



(11)

EP 4 575 368 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.06.2025 Bulletin 2025/26

(51) International Patent Classification (IPC):
F28D 9/00 (2006.01)

(21) Application number: **23219587.5**

(52) Cooperative Patent Classification (CPC):
**F28D 9/005; F28F 3/046; F28F 3/083; F28F 9/026;
F28F 9/0265; F28F 9/027**

(22) Date of filing: **22.12.2023**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(72) Inventor: **NILSSON, Johan**
SE-372 37 RONNEBY (SE)

(74) Representative: **Alfa Laval Attorneys**
Alfa Laval Corporate AB
Group Patent
P.O. Box 73
221 00 Lund (SE)

(71) Applicant: **Alfa Laval Corporate AB**
221 00 Lund (SE)

(54) **HEAT TRANSFER PLATE, CASSETTE AND HEAT EXCHANGER**

(57) A heat transfer plate (8, 8a, 8b), a cassette (57) and a heat exchanger (2) are provided. The heat transfer plate (8, 8a) comprises a heat transfer area (46) provided with a heat transfer corrugation pattern comprising tops (60) and bottoms (62). The heat transfer area (46) comprises at least first and second transverse fields (1, 3) arranged in succession along a longitudinal center axis (L) of the heat transfer plate and each extending from a first long side (7) to a second long side (9) of the heat transfer area (46). The first and second transverse fields (1, 3) are separated by a first transverse border area (11). The heat transfer plate (8, 8a, 8b) is characterized in that a first top pitch (TP1) between the tops (60) extending within the first transverse field (1), within a first transverse sub-field (1') of the first transverse field (1), differs from a second top pitch (TP2) between the tops (60) extending within the second transverse field (3), within a second transverse sub-field (3') of the second transverse field (3).

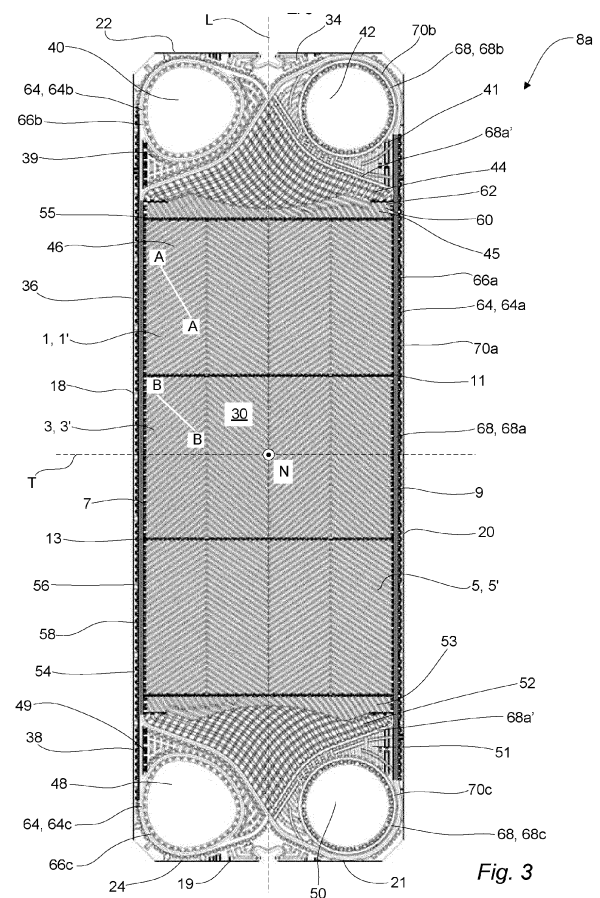


Fig. 3

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Description

Technical Field

[0001] The invention relates to a heat transfer plate, a cassette comprising two such heat transfer plates and a heat exchanger comprising a plurality of such heat transfer plates.

Background Art

[0002] Plate heat exchangers, PHEs, typically comprises two end plates in between which a number of heat transfer plates are arranged in an aligned manner, i.e. in a stack or pack. The heat transfer plates of a PHE may be stacked in different ways. In some PHEs, the heat transfer plates are stacked with the front side and the back side of one heat transfer plate facing the back side and the front side, respectively, of other heat transfer plates, and every other heat transfer plate turned upside down in relation to the rest of the heat transfer plates. In other words, every second one of the heat transfer plates is rotated 180 degrees, around its normal, in relation to the rest of the plates. Typically, this is referred to as the heat transfer plates being "rotated" in relation to each other. In other PHEs, the heat transfer plates are stacked with the front side and the back side of one heat transfer plate facing the front side and back side, respectively, of other heat transfer plates, and every other heat transfer plate turned upside down in relation to the rest of the heat transfer plates. In other words, every second one of the heat transfer plates is rotated 180 degrees, around its transverse center axis, in relation to the rest of the plates. Typically, this is referred to as the heat transfer plates being "flipped" in relation to each other. In other PHEs, the heat transfer plates are stacked with the front side and the back side of one heat transfer plate facing the front side and back side, respectively, of other heat transfer plates. In other words, every second one of the heat transfer plates is rotated 180 degrees, around its longitudinal center axis, in relation to the rest of the plates. Typically, this is referred to as the heat transfer plates being "turned" in relation to each other. Parallel flow channels are formed between the heat transfer plates, one channel between each pair of heat transfer plates. Two fluids of initially different temperatures can flow through every second channel for transferring heat from one fluid to the other, which fluids enter and exit the channels through inlet and outlet port holes in the heat transfer plates.

[0003] Typically, a heat transfer plate comprises two end parts and an intermediate center part. The end parts comprise the inlet and outlet port holes and a distribution area pressed with a distribution corrugation pattern of projections and depressions, such as ridges and valleys, in relation to a reference plane of the heat transfer plate. Similarly, the center part comprises a heat transfer area pressed with a heat transfer corrugation pattern of projections and depressions, such as ridges and valleys, in

relation to said reference plane. The ridges and valleys of the distribution and heat transfer corrugation patterns of one heat transfer plate are arranged to contact, in intended contact points, an upper and a lower adjacent heat transfer plate, respectively, within their respective distribution and heat transfer areas.

[0004] The main task of the distribution area of the heat transfer plates is to spread a fluid entering the channel across a width of the heat transfer plate before the fluid reaches the heat transfer area, and to collect the fluid and guide it out of the channel after it has passed the heat transfer area. On the contrary, the main task of the heat transfer area is heat transfer. Since the distribution area and the heat transfer area have different main tasks, the distribution corrugation pattern normally differs from the heat transfer corrugation pattern. One common distribution corrugation pattern is the so-called chocolate pattern. One common heat transfer corrugation pattern is the so-called herringbone pattern which comprises corrugations in the form of parallel elongate beams extending inclined in relation to a longitudinal center axis of the heat transfer plate. Typically, a herringbone pattern offers small, densely arranged intended contact points between abutting heat transfer plates, i.e. points in which the abutting heat transfer plates are arranged to contact each other. When pressing a heat transfer plate with a herringbone pattern, tension may arise in the heat transfer plate, which tension can make the heat transfer plate bulging or non-flat. To avoid this, the heat transfer areas may be divided in transverse sub-areas separated by plane transition bands. The transition bands will introduce interruptions in the beams, which interruptions will ease the tension in the heat transfer plate and make it more flat. However, the transition bands will also occupy surface area of the heat transfer plate, and some of the intended contact points within the heat transfer area may be located very close to the transition bands. When the heat transfer plate is arranged in a plate pack, it may fail to contact the adjacent heat transfer plates in the intended contact points located close to the transition bands. This may be due to manufacturing tolerances and slight misalignment of the heat transfer plates of the plate pack which may cause the intended contact points close to the transition bands to be aligned with the transition bands of the adjacent heat transfer plates which, in turn, may result in no plate contact. Further, such contact failure may also arise in plate packs comprising a combination of new and old heat transfer plates since the measurements of the heat transfer plates may change during use of the heat transfer plates. Lost contact points may result in a mechanically weakened plate pack.

Summary

[0005] An object of the present invention is to provide a heat transfer plate which enables the creation of a plate pack which is strong but which still may be pressed without becoming too bulging or non-flat. The basic con-

cept of the invention is to vary the pattern within the transverse sub areas of the heat transfer area so as to position the intended contact points of the heat transfer plate on a safe distance from the transition band(s). Other objects of the invention is to provide a cassette comprising two such heat transfer plates and a heat exchanger comprising a plurality of such heat transfer plates. The heat transfer plate, which is also referred to herein as just "plate", the cassette and the heat exchanger are defined in the appended claims and discussed below.

[0006] A heat transfer plate according to the invention has a front side and an opposing back side. It comprises an upper distribution area, a heat transfer area and a lower distribution area arranged in succession along a longitudinal center axis of the heat transfer plate which extends perpendicular to a transverse center axis of the heat transfer plate. The heat transfer area, the upper distribution area and lower distribution area are provided with a heat transfer corrugation pattern, an upper distribution corrugation pattern and a lower distribution corrugation pattern, respectively. The heat transfer corrugation pattern differs from the upper distribution corrugation pattern and the lower distribution corrugation pattern. The heat transfer corrugation pattern comprises tops extending in an imaginary top plane facing the front side of the heat transfer plate, and bottoms extending in an imaginary bottom plane facing the back side of the heat transfer plate. The top plane and the bottom plane are separated by a distance D . The heat transfer area comprises at least first and second transverse fields (corresponding to the sub-areas referred to above) arranged in succession along the longitudinal center axis. Each of the first and second transverse fields extends from a first long side to a second long side of the heat transfer area. The first and second transverse fields are separated by a first transverse border area (corresponding to the transition band referred to above) which extends between two imaginary intermediate planes separated by a distance d , $d < D$, and crossing the longitudinal center axis. The heat transfer plate is characterized in that a first top pitch between the tops extending within the first transverse field, within a first transverse sub-field of the first transverse field, differs from a second top pitch between the tops extending within the second transverse field, within a second transverse sub-field the second transverse field.

[0007] Typically, the first transverse border area is narrow and band-shaped. It may have any suitable form, for example, it may be straight, curved, angled, saw-shaped, etc. The first transverse border area may be plane, i.e. not pressed or provided with any corrugations. When the first transverse border area is plane, a distance between the two intermediate planes is minimum and equal to a thickness of the heat transfer plate before pressing. Alternatively, the first transverse border area could be provided with a pattern with a reduced pressing depth as compared to the pressing depth within the first and second transverse fields. The intermediate planes

could both extend between the top and bottom planes. Alternatively, one of the intermediate planes could coincide with one of the top and bottom planes while the other one of the intermediate planes could extend between the top and bottom planes.

[0008] Typically, a majority of the tops and bottoms are essentially elongate and each part of a respective beam of a heat transfer corrugation pattern of so-called heringbone type. The tops and bottoms may have any suitable form, such as straight, bent, angled, etc.

[0009] The first and second long sides of the heat transfer area may extend essentially parallel to the longitudinal center axis. This is typically the case for a rectangular heat transfer plate.

[0010] The first transverse sub-field may extend from the first long side to the second long side of the heat transfer area. Similarly, the second transverse sub-field may extend from the first long side to the second long side of the heat transfer area.

[0011] The first transverse border area may extend from the first long side to the second long side of the heat transfer area.

[0012] By differentiating the first top pitch, within the first transverse sub-field of the first transverse field, from the second top pitch, within the second transverse sub-field the second transverse field, the points, within the heat transfer area, in which the plate is arranged to contact another plate in a plate pack, i.e. the intended contact points within the heat transfer area, may be arranged on a safe distance from the first transverse border area so as to become actual or real, and not lost, contact points in the plate pack. Thereby, the strength and rigidity of the plate pack may be optimized.

[0013] The plate may be such that each of the first and second transverse fields comprises first and second longitudinal sub-fields arranged in succession along the transverse center axis of the heat transfer plate. Further, the tops within the first longitudinal sub-field of the first transverse field may extend with a smallest angle $\alpha_1 = 0-90$ degrees in relation to the longitudinal center axis, the tops within the second longitudinal sub-field of the first transverse field may extend with a smallest angle $\beta_1 = 0-90$ degrees in relation to the longitudinal center axis, the tops within the first longitudinal sub-field of the second transverse field may extend with a smallest angle $\alpha_3 = 0-90$ degrees in relation to the longitudinal center axis, and the tops within the second longitudinal sub-field of the second transverse field may extend with a smallest angle $\beta_3 = 0-90$ degrees in relation to the longitudinal center axis. The first longitudinal sub-field of the first transverse field and the first longitudinal sub-field of the second transverse field may be aligned along the longitudinal center axis. The second longitudinal sub-field of the first transverse field and the second longitudinal sub-field of the second transverse field may be aligned along the longitudinal center axis.

[0014] Each of the first and second longitudinal sub-fields of the first transverse field may extend between two

separated border lines defining the extension of the first transverse field along the longitudinal center axis of the plate. Similarly, each of the first and second longitudinal sub-fields of the second transverse field may extend between two separated border lines defining the extension of the second transverse field along the longitudinal center axis of the plate. The border lines may cross the longitudinal center axis of the plate and extend from the first to the second long side of the heat transfer area. The first and second longitudinal sub-fields of the first and/or the second transverse field may be neighboring, and the tops extending within the first longitudinal sub-field(s) may form arrows with the tops extending within the second longitudinal sub-field(s). The smallest angle α_1 and the smallest angle β_1 within the first and second longitudinal sub-fields of the first transverse field may be similar and/or measured clockwise and counter-clockwise, respectively. Additionally/alternatively, the smallest angle α_3 and the smallest angle β_3 within the first and second longitudinal sub-fields of the second transverse field may be similar and/or measured clockwise and counter-clockwise, respectively.

[0015] By dividing the first and second transverse fields into at least first and second longitudinal sub-fields, the length of the tops and bottoms of the heat transfer area may be limited or reduced. In turn, this may decrease the tension in, and, thus, the risk of bulging of, the heat transfer plate.

[0016] The plate may be so designed that the smallest angle α_1 within the first longitudinal sub-field within the first transverse sub-field of the first transverse field differs from the smallest angle α_3 within the first longitudinal sub-field within the second transverse sub-field of the second transverse field. Further, additionally/alternatively, the smallest angle β_1 within the second longitudinal sub-field within the first transverse sub-field of the first transverse field may differ from the smallest angle β_3 within the second longitudinal sub-field within the second transverse sub-field of the second transverse field.

[0017] By differentiating, not only the top pitch, but also the smallest angle α_1 within the first transverse sub-field of the first transverse field, from the smallest angle α_3 , within the second transverse sub-field the second transverse field, and/or the smallest angle β_1 within the first transverse sub-field of the first transverse field, from the smallest angle β_3 , within the second transverse sub-field the second transverse field, there are more than one parameter for optimizing the location of the intended contact points within the heat transfer area. Thereby, the object of the invention may be achieved with smaller differences in the top pitch than required when there is one parameter only (the top pitch) to vary for optimizing the location of the intended contact points within the heat transfer area. Smaller differences in the top pitch means smaller variations in surface enlargement within the heat transfer area which, in turn, means a larger heat transferring plate surface. Further, a larger pitch is typically associated with a lower plate strength. Smaller differ-

ences in the top pitch means smaller variations in plate strength within the heat transfer area.

[0018] The smallest angle α_1 and the smallest angle β_1 may each be varying within the first transverse sub-field. Similarly, the smallest angle α_3 and the smallest angle β_3 may each be varying within the second transverse sub-field. However, according to one embodiment of the invention, the smallest angle α_1 is essentially constant within essentially the complete first longitudinal sub-field within the first transverse sub-field of the first transverse field, and/or the smallest angle α_3 is essentially constant within essentially the complete first longitudinal sub-field within the second transverse sub-field of the second transverse field, and/or the smallest angle β_1 is essentially constant within essentially the complete second longitudinal sub-field within the first transverse sub-field of the first transverse field, and/or the smallest angle β_3 is essentially constant within essentially the complete second longitudinal sub-field within the second transverse sub-field of the second transverse field. Such an embodiment may enable a mechanically straight-forward design of the plate.

[0019] The plate may be such that each of the first and second transverse fields also comprises a third longitudinal sub-field. The first, second and third longitudinal sub-fields may be arranged in succession along the transverse center axis of the heat transfer plate. The tops within the third longitudinal sub-field within the first transverse field may extend with a smallest angle $\gamma_1 = 0-90$ degrees in relation to the longitudinal center axis, and the tops within the third longitudinal sub-field within the second transverse field may extend with a smallest angle $\gamma_3 = 0-90$ degrees in relation to the longitudinal center axis. The third longitudinal sub-field of the first transverse field and the third longitudinal sub-field of the second transverse field may be aligned along the longitudinal center axis.

[0020] Dividing the first and second transverse fields into at least first, second and third longitudinal sub-fields may be advantageous for larger heat transfer plates. Further, the plate may be such that each of the first and second transverse fields comprises a fourth longitudinal sub-field. The first, second, third and fourth longitudinal sub-fields may be arranged in succession along the transverse center axis of the heat transfer plate. The tops within the fourth longitudinal sub-field within the first transverse field may extend with a smallest angle $\mu_1 = 0-90$ degrees in relation to the longitudinal center axis, and the tops within the fourth longitudinal sub-field within the second transverse field may extend with a smallest angle $\mu_3 = 0-90$ degrees in relation to the longitudinal center axis. The fourth longitudinal sub-field of the first transverse field and the fourth longitudinal sub-field of the second transverse field may be aligned along the longitudinal center axis.

[0021] Dividing the first and second transverse fields into at least first, second third and fourth longitudinal sub-fields may be advantageous for even larger heat transfer

plates. It should be said that an even number of longitudinal sub-fields within each one of the first and second transverse fields may make the heat transfer plate suitable for use in a plate pack comprising heat transfer plates which are either "rotated", "flipped" or "turned" in relation to each other. An uneven number of longitudinal sub-fields within each one of the first and second transverse fields may make the heat transfer plate unsuitable for use in a plate pack comprising heat transfer plates which are "rotated" in relation to each other.

[0022] The first top pitch may be varying within the first transverse sub-field. Similarly, the second top pitch may be varying within the second transverse sub-field. However, according to one embodiment of the invention, the first top pitch is essentially constant within essentially the complete first transverse sub-field of the first transverse field. Additionally/alternatively, the second top pitch is essentially constant within essentially the complete second transverse sub-field of the second transverse field. Such an embodiment may enable a mechanically straight-forward design of the plate.

[0023] The plate may be so designed that the first transverse sub-field and/or the second transverse sub-field borders on the first transverse border area. Such a design may be advantageous since it may allow application of the invention where it is needed the most; the loss of contact points may be most likely to occur immediately around areas including the first transverse border area.

[0024] The first transverse sub-field and/or the second transverse sub-field may only partly occupy the first transverse field and/or the second transverse field, respectively. Such a configuration may allow different first top pitches, and possibly different smallest angles α_1 and/or smallest angles β_1 , within the first transverse field, and different second top pitches, and possibly different smallest angles α_3 and/or smallest angles β_3 , within the second transverse field. However, according to one embodiment of the invention, the first transverse sub-field and/or the second transverse sub-field occupy the entire first transverse field and/or the entire second transverse field, respectively. Such a configuration may allow the same first top pitch, and possibly the same smallest angle α_1 and/or smallest angle β_1 , within the first transverse field, and the same second top pitch, and possibly the same smallest angle α_3 and/or the same smallest angle β_3 , within the second transverse field. Such an embodiment may enable a mechanically straight-forward design of the plate.

[0025] The first transverse border area may extend between, possibly, but not necessarily, halfway between, the top plane and the bottom plane. By having the first transverse border area displaced from the top and bottom planes, the risk of flow throttling in a plate pack comprising the heat transfer plate may be reduced. Further, a first transverse border area displaced from the top and bottom planes may occupy less space which may result in a larger distance between the intended contact points and the first transverse border area.

[0026] The inventive plate may have a heat transfer area comprising a third transverse field extending from a first long side to a second long side of the heat transfer area. The first, second and third transverse fields may be arranged in succession along the longitudinal center axis. The second and third transverse fields may be separated by a second transverse border area extending between the two imaginary intermediate planes, and crossing the longitudinal center axis. More transverse fields, or rather, more transverse border areas, may offer a larger possibility to ease the tension in the heat transfer plate and make it more flat, which may be advantageous especially in connection with plates of larger sizes.

[0027] The second transverse border area may have the same characteristics as the first transverse border area.

[0028] The plate may be so designed that the first, the second and the third transverse field are provided with a first, a second and a third, respectively, portion of the heat transfer corrugation pattern. The first and third portions may be essentially similar. In a plate pack comprising essentially similar heat transfer plates according to the invention, the first and third portions of the heat transfer corrugation pattern of one heat transfer plate may, depending on how the plates of the plate pack are oriented in relation to each other, abut the third and first portions, respectively, of the heat transfer corrugation pattern of the adjacent heat transfer plates. By having the first and third portions essentially similar, the contact points within the heat transfer area may be arranged in rows extending essentially parallel to the transverse center axis of the plate, and in columns extending essentially parallel to the longitudinal center axis of the plate. This may contribute to the strength of the plate pack.

[0029] The plate may further comprise first and second port holes arranged on one side of the transverse center axis and third and fourth port holes arranged on another side of the transverse center axis. Further, the plate may comprise, as seen from the front side, a sealing groove. The sealing groove may comprise a field sealing groove portion enclosing the heat transfer area, the upper and lower distribution areas and the second and fourth port holes. The plate may further comprise, as seen from the front side, a gasket groove. The gasket groove may comprise a field gasket groove portion enclosing the heat transfer area, the upper and lower distribution areas and the first and third port holes. Such a design of the heat transfer plate may enable permanent attachment of it to another heat transfer plate to form a cassette suitable for use in a so-called semi-welded plate heat exchanger.

[0030] The field sealing groove and the field gasket groove may at least partly coincide.

[0031] The second and fourth port holes may be dedicated to one and the same fluid while the first and third port holes may be dedicated to one and the same, and another fluid. The second and fourth port holes, just like the first and third port holes, may be arranged on opposite sides of the longitudinal center axis of the heat transfer

plate. Such a port hole placement may enable a heat transfer plate of so-called diagonal flow type, and a heat exchanger comprising heat transfer plates according to the invention which are "rotated" in relation to each other. Such a heat exchanger typically demands gaskets of two different designs and it may also require heat transfer plates of two different designs. Alternatively, the first port hole and the third port hole may be arranged on one side of the longitudinal center axis of the heat transfer plate, while the second port hole and the fourth port hole may be arranged on another side of the longitudinal center axis of the heat transfer plate. Such a port hole placement may enable a heat transfer plate of so-called parallel flow type, and a heat exchanger comprising heat transfer plates according to the invention which are "flipped" in relation to each other.

[0032] The design of the heat transfer plate may be such that a bottom of the sealing groove, along at least more than half of a length of the sealing groove, extends in the bottom plane. Such a design may facilitate permanent joining of the heat transfer plate to another heat transfer plate.

[0033] A cassette according to the invention comprises two heat transfer plates. The back side of one of the two heat transfer plates faces the back side of another one of the two heat transfer plates. The two heat transfer plates are welded to each other, possibly along the sealing grooves.

[0034] In the cassette, said another one of the two heat transfer plates may be rotated 180 degrees around a normal of said another one of the two heat transfer plates. In other words, one of the heat transfer plates may be "flipped" or rotated 180 degrees around its transverse center axis. Alternatively, said another one of the two heat transfer plates may be "turned" or rotated 180 degrees around the longitudinal center axis of said another one of the two heat transfer plates.

[0035] A heat exchanger according to the invention comprises a plurality of heat transfer plates according to the above. The heat exchanger further comprises a plurality of gaskets. Each of the gaskets is arranged between two adjacent ones of the heat transfer plates.

[0036] In the heat exchanger, the heat transfer plates may be welded in pairs, back side to back side, possibly along the sealing grooves, into cassettes. Further, each of the gaskets may be arranged in the gasket grooves of two adjacent ones of the cassettes.

[0037] The above discussed advantages with the different embodiments of the heat transfer plate are naturally transferable to the cassette and the heat exchanger according to the invention.

[0038] As a general remark, herein, when it is said that some portion, part, section, etc., of the heat transfer plate extends in a certain plane, angle or with a certain pitch, it is the main extension of the portion, part, section, etc. that is referred to. Naturally, a portion, part, section, etc., may locally have an extension deviating from the main extension, for example at a transition to another adjacent

portion, part, section, etc.

[0039] It should be stressed that the above discussed advantages of the different embodiments of the heat transfer plate according to the invention appears first when the heat transfer plate is arranged in a PHE together with other heat transfer plates (which possibly also are designed according to the present invention), gaskets and other components needed in a properly functioning PHE.

[0040] Still other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

[0041] The invention will now be described in more detail with reference to the appended schematic drawings, in which

Fig. 1 is a schematic front view of a heat exchanger according to the invention,

Fig. 2 is schematic side view of the heat exchanger in Fig. 1,

Fig. 3 is a plan view of a heat transfer plate according to the invention,

Fig. 4 is a schematic cross section taken along the line A-A in Fig. 3,

Fig. 5 is a schematic cross section taken along the line B-B in Fig. 3,

Fig. 6 is an enlargement of a portion of the heat transfer plate in Fig. 3,

Fig. 7 is a plan view of a cassette according to the invention,

Fig. 8 schematically illustrates some intended contact points of a plate not constructed in accordance with the present invention,

Fig. 9 schematically illustrates some intended contact points of the plate illustrated in Fig. 3,

Fig. 10 is an enlargement of a portion of a heat transfer plate according to an alternative embodiment of the present invention, and

Fig. 11 is an enlargement of a portion of Fig. 10.

Detailed description

[0042] Figs. 1 and 2 show a semi-welded plate heat exchanger 2. It comprises a frame plate 4, a pressure plate 6, a pack of heat transfer plates 8, fluid inlets and outlets 10, tightening means 12, an upper bar 14 and a lower bar 16.

[0043] At least a majority of the heat transfer plates 8, hereinafter also referred to as just "plates", are all similar. As will be further discussed below, the plates 8 are welded in pairs, back side to back side, to form tight cassettes, with gaskets arranged between the cassettes. The frame and pressure plates 4 and 6, and therefore the cassettes, are pressed towards each other by the tightening means 12 whereby the gaskets seal between the

cassettes. Parallel flow channels are formed between the heat transfer plates 8, one channel between each pair of adjacent heat transfer plates 8. Two fluids of initially different temperatures, which are fed to/from the plate heat exchanger 2 through the fluid inlets and outlets 10, can flow alternately through every second channel for transferring heat from one fluid to the other, which fluids enter/exit the channels through inlet/outlet port holes in the heat transfer plates 8, which inlet/outlet port holes form inlet/outlet ports which communicate with the fluid inlets and outlets 10 of the plate heat exchanger 2.

[0044] One the plates 8 of the plate heat exchanger 2, denoted 8a, is illustrated in further detail in Fig. 3. The plate 8a is an essentially rectangular sheet of stainless steel. It comprises first and second opposing long sides 18, 20 and first and second opposing short sides 22, 24. Further, the plate 8a has a longitudinal center axis L extending parallel to, and halfway between, the long sides 18, 20 so as to divide the plate 8a into a first half 19 and a second half 21. The plate 8a further has a transverse center axis T extending parallel to, and halfway between, the short sides 22, 24 and thus perpendicular to the longitudinal center axis L.

[0045] The plate 8a has a front side 30 (illustrated in Figs. 3, 4 and 5) and an opposing back side 32 (illustrated in Figs. 4 and 5). Further, the plate 8a comprises an upper end part 34, a center part 36 and a lower end part 38 arranged in succession along the longitudinal center axis L of the heat transfer plate 8a. The upper end part 34 comprises a first port hole 40, a second port hole 42, a first adiabatic area 39, a second adiabatic area 41, an upper distribution area 44 and an upper transition area 45. The center part 36 comprises a heat transfer area 46. The lower end part 38 comprises a third port hole 48, a fourth port hole 50, a third adiabatic area 49, a fourth adiabatic area 51, a lower distribution area 52 and a lower transition area 53. The first and third port holes 40 and 48 are arranged on one side of the longitudinal center axis L while the second and the fourth port holes 42 and 50 are arranged on the other side of the longitudinal center axis L.

[0046] The heat transfer plate 8a is pressed, in a conventional manner, in a pressing tool, to be given a desired structure, such as different corrugation patterns within different portions of the heat transfer plate. The corrugation patterns are optimized for the specific functions of the respective plate portions. Accordingly, the upper and lower distribution areas 44 and 52 comprise upper and lower distribution corrugation patterns adapted for optimized fluid distribution across the heat transfer plate 8a. Further, the heat transfer area 46 comprises a heat transfer corrugation pattern adapted for optimized heat transfer between two fluids flowing on opposite sides of the heat transfer plate 8a. The upper and lower transition areas 45 and 53 comprises a transition corrugation pattern adapted for an optimized combination of strength and fluid distribution. Furthermore, the first, second, third and fourth adiabatic areas 39, 41, 49 and 51 each com-

prises a corrugation pattern adapted to convey fluid between the port holes and the distribution areas with the lowest possible pressure drop. Moreover, the plate 8a comprises an outer edge part 54 extending along an outer edge 56 of the plate. The outer edge part 54 is partly plane and partly corrugated with corrugations 58 arranged to abut corrugations of adjacent plates in the plate pack of the plate heat exchanger 2. Similarly, with reference to Figs. 4 and 5, the heat transfer corrugation pattern comprises corrugations, more particularly alternately arranged straight, elongate ridges with tops 60 and straight, elongate valleys with bottoms 62 as seen from the front side 30 of the plate 8a. The tops 60 and bottoms 62 extend in imaginary parallel top and bottom planes TP and BP, respectively, which top plane TP and bottom plane BP face the front side 30 and the back side 32, respectively, of the plate 8a. The top plane TP and the bottom plane BP are separated by a distance D. These tops 60 and bottoms 62 are arranged to abut tops and bottoms of the adjacent plates in the plate pack of the plate heat exchanger 2. Also the distribution and transition corrugation patterns comprises corrugations arranged to abut corrugations of the adjacent plates in the plate pack of the plate heat exchanger 2. However, this is not further discussed herein.

[0047] Hereinafter, the heat transfer area 46 and the heat transfer corrugation pattern will be further described with reference to Figs 3-6. The heat transfer area 46 comprises first, second and third transverse fields 1, 3 and 5, respectively. The first, second and third transverse fields 1, 3 and 5 comprise first, second and third transverse sub-fields 1', 3' and 5', respectively. For the plate 8a illustrated in Figs. 3-6 the first, second and third transverse sub-fields 1', 3' and 5' occupy the entire first, second and third transverse fields 1, 3 and 5, respectively. The first, second and third transverse fields 1, 3 and 5 contain first, second and third portions, respectively, of the heat transfer corrugation pattern. As is clear from Fig. 3, the first portion of the heat transfer corrugation pattern within the first transverse field 1 is similar to the third portion of the heat transfer corrugation pattern within the third transverse field 5. The first transverse field 1 is arranged closest to the upper transition area 45, the third transverse field 5 is arranged closest to the lower transition area 53, and the second transverse field 3 is arranged between the first and third transverse fields 1 and 5. Each of the first, second and third transverse fields 1, 3 and 5 extends between a first long side 7 and a second long side 9 of the heat transfer area 46. The first and second transverse fields 1 and 3 are separated by a first transverse border area 11, while the second and third transverse fields 3 and 5 are separated by a second transverse border area 13. Each of the first and second transverse border areas 11 and 13 is plane and extends between the first long side 7 and the second long side 9 of the heat transfer area 46. Further, the first and second transverse border areas 11 and 13 extend between two intermediate planes I and extend halfway between the

top and bottom planes TP and BP (Figs. 4 and 5). The two intermediate planes are separated by a distance d equal to a thickness of the plate 8a before pressing.

[0048] Fig. 4 illustrates a cross section of the first and third portions of the heat transfer corrugation pattern, i.e. the tops 60 and the bottoms 62 within the first and third transverse fields 1 and 5. A first top pitch TP1, i.e. a distance between two adjacent ones of the tops 60 within the complete first and third transverse fields 1 and 5, is constant within the complete first and third transverse fields 1 and 5. A first bottom pitch BP1, i.e. a distance between two adjacent ones of the bottoms 62 within the first and third transverse fields 1 and 5, is constant within the complete first and third transverse fields 1 and 5 and equal to TP1. Fig. 5 illustrates a cross section of the second portion of the heat transfer corrugation pattern, i.e. the tops 60 and the bottoms 62 within the second transverse field 3. A second top pitch TP2, i.e. a distance between two adjacent ones of the tops 60 within second transverse field 3, is constant within the complete second transverse field 3. A second bottom pitch BP2, i.e. a distance between two adjacent ones of the bottoms 62 within the second transverse field 3, is constant within the complete second transverse field 3 and equal to TP2. As is clear from Figs. 4 and 5, TP1 is larger than TP2. For example, TP1 may be 2% larger than TP2. However, TP1 may be less than 2% larger than TP2. Also, TP1 may be more than 2% larger than TP2. In an alternative embodiment, TP1 may instead be smaller than TP2. The first and second top and bottom pitches are measured perpendicular to the longitudinal extension of the tops and bottoms.

[0049] With special reference to Fig. 6, the first transverse field 1 is divided into first, second, third and fourth longitudinal sub-fields 1a, 1b, 1c and 1d. Similarly, the second transverse field 3 is divided into first, second, third and fourth longitudinal sub-fields 3a, 3b, 3c and 3d, while the third transverse field 5 is divided into first, second, third and fourth longitudinal sub-fields 5a, 5b, 5c and 5d. The first, second, third and fourth longitudinal sub-fields of each of the first, second and third transverse fields are arranged in succession from the first long side 7 to the second long side 9 of the heat transfer area 46. The first longitudinal sub-fields of the first, second, third and fourth transverse fields are aligned along the longitudinal center axis L of the plate 8a. The same goes for the second longitudinal sub-fields, the third longitudinal sub-fields and the fourth longitudinal sub-fields, of the first, second, third and fourth transverse fields.

[0050] The tops 60, and thus the bottoms 62, within the first longitudinal sub-fields 1a, 3a and 5a extend with smallest angles α_1 , α_3 and α_5 , respectively, in relation to the longitudinal center axis L. The tops 60, and thus the bottoms 62, within the second longitudinal sub-fields 1b, 3b and 5b extend with smallest angles β_1 , β_3 and β_5 , respectively, in relation to the longitudinal center axis L. The tops 60, and thus the bottoms 62, within the third longitudinal sub-fields 1c, 3c and 5c extend with smallest angles γ_1 , γ_3 and γ_5 , respectively, in relation to the long-

itudinal center axis L. The tops 60, and thus the bottoms 62, within the fourth longitudinal sub-fields 1d, 3d and 5d extend with smallest angles μ_1 , μ_3 and μ_5 , respectively, in relation to the longitudinal center axis L. All angles are constants and have a value between 0-90, α_x and γ_x , $x=1, 2$ or 3 , being measured clockwise from the longitudinal center axis L and β_x and μ_x , $x=1, 2$ or 3 , being measured counter-clockwise from the longitudinal center axis L. Further, $\alpha_1=\beta_1=\gamma_1=\mu_1=\alpha_5=\beta_5=\gamma_5=\mu_5$. Further, $\alpha_3=\beta_3=\gamma_3=\mu_3$. Furthermore, here, $\alpha_1=56$ And $\alpha_3=50$, i.e. α_1 is larger than α_3 . However, in an alternative embodiment, the difference between α_1 and α_3 could be smaller or larger. In yet another embodiment, α_1 could instead be smaller than α_3 .

[0051] With reference to Fig. 3, pressed into the plate 8a, as seen from the front side 30 of the plate, is a sealing groove 64 comprising a field sealing groove portion 64a, a first ring sealing groove portion 64b and a third ring sealing groove portion 64c. The sealing groove 64 is illustrated with lines in Fig. 3. The field sealing groove portion 64a encloses the heat transfer area 46, the upper and lower transition areas 45 and 53, the upper and lower distribution areas 44 and 52, the second and fourth adiabatic areas 41 and 51, and the second and fourth port holes 42 and 50. A bottom 66a of the field sealing groove portion 64a extends in the bottom plane BP (Figs. 4-5) along the complete length of the field sealing groove portion 64a. The first ring sealing groove portion 64b encloses the first port hole 40. A bottom 66b of the first ring sealing groove portion 64b extends in the bottom plane BP along the complete length of the first ring sealing groove portion 64b. The third ring sealing groove portion 64c encloses the third port hole 48. A bottom 66c of the third ring sealing groove portion 64c extends in the bottom plane BP along the complete length of the third ring sealing groove portion 64c.

[0052] Further, with reference to Figs. 3 and 7, pressed into the plate 8a, as seen from the front side 30 of the plate, is also a gasket groove 68 for receiving a gasket 59 (comprising a field gasket portion and two ring gasket portions). The gasket groove 68 comprises a field gasket groove portion 68a, a second ring gasket groove portion 68b and a fourth ring gasket groove portion 68c. The field gasket groove portion 68a encloses the heat transfer area 46, the upper and lower transition areas 45 and 53, the upper and lower distribution areas 44 and 52, the first and third adiabatic areas 39 and 49, and the first and third port holes 40 and 48. The field gasket groove portion 68a partly coincides with the field sealing groove portion 64a. Therefore, a bottom 70a of the field gasket groove portion 68a extends in the bottom plane BP (Figs. 4-5) where the field gasket groove portion 68a coincides with the field sealing groove portion 64a. In fact, the bottom 70a of the field gasket groove portion 68a extends in the bottom plane BP everywhere except for at two diagonal sections 68a' of the field gasket groove portion 68a along which the bottom 70a extends between, here halfway between, the top plane TP and the bottom plane BP. The

second ring gasket groove portion 68b encloses the second port hole 42. A bottom 70b of the second ring gasket groove portion 68b extends between, here halfway between, the top plane TP and the bottom plane BP along the complete length of the second ring gasket groove portion 68b. The fourth ring gasket groove portion 68c encloses the fourth port hole 50. A bottom 70c of the fourth ring gasket groove portion 68c extends between, here halfway between, the top plane TP and the bottom plane BP along the complete length of the fourth ring gasket groove portion 68c.

[0053] In the plate pack of the plate heat exchanger 2, the plates 8 are arranged with the front side 30 and the back side 32 of one plate 8 facing the front side and the back side, respectively, of the neighboring heat transfer plates. Further, every second plate 8 is turned upside-down or rotated 180 degrees, in relation to a reference orientation, around a normal direction N which is normal to the figure plane of Fig. 3. In other words, every second plate 8 is "flipped", i.e. rotated 180 degrees around its transverse center axis, in relation to the rest of the plates.

[0054] As mentioned above, the plates 8 of the plate pack are welded together in pairs, back side 32 to back side 32, along their respective sealing grooves 64, to form cassettes 57. Fig. 7 shows one of the cassettes 57 comprising the plate 8a illustrated in Fig. 3 and another similar plate (not visible). Said another plate is "flipped" in relation to the plate 8a. In the plate pack of the plate heat exchanger 2, the welded cassettes 57 are separated by gaskets 59, at least a majority of which gaskets 59 are similar, one of these gaskets 59 being illustrated in Fig. 7. In line with the above, the gaskets 59 are accommodated in the gasket grooves 68 (Fig. 3) of the plates 8, as is illustrated in Fig. 7. Thus, the heat exchanger 2 comprises channels of two different types; welded channels inside the cassettes 57 and gasketed channels between the cassettes 57.

[0055] As described by way of introduction, the plates of a heat exchanger are arranged to contact each other in intended contact points. Fig. 8 illustrates some of the intended contact points CP for a plate not designed in accordance with the present invention, when this is arranged to contact a "flipped" similar plate. The plate illustrated in Fig. 8 comprises a heat transfer area comprising first and second transverse fields 100 and 300 which each comprise first and second longitudinal sub-fields 100a, 100b, 300a and 300b. The first and second transverse fields are separated by a plane first transverse border area 1100. The heat transfer area is provided with a heat transfer pattern of tops and bottoms. Within the complete heat transfer area, the top pitch and the bottom pitch is constant and the same. Further, within the first longitudinal sub-fields 100a and 300a the tops and bottoms have the same constant angle of inclination. Similarly, within the second longitudinal sub-fields 100b and 300b the tops and bottoms have the same constant angle of inclination. As is clear from Fig. 8, some of the contact points, denoted CP', will end up very close to the first

transverse border area 1100. Due to misalignment between the plates, manufacturing tolerances of the plates, possibly different ages of the plates, etc., there is a risk that no contact is achieved, in reality, in the intended contact points CP'.

[0056] Fig. 9 illustrates some of the intended contact points CP for the previously described plate 8a, when this is arranged to contact a "flipped" similar plate. Clearly, due to the previously described varying top and bottom pitch and inclination angle, the contact points CP' arranged closest to the plane first transverse border area 11 will be arranged on a larger distance from the first transverse border area 11 than the contact points CP' of the plate in Fig. 8. Thereby, the risk that no contact is achieved, in reality, in these intended contact points CP' is greatly reduced.

[0057] Fig. 10 illustrates a portion of the heat transfer area 46 of a plate 8b according to an alternative embodiment of the present invention. The plate 8b is to a large extent constructed like the above described plate 8a. Hereinafter, the differences between the plates 8a and 8b will be focused on. Just like the plate 8a, the plate 8b comprises first, second and third transverse fields 1, 3 and 5, respectively. The first, second and third transverse fields 1, 3 and 5 comprise first, second and third transverse sub-fields 1', 3' and 5', respectively. On the plate 8b illustrated in Fig. 10, just like on the plate 8a, the first and third transverse sub-fields 1' and 5' occupy the entire first and third transverse fields 1 and 5, respectively. However, on the plate 8b, the second transverse sub-field 3', which is discontinuous to be composed of two portions, occupies only part of the second transverse field 3. Each of the portions of the second transverse sub-field 3' extends between the first long side 7 and the second long side 9 of the heat transfer area 46, an upper one of the portions bordering on the first transverse field 1 and a lower one of the two portions bordering on the third transverse field 5.

[0058] With reference also to Fig. 11, the plate 8b is, within the heat transfer area 46, provided with a heat transfer corrugation pattern of corrugations, more particularly alternately arranged elongate ridges with tops 60 and elongate valleys with bottoms 62 as seen from the front side 30 of the plate 8a. Within most of the heat transfer area 46, more particularly outside the second transverse sub-field 3', the ridges and valleys, and thus the tops 60 and bottoms 62, are straight. Further, within the complete heat transfer area 46 except for the second transverse sub-field 3', the top pitch and the bottom pitch are essentially constant, i.e. TP1, TP2, BP1 and BP2 (not marked in Figs. 10 and 11, reference made to Figs. 4 and 5) are all essentially constant and have essentially the same value. Further, within the complete heat transfer area 46 except for the second transverse sub-field 3', the tops 60, and thus the bottoms 62, extend with the essentially the same, constant angle, in relation to the longitudinal center axis L, within the first longitudinal sub-fields 1a, 3a and 5a and the third longitudinal sub-fields

1c, 3c and 5c, i.e. α_1 , α_3 , α_5 , γ_1 , γ_3 and γ_5 are all essentially constant and have essentially the same value. Similarly, within the complete heat transfer area 46 except for the second transverse sub-field 3', the tops 60, and thus the bottoms 62, extend with the essentially the same, constant angle, in relation to the longitudinal center axis L, within the second longitudinal sub-fields 1b, 3b and 5b and the fourth longitudinal sub-fields 1d, 3d and 5d, i.e. β_1 , β_3 , β_5 , μ_1 , μ_3 and μ_5 are all essentially constant and have essentially the same value. Further, within the complete heat transfer area 46 except for the second transverse sub-field 3', $\alpha_1 = \beta_1$. However, the ridges and valleys extending into the second transverse sub-field 3' are bent or angled so as to form a slightly different corrugation pattern within the second transverse sub-field 3'. More particularly, within the second transverse sub-field 3', the top pitch TP2 and the bottom pitch BP2 are essentially constant and have essentially the same value. However, the value of TP2 is larger within the second transverse sub-field 3' than outside the second transverse sub-field 3'. Further, within the second transverse sub-field 3', the tops 60, and thus the bottoms 62, extend with the essentially the same, constant angle, in relation to the longitudinal center axis L, within the first longitudinal sub-fields 1a, 3a and 5a and the third longitudinal sub-fields 1c, 3c and 5c, i.e. α_1 , α_3 , α_5 , γ_1 , γ_3 and γ_5 are all essentially constant and have essentially the same value. Similarly, within the second transverse sub-field 3', the tops 60, and thus the bottoms 62, extend with the essentially the same, constant angle, in relation to the longitudinal center axis L, within the second longitudinal sub-fields 1b, 3b and 5b and the fourth longitudinal sub-fields 1d, 3d and 5d, i.e. β_1 , β_3 , β_5 , μ_1 , μ_3 and μ_5 are all essentially constant and have essentially the same value. Further, within the second transverse sub-field 3', $\alpha_1 = \beta_1$. However, the value of α_1 is smaller within the second transverse sub-field 3' than outside the second transverse sub-field 3'.

[0059] Due to the slightly different corrugation pattern within the second transverse sub-field 3' of the plate 8b, i.e. the different corrugation pattern within the upper portion of the second transverse sub-field 3' bordering on the first transverse field 1 and the lower portion of the second transverse sub-field 3' bordering on the third transverse field 5, the intended contact points arranged closest to the plane first and second transverse border areas 11 and 13 will be arranged on a larger distance from the first and second transverse border areas 11 and 13 than if the pattern had not been different within the second transverse sub-field 3'. Thereby, the risk that no contact is achieved, in reality, in these intended contact points CP', when the plate 8b contacts a "flipped" similar plate, is greatly reduced. Thus, this embodiment allows only a local variation of the corrugation pattern in the most critical areas of the plate.

[0060] The above described embodiments of the present invention should only be seen examples. A person skilled in the art realizes that the embodiments discussed

can be varied and combined in a number of ways without deviating from the inventive conception.

[0061] As an example, the above specified distribution, transition and heat transfer corrugation patterns are just exemplary. Naturally, the invention is applicable in connection with other types of corrugation patterns. As an example, the heat transfer corrugation pattern transition may comprise more or less than three transverse fields separated by transverse border areas, for example two or five transverse fields. Similarly, transverse fields may each comprise more or less than four longitudinal sub-fields.

[0062] In the first embodiment described above, $\alpha_1 = \beta_1 = \gamma_1 = \mu_1 = \alpha_5 = \beta_5 = \gamma_5 = \mu_5$, and $\alpha_3 = \beta_3 = \gamma_3 = \mu_3$ such that the heat transfer corrugation pattern on the first half 19 of the plate 8a is a mirroring along the longitudinal center axis L of the heat transfer corrugation pattern on the second half 21 of the plate 8a. This may not be true in alternative embodiments. For example, one or more of α_1 , β_1 , γ_1 , μ_1 , α_5 , β_5 , γ_5 and μ_5 may be different from the others. The corresponding reasoning is valid for α_3 , β_3 , γ_3 and μ_3 .

[0063] The plate heat changer above comprises one plate type only. Naturally, the plate heat exchanger could instead comprise two or more different types of alternately arranged heat transfer plates. Further, the heat transfer plates could be made of other materials than stainless steel.

[0064] The present invention could be used in connection with other types of plate heat exchangers than semi-welded ones, such as all-welded, (all-) gasketed and brazed plate heat exchangers.

[0065] The bottom of the field gasket groove portion need not extend halfway between the top plane and the bottom plane, but may instead extend closer to one of the top and bottom planes, at the two diagonal sections of the field gasket groove portion. Similarly, the bottom of the second ring gasket groove portion, just like the bottom of the fourth ring gasket groove portion, need not extend halfway between the top plane and the bottom plane along their complete lengths but may instead, along part of their lengths or their complete lengths extend in another plane, for example closer to the top plane than the bottom plane. As another example, the bottom of the field gasket groove portion may extend between, possibly halfway between, the first and second planes along the complete length of the field gasket groove portion. As yet another example, the bottom of the field gasket groove portion may extend in the second plane along the complete length of the field gasket groove portion. As a last example, the bottom of the gasket groove may extend in the same plane, for example the second plane, along the complete length of the gasket groove.

[0066] Above, TP1 is larger than TP2 and α_1 is larger than α_3 . These relationships may be different in other embodiments of the invention. For example, TP1 may be larger than TP2 while α_1 is smaller than α_3 . As another example, TP1 may be smaller than TP2 while α_1 is larger

than α_3 . As yet another example, TP1 may be smaller than TP2 while α_1 is smaller than α_3 . Any combination is possible and depends on the specific design of the heat transfer plate.

[0067] In addition to varying the top pitch, and possibly the angle of the tops in relation to the longitudinal center axis of the plate, as described above, the tops extending within the first transverse field could be displaced from the tops extending within the second transverse field. Also, the problem to be solved by the present invention could possibly be solved by displacing the tops extending within the first transverse field from the tops extending within the second transverse field without varying the top pitch or the angle of the tops in relation to the longitudinal center axis of the plate. However, this last option is not covered by the present invention.

[0068] It should be stressed that the attributes front, back, upper, lower, first, second, third, etc. is used herein just to distinguish between details and not to express any kind of orientation or mutual order between the details.

[0069] Further, it should be stressed that a description of details not relevant to the present invention has been omitted and that the figures are just schematic and not drawn according to scale. Some details in the figures may also be exaggerated for the sake of clarity. It should also be said that some of the figures have been more simplified than others. Therefore, some components may be illustrated in one figure but left out on another figure.

Claims

1. A heat transfer plate (8, 8a, 8b) having a front side (30), a back side (32) and comprising an upper distribution area (44), a heat transfer area (46) and a lower distribution area (52) arranged in succession along a longitudinal center axis (L) of the heat transfer plate (8, 8a, 8b) which extends perpendicular to a transverse center axis (T) of the heat transfer plate (8, 8a), the heat transfer area (46), the upper distribution area (44) and lower distribution area (52) being provided with a heat transfer corrugation pattern, an upper distribution corrugation pattern and a lower distribution corrugation pattern, respectively, the heat transfer corrugation pattern differing from the upper distribution corrugation pattern and the lower distribution corrugation pattern and comprising tops (60) extending in an imaginary top plane (TP) facing the front side (30) of the heat transfer plate (8, 8a, 8b) and bottoms (62) extending in an imaginary bottom plane (BP) facing the back side (32) of the heat transfer plate (8, 8a, 8b), the top plane (TP) and the bottom plane (BP) being separated by a distance D, wherein the heat transfer area (46) comprises at least first and second transverse fields (1, 3) arranged in succession along the longitudinal center axis (L) and each extending from a first long side (7) to a second long side (9) of the heat

transfer area (46), the first and second transverse fields (1, 3) being separated by a first transverse border area (11) extending between two imaginary intermediate planes (I) separated by a distance d, $d < D$, and crossing the longitudinal center axis (L), characterized in that a first top pitch (TP1) between the tops (60) extending within the first transverse field (1), within a first transverse sub-field (1') of the first transverse field (1), differs from a second top pitch (TP2) between the tops (60) extending within the second transverse field (3), within a second transverse sub-field (3') of the second transverse field (3).

2. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, wherein each of the first and second transverse fields (1, 3) comprises first and second longitudinal sub-fields (1a, 1b, 3a, 3b) arranged in succession along the transverse center axis (T) of the heat transfer plate (8, 8a, 8b), wherein the tops (60) within the first longitudinal sub-field (1a) of the first transverse field (1) extend with a smallest angle $\alpha_1 = 0-90$ degrees, the tops (60) within the second longitudinal sub-field (1b) of the first transverse field (1) extend with a smallest angle $\beta_1 = 0-90$ degrees, the tops (60) within the first longitudinal sub-field (3a) of the second transverse field (3) extend with a smallest angle $\alpha_3 = 0-90$ degrees, and the tops (60) within the second longitudinal sub-field (3b) of the second transverse field (3) extend with a smallest angle $\beta_3 = 0-90$ degrees, in relation to the longitudinal center axis (L), the first longitudinal sub-field (1a) of the first transverse field (1) and the first longitudinal sub-field (3a) of the second transverse field (3) being aligned along the longitudinal center axis (L) and the second longitudinal sub-field (1b) of the first transverse field (1) and the second longitudinal sub-field (3b) of the second transverse field (3) being aligned along the longitudinal center axis (L).

3. Heat transfer plate (8, 8a, 8b) according to claim 2, wherein the smallest angle α_1 within the first longitudinal sub-field (1a) within the first transverse sub-field (1') of the first transverse field (1) differs from the smallest angle α_3 within the first longitudinal sub-field (3a) within the second transverse sub-field (3') of the second transverse field (3), and/or the smallest angle β_1 within the second longitudinal sub-field (1b) within the first transverse sub-field (1') of the first transverse field (1) differs from the smallest angle β_3 within the second longitudinal sub-field (3b) within the second transverse sub-field (3') of the second transverse field (3).

4. Heat transfer plate (8, 8a, 8b) according to any of claims 2-3, wherein the smallest angle α_1 is essentially constant within essentially the complete first longitudinal sub-field (1a) within the first transverse

- sub-field (1') of the first transverse field (1), and/or the smallest angle α_3 is essentially constant within essentially the complete first longitudinal sub-field (3a) within the second transverse sub-field (3') of the second transverse field (3), and/or the smallest angle β_1 is essentially constant within essentially the complete second longitudinal sub-field (1b) within the first transverse sub-field (1') of the first transverse field (1), and/or the smallest angle β_3 is essentially constant within essentially the complete second longitudinal sub-field (3b) within the second transverse sub-field (3') of the second transverse field (3).
5. Heat transfer plate (8, 8a, 8b) according to any of claims 2-4, wherein each of the first and second transverse fields (1, 3) comprises a third longitudinal sub-field (1c, 3c), the first, second and third longitudinal sub-fields (1a, 1b, 1c, 3a, 3b, 3c) being arranged in succession along the transverse center axis (T) of the heat transfer plate (8, 8a, 8b), wherein the tops (60) within the third longitudinal sub-field (1c) within the first transverse field (1) extend with a smallest angle $\gamma_1 = 0-90$ degrees, and the tops (60) within the third longitudinal sub-field (3c) within the second transverse field (3) extend with a smallest angle $\gamma_3 = 0-90$ degrees, in relation to the longitudinal center axis (L), the third longitudinal sub-field (1c) of the first transverse field (1) and the third longitudinal sub-field (3c) of the second transverse field (3) being aligned along the longitudinal center axis (L).
 6. Heat transfer plate (8, 8a, 8b) according to claim 5, wherein each of the first and second transverse fields (1, 3) comprises a fourth longitudinal sub-field (1d, 3d), the first, second, third and fourth longitudinal sub-fields (1a, 1b, 1c, 1d, 3a, 3b, 3c, 3d) being arranged in succession along the transverse center axis (T) of the heat transfer plate (8, 8a, 8b), wherein the tops (60) within the fourth longitudinal sub-field (1d) within the first transverse field (1) extend with a smallest angle $\mu_1 = 0-90$ degrees, and the tops (60) within the fourth longitudinal sub-field (3d) within the second transverse field (3) extend with a smallest angle $\mu_3 = 0-90$ degrees, in relation to the longitudinal center axis (L), the fourth longitudinal sub-field (1d) of the first transverse field (1) and the fourth longitudinal sub-field (3d) of the second transverse field (3) being aligned along the longitudinal center axis (L).
 7. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, wherein the first top pitch (TP1) is essentially constant within essentially the complete first transverse sub-field (1') of the first transverse field (1), and/or the second top pitch (TP2) is essentially constant within essentially the complete second transverse sub-field (3') of the second transverse field (3).
 8. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, wherein the first transverse sub-field (1') and/or the second transverse sub-field (3') borders on the first transverse border area.
 9. Heat transfer plate (8, 8a) according to any of the preceding claims, wherein the first transverse sub-field (1') and/or the second transverse sub-field (3') occupy the entire first transverse field (1) and/or the entire second transverse field (3), respectively.
 10. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, wherein the first transverse border area (11) extends between the top plane (TP) and the bottom plane (BP).
 11. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, wherein the heat transfer area (46) comprises a third transverse field (5) extending from a first long side (7) to a second long side (9) of the heat transfer area (46), the first, second and third transverse fields (1, 3, 5) being arranged in succession along the longitudinal center axis (L), wherein the second and third transverse fields (3, 5) are separated by a second transverse border area (13) extending between said two imaginary intermediate planes (I), and crossing the longitudinal center axis (L).
 12. Heat transfer plate (8, 8a, 8b) according to claim 11, wherein the first, the second and the third transverse field (1, 3, 5) are provided with a first, a second and a third, respectively, portion of the heat transfer corrugation pattern, wherein the first and third portions are essentially similar.
 13. Heat transfer plate (8, 8a, 8b) according to any of the preceding claims, comprising first and second port holes (40, 42) arranged on one side of the transverse center axis (T) and third and fourth port holes (48, 50) arranged on another side of the transverse center axis (T), and further comprising, as seen from the front side (30), a sealing groove (64) comprising a field sealing groove portion (64a) enclosing the heat transfer area (46), the upper and lower distribution areas (44, 52) and the second and fourth port holes (42, 50), and further comprising, as seen from the front side (30), a gasket groove (68) comprising a field gasket groove portion (68a) enclosing the heat transfer area (46), the upper and lower distribution areas (44, 52) and the first and third port holes (40, 48).
 14. A cassette (57) comprising two heat transfer plates (8, 8a, 8b) according to any of the preceding claims, wherein the back side (32) of one of the two heat transfer plates (8, 8a, 8b) faces the back side (32) of another one of the two heat transfer plates (8, 8a, 8b)

and the two heat transfer plates (8, 8a, 8b) are welded to each other.

15. A heat exchanger (2) comprising a plurality of heat transfer plates (8, 8a, 8b) according to any of the claims 1-13 and a plurality of gaskets (59), wherein each of the gaskets is arranged between two adjacent ones of the heat transfer plates (8, 8a, 8b).

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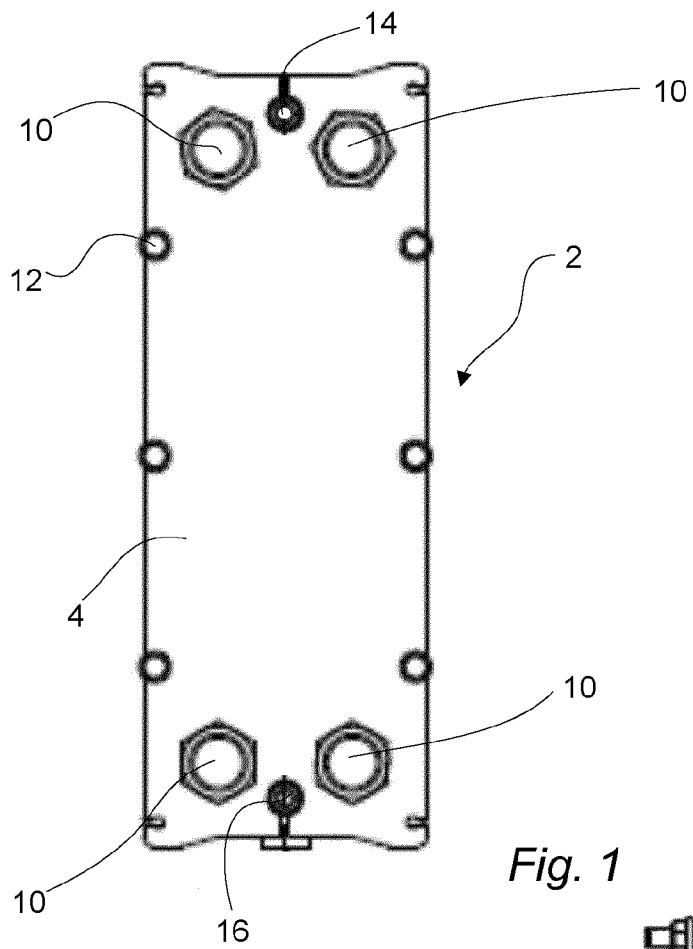


Fig. 1

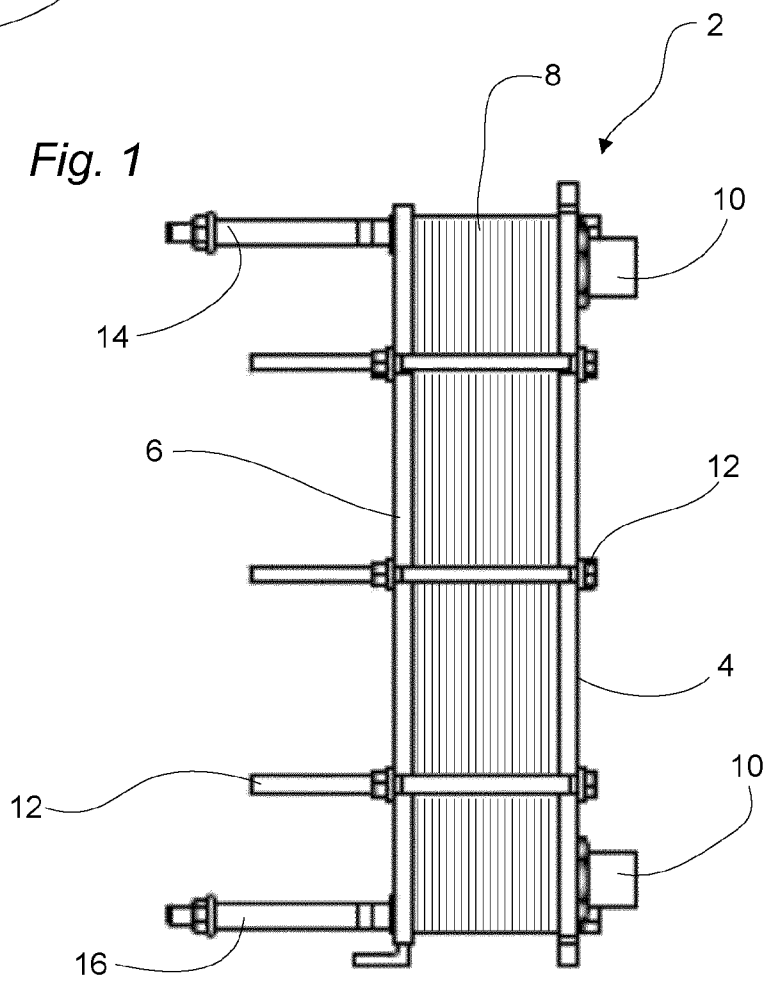


Fig. 2

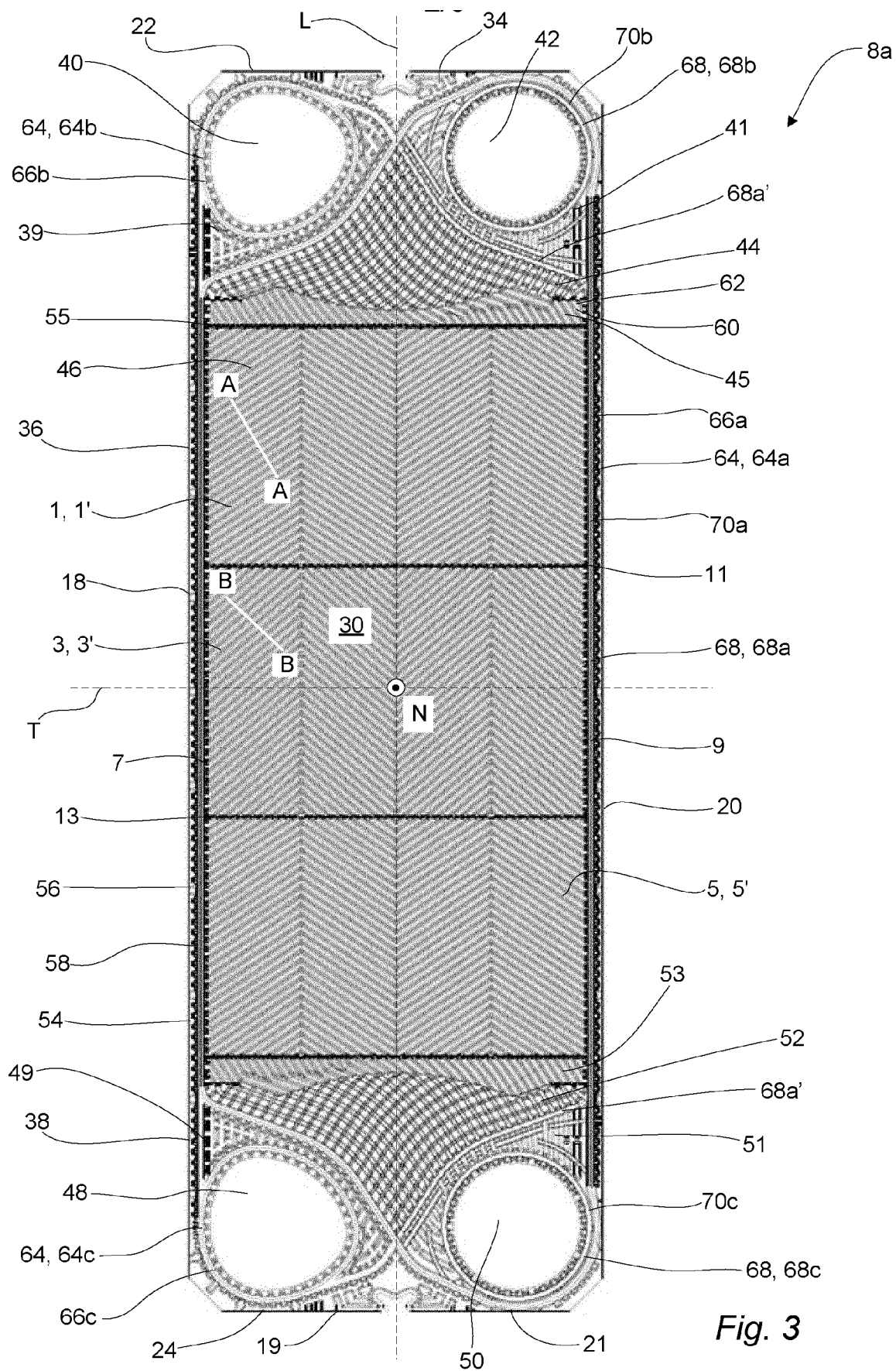
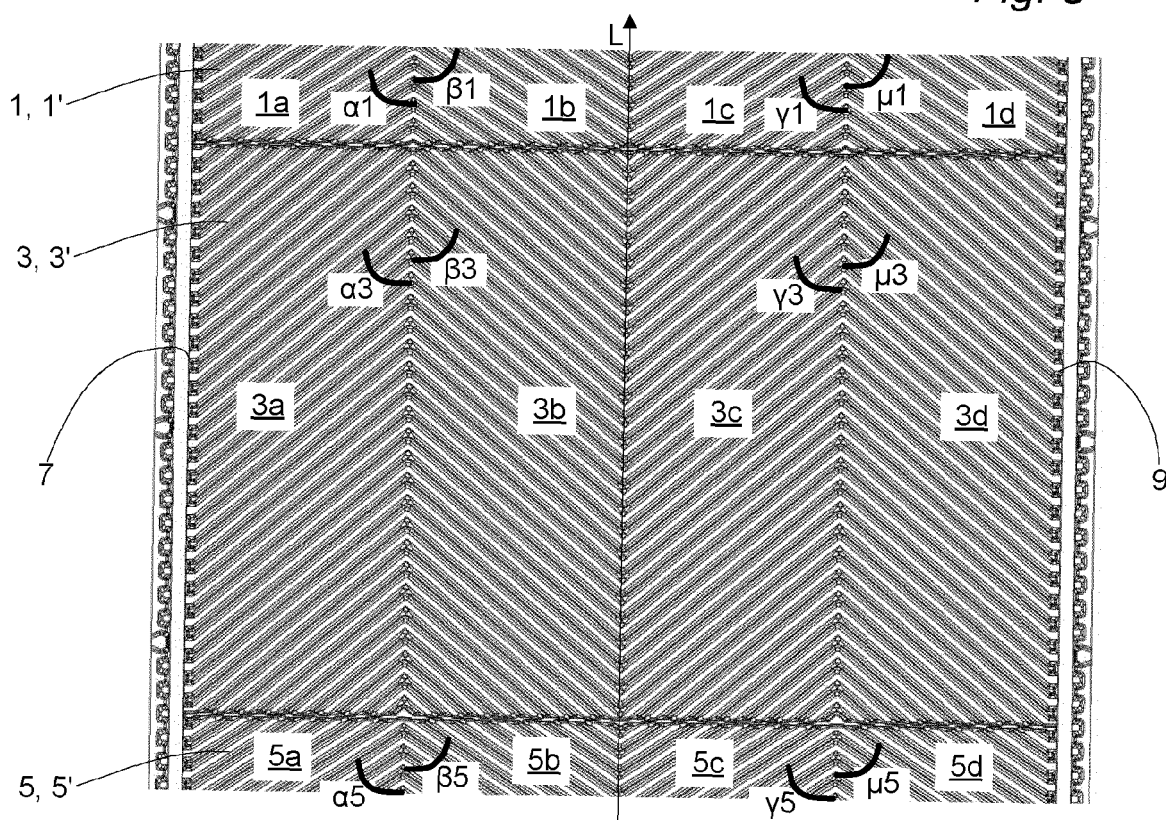
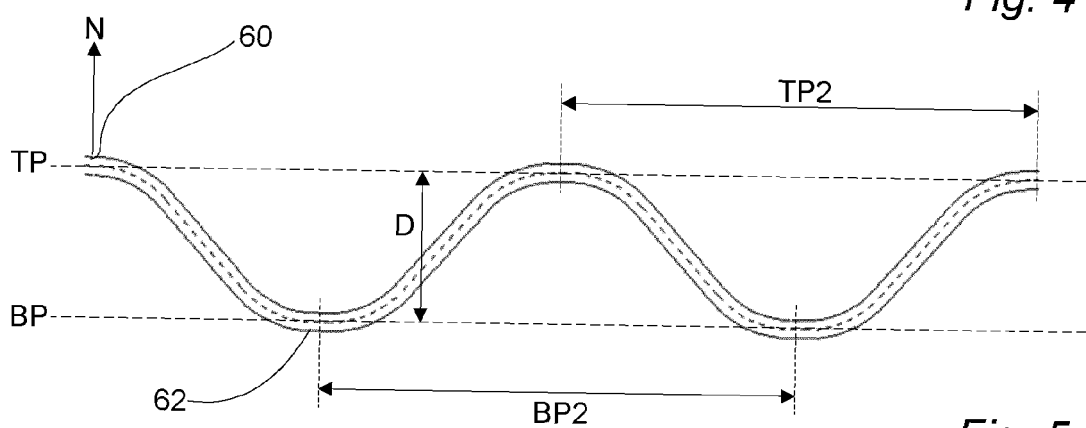
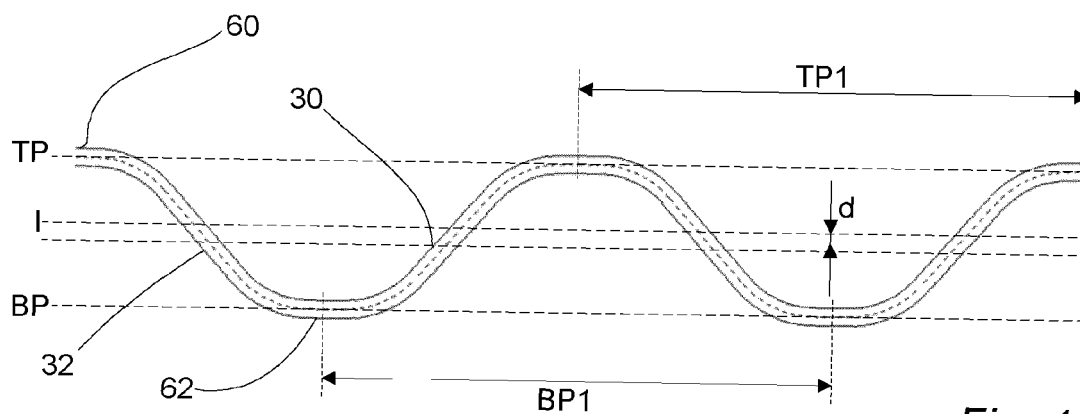


Fig. 3



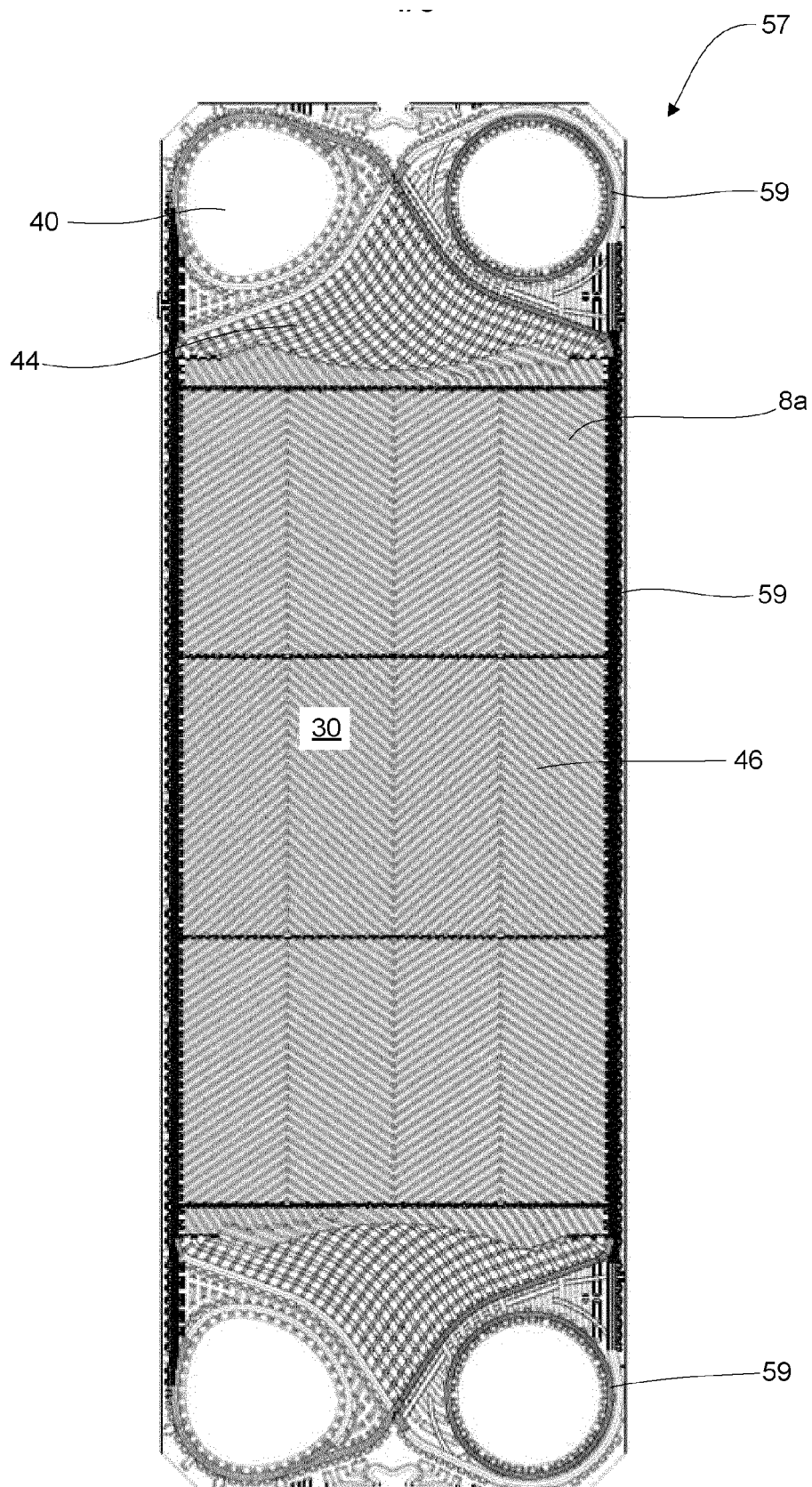
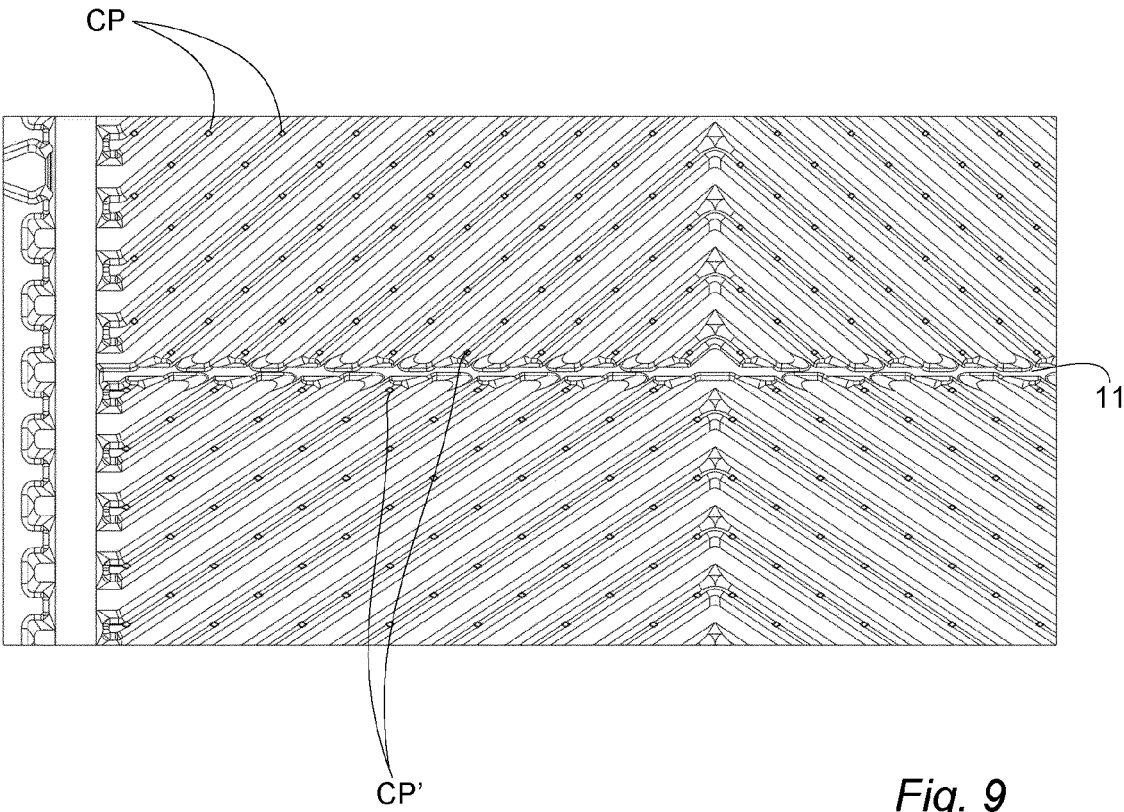
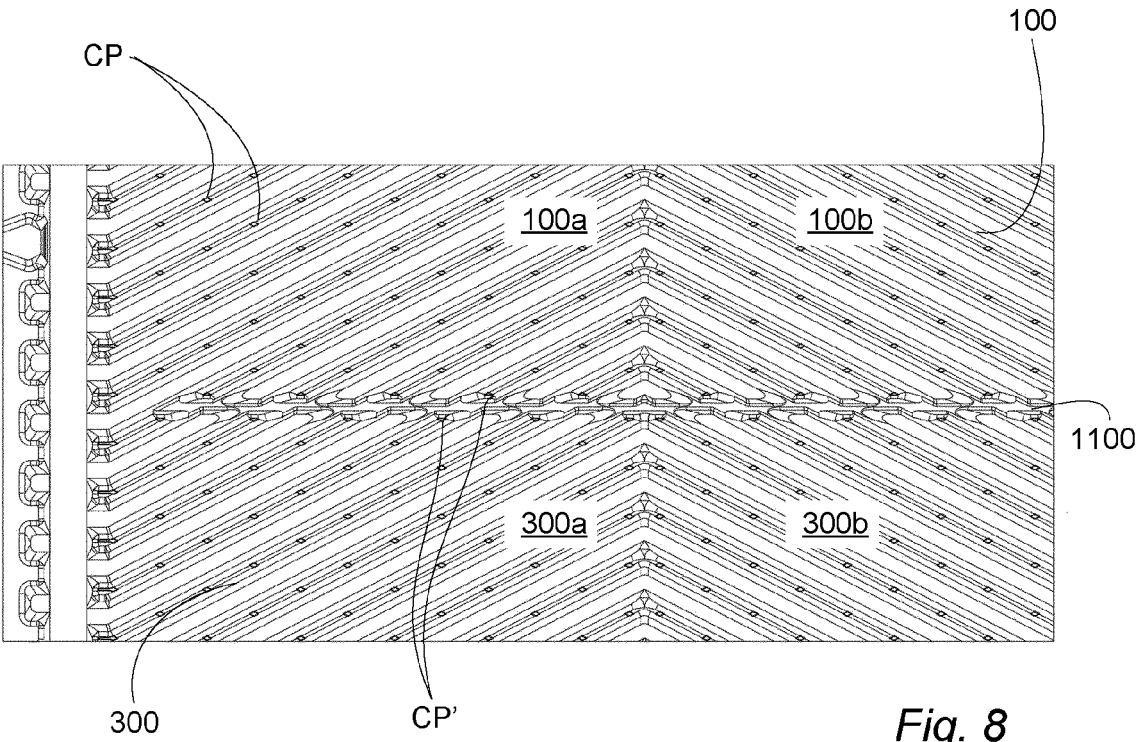


Fig. 7



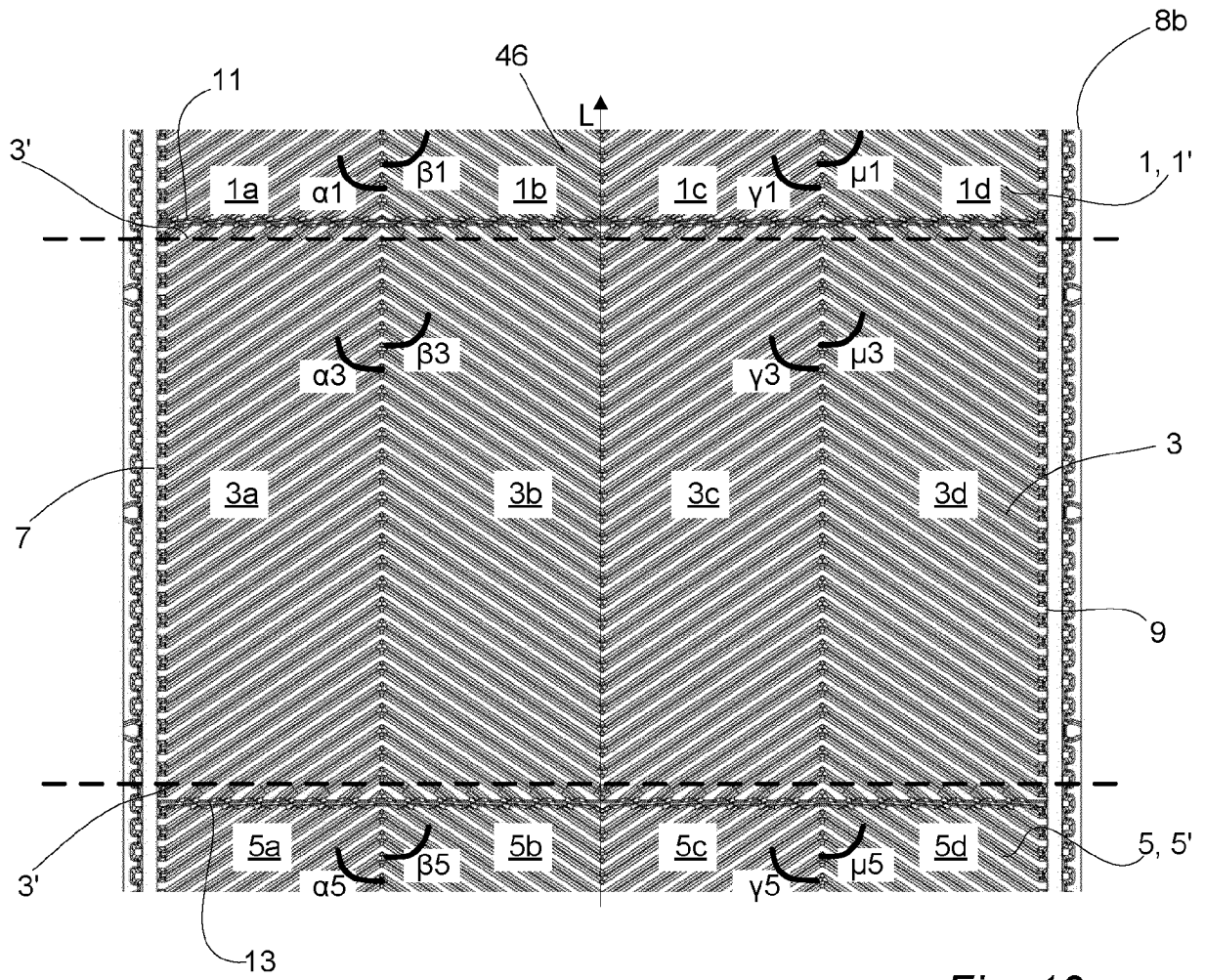


Fig. 10

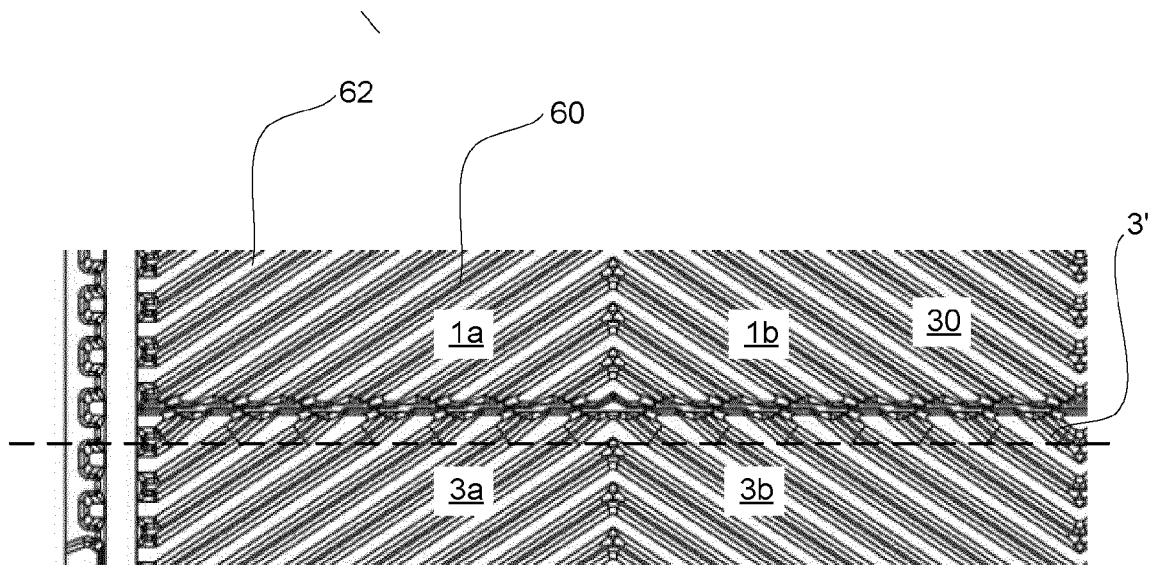


Fig. 11



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Application Number

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The present search report has been drawn up for all claims			
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Munich		23 May 2024	Jessen, Flemming
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