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DESCRIPTION

AREA OF INVENTION

[0001] The present invention relates to a plate heat exchanger plate according to the precharacterizing portion of claim 1 and a plate heat exchanger comprising such a plate.

BACKGROUND OF INVENTION

[0002] Plate heat exchangers provided with a plate package of plate heat exchanger plates are utilized for exchange of heat between two or more heat exchange fluids. The plates form plate interspaces adapted to be flowed through by the heat exchange fluids. The plates are provided with port holes which form channels extending through the plate package. In case of heat exchange between the two heat exchange fluids each channel communicates with every second plate interspace. A first heat exchange fluid flows from a first channel through each alternate plate interspace over heat exchange surfaces of the plates to a second channel at an opposite end of the plate package. A second heat exchange fluid flows from a third channel through every other alternate plate interspace over heat exchange surfaces on opposite sides of the plates to a fourth channel at an opposite end of the plate package. The heat exchange fluids may be e.g. gases, liquids, liquids containing solid matter, etc.

[0003] The heat exchange surfaces of the heat exchange plates are provided with corrugations. These corrugations may have many different forms but generally comprises elevated and depressed portions. The corrugations may define the width of the plate interspaces, create a turbulent flow in the plate interspaces and serve as a support for adjacent plates in the plate package. The plates are commonly manufactured from sheet metal, which is provided with the corrugations in one or more pressing operations.

[0004] There are many different corrugation patterns used for heat exchange plates. One type of corrugation pattern comprises first ridges and grooves arranged in a first direction and second ridges and groove arranged in a second direction such that a V-shaped pattern resembling a herringbone pattern is formed at least in some portions of the plate.

[0005] When the V-shaped pattern of corrugations comprising ridges and grooves points in a direction from an edge of a plate towards the centre of the plate, edge portions of the plate may be deformed due to the sheet metal material being displaced in the pressing operation. Also when the V-shaped pattern is arranged in proximity of a plate edge and points in a different direction, the relevant edge portion may be affected. Besides not looking good, deformed edge portions may cause weak edges of the plate. In particular plate heat exchangers with gaskets arranged between the plates must have strong stable edge portions to prevent leakage of the plate heat exchanger. In order to prevent weak edges, the sheet

metal blanks from which the heat exchanger plates are manufactured, must be cut larger than for heat exchanger plates with other corrugation patterns. Accordingly, the utilization of sheet metal material is not optimal.

[0006] WO94/19657 discloses such a heat exchanger plate, where several such above mentioned V-shaped patterns point towards the centre of the plate and towards the edges of the plate.

DISCLOSURE OF INVENTION

[0007] An object of the present invention is to provide plate heat exchanger plates with uniformly displaced edges, thus allowing a design with efficient use of sheet material for heat transfer purposes.

[0008] According to an aspect of the invention, the object is achieved by a plate heat exchanger plate delimited by two substantially parallel first side edges and two substantially parallel second side edges and provided with port holes adjacent a first distribution portion at a first end of the plate, port holes adjacent a second distribution portion at a second end of the plate, and between the first and second distribution portions a main heat transfer portion comprising a corrugation pattern. The main heat transfer portion comprises a first area comprising a first field with first corrugations arranged substantially on one side of a straight first line intersecting with the second side edges and a second field with second corrugations arranged substantially on an opposite side of the first line. The first corrugations comprise ridges and grooves directed at an angle of between 0 - < 90 degrees with the first line measured in a clockwise or counter clockwise angular direction. The second corrugations comprise ridges and grooves directed at an angle of between >270 - <360 degrees with the first line measured in the angular direction. The main heat transfer portion comprises a first outer area arranged between the first area and a first of the second side edges and extends along the first second side edge between the first and second distribution portions. In the first outer area there are arranged first protrusions and recesses directed in a first general direction in relation to a straight second line parallel to one of the first side edges. The first general direction comprises one or more angles between 0 - <90 degrees in relation to the second line.

[0009] Since the first outer area comprises first protrusions and recesses directed only in a first general direction, the first second side edge is uniformly affected during a pressing operation, despite the first area of the main heat transfer portion comprising corrugations which may displace portions of the sheet material forming the plate in a pressing operation. As a result, the above mentioned object is achieved. A straight edge comparatively close to the main heat transfer portion is achieved. Thus, a larger part of the plate may be utilized for heat transfer than if the plate would not be provided with the first outer area of the above mentioned kind.

[0010] The protrusions and recesses form corrugations of the heat exchange plate and may

have different forms such as singular tips and dimples or ridges and grooves. In any case, the protrusions and recesses form a pattern which may be seen to have a direction. The protrusions and recesses in the first outer area are directed only in the first general direction in relation to the second line. By general direction in relation to the second line is meant that the direction of the protrusions and recesses may vary in different portions of the outer area but that the general direction in the different portions is the same, for instance within 90 degrees of the second line.

[0011] According to example embodiments the main heat transfer portion may comprise a second outer area arranged between the first area and a second of the second side edges opposite to the first outer area and extend along the second of the second side edges between the first and second distribution portions, wherein in said second outer area there are arranged second protrusions and recesses directed in a second general direction in relation to said second line. The second general direction comprises one or more angles between 0 - <90 degrees in relation to the second line. In this manner also the second of the second side edges may be maintained straight during manufacturing of the heat exchanger plate.

[0012] According to example embodiments the first area may comprise a third field with third corrugations comprising ridges and grooves arranged substantially on the said one side of the first line and directed at an angle of between > 90 - < 180 degrees from the first line in the angular direction and a fourth field with fourth corrugations comprising ridges and grooves arranged substantially on the opposite side of the first line and directed at an angle of between > 180 - < 270 degrees from the first line in the angular direction. A plate comprising such third and fourth fields may have V-shaped corrugation formations pointing towards the centre of the plate from both sides and thus may benefit from the outer areas arranged along both second sides.

[0013] According to example embodiments the ridges and grooves of the first corrugations may be directed at an angle of between > 45 - < 90 degrees with the first line measured in the angular direction and the ridges and grooves of the second corrugations may be directed at an angle of between > 270 - < 315 degrees with the first line measured in the angular direction. Ridges and grooves of the first and second corrugations with these specified angles form a corrugation pattern which subjects a heat exchange fluid to a relatively low flow resistance. In a pressing operation the ridges and grooves of the first and second corrugations with these specified angles are particularly prone to displace the sheet material from which the plate is formed and may benefit from at least one outer area on the main heat transfer portion.

[0014] According to example embodiments the ridges and grooves of the third corrugations may be directed at an angle of between > 90 - < 135 degrees with the first line measured in the angular direction and the ridges and grooves of the fourth corrugations may be directed at an angle of between > 225 - < 270 degrees with the first line measured in the angular direction. In a pressing operation the ridges and grooves of the third and fourth corrugations with these specified angles are again, particularly prone to displace the sheet material from which the plate is formed and may benefit from a second outer area on the main heat transfer portion.

[0015] As mentioned above, the first general direction and the second general direction comprise one or more angles between 0 - <90 degrees in relation to the second line. The first and second general direction may be the same direction or they may be directed differently from each other.

[0016] According to example embodiments the first outer area and/or the second outer area may have a width measured in parallel with the second line, which is narrower than the first field measured in parallel with the second line. The first and second outer areas may thus form peripheral areas of the main heat transfer portion.

[0017] According to example embodiments the first and/or second protrusions and recesses in the first outer area and/or the second outer area may comprise corrugations in the form of ridges and grooves.

[0018] According to example embodiments, in the first and second outer areas the ridges may have a different width than the grooves measured across the ridges and grooves. For instance may all of the ridges be wider than all of the grooves, or all of the ridges may be narrower than all of the grooves. In this manner different flow resistances for a heat exchange fluid flowing in a plate interspace between two plate heat exchanger plates may be created. Thus, an even distribution of heat exchange fluid over the entire main heat transfer portion may be promoted.

[0019] According to example embodiments the first protrusions and recesses may be directed in a first direction in relation to the second line and/or the second protrusions and recesses may be directed in a second direction in relation to the second line. The protrusions and recesses in the first outer area may thus be directed in one direction only in relation to the second line. Similarly, the protrusions and recesses in the second outer area may thus be directed in one direction only in relation to the second line. In this manner the plate will be uniformly affected near the second side edges during forming of the plate in one or more pressing operation.

[0020] According to example embodiments the first side edges may be short sides and the second side edges may be long sides of the plate.

[0021] According to example embodiments the first outer area and/or the second outer area may be divided into two or more fields. This may stabilize a large plate heat exchanger plate.

[0022] According to an aspect of the invention there is provided a plate heat exchanger comprising a plate package of plate heat exchanger plates according to any aspect or example embodiment mentioned above.

[0023] According to example embodiments the plate heat exchanger plates may be arranged alternately in the plate package such that a first outer area of one plate abuts a second outer area of an abutting plate. In this manner the plate interspaces between the plates in the areas

of the outer areas may be defined by different outer areas of the two abutting plates. In example embodiments only one type of plate heat exchanger plate may be required to form the plate package.

[0024] According to example embodiments the plate heat exchanger may be adapted for substantially parallel flow of at least two heat exchange fluid over the main heat transfer portion of plates in the plate package.

[0025] Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following description. Those skilled in the art will realize that different features of the present invention may be combined to create embodiments other than those described in the following, without departing from the scope of the present invention, as defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The various aspects of the invention, including its particular features and advantages, will be readily understood from the following detailed description and the accompanying drawings, in which:

Figs. 1 and 2 schematically illustrate plate heat exchanger plates according to example embodiments,

Fig. 3 illustrates schematically a cross section through parts of a plate package of a plate heat exchanger, and

Fig. 4 illustrates a plate heat exchanger according to example embodiments.

DETAILED DESCRIPTION OF EMBODIMENTS

[0027] The present invention will now be described more fully with reference to the accompanying drawings, in which example embodiments are shown. However, this invention should not be construed as limited to the embodiments set forth herein. Disclosed features of example embodiments may be combined as readily understood by one of ordinary skill in the art to which this invention belongs. Like numbers refer to like elements throughout.

[0028] Well-known functions or constructions may not be described in detail for brevity and/or clarity.

[0029] Fig. 1 schematically illustrates a plate heat exchanger plate 2 according to example embodiments. Several of such plates 2 are arranged in a plate package of a plate heat

exchanger. The plate heat exchanger is arranged for heat exchange between two heat exchange fluids when the two fluids flow through alternate plate interspaces formed between the plates 2. The plate 2 is substantially rectangular and has two first side edges 4a, 4b, which form short sides of the plate 2 and two second side edges 6a, 6b, which form long sides of the plate 2. The plate 2 is provided with four port holes 8a, 8b and 10a, 10b. The port holes 8a, 8b, 10a, 10b form four channels extending through the plate package. Two of the channels communicate with every second plate interspace and the other two channels communicate with the remaining plate interspaces. In use, a first heat exchange fluid will flow through a first port hole 8a over one side of the plate 2 to a second port hole 8b and a second heat exchange fluid will flow over the other side of the plate 2 between the third and fourth port holes 10a, 10b. Thus, heat from one of the heat exchange fluids is transferred through the plate 2 to the other heat exchange fluid.

[0030] With reference to the visible side of the plate 2 in Fig. 1 there is provided in connection with the first port hole 8a a first distribution portion 12a. In connection with the second port hole 8b there is provided a second distribution portion 12b. Between the first and second distribution portions 12a, 12b there is arranged a main heat transfer portion 14. The first distribution portion 12a serves, in use, to distribute a relevant fluid over the width of the main heat transfer portion 14. Consequently, the second distribution portion 12b serves to funnel the fluid from the main heat transfer portion 14 to the second port hole 8b. The distribution portions 12a, 12b are provided with a corrugation pattern, which may provide efficient distribution and funnelling of the heat exchange fluid.

[0031] On the opposite side of the plate 2 there are provided distribution portions in connection with the third and fourth port holes 10a, 10b. These distribution portions, in use, have the same function as the first and second distribution portions 12a, 12b, although with respect to a different heat exchange fluid.

[0032] The plate 2 is provided with gasket grooves, which are adapted to receive one or more gaskets. When one ore more gaskets are arranged in the gasket grooves between two abutting plates 2, the gasket/s delimit the port holes, distribution portions and main heat transfer portion from the ambient environment, and in use seal the plate interspace and channels formed by the port holes to prevent leaking of heat exchange fluids. Accordingly, in the view illustrated in Fig. 1 one gasket 15 is placed in the gasket groove encircling an area comprising the first and second port holes 8a, 8b, the first and second distribution portions 12a, 12b and the main heat transfer portion 14. Also, the gasket 15 is arranged around each of the third and fourth port holes 10a, 10b. Alternatively, separate gaskets may be used around each of the third and fourth port holes 10a, 10b.

[0033] The main heat transfer portion 14 comprises three main areas namely, a first area 16 arranged between a first outer area 18 and a second outer area 20. The first area 16 comprises several fields with corrugations comprising ridges and grooves directed in different directions. In this example there are twelve such fields in the first area 16, which are emphasized by continuous lines. The first outer area 18 extends between the first and second

distribution portions 12a, 12b along a first of the second side edges 6a and comprises three fields 22a, 22b, 22c. The second outer area 20 extends between the first and second distribution portions 12a, 12b along a second of the second side edges 6b and comprises three fields 24a, 24b, 24c.

[0034] A closer look will now be taken at the directions of the ridges and grooves of the fields of the first area 16. For the purpose of illustration a straight first line 26 intersects with the two second side edges 6a, 6b. A first field 30 is arranged one side of the first line 26. Measured in a clockwise direction the ridges and grooves in the first field 30 are directed at an angle of about 60 degrees with the first line 26. A second field 32 is arranged on an opposite side of the line 26. Measured in the same direction as the ridges and grooves in the first field 30, the ridges and grooves in the second field 32 are directed at an angle of about 300 degrees with the first line 26. On the same side of the first line 26 as the first field 30 there is arranged a third field 34 provided with ridges and grooves directed at an angle of about 120 degrees with the first line 26, measured in the same direction as before. On the same side of the first line 26 as the second field 32 there is arranged a fourth field 36 provided with ridges and grooves directed at an angle of about 240 degrees with the first line 26, again measured in the same direction as before.

[0035] The first and second outer areas 18, 20 are provided with protrusions and recesses. In this embodiment the protrusions and recesses are formed as ridges and grooves similar to the corrugations in the first area 16. In the outer areas 18, 20 the ridges and grooves have the same general direction in all three fields 22a-c, 24a-c. In the first outer area 18 the ridges and grooves in the middle field 22b have a slightly different angle than in the two surrounding fields 22a, 22c. Similarly, in the second outer area 20 the ridges and grooves do not have the same direction in all three fields 24a, 24b, 24c. However, in all three fields 22a-c, 24a-c of the first and second outer areas 18, 20 the ridges and grooves all have the same general direction, i.e. the angle of the ridges and grooves in the different fields is within 0-90 degrees of a straight second line 27 parallel to one of the first side edges 4a.

[0036] In one or more pressing operations when the plate 2 is manufactured from sheet metal, the corrugations may cause the plate material to move, i.e. during pressing the plate material may be displace at least to some extent. The corrugations in the first and second fields 30, 32 form a V-shaped pattern pointing from the first second side edge 6a towards the middle of the plate 2. In the area of this V-shaped pattern the plate material may be moved towards the middle of the plate 2. Thanks to the first outer field 18 arranged between the first area and the first second side edge 6a, the first second side edge 6a will be affected uniformly in the pressing operation.

[0037] At other parts of the plate 2 the material may be displaced in different directions during the pressing operation. However, the first and second outer fields 18, 20 will ensure that the second side edges 6a, 6b are displaced uniformly along the main heat transfer portion 14 of the plate 2 during the pressing operation. Accordingly, the second side edges 6a, 6b of the plate 2 will remain substantially even also after the pressing operation.

[0038] Fig. 2 illustrates schematically a plate heat exchanger plate 2 according to example embodiments. In general layout and function the plate 2 corresponds to the plate 2 illustrated in Fig. 1. The main difference between the two plates is the first area 16 of the main heat transfer portion 14 of the plate 2. The corrugation pattern of ridges and grooves in the first area 16 in Fig. 2 is configured differently than in Fig. 1.

[0039] The first area 16 comprises several fields, in which the ridges and groves of the corrugations are directed in different directions. A straight first line 26 intersects with second side edges 6a, 6b of the plate 2. A first field 30 is arranged on one side of the first line 26. Measured in a clockwise direction the ridges and grooves in the first field 30 are directed at an angle of about 40 degrees with the first line 26. A second field 32 is arranged on an opposite side of the line 26. Measured in the same direction as the ridges and grooves in the first field 30, the ridges and grooves in the second field 32 are directed at an angle of about 320 degrees with the first line 26. The corrugations in the first and second fields 30, 32 form a V-shaped pattern pointing from a first of the second side edges 6a towards a second of the second side edges 6b. Again, a first outer area 18 extends between first and second distribution portions 12a, 12b along the first second side edge 6a and a second outer area 20 extends between the first and second distribution portions 12a, 12b along the second of the second side edges 6b. In this embodiment the outer areas 18, 20 each comprise one field of protrusions and recesses in the form of ridges and grooves. The ridges and grooves in the first outer area 18 are directed in one first direction only and the ridges and grooves in the second outer area 20 are directed in one second direction only.

[0040] Again, each of the first outer area 18 and the second outer area 20 with their protrusions and recesses directed in one direction in relation to a straight second line 27 parallel to a first side edge 4a ensure that the second side edges 6a, 6b are maintained essentially straight when the plate 2 is provided with a corrugation pattern during manufacturing.

[0041] The first and second outer areas 18, 20, respectively, are narrower that the first field 30 or the second field 32 in a direction parallel to the second line 27. Thus, the first and second outer areas 18, 20 form a smaller portion of the main heat transfer portion 14 than the first area 16.

[0042] Fig. 3 illustrates schematically a cross section through parts of a plate package 40 of a plate heat exchanger. The parts illustrated correspond to portions of first and second outer areas 18, 20 of heat transfer plates 2. The plates 2 are provided with ridges and grooves of different widths in the first and second outer areas 18, 20. In an outer area 18, 20 e.g. all the ridges may have the same width and all grooves may have the same widths, which is narrower than the width of the ridges. Because of the ridges and grooves having different widths, a plate interspace 42 between two abutting plates 2 will be differently shaped at different sides of the same plate interspace 42. A heat exchange fluid flowing through the plate interspace 42 will thus be subject to different flow resistances at the different sides of the same plate interspace

42.

[0043] In the following reference will be made to upper, left and right sides of the plates 2 in the plate package 40. This is purely for ease of explanation with reference to Fig. 3 and is in no way limiting for aspects of the present invention. The ridges and grooves of each plate 2 are differently formed on the left side and the right side. That is, for instance the second plate 2 from the top in the plate package 40, on its left side forms a first area 18, and on the right side forms a second outer area 20. In the view illustrated in Fig. 3, the first area 18 is provided with wide ridges and narrow grooves and the second area 20 is provided with narrow ridges and wide grooves. The plate interspace 42 between two abutting plates 2 is different on the left and right sides of the plate package 40. As illustrated in Fig. 3, e.g. the two upper plates 2 are arranged such that on the left side a second outer area 20 of the top plate 2 abuts a first area 18 of the second plate 2 from the top. Since wide ridges abut wide grooves, the flow resistance will be high. Consequently, on the right hand side, the flow resistance between the two uppermost plates 2 is low, because here narrow ridges abut narrow grooves.

[0044] The plates 2 in the plate package 40 may be of the same sort. The above mentioned arrangement of first and second outer areas 18, 20 of different plates 2 may be achieved by rotating every alternate plate 2 of the same sort 180 degrees about a vertical axis 44.. By arranging the gaskets in a suitable manner the channels formed by the port holes through the plate package 40 and the plate interspaces 42 are sealed.

[0045] As explained in connection with Fig. 1, the heat exchange fluids are intended to flow in so called parallel flow over the plates 2, i.e. one heat exchange fluid flows between the first and second port holes 8a, 8b and the other heat exchanged fluid flows between the third and fourth port holes 10a, 10b. In parallel flow the distances a heat exchange fluid has to flow to pass a heat exchange surface of the plate 2 varies over the width of the plate 2, the shortest distance will be along the second side edge 6a closest to the first and second port holes 8a, 8b and the longest distance will be from the first port hole 8a across the plate 2 to the opposite second side edge 6b, along this second side edge 6b and back across the to plate 2 to the second port hole 8b. Similarly, on an opposite side of the plate a heat exchange fluid will flow the shortest distance directly between the third an fourth port holes 10a, 10b and for the longest distance the heat exchange fluid has to cross the plate twice on its way between the third and fourth port holes 10a, 10b. Thanks to the different flow resistances in each one and the same plate interspaces 42, in use, the distribution of the heat exchanged fluids in each plate interspace 42 will be affected. If high flow resistance is provided for the shortest path and low flow resistance for the longest path, the heat exchange fluid will be distributed more evenly over the entire relevant surface of the plate 2 than if the flow resistance would equal in the shortest and longest paths.

[0046] Fig. 4 illustrates a plate heat exchanger 50 according to example embodiments. The plate heat exchanger 50 comprises a plate package 40 of plates 2 according to any of the above example embodiments. Between the plates 2 there are arranged gaskets (not visible). The plate package 40 is arranged in a frame 52 comprising a frame plate 54, an upper bar 56

and a lower bar 58. The plate package 40 is clamped between the frame plate 54 and a pressure plate 60 by means of bolts 62 and nuts 64. The frame plate 54 is provided with four openings 66, each one leading to a channel formed by the four port holes 8a, 8b, 10a, 10b of the plates 2 in the plate package 40.

[0047] Example embodiments may be combined as understood by a person skilled in the art. For instance may an outer area comprising several fields have one direction for the protrusions and recesses in all fields. It is also understood by those skilled in the art that the present invention may be utilized for plates of other types of plate heat exchangers than plate heat exchanger provided with gaskets, such as welded and brazed plate heat exchangers.

[0048] Although the invention has been described with reference to example embodiments, many different alterations, modifications and the like will become apparent for those skilled in the art. Different fields in the main heat transfer portion of a plate, i.e. fields in the outer areas and/or the first area may be distinguished from each other by different corrugation patters or directions of corrugation patterns. Such fields may also be separated by dedicated formations in the plate. Each field may be separate or the fields may be separated two or more together. Also, the plates may be adapted for diagonal flow of heat exchange fluids instead of parallel flow. That is, the heat exchange fluids may be intended to flow over the plate surface between port holes arranged diagonally, at opposing ends of the plates. In this case the first and second outer areas of the main heat transfer portions of the plates may be formed such that the plate interspaces adjacent the first and second outer areas are substantially similar along both second side edges of the plate.

[0049] Therefore, it is to be understood that the foregoing is illustrative of various example embodiments and the invention is not to be limited to the specific embodiments disclosed and that modifications to the disclosed embodiments, combinations of features of disclosed embodiments as well as other embodiments are intended to be included within the scope of the appended claims.

[0050] As used herein, the term "comprising" or "comprises" is open-ended, and includes one or more stated features, elements, steps, components or functions but does not preclude the presence or addition of one or more other features, elements, steps, components, functions or groups thereof.

[0051] As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0052] As used herein, the common abbreviation "e.g.", which derives from the Latin phrase "exempli gratia," may be used to introduce or specify a general example or examples of a previously mentioned item, and is not intended to be limiting of such item. If used herein, the common abbreviation "i.e.", which derives from the Latin phrase "id est," may be used to specify a particular item from a more general recitation.

[0053] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0054] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

REFERENCES CITED IN THE DESCRIPTION

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PLADEVARMEVEKSLERPLADE OG PLADEVARMEVEKSLER

PATENTKRAV

1. Pladevarmevekslerplade (2), der er afgrænset af to i alt væsentligt parallelle første sidekanter (4a, 4b) og to i alt væsentligt parallelle anden sidekanter (6a, 6b) og forsynet med åbningshuller (8a, 10a), der støder op til en første fordelingssektion (12a) ved en første ende af pladen (2), åbningshuller (8b, 10b), der støder op til en anden fordelingssektion (12b) ved en anden ende af pladen (2), og mellem første og anden fordelingssektioner (12a, 12b) en hovedvarmeoverføringsdel (14), der omfatter et bølgemønster, hvor hovedvarmeoverføringsdelen (14) omfatter et første område (16), der omfatter et første felt (30) med første bølger anbragt i alt væsentligt på én side af en lige første linje (26), der skærer anden sidekanter (6a, 6b), og et andet felt (32) med anden bølger anbragt i alt væsentligt på en modsat side af den første linje (26), og hvor de første bølger omfatter toppe og fordybninger, der er orienteret i en vinkel på mellem 0 - < 90 grader med den første linje (26) målt i vinkelretning med eller mod uret og anden bølger omfatter toppe og fordybninger, der er orienteret i en vinkel på mellem >270 - <360 grader med den første linje (26) målt i vinkelretningen, kendetegnet ved, at hovedvarmeoverføringsdelen (14) omfatter et første ydre område (18), der er anbragt mellem det første område (16) og en første af de anden sidekanter (6a) og strækker sig langs den første anden sidekant (6a) mellem de første og anden fordelingssektioner (12a, 12b), hvor der i det første ydre område (18) er anbragt første fremspring og indskæringer, der er orienteret i en første generel retning i forhold til en lige anden linje (27) parallelt med én af de første sidekanter (4a, 4b), hvor den første generelle retning omfatter én eller flere vinkler mellem 0 - <90 grader i forhold til den anden linje (27).

2. Plade (2) ifølge krav 1, hvor hovedvarmeoverføringsdelen (14) omfatter et andet ydre område (20), der er anbragt mellem det første område (16) og en anden af de anden sidekanter (6b) modsat det første ydre område (18) og strækker sig langs den anden af de anden sidekanter (6b) mellem de første og anden fordelingssektioner (12a, 12b), hvor der i det andet ydre område (20) er anbragt anden fremspring og indskæringer, der er orienteret i en anden generel retning i forhold til den anden linje (27), hvor den anden generelle retning omfatter én eller flere vinkler mellem 0 - <90 grader i forhold til den anden linje (27).

3. Plade (2) ifølge et hvilket som helst af kravene 1 og 2, hvor det første område (16) omfatter et tredje felt (34) med tredje bølger, der omfatter toppe og fordybninger, der er anbragt i alt væsentligt på den ene side af den første linje (26) og orienteret i en vinkel på mellem >90 - <180 grader fra den første linje (26) i vinkelretningen, og et fjerde felt (36) med fjerde bølger, der omfatter toppe og fordybninger, der er anbragt i alt væsentligt på den modsatte side af den første linje (26) og orienteret i en vinkel på mellem >180 - < 270 grader fra den første linje (26) i vinkelretningen.

4. Plade (2) ifølge et hvilket som helst af de foregående krav, hvor toppene og fordybningerne af de første bølger er orienteret i en vinkel på mellem >45 - <90 grader med den første linje (26) målt i vinkelretningen og toppene og fordybningerne af anden bølger er orienteret i en vinkel på mellem >270 - <315 grader med den første linje (26) målt i vinkelretningen.

5. Plade (2) ifølge et hvilket som helst af kravene 3 og 4, hvor toppene og fordybningerne af de tredje bølger er orienteret i en vinkel på mellem >90 - <135 grader med den første linje (26) målt i vinkelretningen og toppene og fordybningerne af de fjerde bølger er orienteret i en vinkel på mellem >225 - <270 grader med den første linje (26) målt i vinkelretningen.

6. Plade (2) ifølge et hvilket som helst af kravene 2-5, hvor det første ydre område (18) og/eller det andet ydre område (20) har en bredde målt parallelt med den anden linje (27), der er smallere end det første felt (30) målt parallelt med den anden linje (27).

7. Plade (2) ifølge et hvilket som helst af kravene 2-6, hvor de første og/eller anden fremspring og indskæringer i det første ydre område (18) og/eller det andet ydre område (20) omfatter bølger i form af toppe og fordybninger.

8. Plade (2) ifølge krav 7, hvor i det første og det andet ydre område (18, 20) toppene har en anden bredde end fordybningerne målt over toppene og fordybningerne.

9. Plade (2) ifølge et hvilket som helst af kravene 2-8, hvor de første fremspring og indskæringer er orienteret i en første retning i forhold til den anden linje (27) og/eller anden fremspring og indskæringer er orienteret i en anden retning i forhold til den anden linje (27).

10. Plade (2) ifølge et hvilket som helst af de foregående krav, hvor de første sidekanter (4a, 4b) er korte sider og anden sidekanter (6a, 6b) er lange sider af pladen (2).

11. Plade (2) ifølge et hvilket som helst af kravene 2-10, hvor det første ydre område (18) og/eller det andet ydre område (20) er opdelt i to eller flere felter (22a, 22b, 22c, 24a, 24b, 24c).

12. Pladevarmeveksler (50), der omfatter en pladepakke (40) af pladevarmevekslerplader (2) ifølge et hvilket som helst af de foregående krav.

13. Pladevarmeveksler (50) ifølge krav 12, hvor pladevarmevekslerpladerne (2) er anbragt skiftevis i pladepakken (40), således at et første ydre område (18) af én plade (2) lægger an mod et andet ydre område (20) af en anlægsplade (2).

14. Pladevarmeveksler (50) ifølge et hvilket som helst af kravene 12 og 13, der er tilpasset til i alt væsentligt parallel strømning af mindst to varmeudvekslingsfluider over hovedvarmeoverføringsdelen (14) af plader (2) i pladepakken (40).

DRAWINGS

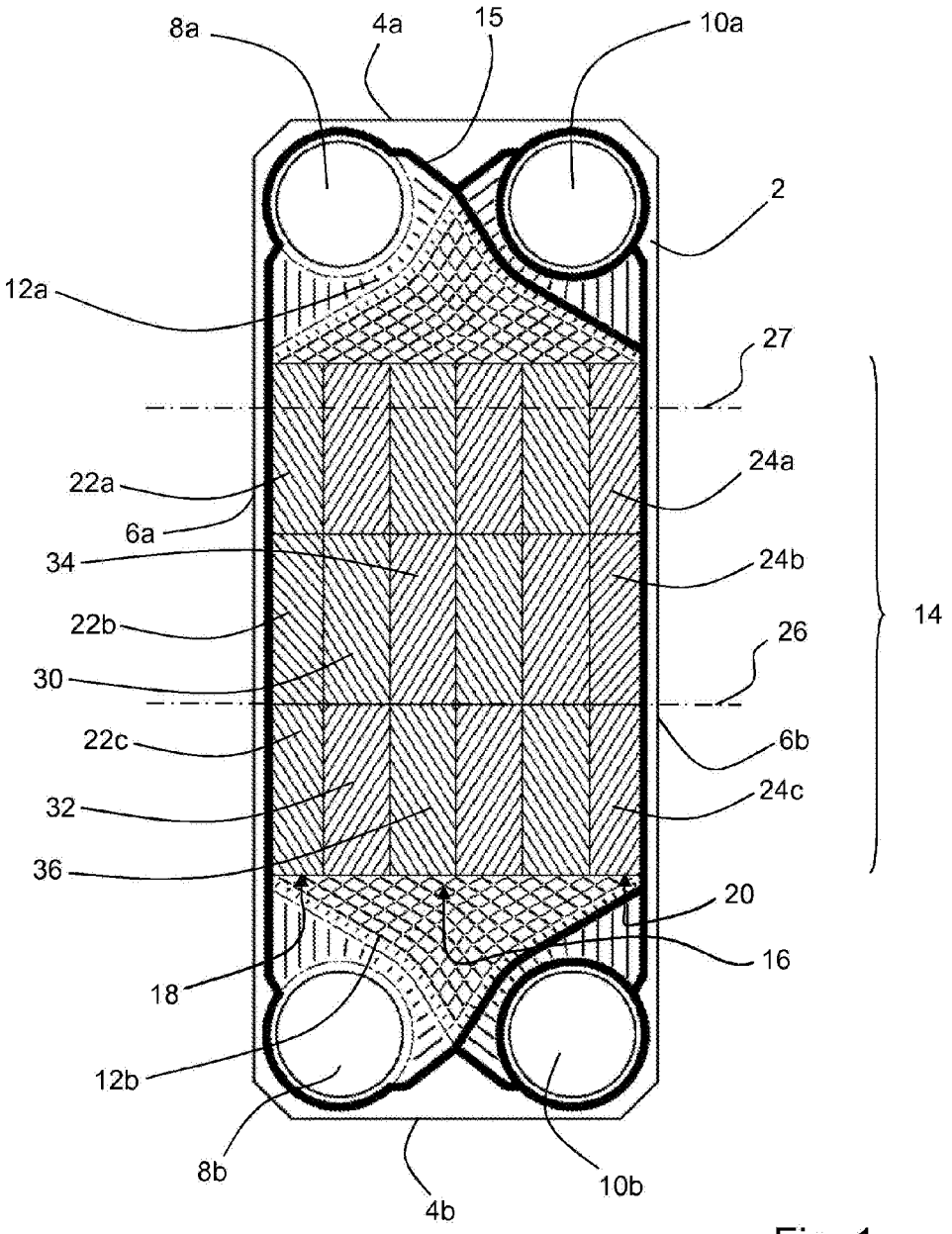


Fig. 1

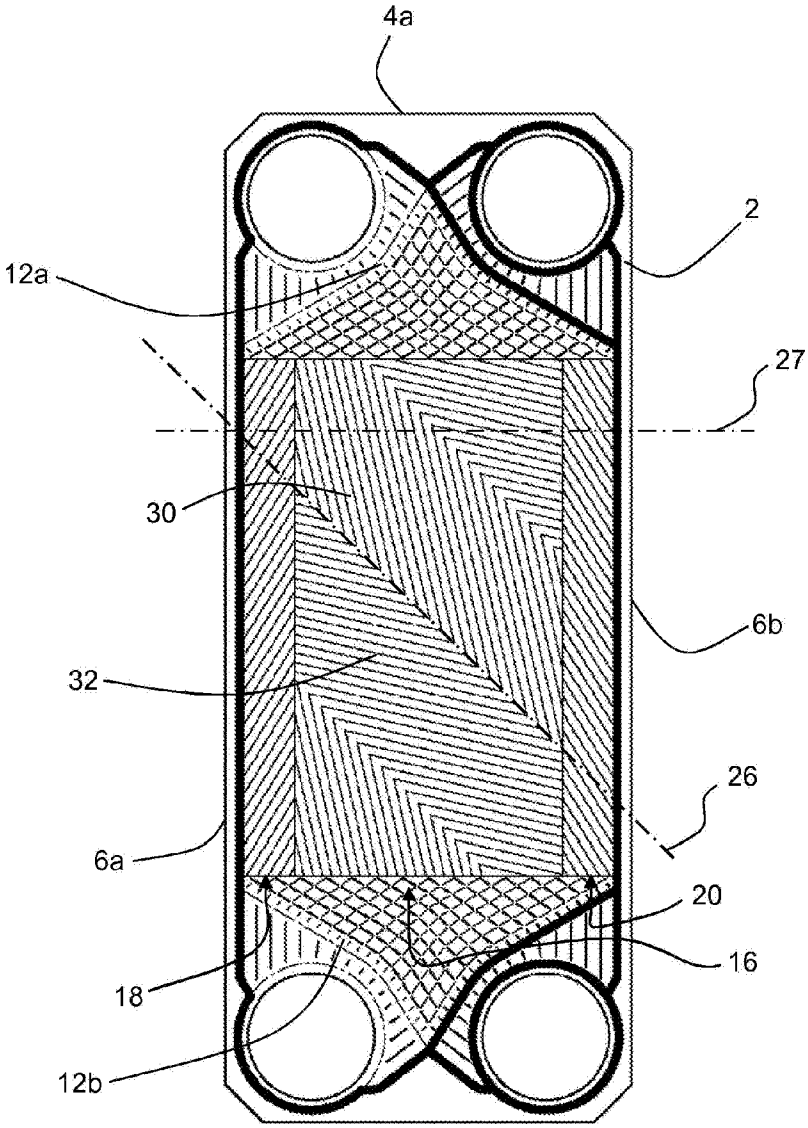


Fig. 2

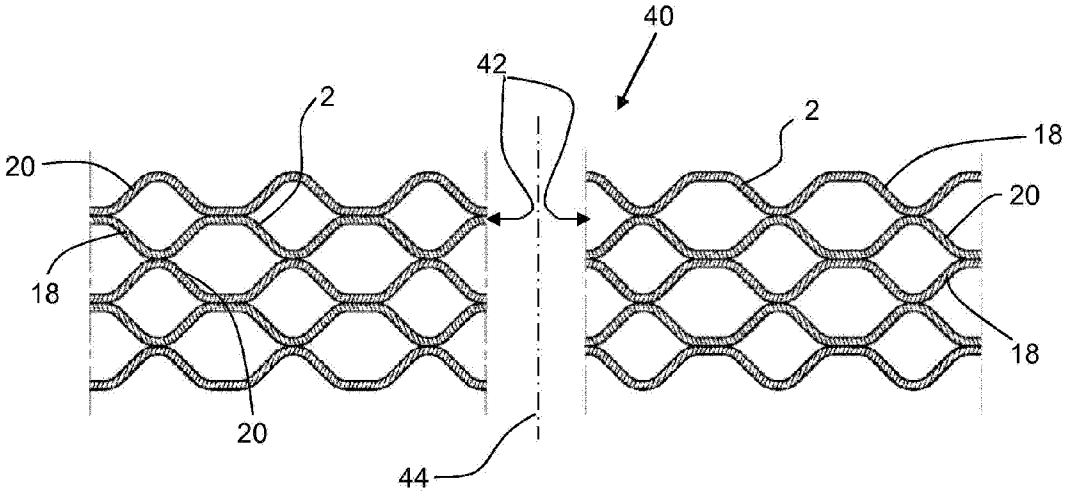


Fig. 3

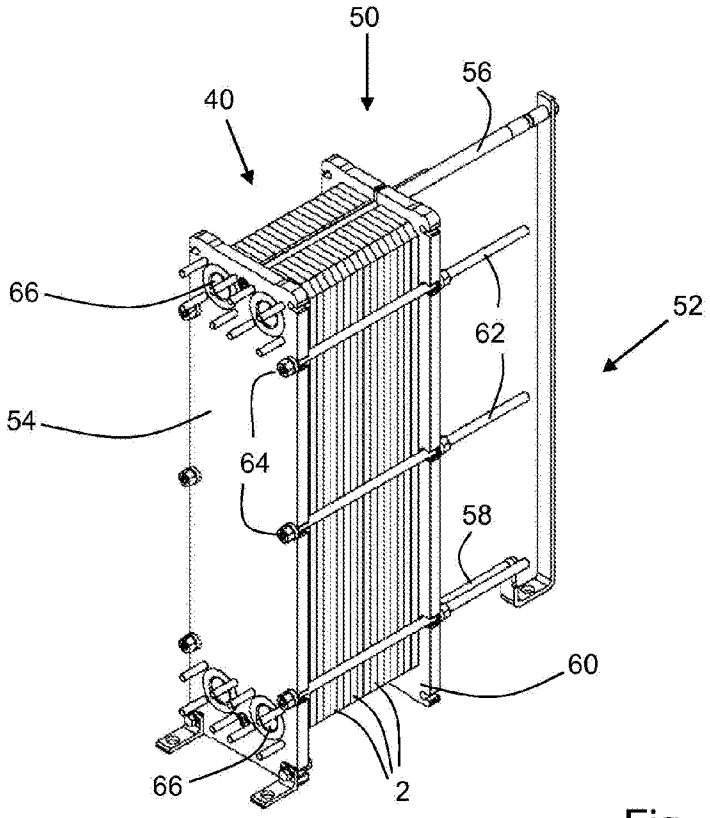


Fig. 4