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(54) Title: PLATE HEAT EXCHANGER PLATE AND PLATE HEAT EXCHANGER

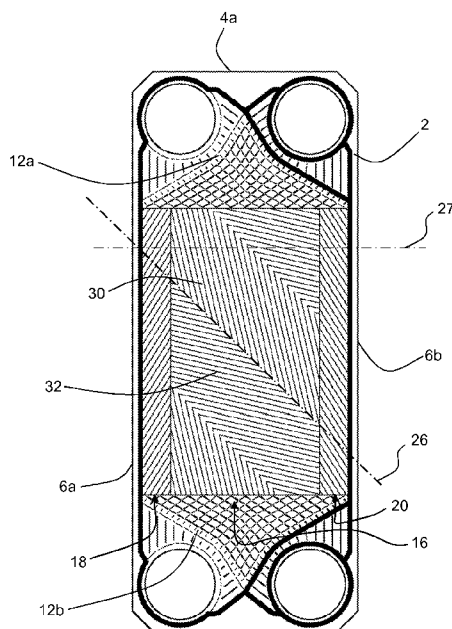


Fig. 2

(57) Abstract: A plate heat exchanger plate (2) with a main heat transfer portion (14) comprising a first area (16) comprising a first field (30) with first corrugations arranged substantially on one side of a straight first line (26) intersecting with second side edges (6a, 6b) and a second field (32) with second corrugations arranged substantially on an opposite side of the first line (26) is provided. The main heat transfer portion (14) comprises a first outer area (18) arranged between a first area (16) and a first of the second side edges (6a) and extends along the first second side edge (6a) between two distribution portions (12a, 12b). In the first outer area (18) there are arranged first protrusions and recesses directed in a first general direction in relation to a straight second line (27) parallel to one of first side edges (4a, 4b). A plate (2) with a straight first second edge (6a) may thus be provided when corrugations in the first area (16) are directed in different directions.



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PLATE HEAT EXCHANGER PLATE AND PLATE HEAT EXCHANGER

AREA OF INVENTION

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

BACKGROUND OF INVENTION

Plate heat exchangers provided with a plate package of plate heat
exchanger plates are utilized for exchange of heat between two or more heat
10 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
15 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
20 exchange fluids may be e.g. gases, liquids, liquids containing solid matter, etc.

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
25 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.

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.

When the V-shaped pattern of corrugations comprising ridges and
5 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
10 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
15 other corrugation patterns. Accordingly, the utilization of sheet metal material is not optimal.

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.

20 DISCLOSURE OF INVENTION

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.

According to an aspect of the invention, the object is achieved by a
25 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
30 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.

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.

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.

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
5 said second line. In this manner also the second of the second side edges may be maintained straight during manufacturing of the heat exchanger plate.

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
10 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
15 formations pointing towards the centre of the plate from both sides and thus may benefit from the outer areas arranged along both second sides.

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
20 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
25 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.

According to example embodiments the ridges and grooves of the third corrugations may be directed at an angle of between $> 90 - < 135$ degrees with
30 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.

5 According to example embodiments the first general direction and /or the second general direction may 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.

10 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.

15 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.

 According to example embodiments, in the first and second outer areas the ridges may have a different width than the grooves measured across the
20 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
25 portion may be promoted.

 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
30 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.

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

5 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.

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

 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
15 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.

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

 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
25 described in the following, without departing from the scope of the present invention, as defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

 The various aspects of the invention, including its particular features and advantages, will be readily understood from the following detailed
30 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

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

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention will now be described more fully with reference to the accompanying drawings, in which example embodiments are shown.

10 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.

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

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
20 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
25 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
30 holes 10a, 10b. Thus, heat from one of the heat exchange fluids is transferred through the plate 2 to the other heat exchange fluid.

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.

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.

The plate 2 is provided with gasket grooves, which are adapted to receive one or more gaskets. When one or 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.

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
5 second distribution portions 12a, 12b along a second of the second side edges 6b and comprises three fields 24a, 24b, 24c.

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
10 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
15 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
20 and grooves directed at an angle of about 240 degrees with the first line 26, again measured in the same direction as before.

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
25 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
30 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.

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 displaced 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.

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.

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.

The first area 16 comprises several fields, in which the ridges and grooves 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
5 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
10 directed in one second direction only.

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
15 corrugation pattern during manufacturing.

The first and second outer areas 18, 20, respectively, are narrower than 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.

20 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
25 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
30 resistances at the different sides of the same plate interspace 42.

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

5 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
10 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.

15 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
20 package 40 and the plate interspaces 42 are sealed.

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
25 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
30 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 and 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
5 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.

Fig. 4 illustrates a plate heat exchanger 50 according to example
10 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
15 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.

Example embodiments may be combined as understood by a person skilled in the art. For instance may an outer area comprising several fields have
20 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.

Although the invention has been described with reference to example
25 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 patterns or directions of corrugation patterns. Such fields may also be separated by dedicated
30 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
5 are substantially similar along both second side edges of the plate.

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
10 other embodiments are intended to be included within the scope of the appended claims.

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
15 features, elements, steps, components, functions or groups thereof.

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

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
20 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.

The terminology used herein is for the purpose of describing particular
25 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.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of
30 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.

CLAIMS

1. A plate heat exchanger plate (2) delimited by two substantially parallel first side edges (4a, 4b) and two substantially parallel second side edges (6a, 6b) and provided with port holes (8a, 10a) adjacent a first distribution portion (12a) at a first end of said plate (2), port holes (8b, 10b) adjacent a second distribution portion (12b) at a second end of said plate (2), and between said first and second distribution portions (12a, 12b) a main heat transfer portion (14) comprising a corrugation pattern, wherein said main heat transfer portion (14) comprises a first area (16) comprising a first field (30) with first corrugations arranged substantially on one side of a straight first line (26) intersecting with said second side edges (6a, 6b) and a second field (32) with second corrugations arranged substantially on an opposite side of said first line (26), and wherein said first corrugations comprise ridges and grooves directed at an angle of between $0 - < 90$ degrees with said first line (26) measured in a clockwise or counter clockwise angular direction and said second corrugations comprise ridges and grooves directed at an angle of between $>270 - <360$ degrees with said first line (26) measured in said angular direction, **characterised in that** said main heat transfer portion (14) comprises a first outer area (18) arranged between said first area (16) and a first of said second side edges (6a) and extends along said first second side edge (6a) between said first and second distribution portions (12a, 12b), wherein in said first outer area (18) there are arranged first protrusions and recesses directed in a first general direction in relation to a straight second line (27) parallel to one of said first side edges (4a, 4b).

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2. The plate (2) according to claim 1, wherein said main heat transfer portion (14) comprises a second outer area (20) arranged between said first area (16) and a second of said second side edges (6b) opposite to said first outer area (18) and extends along said second of said second side edges (6b) between said first and second distribution portions (12a, 12b), wherein in said

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second outer area (20) there are arranged second protrusions and recesses directed in a second general direction in relation to said second line (27).

3. The plate (2) according to any one of claims 1 and 2, wherein said
5 first area (16) comprises a third field (34) with third corrugations comprising ridges and grooves arranged substantially on said one side of said first line (26) and directed at an angle of between $> 90 - < 180$ degrees from said first line (26) in said angular direction and a fourth field (36) with fourth corrugations comprising ridges and grooves arranged substantially on said opposite side of
10 said first line (26) and directed at an angle of between $> 180 - < 270$ degrees from said first line (26) in said angular direction.

4. The plate (2) according to any one of the preceding claims, wherein said ridges and grooves of said first corrugations are directed at an angle of
15 between $> 45 - < 90$ degrees with said first line (26) measured in said angular direction and said ridges and grooves of said second corrugations are directed at an angle of between $> 270 - < 315$ degrees with said first line (26) measured in said angular direction.

20 5. The plate (2) according to any one of claims 3 and 4, wherein said ridges and grooves of said third corrugations are directed at an angle of between $> 90 - < 135$ degrees with said first line (26) measured in said angular direction and said ridges and grooves of said fourth corrugations are directed at an angle of between $> 225 - < 270$ degrees with said first line (26) measured in
25 said angular direction.

6. The plate (2) according to any one of claims 2-5, wherein said first general direction and /or said second general direction comprise/s one or more angles between $0 - < 90$ degrees in relation to said second line (27).

7. The plate (2) according to any one of claims 2-6, wherein said first outer area (18) and/or said second outer area (20) have/has a width measured in parallel with said second line (27), which is narrower than said first field (30) measured in parallel with said second line (27).

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8. The plate (2) according to any one of claims 2-7, wherein said first and/or second protrusions and recesses in said first outer area (18) and/or said second outer area (20) comprise corrugations in the form of ridges and grooves.

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9. The plate (2) according to claim 8, wherein in said first and second outer areas (18, 20) said ridges have a different width than said grooves measured across said ridges and grooves.

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10. The plate (2) according to any one of claims 2-9, wherein said first protrusions and recesses are directed in a first direction in relation to said second line (27) and/or said second protrusions and recesses are directed in a second direction in relation to said second line (27).

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11. The plate (2) according to any one of the preceding claims, wherein said first side edges (4a, 4b) are short sides and said second side edges (6a, 6b) are long sides of said plate (2).

12. The plate (2) according to any one of claims 2-11, wherein said first outer area (18) and/or said second outer area (20) are/is divided into two or more fields (22a, 22b, 22c, 24a, 24b, 24c).

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13. A plate heat exchanger (50) comprising a plate package (40) of plate heat exchanger plates (2) according to any one of the preceding claims.

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14. The plate heat exchanger (50) according to claim 13, wherein said plate heat exchanger plates (2) are arranged alternately in said plate package (40) such that a first outer area (18) of one plate (2) abuts a second outer area (20) of an abutting plate (2)..

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15. The plate heat exchanger (50) according to any one of claims 13 and 14, which is adapted for substantially parallel flow of at least two heat exchange fluid over said main heat transfer portion (14) of plates (2) in said plate package (40).

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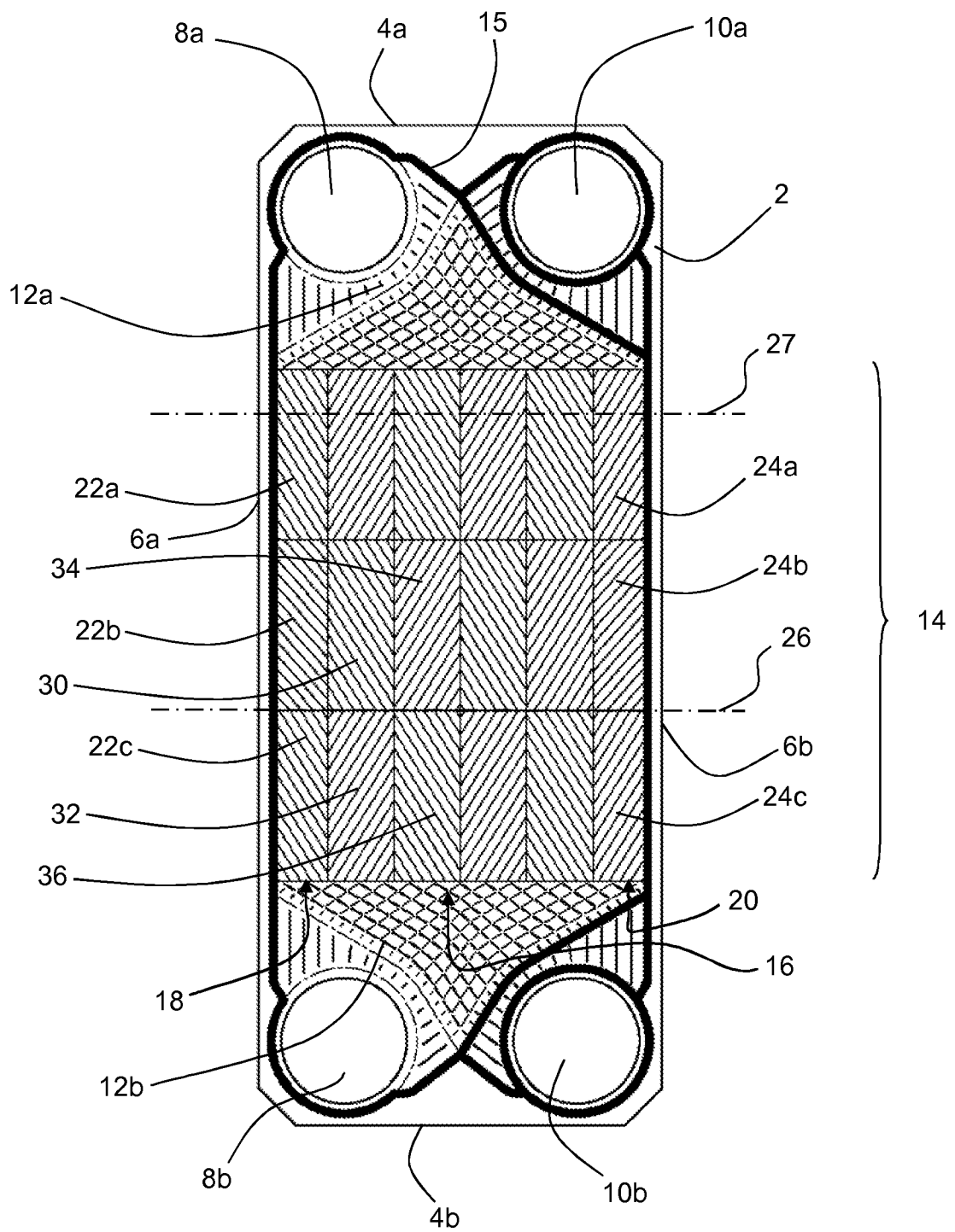


Fig. 1

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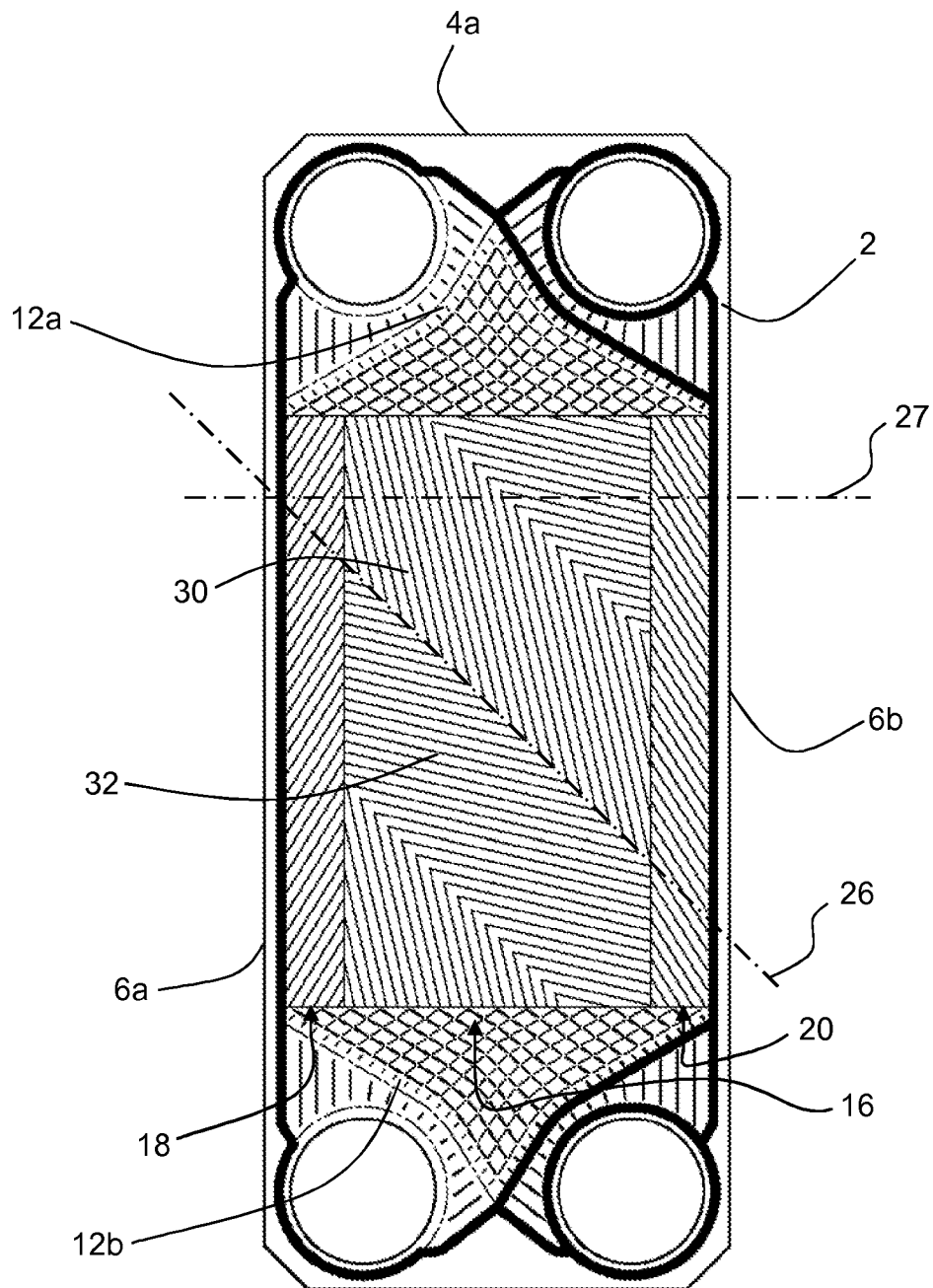


Fig. 2

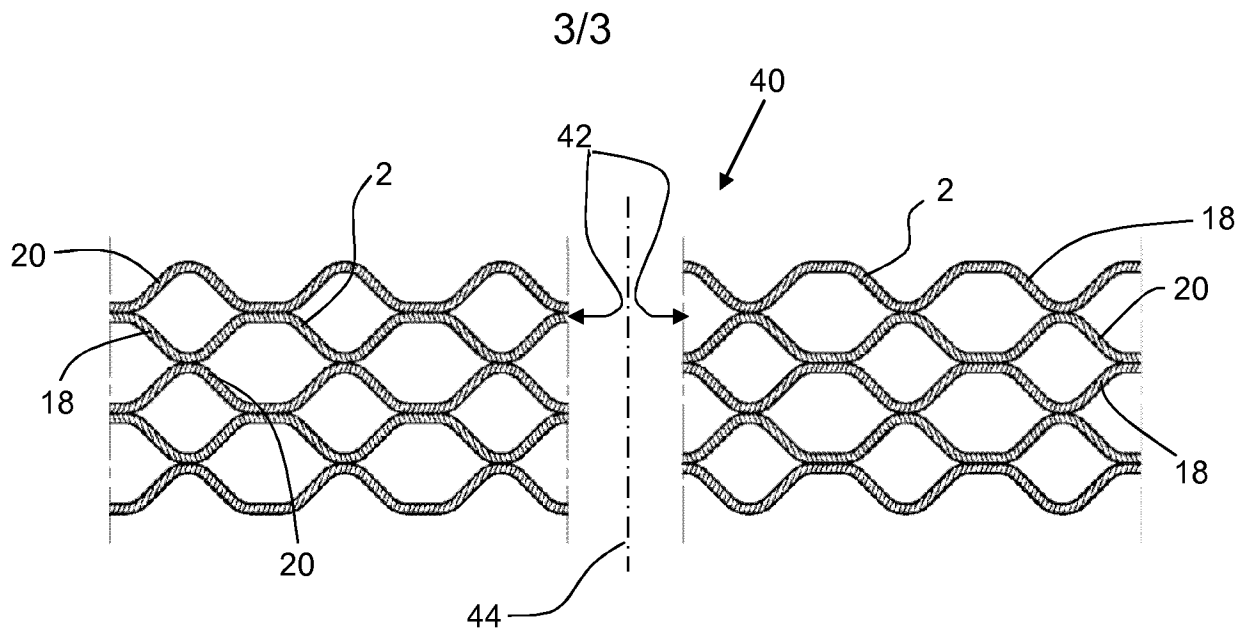


Fig. 3

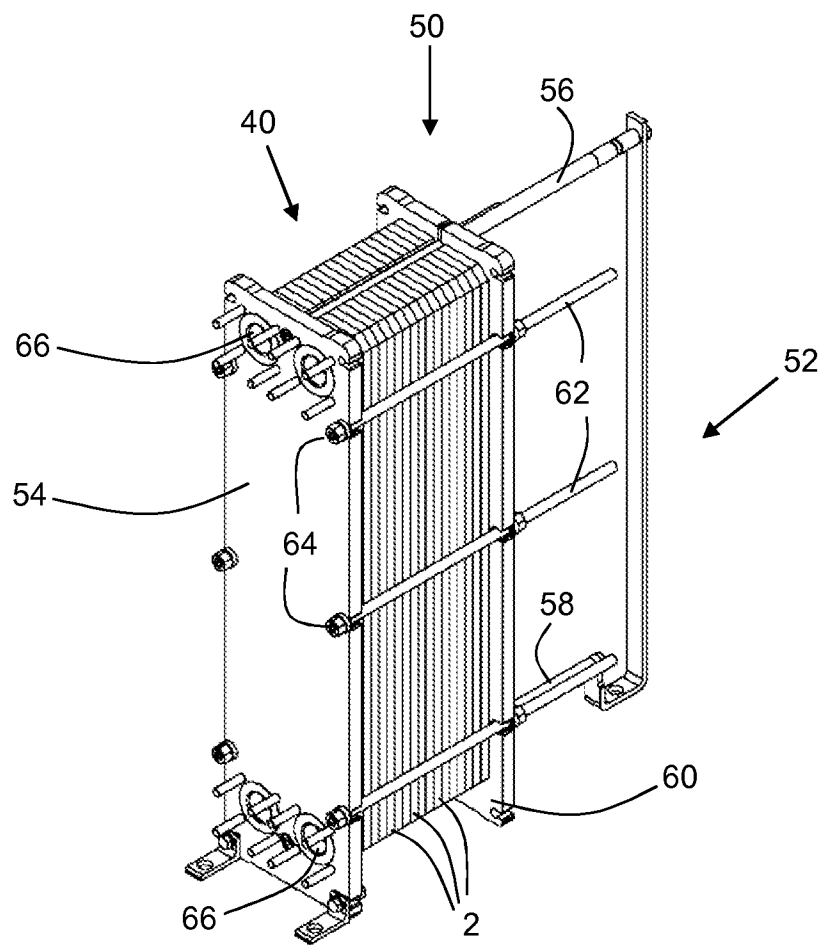


Fig. 4