferring region 32. Thereby they are not contacting the corresponding reinforcement corrugations 50 in the neighbouring plates 10, 10A, 10B, thus enabling the flow and pressure distribution over the furrows 40.

[0078] The furrows 40 is part of the border of the respective first 33, 33' and second 34, 34' distribution areas, these thus being bordered respectively by a furrow 40, opening 13, 13' and a rim 14A section.

[0079] In an embodiment the furrows 40 merge into the projection 44.

Claims

1. A plate-and-shell heat exchanger (100) comprising a shell (20) and a plurality of heat transfer plates (10A, 10B) within the shell (20), said plates (10A, 10B) forming fluidly connected first cavities (11) for providing a first fluid flow path (12) for a first fluid flow and the shell (20) forming a second cavity (21) in which the plates (10) are arranged and providing a second fluid flow path (22) for a second fluid flow separated from the first fluid flow path (12) by the plates (10), wherein the first fluid flow path (12) leads through inlet and outlet plate openings (13, 13') between adjacent plates (10A, 10B) and the second fluid flow path (22) leads through second inlet and outlet openings (24, 24') of the shell (20), wherein an opening (13, 13') is positioned in a first distribution area (33, 34), and were a central transferring regions (32) extend between the openings (13, 13'), wherein a furrow (40) is formed between the central heat transferring region (32) and the first (33, 34) distribution area.

2. A plate-and-shell heat exchanger (100) according to claim 1, wherein the central transferring regions (32) is formed with a corrugated pattern (30) and the first distribution area (33, 34) is formed with a first distribution corrugated pattern (30).

3. A plate-and-shell heat exchanger (100) according to claim 2, wherein neither the first distribution corrugations (30) or the central heat transferring region (32) corrugations (30) cross the furrow (40) to extend between the central heat transferring region (32) and the first (33, 34) distribution area.

4. A plate-and-shell heat exchanger (100) according to claim 3, wherein the furrow (40) is formed with a reinforcement pattern (50).

5. A plate-and-shell heat exchanger (100) according to claim 4, where the reinforcement pattern (50) is formed as reinforcement corrugations with a series of parallel ridges and grooves extending in the direction a line P being perpendicular to the length direction L of the furrow (40).

6. A plate-and-shell heat exchanger (100) according to claim 4 or 5, wherein the reinforcement corrugations (50) reach across the furrow (40) connecting the respective first distribution area (33, 34) to the central heat transferring region (32).

7. A plate-and-shell heat exchanger (100) according to claim 4, 5 or 6, wherein the reinforcement corrugations (50) are narrower than the corrugations (30) in the respective first distribution area (33, 34) and the central heat transferring region (32).

8. A plate-and-shell heat exchanger (100) according to any of claims 4-7, where the furrow (40) is formed with a section (51) where at least one reinforcement corrugation (50) merges one or both ends of a top or bottom into a top or bottom of a corrugation (30) in the respective first distribution area (33, 34) and the central heat transferring region (32).

9. A plate-and-shell heat exchanger (100) according to any of claims 4-8, where the furrow (40) is formed with a section (52) where at least one reinforcement corrugation (50) merges one or both ends of a top or bottom connection to a bottom or top of a corru-

gation (30) in the respective first distribution area (33, 34) and the central heat transferring region (32).

10. A plate-and-shell heat exchanger (100) according to any of claims 4-9, where the furrow (40) is formed with a section (52) where at least one reinforcement corrugation (50) merges one or both ends of a top or bottom of into the side wall connecting a top and bottom of a corrugation (30) in the respective first distribution area (33, 34) and the central heat transferring region (32).

11. A plate-and-shell heat exchanger (100) where the second opening (13') is formed in a second distribution area (33', 34') and where a furrow (40) as in any of the previous claims is formed in connection to the second opening (13') and second distribution area (33', 34) the same manner as the furrow (40) in relation to the first opening (13) of the previous claims.

12. A plate-and-shell heat exchanger (100) according to any of the previous claims, where the corrugations (50) is lower than the corrugations (30) in the respective first (33, 33') and/or second (34, 34') distribution areas and the central heat transferring region (32).

13. A plate-and-shell heat exchanger (100) according to any of the previous claims, where the distribution furrow (40) could extend across the whole of the plate (10A, 10B) from rim (14A) to rim (14A).

14. A plate-and-shell heat exchanger (100) according to any of the previous claims, wherein the furrow (40) is formed of a first part (41) and a second part (42), each extending from the rim (14B) of the of opening (13, 13') to the rim (14A) of the plate (10A, 10B).

15. A plate-and-shell heat exchanger (100) according to claim 14, wherein the opening (13, 13') in the area (43) between the first furrow part (41) and second furrow part (42) is in direct fluidic contact with the central heat transferring region (32).

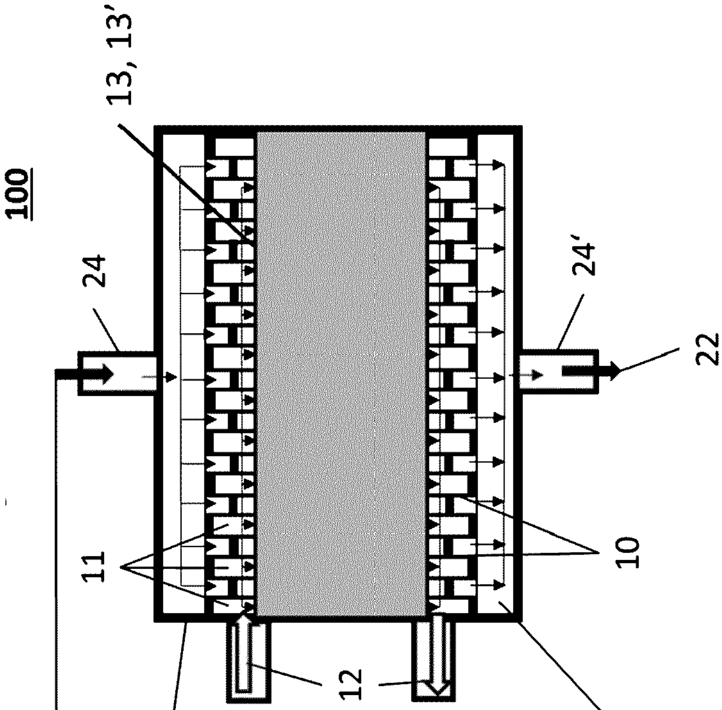
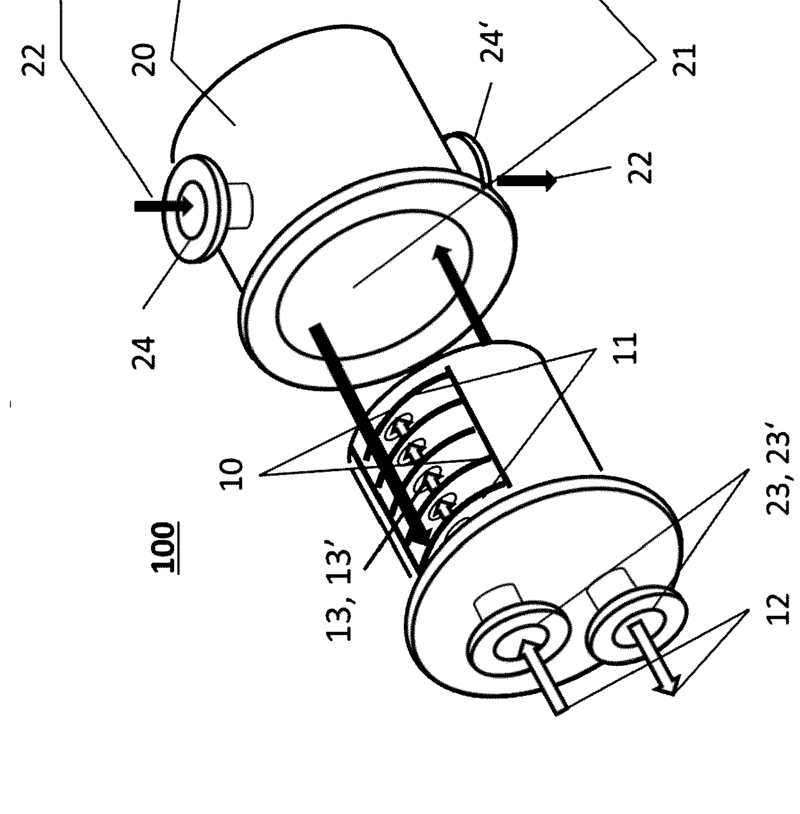

100
24
13, 13′
24′
22
11
10
12
12

Fig. 1b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23, 23′
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12

Fig. 1a

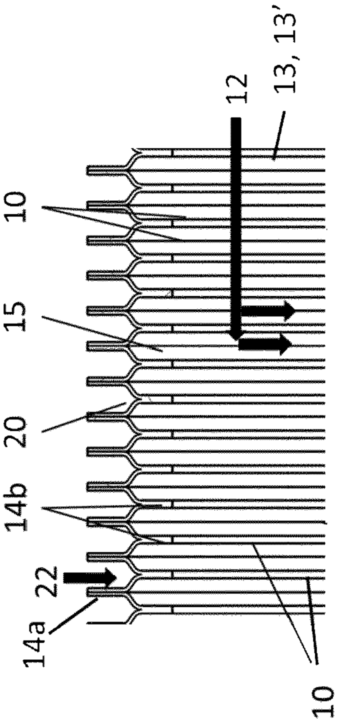

Fig. 2B

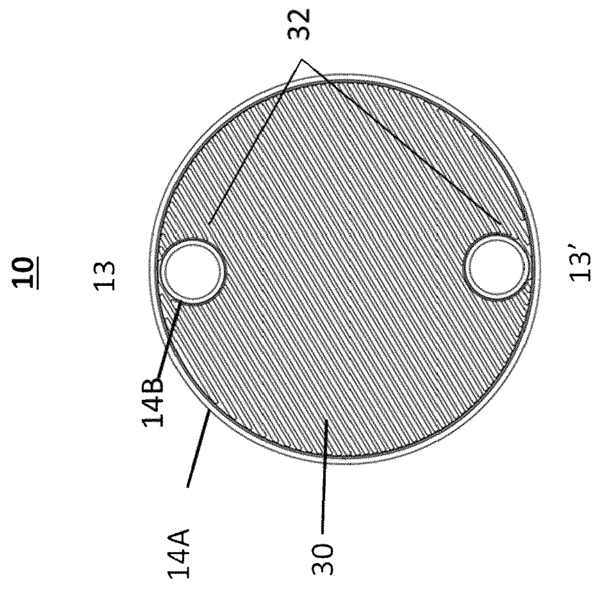

Fig. 2A

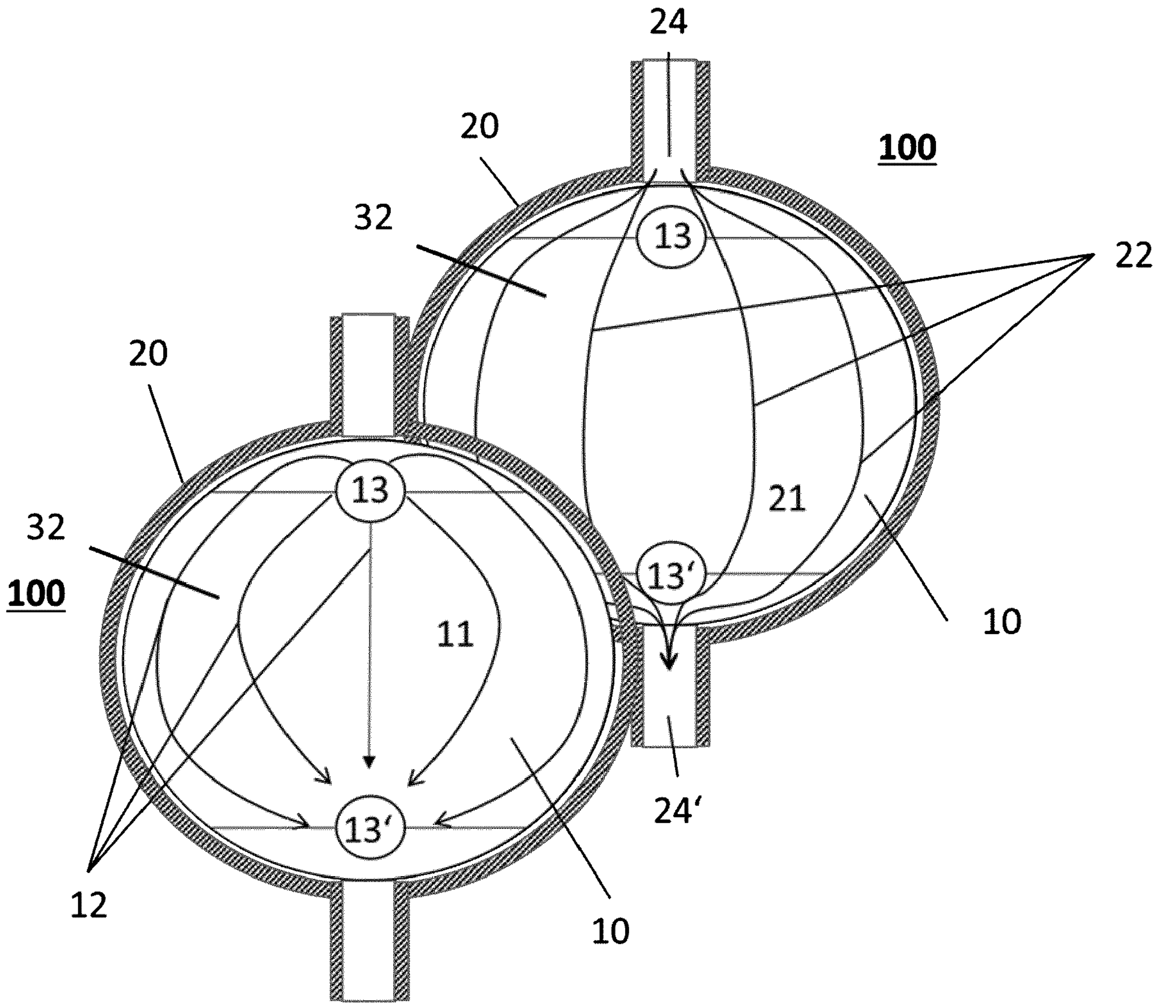

Fig. 3

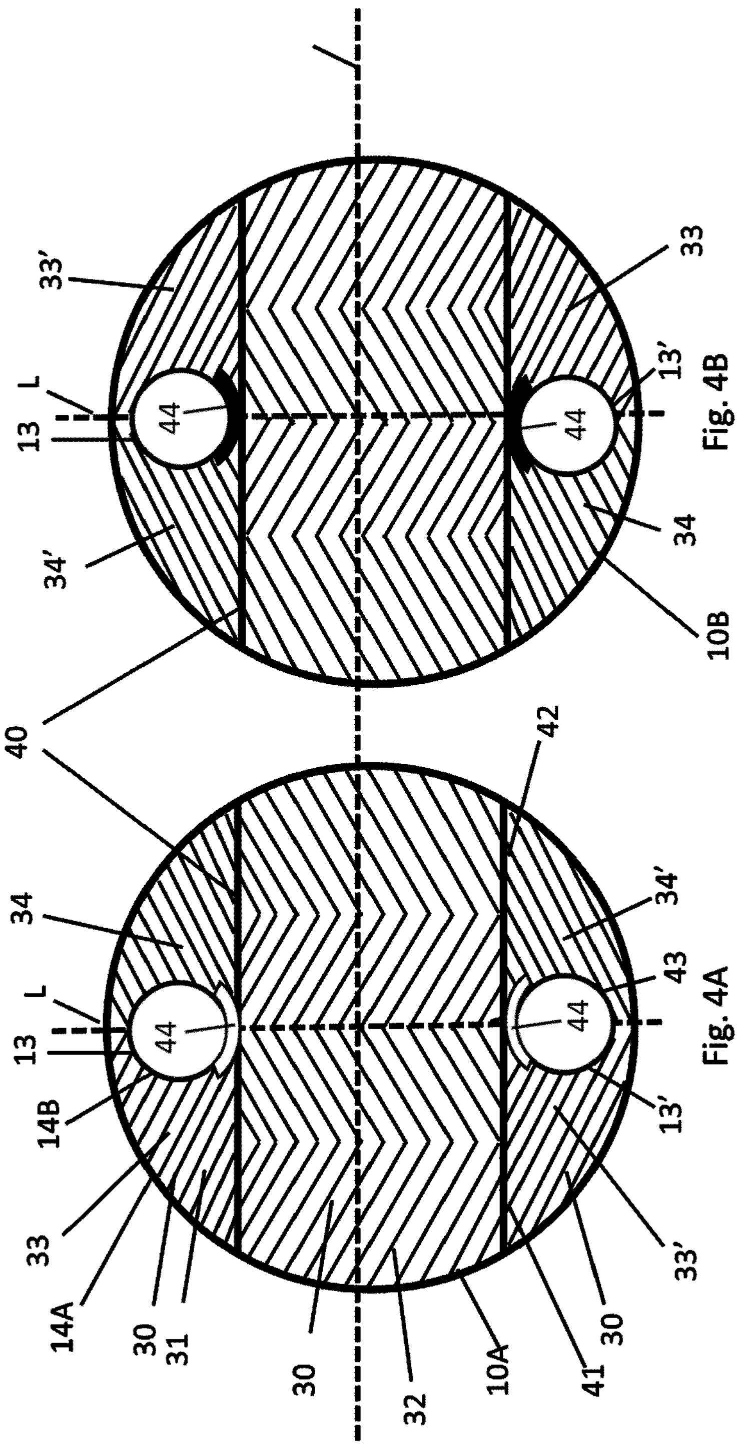

Fig. 4B

Fig. 4A

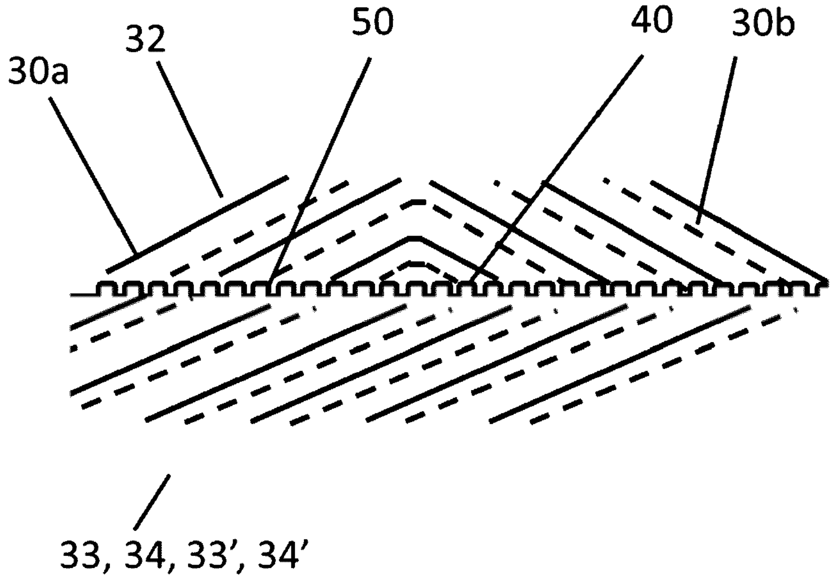

Fig. 5

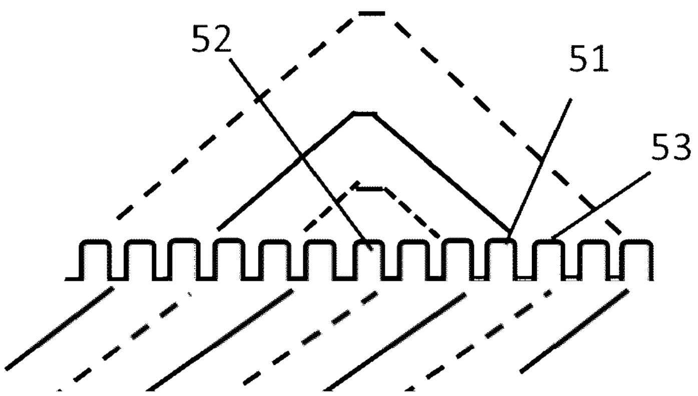

Fig. 6

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EUROPEAN SEARCH REPORT

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EP 21 20 8296

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	31 March 2022	Vassoille, Bruno

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