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(54) **A PLATE HEAT EXCHANGER**

PLATTENWÄRMETAUSCHER

ECHANGEUR THERMIQUE A PLAQUES

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Description

THE FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention refers to a plate heat exchanger according to the preamble of claim 1. Such a plate heat exchanger is disclosed in EP-B-1 456 593.

[0002] In many heat exchanger applications, it is desirable to achieve a high, or a very high, design pressure, i.e. to be able to permit a high or a very high pressure of one or both of the media flowing through the plate interspaces. It is also desirable to be able to permit such high pressures in plate heat exchangers of the kind defined above having permanently joined heat exchanger plates, e.g. through brazing. Such high design pressures are difficult to achieve without the provision of external strengthening components.

[0003] The strength of the brazed plate heat exchanger is at least partly defined by the joining areas between adjacent heat exchanger plates. The distribution of this joining areas is important in order to be able to provide a high design pressure. In prior art plate heat exchangers, the area along the centre line tend to include less joining areas than remaining parts of the heat transfer area due to the pattern of the ridges and valleys. The central area is therefore negatively affecting the total strength and the design pressure of the plate heat exchanger. This problem of less support in the area along the centre line is in particular accentuated in so called low theta pattern of ridges and valleys, where the angle of inclination of the ridges to the centre line is small.

[0004] One example of an application which requires very high design pressures is plate heat exchangers for evaporators and condensers in cooling circuits having carbon dioxide as a cooling agent. Carbon dioxide is in this context very advantageous from an environmental point of view in comparison with traditional cooling agents, such as freons.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is to provide a plate heat exchanger having a high design pressure, and more precisely a plate heat exchanger permitting a very high pressure of at least one of the media flowing therethrough. More specifically, the object is to improve the strength of the plate heat exchanger in an area along a central line of each heat exchanger plate.

[0006] This object is achieved by the plate heat exchanger initially defined, which is characterized in that that each connection part includes a projection extending along the centre line outwardly from the curved path and that projections of the connection parts form a respective central joining area at the centre line. By means of such a projection of the connection parts of the ridges, it is possible to locate the central joining areas so that these form a part of a uniform distribution of joining areas on the heat transfer area of each heat exchanger plate. The support points may thus also be uniformly distributed over the heat transfer area, which ensures a uniform strength of the plate heat exchanger. This is an important condition for achieving a high design pressure.

[0007] According to an embodiment of the invention, each connection part has a concave side and a convex side, and has a width, measured between the concave side and the convex side and wherein the width has a maximum value at the centre line. The width of the connection part thus has its maximum at the projection. The width thus decreases with an increasing distance from the central line.

[0008] According to a further embodiment of the invention, the joining areas, including the central joining area, are arranged along a plurality of transversal lines extending perpendicular to the centre line, wherein each central joining area is located on a respective one of the transversal lines. Advantageously, the connection parts may be configured in such a manner that the joining areas, including the central joining area, are equidistantly, or substantially equidistantly, located along the transversal line. In other words, the distance between the central joining area and an adjacent joining area is equal, or substantially equal, to the distance along the transversal line between any two adjacent joining areas.

[0009] According to a further embodiment of the invention, the projection is delimited by two opposite side lines and a forward front line, wherein the side lines are substantially straight and converge towards each other towards the front line.

[0010] According to a further embodiment of the invention, the angle α of inclination is equal to or greater than 10° and less than 45°. The pattern formed by a V-configuration of the heat transfer area is thus a so called low theta pattern, characterized by a relatively low heat transfer and a relatively low flow resistance. Advantageously, the angle α of inclination is less than 40°, less than 35°, or even less than 30°.

[0011] According to a further embodiment of the invention, the pattern of each heat exchanger plate has two distribution areas on a respective side of the heat transfer area, each distribution area surrounding two of the portholes. Advantageously, each distribution area may have ridges and valleys arranged in a V-configuration with a first part having a first extension line forming a positive angle α of inclination with the centre line at one side of the centre line, a second part having a second extension line forming a corresponding negative angle α of inclination with the centre line at the other side of the centre line, wherein the angle α of inclination is greater than 45°. The pattern formed by the V-configuration of the distribution areas is thus a so called high theta pattern, characterized by a relatively high heat transfer and a relatively high flow resistance. Such a high theta pattern contributes to an improved distribution of the media.

[0012] According to a further embodiment of the invention, said ridges and valleys, on one side of the heat exchanger plate, extend between a primary level at a distance from the main extension plane and a secondary level at a distance from and on an opposite side of the main extension plane, and wherein each heat exchanger plate has a depth defined by the distance between the primary level and the secondary level and being equal to or less than 1,0 mm. Such a small depth of the heat exchanger plates improves the strength of the plate and the plate heat exchanger. The small depth of the heat exchanger plates permits a small distance between the ridges and valleys, on the heat transfer area, and thus a small distance between the joining areas between adjacent heat exchanger plates. Consequently, a small depth results in a small distance between the joining areas, and thus in a large number of such joining areas over the heat transfer area.

[0013] According to a further embodiment of the invention, the ridges are disposed at a distance from and extend in parallel with each other, wherein the distance between adjacent ridges on the heat transfer area is less than 4 mm. Such a small distance between adjacent ridges is advantageous as explained above and contributes to a large number of joining areas at the heat transfer area. Advantageously, this distance may be approximately 3 mm.

[0014] According to a further embodiment of the invention, each heat exchanger plate, before the forming, has a metal sheet thickness t, which lies in the range $0,2 \leq t \leq 0,4$ mm.

[0015] According to a further embodiment of the invention, the braze material has a braze volume with respect to the heat transfer area of the plate heat exchanger, wherein the first interspaces and the second interspaces have an interspace volume with respect to the heat transfer area of the plate heat exchanger, and wherein the proportion of the braze volume to the interspace volume is at least 0,05. Such a relatively large volume of braze material enhances the strength of the joining between the heat exchanger plates, and thus the strength of the plate heat exchanger.

[0016] According to a further embodiment of the invention, the distribution areas comprise a first porthole, a second porthole, a third porthole, and a fourth porthole. Advantageously, every second heat exchanger plate 1 is rotated 180° in the main extension plane in the plate package.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will now be explained more closely by means of a description of various embodiments and with reference to the drawings attached hereto.

Fig. 1 shows a side view of a plate heat exchanger according to the invention.

Fig. 2 shows a plan view of the plate heat exchanger in Fig. 1.

Fig. 3 shows a plan view of a heat exchanger plate of the plate heat exchanger in Fig. 1.

Fig. 4 shows a cross-sectional view through some of the heat exchanger plates at a heat transfer area of the plate heat exchanger in Fig. 1.

Fig. 5 shows a plan view of a part of the heat transfer area of a heat exchanger plate in Fig. 3.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

[0018] Figs. 1 and 2 shows a plate heat exchanger comprising a plurality of heat exchanger plates 1, a first end plate 2, which is provided beside an outermost one of the heat exchanger plates 1, and a second end plate 3, which is provided beside the other opposite outermost heat exchanger plate 1.

[0019] The heat exchanger plates 1 are produced through forming of a metal sheet and provided beside each other. The first end plate 2, the second end plate 3 and the heat exchanger plates 1 are permanently joined to each other through brazing by means of a braze material to form a plate package. The plate package define or have first plate interspaces 4 for a first medium and second plate interspaces 5 for a second medium, see Fig. 4. The first and second medium may be any suitable heat transfer medium. For instance, the first and/or the second medium may be carbon dioxide.

[0020] The plate heat exchanger of the embodiments disclosed has four portholes S1, S2, S3 and S4, wherein the porthole S1 is connected to a connection pipe 11 and communicates with the first plate interspaces 4, the porthole S2 is connected to a connection pipe 12 and communicates with the first plate interspaces 4, the porthole S3 is connected to a connection pipe 13 and communicates with the second plate interspaces 5 and the porthole S4 is connected to a connection pipe 14 and communicates with the second plate interspaces 5. It is to be noted that the plate heat exchanger may have another number of portholes than those disclosed, e.g. 2, 3, 5, 6, 7 or 8 portholes. Connection pipes may be provided extending from the first end plate 2, as disclosed, and/or from the second end plate 3.

[0021] Each heat exchanger plate 1 has, in the embodiments disclosed, a rectangular shape with two long side edges 15 and two short side edges 16, see Fig. 3. A longitudinal centre axis x extends between and in parallel with the two long side edges 15 and transversely to the short side edges 16. Each heat exchanger plate 1 also extends along a main extension plane p, see Fig. 4. In the plate package, every second heat exchanger plate 1 is rotated 180° in the main extension plane p.

[0022] As can be seen from Fig. 3, each heat exchanger plate 1 has a heat transfer area 20, at which the main part of the heat transfer between the first and second media takes place, a first distribution area 21 and a second distribution area 22. In the embodiments disclosed, the first distribution area 21 comprises and surrounds a first porthole 23 and a second porthole 23. The second distribution area 22 comprises and surrounds a third porthole 23 and a fourth porthole 23. Each porthole 23 is defined by a porthole edge 25.

[0023] It is to be noted that the heat exchanger plate 1 according to another embodiment may be designed without separate distribution areas.

[0024] All of the areas 20-22 extend, on one side of the heat exchanger plate 1, between a primary level p' at a distance from the main extension plane p, and a secondary level p" at a distance from and on an opposite side of the main extension plane p, see Fig. 4. With respect to said one side of the heat exchanger plate 1, the primary level p' forms an upper level of the heat exchanger plate 1, and the secondary level p" forms a lower level of the heat exchanger plate 1 as can be seen in Fig. 4. The primary level p' is thus located more closely to the first end plate 2 than the secondary level p". Each heat exchanger plate 1 also has a flange 26 extending around the heat exchanger plate 1 along the long side edges 15 and the short side edges 16. As can be seen in Fig. 4, the flange 26 extends further away from the main extension plane p than the secondary level p".

[0025] Each heat exchanger plate 1 is made through forming of a metal sheet having a metal sheet thickness t. It is to be noted that the metal sheet thickness t may vary and be somewhat changed after the forming of the heat exchanger plate 1. The metal sheet thickness t, before the forming, may lie in the range $0,2 \leq t \leq 0,4$ mm. Advantageously, the metal sheet thickness t, before the forming, may be 0,3 mm or approximately 0,3 mm.

[0026] Each heat exchanger plate 1 also has a depth d, see Fig. 4. The depth d is defined by the distance between the primary level p' and the secondary level p". The depth d may be equal to or less than 1,0 mm, preferably equal to or less than 0,90 mm, more preferably equal to or less than 0,85 mm or most preferably equal to or less than 0,80 mm.

[0027] As can be seen in Figs. 3 and 5, the heat transfer area 20 comprises a corrugation of ridges 27 and valleys 27' arranged in such a manner that the ridges 27 of one of the heat exchanger plates 1 abut the valleys 27' of an adjoining one of the heat exchanger plates 1 to form a plurality of joining areas 28 between a heat exchanger plate 1 and an adjacent heat exchanger plate 1. The joining areas 28 are arranged along a plurality of transversal lines y extending perpendicular to the centre line x.

[0028] The ridges 27 and valleys 27' extend along an extension line e forming an angle α of inclination with the centre line x, see Fig. 5. The angle α of inclination is less than 45° and lies in the range $10° \leq \alpha \leq 45°$. Advantageously, the angle α of inclination may be less than 40°, less than 35°, or even less than 30°. In the embodiments disclosed, the extension line e of each ridge 27 and valley 27' forms a positive angle α of inclination at one side of the centre line x and a corresponding negative angle α of inclination at the other side of the centre line x. As can be seen in Fig. 5, the ridges 27 and valleys 27' also form joining areas 29 at the centre line x. Furthermore, joining areas 30 are formed between the flanges 26 of adjacent heat exchanger plates 1.

[0029] The ridges 27 are disposed at a distance r form each other, and extend in parallel with each other and with the valleys 27'. The distance r between adjacent ridges 27, or between the respective central extension line e of adjacent ridges 27, may be less than 4 mm, or may be approximately 3 mm, or 3 mm, see Fig. 5.

[0030] Each of the ridges 27 and valleys 27' thus has a V-shaped configuration with a first part 31, for which the extension line e forms said positive angle α of inclination with the centre line x at one side of the centre line x, a second part 32, for which the extension line e forms said corresponding negative angle α of inclination with the centre line x at the other side of the centre line x, and a connection part 33 connecting the first part and the second part and extending along a curved path. The connection part 33 is located at the centre line x, so that the centre line x extends through the connection part 33, see Figs 3 and 5.

[0031] Each connection part 33 includes a projection 34 extending along the centre line x outwardly from the curved path 35. The projections 34 of the connection parts 33 form a respective one of the central joining areas 29 at the centre line x. The joining area 29 is thus located on the projection 34, beside, or substantially beside the curved path 35. Moreover, each central joining area 29 is located on a respective one of the transversal lines y.

[0032] Furthermore, as can be seen in Figs. 3 and 5, each connection part 33 has a concave side and a convex side. Each ridge 27, including the first part 31, the second part 32 and the connection part 33, has a width w. The width w of the connection part 33, measured between the concave side and the convex side, has a maximum value at the centre line x. The projection 34 of the connection part 33 is delimited by two opposite side lines 36, 37 and a forward front line 38. The front line 38 is curved whereas the two side lines 36 , 37 are straight, or substantially straight. The two side lines 36, 37 may extend in parallel, or substantially in parallel with each other, or may, as in the embodiments disclosed, see especially Fig. 6, converge towards each other towards the front line 38.

[0033] The connection parts 33 are configured in such a manner that the joining areas 28, 29, i.e. both the joining areas 28 and the central joining areas 29, are substantially equidistantly located along the transversal lines y. Consequently, the distance between adjacent joining areas 28, 29 are equal, or approximately equal, for all joining areas 28, 29. This means that the area A surrounding each joining area 28, 28 is equal, or approximately equal for all joining areas 28, 29. The area A is indicated as a rhombic area around three of the joining areas 28, 29 in Fig. 5. Consequently, the load to be carried by any one of the central joining areas 29 is equal, or approximately equal, to the load to be carried by any one of the remaining joining areas 28.

[0034] Each distribution area 21, 22 is separated from the heat transfer area 20. The heat transfer area 20 is located intermediately between the two distribution areas 21, 22 and separated from the distribution areas 21, 22 by a respective thin transition area 39, see Fig. 3, having a width in the order of the width w of the ridges 27. Also the distribution areas 21, 22 have ridges an valleys 27, 27' arranged in a V-configuration, which differs from the corresponding configuration of the heat transfer area 20 in that the angle α of inclination is greater, and more specifically greater than 45°, preferably greater than 50°, or even greater than 55°. Furthermore, the connection portion of the ridges 27 of the distribution areas 21, 22 is not provided with any projection. The corresponding central joining area is located on the curved path of the connection portion.

[0035] In case of the embodiment without separate distribution areas, there are also no transition areas. The pattern of the ridges and valleys of the heat transfer area 20 then extend with the same V-configuration over the whole heat exchanger plate 1, i.e. the angle α of inclination is equal or substantially equal over the whole heat exchanger plate 1. In this embodiment, the portholes 23 thus extend through the heat transfer area 20.

[0036] As mentioned above the plate heat exchanger is brazed by means of a braze material introduced between the heat exchanger plates 1 before the brazing operation. The braze material has a braze volume with respect to the heat transfer area 20 of the plate heat exchanger. The first interspaces 4 and the second interspaces 5 of the plate heat exchanger have an interspace volume with respect to the heat transfer area 20 of the plate heat exchanger. In order to obtain a high strength of the plate heat exchanger, it is advantageous to provide a sufficiently large quantity of braze material forming the above-mentioned joining areas 28, 29 between adjacent heat exchanger plates 1. Consequently, the proportion of the braze volume to the interspace volume may be at least 0,05, at least 0,06, at least 0,08 or at least 0,1.

[0037] The present invention is not limited to the embodiments disclosed but may be varied and modified within the scope of the following claims.

Claims

1. A plate heat exchanger comprising a plurality of heat exchanger plates (1), which are made through forming of a metal sheet and are provided beside each other and permanently joined to each other by means of a braze material to form a plate package having first plate interspaces (4) and second plate interspaces (5),
wherein each heat exchanger plate (1) extends along a main extension plane (p) and defines a longitudinal centre line (x), wherein each heat exchanger plate (1) has a pattern forming a heat transfer area (20), and a plurality of portholes (23), wherein the heat transfer area (20) comprises ridges (27) and valleys (27') arranged in such a manner that the ridges (27) of one of the heat exchanger plates (1) abut the valleys (27') of an adjoining one of the heat exchanger plates (1) to form a plurality of joining areas (28, 29),
wherein each of the ridges (27) and valleys (27') has a V-shaped configuration with a first part (31) having a first extension line forming a positive angle α of inclination with the centre line (x) at one side of the centre line (x), a second part (32) having a second extension line forming a corresponding negative angle α of inclination with the centre line (x) at the other side of the centre line (x), and a connection part (33) connecting the first part (31) and the second part (32) and extending along a curved path,
<u>characterized in</u> that each connection part (33) includes a projection (34) extending along the centre line (x) outwardly from the curved path (35) and that projections (34) of the connection parts (33) form a respective central joining area (29) at the centre line (x).

2. A plate heat exchanger according to claim 1, wherein each connection part (33) has a concave side and a convex side, and has a width (w), measured between the concave side and the convex side and wherein the width (w) has a maximum value at the centre line (x).

3. A plate heat exchanger according to claim 2, wherein the joining areas (28, 29), including the central joining area (29), are arranged along a plurality of transversal lines (y) extending perpendicular to the centre line (x), and wherein each central joining area (29) is located on a respective one of the transversal lines (y).

4. A plate heat exchanger according to claim 3, wherein the connection parts (33) are configured in such a manner that the joining areas (28, 29), including the central joining area (29), are substantially equidistantly located along the transversal lines (y).

5. A plate heat exchanger according to any one of the preceding claims, wherein the projection (34) is delimited by two opposite side lines (36, 37) and a forward front line (38), and wherein the side lines (36, 37) are substantially straight and converge towards each other towards the front line (38).

6. A plate heat exchanger according to any one of the preceding claims, wherein the angle α of inclination is equal to or greater than 10° and less than 45°.

7. A plate heat exchanger according to claim 6, wherein the angle α of inclination is less than 40°.

8. A plate heat exchanger according to claim 6, wherein

the angle α of inclination is less than 35°.

9. A plate heat exchanger according to claim 6, wherein the angle α of inclination is less than 30°.

10. A plate heat exchanger according to any one of the preceding claims, wherein the pattern of each heat exchanger plate has two distribution areas (21, 22) on a respective side of the heat transfer area (20), each distribution area (21, 22) surrounding two of the portholes (23).

11. A plate heat exchanger according to claim 10, wherein each distribution area (21, 22) has ridges (27) and valleys (27') arranged in a V-configuration with a first part (31) having a first extension line forming a positive angle α of inclination with the centre line (x) at one side of the centre line (x), a second part (32) having a second extension line forming a corresponding negative angle α of inclination with the centre line (x) at the other side of the centre line (x), and wherein the angle α of inclination is greater than 45°.

12. A plate heat exchanger according to any one of the preceding claims, wherein the ridges (27) are disposed at a distance (r) from and extend in parallel with each other, wherein the distance (r) between adjacent ridges (27) on the heat transfer area (20) is less than 4 mm.

13. A plate heat exchanger according to any one of the preceding claims, wherein said ridges and valleys, on one side of the heat exchanger plate, extend between a primary level (p') at a distance from the main extension plane (p) and a secondary level (p") at a distance from and on an opposite side of the main extension plane (p), and wherein each heat exchanger plate (1) has a depth (d) defined by the distance between the primary level (p') and the secondary level (p") and being equal to or less than 1,0 mm.

14. A plate heat exchanger according to any one of the preceding claims, wherein each heat exchanger plate (1), before the forming, has a metal sheet thickness t, which lies in the range $0,2 \leq t \leq 0,4$ mm.

15. A plate heat exchanger according to any one of the preceding claims, wherein the braze material has a braze volume with respect to the heat transfer area (20) of the plate heat exchanger, wherein the first interspaces (4) and the second interspaces (5) have an interspace volume with respect to the heat transfer area (20) of the plate heat exchanger, and wherein the proportion of the braze volume to the interspace volume is at least 0,05.

16. A plate heat exchanger according to any one of the preceding claims, wherein the distribution areas (21, 22) comprise a first porthole (23), a second porthole (23), a third porthole (23) and a fourth porthole (23).

Patentansprüche

1. Plattenwärmetauscher, umfassend eine Vielzahl von Wärmetauscherplatten (1), die durch Formen eines Blechs hergestellt und nebeneinander ausgebildet sind, und mittels eines Hartlots dauerhaft miteinander zusammengefügt sind, um ein Plattenpaket mit ersten Plattenzwischenräumen (4) und zweiten Plattenzwischenräumen (5) zu bilden,
worin sich jede Wärmetauscherplatte (1) entlang einer Hauptausdehnungsebene (p) erstreckt und eine Längsmittellinie (x) definiert,
worin jede Wärmetauscherplatte (1) eine Struktur hat, die einen Wärmeübertragungsbereich (20) und eine Vielzahl von Durchgangslöchern (23) bildet,
worin der Wärmeübertragungsbereich (20) Stege (27) und Kehlungen (27') umfasst, die auf eine solche Weise angeordnet sind, dass die Stege (27) einer der Wärmetauscherplatten (1) an den Kehlungen (27') einer angrenzenden der Wärmetauscherplatten (1) anliegen, um eine Vielzahl von Fügebereichen (28, 29) zu bilden,
worin jeder der Stege (27) und Kehlungen (27') eine v-förmige Konfiguration hat, wobei ein erster Teil (31) eine erste Ausdehnungslinie hat, die einen positiven Neigungswinkel α mit der Mittellinie (x) auf einer Seite der Mittellinie (x) bildet, ein zweiter Teil (32) eine zweite Ausdehnungslinie hat, die einen entsprechenden negativen Neigungswinkel α mit der Mittellinie (x) auf der anderen Seite der Mittellinie (x) bildet, und ein Verbindungsteil (33) den ersten Teil (31) und den zweiten Teil (32) verbindet und sich entlang einem gekrümmten Weg erstreckt,
dadurch gekennzeichnet, dass jeder Verbindungsteil (33) einen Vorsprung (34) aufweist, der sich entlang der Mittellinie (x) vom gekrümmten Weg (35) nach außen hin erstreckt, und dass Vorsprünge (34) der Verbindungsteile (33) einen jeweiligen mittleren Fügebereich (29) an der Mittellinie (x) bilden.

2. Plattenwärmetauscher nach Anspruch 1, worin jeder Verbindungsteil (33) eine konkave Seite und eine konvexe Seite hat und eine Breite (w) hat, die zwischen der konkaven Seite und der konvexen Seite gemessen wird und worin die Breite (w) einen Höchstwert an der Mittellinie (x) hat.

3. Plattenwärmetauscher nach Anspruch 2, worin die Fügebereiche (28, 29) einschließlich des mittleren Fügebereichs (29) entlang einer Vielzahl von Querlinien (y) angeordnet sind, die sich senkrecht zur Mittellinie (x) erstrecken, und worin jeder mittlere Fügebereich (29) auf einer jeweiligen der Querlinien (y) angeordnet ist.

4. Plattenwärmetauscher nach Anspruch 3, worin die Verbindungsteile (33) auf eine solche Weise konfiguriert sind, dass die Fügebereiche (28, 29) einschließlich des mittleren Fügebereichs (29) im Wesentlichen im gleichen Abstand entlang der Querlinien (y) angeordnet sind.

5. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin der Vorsprung (34) durch zwei gegenüberliegende Seitenlinien (36, 37) und eine vordere Stirnlinie (38) begrenzt ist und worin die Seitenlinien (36, 37) im Wesentlichen gerade sind und zur vorderen Stirnlinie (38) hin zusammenlaufen.

6. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin der Neigungswinkel α gleich oder größer als 10° und kleiner als 45° ist.

7. Plattenwärmetauscher nach Anspruch 6, worin der Neigungswinkel α kleiner als 40° ist.

8. Plattenwärmetauscher nach Anspruch 6, worin der Neigungswinkel α kleiner als 35° ist.

9. Plattenwärmetauscher nach Anspruch 6, worin der Neigungswinkel α kleiner als 30° ist.

10. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin die Struktur jeder Wärmetauscherplatte zwei Verteilungsbereiche (21, 22) auf einer jeweiligen Seite des Wärmeübertragungsbereichs (20) hat, wobei jeder Verteilungsbereich (21, 22) zwei der Durchgangslöcher (23) umgibt.

11. Plattenwärmetauscher nach Anspruch 10, worin jeder Verteilungsbereich (21, 22) Stege (27) und Kehlungen (27') hat, die in einer V-Konfiguration angeordnet sind, wobei ein erster Teil (31) eine erste Ausdehnungslinie hat, die einen positiven Neigungswinkel α mit der Mittellinie (x) auf einer Seite der Mittellinie (x) bildet, ein zweiter Teil (32) eine zweite Ausdehnungslinie hat, die einen entsprechenden negativen Neigungswinkel α mit der Mittellinie (x) auf der anderen Seite der Mittellinie (x) bildet, und worin der Neigungswinkel α größer als 45° ist.

12. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin die Stege (27) in einem Abstand (r) voneinander angeordnet sind und sich parallel zueinander erstrecken, worin der Abstand (r) zwischen benachbarten Stegen (27) des Wärmeübertragungsbereichs (20) kleiner als 4 mm ist.

13. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin die Stege und Kehlungen sich auf einer Seite der Wärmetauscherplatte zwischen einem Primärniveau (p') in einem Abstand von der Hauptausdehnungsebene (p) und einem Sekundärniveau (p") in einem Abstand von und auf einer gegenüberliegenden Seite der Hauptausdehnungsebene (p) erstrecken und worin jede Wärmetauscherplatte (1) eine Tiefe (d) hat, die durch den Abstand zwischen dem Primärniveau (p') und dem Sekundärniveau (p") definiert ist und gleich oder kleiner als 1,0 mm ist.

14. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin jede Wärmetauscherplatte (1) vor dem Formen eine Blechdicke t hat, die im Bereich $0{,}2 \leq t \leq 0{,}4$ mm liegt.

15. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin das Hartlot ein Lotvolumen in Bezug auf den Wärmeübertragungsbereich (20) des Plattenwärmetauschers hat, worin die ersten Zwischenräume (4) und die zweiten Zwischenräume (5) ein Zwischenraumvolumen in Bezug auf den Wärmeübertragungsbereich (20) des Plattenwärmetauschers haben und worin das Verhältnis des Lotvolumens zum Zwischenraumvolumen mindestens 0,05 beträgt.

16. Plattenwärmetauscher nach einem der vorhergehenden Ansprüche, worin die Verteilungsbereiche (21, 22) ein erstes Durchgangsloch (23), ein zweites Durchgangsloch (23), ein drittes Durchgangsloch (23) und ein viertes Durchgangsloch (23) umfassen.

Revendications

1. Echangeur de chaleur à plaques comprenant une pluralité de plaques d'échangeur de chaleur (1), qui sont réalisées par la mise en forme d'une feuille métallique et qui sont disposées les unes à côté des autres et jointes de manière permanente les unes aux autres au moyen d'un matériau de brasage pour former un ensemble de plaques ayant des premiers espaces entre plaques (4) et des deuxièmes espaces entre plaques (5),
dans lequel chaque plaque d'échangeur de chaleur (1) s'étend le long d'un plan d'extension principal (p) et définit une ligne centrale longitudinale (x),
dans lequel chaque plaque d'échangeur de chaleur (1) comporte un motif formant une zone de transfert de chaleur (20), et une pluralité de lumières (23),
dans lequel la zone de transfert de chaleur (20) comprend des arêtes (27) et des creux (27') agencés d'une manière telle que les arêtes (27) de l'une des plaques d'échangeur de chaleur (1) sont en butée avec les creux (27') d'une plaque contiguë parmi les plaques d'échangeur de chaleur (1) pour former une pluralité de zones de jonction (28, 29),
dans lequel chacun des arêtes (27) et des creux (27') a une configuration en forme de V avec une première

partie (31) ayant une première ligne d'extension formant un angle d'inclinaison α positif avec la ligne centrale (x) d'un côté de la ligne centrale (x), une deuxième partie (32) ayant une deuxième ligne d'extension formant un angle d'inclinaison α négatif avec la ligne centrale (x) de l'autre côté de la ligne centrale (x), et une partie de liaison (33) reliant la première partie (31) et la deuxième partie (32) et s'étendant le long d'un trajet incurvé,
caractérisé en ce que chaque partie de liaison (33) comprend une protubérance (34) s'étendant le long de la ligne centrale (x) à l'extérieur du trajet incurvé (35) et **en ce que** les protubérances (34) des parties de liaison (33) forment une zone de jonction centrale (29) respective au niveau de la ligne centrale (x).

2. Echangeur de chaleur à plaques selon la revendication 1, dans lequel chaque partie de liaison (33) a un côté concave et un côté convexe, et a une largeur (w), mesurée entre le côté concave et le côté convexe, et dans lequel la largeur (w) a une valeur maximum au niveau de la ligne centrale (x).

3. Echangeur de chaleur à plaques selon la revendication 2, dans lequel les zones de jonction (28, 29), comprenant la zone de jonction centrale (29), sont agencées le long d'une pluralité de lignes transversales (y) s'étendant perpendiculairement à la ligne centrale (x), et dans lequel chaque zone de jonction centrale (29) est située sur une ligne respective parmi les lignes transversales (y).

4. Echangeur de chaleur à plaques selon la revendication 3, dans lequel les parties de liaison (33) sont configurées d'une manière telle que les zones de jonction (28, 29), comprenant la zone de jonction centrale (29), sont situées sensiblement de manière équidistante le long des lignes transversales (y).

5. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel la protubérance (34) est délimitée par deux lignes latérales (36, 37) opposées et une ligne avant (38), et dans lequel les lignes latérales (36, 37) sont sensiblement droites et convergent l'une vers l'autre vers la ligne avant (38).

6. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel l'angle d'inclinaison α est supérieur ou égal à 10° et inférieur à 45°.

7. Echangeur de chaleur à plaques selon la revendication 6, dans lequel l'angle d'inclinaison α est inférieur à 40°.

8. Echangeur de chaleur à plaques selon la revendication 6, dans lequel l'angle d'inclinaison α est inférieur à 35°.

9. Echangeur de chaleur à plaques selon la revendication 6, dans lequel l'angle d'inclinaison α est inférieur à 30°.

10. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel le motif de chaque plaque d'échangeur de chaleur comporte deux zones de distribution (21, 22) d'un côté respectif de la zone de transfert de chaleur (20), chaque zone de distribution (21, 22) entourant deux des lumières (23).

11. Echangeur de chaleur à plaques selon la revendication 10, dans lequel chaque zone de distribution (21, 22) comporte des arêtes (27) et des creux (27') agencés en une configuration en V avec une première partie (31) ayant une première ligne d'extension formant un angle d'inclinaison α positif avec la ligne centrale (x) d'un côté de la ligne centrale (x), une deuxième partie (32) ayant une deuxième ligne d'extension formant un angle d'inclinaison α négatif correspondant avec la ligne centrale (x) de l'autre côté de la ligne centrale (x), et dans lequel l'angle d'inclinaison α est supérieur à 45°.

12. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel les arêtes (27) sont disposées à une distance (r) les unes des autres et s'étendent parallèlement les unes aux autres, dans lequel la distance (r) entre les arêtes (27) adjacentes sur la zone de transfert de chaleur (20) est inférieure à 4 mm.

13. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel lesdites arêtes et lesdits creux, d'un côté de la plaque d'échangeur de chaleur, s'étendent entre un niveau principal (p') à une distance du plan d'extension principal (p) et un niveau secondaire (p") à une distance du plan d'extension principal (p) et d'un côté opposé de celui-ci, et dans lequel chaque plaque d'échangeur de chaleur (1) a une profondeur (d) définie par la distance entre le niveau principal (p') et le niveau secondaire (p") et inférieure ou égale à 1,0 mm.

14. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel chaque plaque d'échangeur de chaleur (1), avant la mise en forme, a une épaisseur de feuille métallique t, qui se trouve dans la plage de $0,2 \leq t \leq 0,4$ mm.

15. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel le matériau de brasage a un volume de brasage en relation avec la zone de transfert de chaleur (20) de l'échangeur de chaleur à plaques, dans lequel les premiers espaces entre plaques (4) et les deuxième espaces entre plaques (5) ont un volume d'espace entre plaques en relation avec la zone de transfert de chaleur (20) de l'échangeur de chaleur à plaques, et dans lequel la proportion du volume de brasage par rapport au volume d'espace entre plaques est d'au moins 0,05.

16. Echangeur de chaleur à plaques selon l'une quelconque des revendications précédentes, dans lequel les zones de distribution (21, 22) comprennent une première lumière (23), une deuxième lumière (23), une troisième lumière (23) et une quatrième lumière (23).

Fig 1

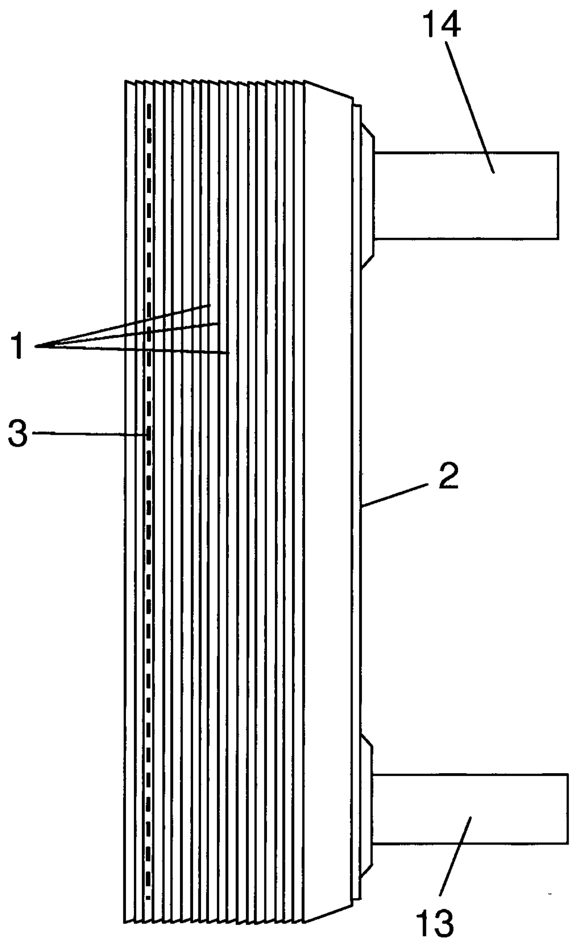

Fig 2

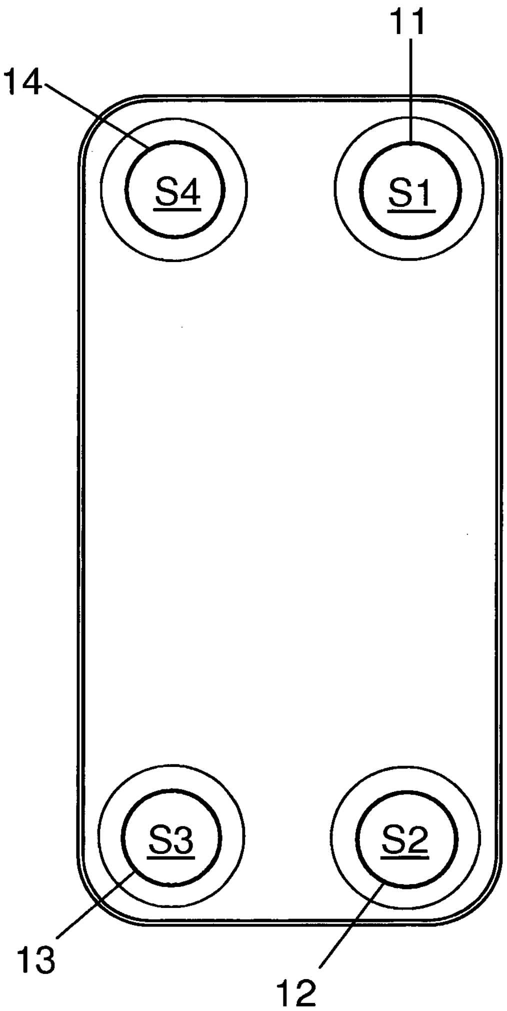

Fig 3

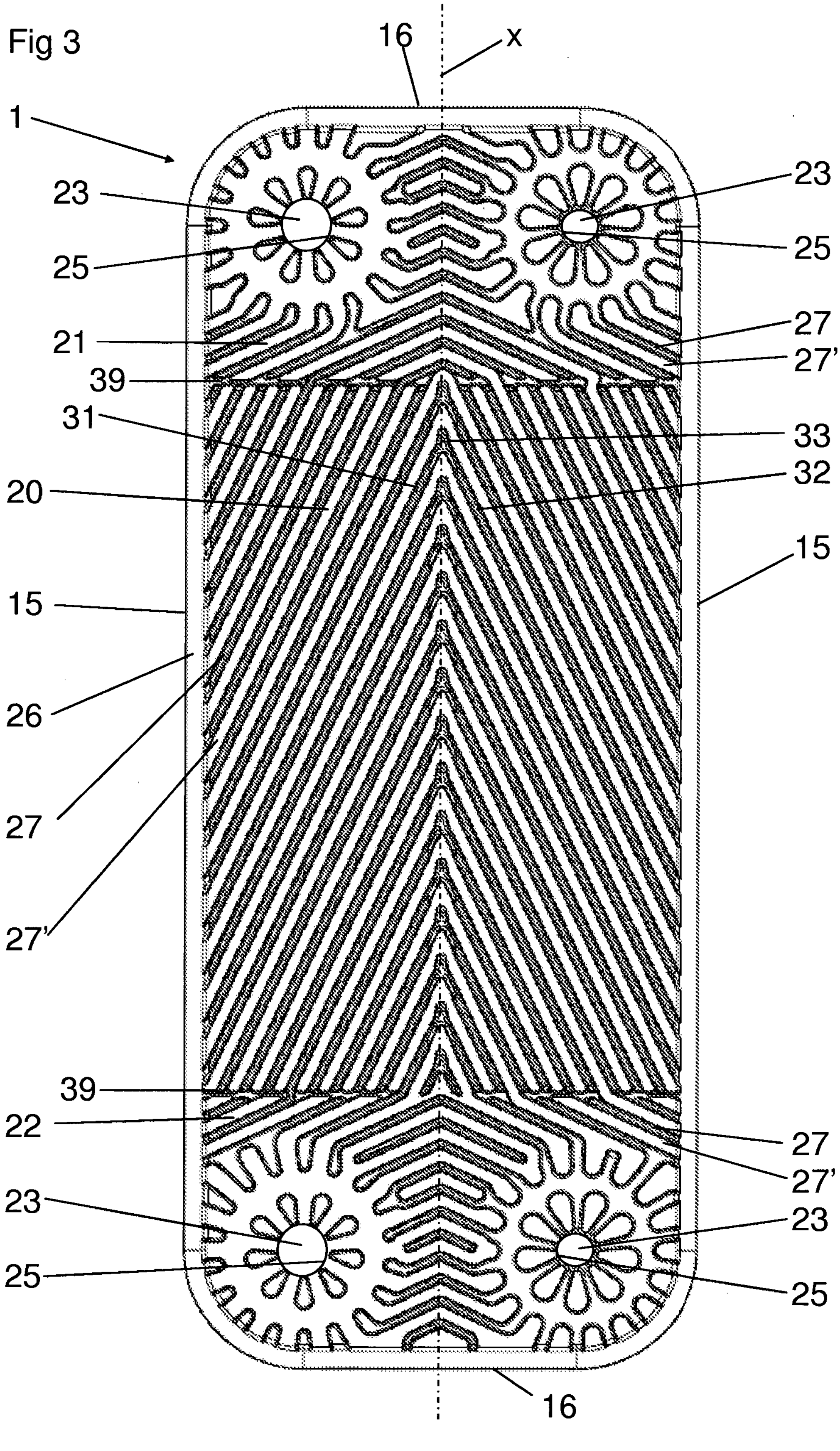
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Fig 4

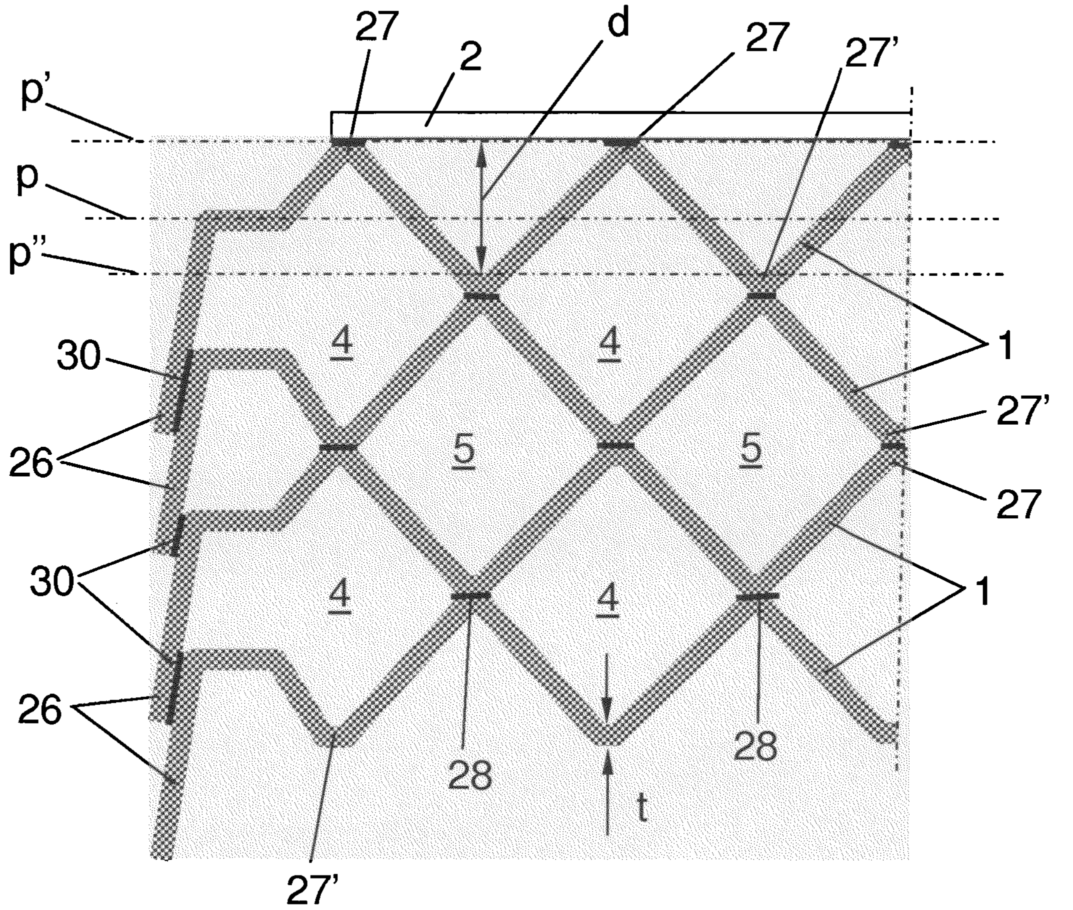
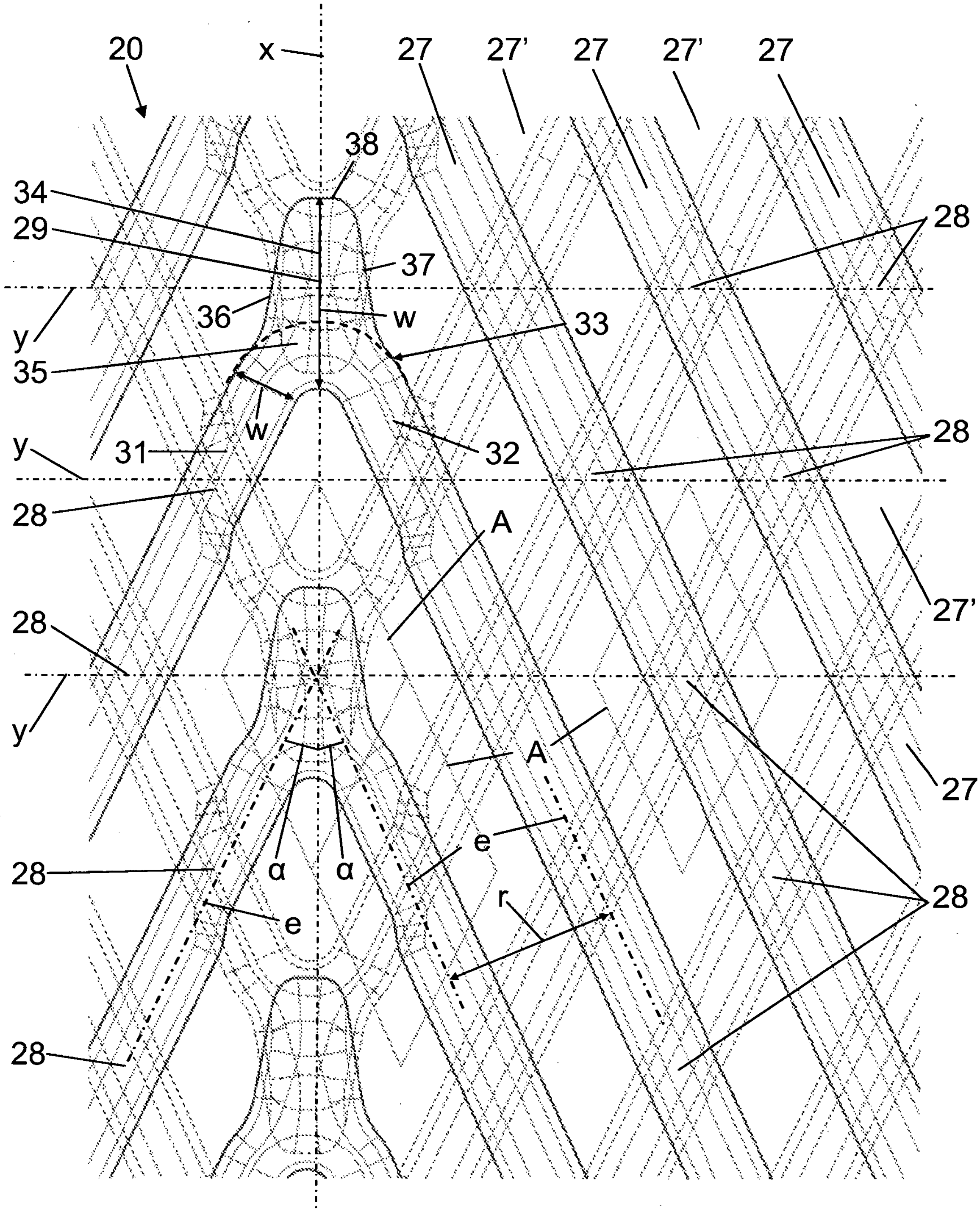


Fig 5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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

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